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F O R E W O R D

The Convention adopted by the Third United Nations Conference on the Law of the Sea (UNCLOS) defines a new international regime inter alia for use of the ocean and its resources. It codifies the need for ensuring that such use is peaceful, that resources are equitably and efficiently utilized, that the marine environment is studied, monitored and protected, and that its living resources are conserved. The Convention is thus a contribution to the realization of a new, more just and equitable international economic and social order, which would meet the interests of mankind as a whole - including both present and future generations - with particular attention to the interests of people in the more disadvantaged countries.

Scientific research is regarded as an essential activity under the new regime. By leading us to a better understanding of the nature of the ocean, of the natural processes in and affecting it and of the resources it contains, marine science provides a basis for resource development and better management of human activities in or affecting the ocean. It is also, of course, the source of the new technologies for exploring, using and monitoring the oceans, their quality and resources.

Given an appropriate legal regime, States nevertheless risk being frustrated in their aspirations to explore and use the ocean, and to do so in accordance with the principles established. The capacity of many of them to participate in marine research is quite inadequate; they are conscious of their lack of specialists and of appropriate infrastructures concerning marine science and technology. Many States still have very limited access even to existing data pools, as well as to instruments. Such States face difficulties in analyzing and evaluating for their purposes relevant information to which they may, in theory, have access.

The Convention reflects an awareness of these problems. It encourages States to co-operate with one another in the development and transfer of marine science and technology. This co-operation can, in principle, be effected both directly and through competent international organizations. There are many ways of doing this, and the most effective ones must be sought in each case. But it is universally agreed that among the means available the conduct of international programmes and the establishment of both a comprehensive network of national research and service centres and international centres are very important.

Several international organizations are currently engaged in promoting those means of co-operation in science and technology transfer. Those organizations of the United Nations System which work together through the Inter-secretariat Committee on Scientific Programmes Relating to Oceanography (ICSPRO) need particular mention in this regard, they are: the UN, Unesco, FAO, WMO and IMO. Some others, notably UNEP and IAEA, also have an interest in certain aspects of marine science and technology.

The IOC is acting as the joint specialized mechanism of the five first mentioned organizations as far as ocean science and technology is concerned, thus playing a central role in this matter. The IOC promotes and co-ordinates scientific research programmes, and related ocean services. These services, it should be noted, include arrangements for international exchanges of oceanographic data (IODE), and an information system for

aquatic sciences and fisheries (ASFIS). IOC also has had for several years a special parallel programme for training, education and mutual assistance (TEMA) among States. More recent than recognition of needs for access to information and for availability of scientific and technical skills has been the awareness that a key to progress in marine science is the existence of appropriate national infrastructures. This awareness has emerged from many years of experience in the world-wide development of marine science and the conduct of international activities. But it has been greatly sharpened by the discussions in UNCLOS and concurrent consideration in the governing bodies of IOC - its Assembly and its Executive Council. Accordingly, the IOC has adopted a Comprehensive Plan to assist its Member States in developing their national capabilities for marine science and ocean services. This has the dual objective of directly helping the developing states with limited or no capacity to achieve their goals in ocean affairs, whatever those may specifically be, and of facilitating their participation in international activities - to the same end, eventually. The Plan is intended also to help participation in international activities, particularly those undertaken within the framework of the IOC itself. In the matter of developing national infrastructures, Unesco's Division of Marine Sciences naturally plays a complementary role.

In identifying and elaborating the ways to improved co-operation, and particularly more effective transfer of marine science and technology, free and concentrated debate is timely. The Workshop, the proceedings of which are reported here, provided an informal forum for such debate. The nature of the subject is such that the involvement of the United Nations University (UNU) is most appropriate and desirable as it can contribute significantly to the objective of TEMA.

Hence the Workshop was organized jointly by UNU and IOC with the Unesco Division of Marine Sciences. From it emerged ideas for strengthening co-operation among States, in the context of the New Ocean Regime, for their individual and collective benefit.

A GENERAL REVIEW OF THE NEW CONVENTION ON THE LAW OF THE SEA HAVING A BEARING ON MARINE SCIENCE AND ITS APPLICATION

Alexander YANKOV

Professor of International Law
Sofia University
Sofia, Bulgaria

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INTRODUCTION

The adoption of a comprehensive Convention on the Law of the Sea was the culmination of a long and arduous negotiation on all problems relating to the régime over the ocean space. The outcome of these negotiations emerging from the evolving process of consensus reflects a collective effort to harmonize the multiple uses of the seas, and accommodate different national exigencies and interests placing them into a proper global perspective. The Conference and its final results affirmed the role of the United Nations as the most representative forum and coordinating factor for multilateral negotiations on complex international issues of vital importance to the international community as a whole. The elaboration of a comprehensive legal framework for international cooperation in the exploration and exploitation of the World's Ocean and its resources is designed to provide a viable basis for the promotion of economic and social progress and the maintenance of international understanding and peace.

The new Convention draws together the basic components of a legal régime universal in scope and field of application. This new legal régime is based not only on existing rules and principles, but constitutes an endeavour to solve outstanding problems and deficiencies of the present law and respond, as much as possible, to the pressing economic and ecological demands and the challenges of the technological advantages and hazards of the future. It is an attempt to meet the new prospects for deep ocean resource exploitation in the area beyond the jurisdiction of coastal States and the new dimensions of traditional uses of ocean space.

The new Convention reflects a compromise solution of critical issues which the two previous Conferences of the United Nations on the Law of the Sea, in 1958 and 1960, failed to resolve or avoided altogether, especially with regard to the maximum breadth of the territorial sea, the outer limits of the continental shelf, the large scale exploration, exploitation and management of ocean resources, the protection and preservation of the marine environment, the universal recognition of shared interests in navigation and oceanic research, and the procedural and institutional arrangements for the settlement of disputes on maritime matters.

The Conference has been under the strong impact of the world-wide debate that has been going on for years within and outside the United Nations, on restructuring international economic relations on a just and democratic basis. The long and intensive negotiations on the new law of the sea have been, in many ways, an expression of public awareness of the evergrowing significance of the seas and their natural wealth for the economic and social progress of all peoples of the world, and of developing States in particular. Therefore, as the Secretary-General of the United Nations rightly pointed out, "The Conference should also be viewed as part of the great effort being made throughout the United Nations system to establish a new international economic order". I/

The conduct of marine scientific research has, for the first time in the codification history of maritime law, acquired a prominent place within the comprehensive set of legal rules, constituting the new régime of the seas. This is a genuine reflexion of the ever-increasing role of oceanic science and tech-

nology in all activities relating to the seas and their resources.

Throughout the negotiating process on the new Convention, marine science and technology problems were considered an important and indispensable component of the overall "package" constituting the comprehensive legal régime of the seas. When in 1978 UNCLOS-III was faced with a number of other "hard-core" issues, its programme of work contained, nevertheless, specific reference to the need of achieving consensus on all matters relating to marine science and technology. 2/

The notable part of marine scientific research and its application within the Convention, including the development and transfer of technology, is evidenced by the fact that there are two parts of the Convention specially devoted to those matters. Out of 320 articles of the Convention, about 100 deal with the conduct of oceanic investigation, the use of scientific methods and means in the exploration, exploitation, conservation and management of the resources of the sea, the training of personnel in these fields, and the application of science in the protection and preservation of the marine environment. These provisions constitute a relatively complete set of general legal guidelines and model rules and principles. They form the legal régime for international co-operation in marine science, and provide the basis for relevant regional, sub-regional or other international instruments in this field.

The Convention adopted by the Conference should in no way be praised as an ideal accomplishment. It is an expression of possible compromise which was attained in existing circumstances. This aspect of the Convention has its imprint also on the provisions relating to the conduct of marine scientific research. They virtually reflect prevailing trends in negotiations on the scope and content of national jurisdiction over marine areas and the interplay between differing positions regarding shared interests in the uses of the sea and its natural resources. A general review of Convention provisions bearing on oceanic research and its application presumably would reveal the impact of new concepts and of attitudes of States with regard to the conduct of marine scientific research.

1. THE SHAPING OF THE NEW REGIME OF OCEANIC RESEARCH

1.1 THE HISTORICAL BACKGROUND: THE EXPERIENCE OF THE 1958 CONFERENCE OF THE UNITED NATIONS ON THE LAW OF THE SEA

It has been generally recognized that UNCLOS-III was the first attempt to develop a detailed set of general rules of international law governing the activities of States and international institutions in the field of oceanographic investigation. Any similar or comparable precedents in the codification history of maritime law could, at best, indicate only some sporadic efforts resulting in the adoption of individual provisions on that matter, as embodied in a few multilateral treaties.

This state of customary and conventional international law was, to a great extent, an expression of a general policy in respect of marine scientific research

and the application of oceanic science and technology in the uses of the seas. Marine science and technology were not considered among the major components of maritime affairs. The prevalent features of marine scientific activities were their relatively modest range of exploratory surveys, confined mainly to oceanographic studies of general nature and carried out in limited areas of the ocean space. In most instances marine scientific investigations were undertaken within or adjacent to the territorial sea. The economic and military implications of marine science and its applications had not acquired the significance which has since been attached to them, particularly in the course of the last two decades.

Perhaps, these facts could explain the rudimentary and incomplete legal régime for the conduct of marine scientific research, the ad hoc character of the arrangements, and the informal way of obtaining consent, when required, for conduct of such activity by a foreign researcher in marine areas under the jurisdiction of a coastal State. 3/ This situation prevailing in the past should not induce any unwarranted eulogy of the liberal nature of the otherwise fragmentary régime regulating scientific activities which were limited in scope, intensity and field of application, nor should they lead to pessimistic and thus, self-defeating prognostics about impediments imposed by the new régime and their adverse effects on marine science.

A brief account of the legislative history of the relevant provisions of the Geneva Conventions on the Law of the Sea of 1958 might helpfully show the options and the limitations with which UNCLOS-III was faced in working out a new régime of scientific research.

It is well-known that among the 73 draft-articles on the Law of the Sea, adopted by the International Law Commission in 1956, there was no single provision relating to marine scientific research. 4/ Although during the consideration of the draft-articles on the freedom of the high seas (draft-article 27) reference was made to the freedom of scientific research, it was not agreed to include such a provision in the text. Draft-article 27 stipulated that the freedom of the high seas comprised, inter alia, freedom of navigation, freedom of fishing, freedom to lay cables and pipelines, and freedom to fly over the high seas. The Commission, nevertheless, pointed out in its commentary that "the list of freedoms of the high seas contained in this article is not restrictive". 5/ It was clarified further that "the Commission has merely specified four of the main freedoms (emphasis added), but it is aware that there are other freedoms, such as freedom to undertake scientific research on the high seas" (emphasis added). 6/ As far as the freedom to explore or exploit the subsoil of the high seas was concerned, it was further explained that no specific mention was made of this freedom, because "such exploitation had not yet assumed sufficient practical importance to justify special regulation". 7/

The issue was raised again at the United Nations Conference on the Law of the Sea in 1958. In the general debate on the régime of the high seas there were some statements 8/ and a formal proposal was submitted by Portugal which was rejected. 9/

The fact that the freedom of marine scientific research was not explicitly listed among the freedoms of the high seas did not affect the correct interpretation of the International Law Commission which has been generally agreed upon by the overwhelming majority of States and competent international organizations. 10/

In this connexion UNCLOS-III removed the grounds for some unfounded interpretations about the scope of the freedom of the high seas, including the freedom of research by the adoption of article 87 of the new Convention, which explicitly states that the freedom of the high seas "comprises, inter alia, ... freedom of scientific research, subject to Parts VI and XIII", i.e. the régime of the continental shelf and marine scientific research, respectively.

The other important development with far-reaching impact on the legal rules concerning the conduct of marine scientific research was the experience of the International Law Commission and the First United Nations Conference on the Law of the Sea concerning the régime for the exploration and exploitation of the Continental shelf. This was the only part of the set of draft-articles prepared by the Commission where, though implicitly, reference was made to the significance of oceanic science for the exploration of the continental shelf and the exploitation of its natural resources or the conservation of the living resources of the sea. 11/

Conceivably, upon the exhortations of the scientific community, 12/ the International Law Commission, and later on the Conference on the Law of the Sea in 1958, made an attempt at improving the draft articles relating to scientific research. This assumption could be substantiated by the reference to marine scientific research in the commentary of the Commission to draft articles 68 (on the sovereign right of the coastal State over the continental shelf for the purpose of exploring and exploiting its natural resources), 13/ and the number of formal proposals submitted by delegations at the Conference. 14/ The commentary of the Commission regarding the conduct of marine scientific research on the continental shelf and on its superjacent waters, though accurate and convincing as it might be, could not overcome the lack of explicit provisions on the régime of scientific investigation undertaken by foreign researchers on the continental shelf. 15/

It was evident that special provisions would be an indispensable element of the régime covering new fields of the uses of the sea. Consequently, the Fourth Committee of the Conference (Continental Shelf) proposed a new text adopted later by the Conference as article 5 of the Convention on the Continental Shelf. 16/

The main feature of the régime, in brief, were the following: first, implied distinction between "pure" and "applied" research; secondly, the consent of the coastal State is required for any research concerning the continental shelf and undertaken there; thirdly, the consent shall not normally be witheld "if the request is submitted by a qualified institution with a view to purely scientific research into the physical or biological characteristics of the continental shelf"; fourthly, the fundamental or other scientific research would be carried out with the intention of open publication; fifthly, the exploration of the continental shelf and the exploitation of its natural resources must not unjustifiably interfere with scientific research; and sixthly, "the coastal State shall have the right, if it so desires, to participate or to be represented in the research". According to

the commentary of the International Law Commission, "the consent of the State will only be required for research relating to the exploration or exploitation of the sea-bed or subsoil" (emphasis added). 17/

The uncertainties contained in the régime established by the 1958 Geneva Convention on the Continental Shelf regarding the requirement for the consent of the coastal State, as well as the existing ambiguities lodged in some provisions of that régime, caused deep anxiety within national and international scientific institutions. 18/ Nevertheless, the rules established by the Convention, as a whole, constitute a significant stage in the codification and progressive development of the law of the sea, in general, and the régime for the conduct of oceanographic investigation in the high seas and on the continental shelf, in particular. 19/

The legal régime for the conduct of scientific research set out by the relevant provisions of the Geneva Conventions on the law of the sea exercised significant influence on the arguments and attitudes with regard to marine science and technology matters considered by the Sea-Bed Committee and UNCLOS-III. Moreover, the legislative history and authoritative interpretations of these Conventions, may, in some instances, assist in the enlightenment and better understanding of the provisions of the new Convention.

1.2 NEW TRENDS IN MARITIME AFFAIRS AND THEIR IMPACT ON THE EMERGING REGIME OF SCIENTIFIC RESEARCH: FROM THE SEA-BED COMMITTEE TO UNCLOS-III

The next historic stage in the development of the new régime of oceanic research was the work of the Committee on the Peaceful Uses of the Sea-bed and the Ocean Floor beyond the Limits of National Jurisdiction (the Sea-Bed Committee), followed by the Third United Nations Conference on the Law of the Sea. The time elapsed between the 1958 Geneva Conference on the Law of the Sea and the inauguration of negotiations on the new legal order over the ocean space was, in fact, less than a decade, 20/ , while the Conventions adopted by that Conference entered into force only a few years before the establishment of the Sea-Bed Committee. 21/

During this short period remarkable economic, political and technological developments occurred with profound effects on the perceptions and attitudes of States in respect of the increasing significance of the uses of the seas and the exploration and exploitation of their resources. The world's ocean opened up new visions and offered promising opportunities for the resolution of many critical problems of global significance, such as the supply of food, energy and minerals, and the protection and preservation of the world's ecosystems. The traditional uses of the sea mainly for navigation and fishing have acquired, with sophisticated equipment, impressive magnitude in volume and intensity of operation. The technological revolution added new dimensions to the usual fields of maritime activities and revealed the unforeseen capacities of the oceans for the extraction from the sea-bed of natural gas, petroleum, polymetallic nodules and other minerals, and the utilization of renewable sources of energy from the marine environment.

The great advances of oceanic science and technology have increased enormously the accessibility to man of any part of ocean space, including the deep sea-bed and its subsoil. The exploration and exploitation of the seas and their natural resources for economic, scientific, recreational and other purposes have obtained real practical importance.

The oceans have always been an area with particular relevance to the security of States. However, in a world overloaded with modern weapons of mass destruction and engaged in an accelerating arms race, the navy has become a major factor in the international military balance and power relationship with far-reaching and immediate potential dangers to international peace and security.

The expansion and proliferation of the uses of the seas have rapidly multiplied the hazards at sea and have hastened the accumulation of pollutants which cause serious deterioration of the marine environment, particularly in the most productive areas. Global ecological problems have reached a stage of grave and well-founded concern.

These new challenges, in their complexity, could explain the crucial role of the oceans in world politics, providing, as never before, new vistas for international co-operation. At the same time it became all too obvious that the oceans could be an arena of competing interests prone to disputes which could lead to international conflict.

In this situation the need to update the law of the sea so that it might adequately meet the requirements of the new developments, was absolutely evident. The General Assembly of the United Nations reacted promptly to this demand and already in 1969 when considering the first report of the Sea-Bed Committee, indicated that problems relating to all sea-areas, including the sea-bed and ocean floor beyond the limits of national jurisdiction "are closely linked together", and requested the Secretary-General "to ascertain the views of Member-States on the desirability of convening at an early date a conference on the law of the sea to review the régimes of the maritime areas" (emphasis added). 22/

At its next session the General Assembly decided by a special resolution, to convene in 1973 a conference on the law of the sea. 23/ The resolution reiterated the view that "the problems of ocean space are closely interrelated and need to be considered as a whole" 24/, and emphasized further that "the political and economic realities, scientific development and rapid technological advances of the last decade have accentuated the need for early and progressive development of the law of the sea, in a framework of close international co-operation". 25/

In accordance with these basic propositions, the conference on the law of the sea was called to deal with "the establishment of an equitable international régime" comprising the legal status of all sea areas, the regulation of the various uses of the seas, the preservation of the marine environment and the conduct of scientific research. 26/

This resolution of the General Assembly was not only an expression of the widely shared perception of the unity of the marine environment, but it stimulated a notable new outlook in the discussions taking place in the Sea-Bed Committee. The objectives and the scope of the negotiations were considerably expanded and shifted from problems relating predominantly to the sea-bed beyond the limits of national jurisdiction towards a comprehensive scope of subjects and issues, encompassing all components of the marine environment and covering the ocean space as a whole, including areas under national jurisdiction. 27/

This important development introduced new elements to the terms of reference and functions of the Sea-Bed Committee, which became a preparatory body for UNCLOS-III.

The evolving process of negotiation on the complexity of maritime problems extended significantly the scope of matters relating to marine scientific research. There was a major departure from problems, of oceanic science and technology, confined basically to the exploration and exploitation of the sea-bed and ocean floor beyond national jurisdiction, towards problems covering all components of the marine environment in ocean space.

Undoubtedly, the initiation of new concepts of maritime law, which would deeply effect the legal order over the world's ocean had profound impact on the shaping of the new régime for the conduct of marine scientific research. Some established rules of customary and conventional law were regarded as outdated or insufficient to meet the new economic, security and ecological perceptions of the coastal States and their growing assertions of rights over the natural resources of areas adjacent to their coasts. At the same time, since the very beginning of the work of the Sea-Bed Committee, the principles and rules of the existing law of the sea were deemed inadequate to regulate problems of global magnitude such as the rational and equitable exploration and exploitation of the deep sea-bed beyond the limits of national jurisdiction for the benefit of mankind as a whole.

The most prominent among those concepts was the entirely novel principle that the sea-bed and ocean floor and subsoil thereof beyond the limits of national jurisdiction are the common heritage of mankind. 28/ This principle became one of the foundation stones of the régime for the deep sea-bed within an international area of the oceans outside national jurisdiction. The legal status of this area and its resources constitute a new situation in the law of the sea, where no State shall claim or exercise sovereign rights over the international sea-bed area or its resources, nor shall appropriate any part thereof. The rights pertaining to the resources of this area shall be exercized by the International Sea-Bed Authority which has the power to carry out mining operations through its Enterprise or in joint ventures with States or private persons, and to control and co-ordinate all activities relating to the exploration and exploitation of deep-sea mineral resources.

This wholly new régime also bears on marine scientific research and transfer of technology. Proposals relating to the conduct of marine scientific research in the International Sea-Bed Area were advanced already during the initial stage of the negotiations in the Sea-Bed Committee in 1968 and 1969. 29/

Throughout the long process of negotiation the text of these proposals was modified by inclusion of some new elements. However, two essential aspects should be singled out, namely, that all States and international organizations have the right to conduct scientific research in the international sea-bed area, and that the International Sea-Bed Authority may also carry out such activity relating to the sea-bed and its resources, directly or through contracts with States, international organizations or scientific institutions.

The appearance of new concepts with noteworthy effect on the legal régime over the ocean space, including the rules governing marine scientific activities, was an expression of a marked trend towards expansion of the scope and field of application of national jurisdiction. In this movement were involved a large number of coastal States constituting a highly representative group and exercising formidable pressure on the deliberations in both the Sea-Bed Committee and UNCLOS-III. As a result of lengthy and intensive discussions and negotiations the entirely novel notion of exclusive economic zone obtained almost general recognition.

Then other developments in the same direction occurred, manifest in the extension of the outer limits of the continental shelf; the enlargement of the contiguous zone; the recognition of the claims of archipelagic States to draw straight archipelagic baselines resulting in considerable extension of the maritime space under their sovereignty; and the acquiescence in propositions leading to the substantive extension of the scope and content of coastal States' rights over large parts of the ocean space.

Thus, new areas were added to the traditional maritime zones. Most of them fall under national sovereignty and jurisdiction, while the international sea-bed area came under the special international régime with its institutional structure.

This new legal situation had two major effects on the freedom of oceanic investigation: first, the zonal approach to the régimes for the conduct of marine scientific research, and secondly, the considerable reduction of the ocean space in which such freedom could be exercised within the framework of the freedom of the high seas. The establishment of distinct régimes for scientific activities in the various parts of the ocean space would inevitably affect the integrity of oceanic studies in an environment which could not be compartmentalized to accord with political considerations and legal criteria. Concern about the adverse effect of the zonal approach and of some other limitations on the freedom of research flowing from these developments was expressed on several occasions in the Sea-Bed Committee and later on in UNCLOS-III. 30/

The legal status of the exlusive economic zone entails sovereign rights of the coastal State for exploration, exploitation, conservation and management of the natural resources of the entire marine environment within that zone, and with regard to other activities for economic uses, including the production of energy from waters, currents and winds. In addition, the coastal State has jurisdiction over the establishment and use of artificial islands, installations and structures as well as over marine scientific research, the protection and preservation of the marine environment and other rights within the zone, provided for in the new Convention.

The legal régime of the continental shelf, including the regulation of research activities on it, is based, in general, upon the rules established by the Geneva Convention on the Continental Shelf of 1958. However, the new definition of the continental shelf, and particularly the determination of its outer edge up to 350 nautical miles, or 150 nautical miles from the 2,500 metre isobath, was tantamount to sizable extension of the part of the sea-bed falling under national jurisdiction.

The total area of the ocean space comprising the exclusive economic zones and continental shelf holds nearly all the proven offshore deposits of oil and natural gas and the presently exploitable minerals, and well over 85 percent of the current catch of fish. The priority assigned to the use of the sea for economic purposes, as a major policy objective of coastal States, should not overshadow the vital importance for them, and for the international community, of the promotion of oceanic research. However, during the negotiations on the new Convention on the Law of the Sea, these two perceptions, expressing different concerns, were seemingly contradictory. They gave rise to complex and difficult negotiations which were of crucial importance not only to the outcome of the work of UNCLOS-III on marine scientific research but to the success of the Conference itself.

The conflicting positions were polarized on two interrelated issues bearing upon the requirements for the conduct of scientific research in the exclusive economic zone and on the continental shelf. One of them was about the need to draw a distinction between "fundamental" or "pure" research on the one hand, and "applied" or "resource-related" research, on the other and the feasibility of making that distinction. The other critical issue was about the consent of a coastal State as a mandatory requirement for research activities in the exclusive economic zone and the continental shelf of that State. 31/ The proponents of the distinction between the two categories of research maintained that while fundamental research should be carried out in accordance with the principle of the freedom of the high sea, or with an advance notification to the coastal State concerned, the resource-related or applied research could be carried out only with the consent of the coastal State. A number of proposals were made along those lines. They were also reflected in the draft-articles on marine scientific research embodied in the Single Negotiating Text. 32/

The opposing view was that "there was little merit in drawing a line between pure research and research more closely identified with commercial prospecting since the end results might be to restrict research to the detriment of the international community", 33/ and that "in any event, it would be extremely difficult to make such distinctions since it was felt that most scientific information could in reality be used for commercial or military purposes". 34/

The prevailing reaction was to adopt a broad and comprehensive notion of marine research comprising any oceanic investigation and related activity designed to increase knowledge about the marine environment and its resources. There were some views that "the real distinction should be drawn between oceanic research, whatever its aim and however it might be carried out, on the one hand, and the exploration of marine resources, on the other". 35/

However, the real and most contentious issue behind the debate on the definition of marine scientific research was the problem of the coastal State's consent and the modalities for granting consent. On this matter divergent views were expressed, and contradictory proposals were submitted to the Sea-Bed Committee.

The outcome of these negotiations in the Sea-Bed Committee were reflected in two opposing variants of draft-articles. One of them stipulated that the coastal State has the right to authorize marine scientific research in areas under national jurisdiction 36/, while the other provided that "all States, whether coastal or not, shall enjoy the right to undertake scientific research in national ocean space" 37/, on 30 days' advance notification, when required by the coastal State. 38/ The rule of authorization derived from the principle of express prior consent of the coastal State by virtue of its sovereign rights and jurisdiction. The notification régime was based on the freedom of scientific research.

In the course of the negotiations at UNCLOS-III, three main trends emerged on the consent and its modalities. Most of the developing and some other States insisted on the requirement for "explicit consent" 39/. Some West European and certain developing land-locked States were in favour of a notification régime based on the freedom of research. 40/ A group of socialist States advanced the idea of a qualified consent régime, requiring consent for "marine scientific research related to the exploration and exploitation of the living and non-living resources of the zone, 41/ and advance notification for "research unrelated to the exploration and exploitation" of these resources. 42/ Within these main trends were proposals containing certain modification of the basic concepts. 43/

The intensive negotiations provided some ground for a compromise, which was reflected in the Revised Single Negotiating Text presented to the Fourth Session of UNCLOS-III in 1976. 44/ According to draft-article 60, marine scientific activities in the economic zone or on the continental shelf shall be conducted with the consent of the coastal State applied with specific exception. It stipulated further that the coastal State should not withold its consent unless the research project "bears substantially upon the exploration and exploitation of the living and non-living resources", "involves drilling or the use of

explosives", "involves the construction, operation or use of artificial islands, installations and structures", or "unduly interferes with economic activities of the coastal State". 45/

There were also some other requirements, such as the description of the purposes and nature of a research project; the right of the coastal State to participate in the conduct of the research programme and receive information on the results derived therefrom, including samples taken during the investigation carried out on the continental shelf.

However, despite the efforts to reach a consensus on the basis of a compromise, as was stated in the report of the Third Committee, "it became clearly apparent that the positions were moving further away from the revised single negotiating text in divergent directions, furthering the divisions between existing trends instead of moving to a compromise". 46/ At this critical moment of the negotiations the Chairman of the Committee took the initiative to submit "a test proposal", which was an attempt at compromise taking into consideration the various concerns of different interest groups, and an effort to avoid a deadlock on this subject". 47/

The new proposal, submitted by the Chairman, was based on the previous text. It contained in addition some substantive new elements. It was stated in it that "coastal States shall normally grant their consent" and "to this end, coastal States shall establish rules and procedures ensuring that such consent will not be delayed or denied unreasonably". 48/ This new provision concerning rules and procedures, designed to provide certain guarantees to States undertaking research activities against undue delays and impediments, was considered as a safeguard clause to meet, to some extent, the legitimate concern of those States. The text as a whole contained some ambiguities, such as the determination of the objectives and character of a project which "bears upon the exploration and exploitation of the living and non-living resources", or the interpretation of the term "normally" in paragraph 3, stiptulating that "coastal States normally grant their consent". These and other aspects were critically scrutinized. Nevertheless, as was pointed out in the Report of the Third Committee to the Plenary of the Conference, the new proposal was considered by a majority of delegations as a basis for negotiations, though a number of States actively involved in oceanographic research viewed the proposal with opposition. Nevertheless, the "test proposal" served as a basis of article 246.

The survey of the making of the research régime highlighted the critical issues engendered by the new developments relating to the uses of the sea. The rules and principles embodied in the Convention adopted by UNCLOS-III regarding oceanic science and technology reflect the achievable compromise solutions on these issues in the given circumstances.

2. THE LEGAL FOUNDATIONS OF THE NEW REGIME OF SCIENTIFIC RESEARCH

2.1 GENERAL PRINCIPLES UNDERLYING THE REGIME OF SCIENTIFIC RESEARCH

The régime of scientific research is an integral part of the comprehensive framework of the law of the sea. The general rules governing the legal status of maritime areas and the uses of the oceans and their resources provided also the legal foundations of the régime of scientific research. There are, however, some principles which are directly related to scientific research. Some of them are embodied in explicit provisions, such as article 240 of the Convention, entitled "General principles for the conduct of marine scientific research". This article is not exhaustive, nor should it be taken as the only provision enunciating general rules.

Nevertheless, it may be appropiate to start the examination of the general principles related to scientific research with the consideration of article 240. It stipulates in subparagraph (a) that "marine scientific research shall be conducted exclusively for peaceful purposes" (emphasis added). This is the main but not the unique provision on the peaceful objectives and character of scientific research, conducted in any part of the ocean space. Article 143 on marine scientific research in the international sea-bed area contains similar provision with the additional words"... and for the benefit of mankind as a whole, in accordance with Part XIII". This article reiterates one of the principles of the Declaration on the Sea-Bed adopted by the General Assembly in 1970. 49/

The conduct of marine scientific research for peaceful purposes is only one important aspect of the more general principle of the peaceful uses of the seas and their resources. It entails certain obligations for the State-parties to the Convention not to use military installations, structures, fortifications and other military means, testing of any type of weapons, nuclear explosions on the sea-bed beyond twelve miles and on the waters under their jurisdiction or control, including the territorial sea, the exclusive economic zone and the high seas. This interpretation may be supported by the relevant provisions of some multilateral treaties, such as the Antarctic Treaty of 1959, 50/the Treaty Banning Nuclear Weapon Tests in the Atmosphere, in the Outer Space and Under Water of 1963, 51/ the Treaty on Principles Governing the Activities of States in the Exploration and Use of the Outer Space, including the Moon and Other Celestial Bodies of 1966, 52/ the Treaty on the Prohibition of the Emplacement of Nuclear Weapons and other Weapons of Mass Destruction on the Sea-Bed and Ocean Floor and in its Subsoil Thereof, 53/, and other international treaties in the field of arms limitation and disarmament.

Another important general principle underlying the new régime of scientific research is the principle of cooperation. The duty of States to cooperate with each other was enunciated as a fundamental rule of conduct in international relations by the Declaration on Principles of International Law concerning Friendly Relations and Cooperation among States in accordance with the Charter of the United Nations. 54/ This principle stipulates that "States have the duty to cooperate with one another, irrespective of the differences in their political, economic and social systems, in the various spheres of international relations, in order to maintain international peace and security and to promote international

economic stability and security, the general welfare of nations and international cooperation free from discrimination based on such differences". 55/

One of the substantive components of the principle of cooperation is the duty of States to "conduct their international relations in the economic, social, cultural, technical and trade fields in accordance with the principles of sovereign equality and non-intervention". 56/

These fundamental rules of international conduct are applicable to any activities relating to the oceans and the marine environment, including marine scientific research. Parts XIII of the new Convention (Marine Scientific Research) and XIV (Development and Transfer of Technology) contain a considerable number of provisions on the promotion of international cooperation in oceanic science and its application. Section 2 of Part XIII (Articles 242-244) and Section 2 of Part XIV (Article 270-274), are entitled: "International Co-operation". These are not the only provisions pertaining to the duty of States and competent international organizations to undertake cooperative actions in marine science and technology. In fact the whole régime of scientific research is designed to promote international cooperation in this field. Nevertheless, it may be appropriate to single out some of the provisions dealing directly with the duty of States and international organizations to promote cooperation on an international scale. In this connexion, of special relevance is article 242 which contains not only a general provision on the obligation of States and international organizations to promote international cooperation, but also the duty to "provide, as appropriate, other States with a reasonable opportunity" to benefit from research activities. Furthermore, articles 243 and 244 deal with international assistance and cooperative measures to create conditions favourable to the conduct of research and for the integration of the efforts of scientists and the exchange and dissemination of scientific data and information.

There are also other provisions in various parts of the Convention on international cooperation, in general, or oceanic science and technology, in particular. 57/ The principle of coordination and harmony between the various uses of the sea is another general rule built into the régime of scientific research, as embodied in article 240, which provides that"marine scientific research shall not unjustifiably interfere with other legitimate uses of the sea". The provision of article 241, stipulating that "marine scientific research activities shall not constitute the legal basis for any claim to any part of the marine environment or its resources", is also among the general rules for the conduct of oceanic research. As was pointed out, article 240 contains several general principles, such as the requirement for carrying scientific research "with appropriate scientific methods and means"and in compliance with the relevant regulations for the protection and preservation of the marine environment.

There are some fundamental principles of general international law which are also applicable to the research régime, such as the liability and responsibility for damage to the marine environment resulting from oceanic research, including damage caused by pollution arising out of it, and the peaceful settlement of disputes concerning the interpretation or application of the

relevant provisions of the Convention. It should be pointed out, in addition, that most of the general rules of the law of the sea relating to the exploitation, conservation and management of marine resources, safety or navigation, protection and preservation of the marine environment, the prevention of damage to the health of persons; the status of installations or equipment in the marine environment, etc. are very relevant to the régime for the conduct of marine scientific research. Most of these matters are regulated also by specific provisons relating to marine scientific activities or by provisions which also have certain legal effect on such activities. 58/

The general principles of law which were identified briefly, should not be viewed as an exhaustive code for the regulation of marine scientific research. 59/ The principle of the freedom of the high seas, as set out particularly in paragraph (f) of article 87 and article 257 on the freedom of scientific research in the high seas, is a provision absolutely pertinent to the régime of oceanic investigation. Important aspects of the overall régime of scientific research in terms of general rules are provided for in article 245 on research in the territorial sea. Articles 246, 255 (on implied consent), and related provisions, concerning marine scientific research in the exclusive economic zone and on the continental shelf, as was pointed out also contain general rules. There are several provisions such as articles 143, 144 and 256 on scientific research in the international sea-bed area, to which reference was made in connexion with the new régime for scientific research in the international sea-bed area. All these provisions taken together with the above-mentioned general rules, constitute the legal foundation of the régime. They represent a framework for the conduct of oceanic investigation and could offer a basis for special agreements on the promotion of science and technology.

The new Convention on the Law of the Sea for the first time in the history of international law set forth as a general principle the right of all States and competent international organizations to conduct marine scientific research, as provided for in article 238. The significance of this principle could also be illustrated by the fact that most of the provisions of Parts XIII and XIV place States and international organizations in the field of international cooperation on equal footing. Usually, they start by the expression: "States and competent international organizations", when defining their rights and obligations, or use the expression: "States, directly or through competent international organizations". Furthermore, there is a special provision (article 247) on marine scientific research projects undertaken by or under the auspices of international organizations. This is an important aspect of the régime of scientific research. It emphasizes the advantages of coordinated research efforts through projects undertaken or sponsored by international organizations. Article 278 of the Convention provides for closer cooperation among the competent international organizations themselves for "the effective discharge of their functions and responsibilities", in the field of marine science and technology.

Though most of the provisions are formulated as general principles or guidelines, their implementation could provide favourable conditions for

the conduct of research and for the promotion of broad international programmes.

2.2 PROVISIONS OF THE CONVENTION BEARING UPON MARINE SCIENCE AND ITS APPLICATION TO EXPLORATION, EXPLOITATION, MANAGEMENT AND CONSERVATION OF THE RESOURCES OF THE SEA

The basic objective of the régime of marine scientific research and of the development and transfer of technology, is to provide a legal framework for the acquisition of knowledge about the marine environment and its natural resources. The scientific understanding of the characteristics and phenomena of the oceans, their physical, geological, chemical, biological and other features, would make the assessment of oceanic processes and the evaluation of their resources more accurate. To that end article 243 of the Convention stipulates that States and international organizations, through bilateral and multilateral agreements shall create favourable conditions for research and "integrate the efforts of scientists in studying the essence of phenomena and processes occuring in the marine environment and the interrelations between them".

It has been generally admitted, however, that the present level of scientific knowledge is quite inadequate to accomplish these tasks. Marine science has, moreover, the mission to improve the possibilities of reliable prediction of such processes and evaluation of the location, distribution and quality of resources. Consequently, it has been emphasized that "scientific investigation should precede industrial exploration". 60/ For it is obvious that without adequate scientific knowledge, oceanic science and technology would not be able to offer appropriate services in the exploration, exploitation, management and conservation of the natural resources of the sea and in the protection and preservation of the marine environment.

The provisions of the new Convention attach particular importance to marine science and its application to the exploration, exploitation, management and conservation of the living and non-living resources of the marine environment. In addition to the articles in Parts XIII and XIV which contain a set of rules, applicable to any facet of scientific research, and also on development and transfer of technology for all purposes of the uses of the sea, there are several articles relating to marine science and its application in various fields of maritime activities. This proposition may be substantiated by the fact that reference to the function of marine science in the exploration, exploitation, management and conservation of marine resources could be found throughout the Convention. 61/

It has been pointed out already that the régime of scientific research is founded upon a comprehensive notion of scientific investigation, comprising both fundamental and applied studies. The general rule for the conduct of marine scientific research in areas under national jurisdiction is the requirement of consent of the coastal State. Article 246 provides that, though coastal States shall, in normal circumstances, grant their consent, they may, in their discretion, withold their consent to the conduct of marine scientific research in their exclusive economic zone or on their

continental shelf if the research project is "of direct significance for the exploration and exploitation of natural resources, whether living or non-living".

This qualified consent entails, as an exception, a two-tier régime, depending upon the objective and character of the research project. The determination of whether the research is of direct significance for the exploration and exploitation of the natural resources should be made by a coastal State, on the basis of data at its disposal and the capability to assess the project. In order to avoid abuses in the operation of the régime of qualified consent, a coastal State would need adequate scientific understanding of the nature of each research project. The Convention stipulates that the coastal State shall establish rules and procedures ensuring that consent is not delayed or denied unreasonably. All these considerations further underline the need to achieve the level of scientific knowledge necessary for a sound, objective and accurate assessment of the characteristics of research projects.

The application of marine science to the study of the biological characteristics of the oceans and the exploration, management and conservation of the living resources. is an important part of the new legal régime of the ocean space. The exploration and exploitation of the living resources of the exclusive economic zone raise a number of problems relating to the role of scientific research in evaluation of resources, and the undertaking of appropriate conservation and management measures, based on scientific criteria.

In this connexion article 61 on the conservation of the living resources of the exclusive economic zone, contains some provisions referring to marine science and its application. Coastal States are called, taking into account the best scientific evidence, to undertake proper conservation and management measures in order to avoid over-exploitation and to maintain or restore populations of harvested species at levels which can produce maximum sustainable yield.

It is obvious that on this matter the contribution of marine science is of vital importance. Therefore, article 61 provides for the promotion of international cooperation in acquiring scientific data and exchange of information on the conservation of the living resources.

The conservation requirements established by the coastal State in its exclusive economic zone, have to be respected also by nationals of other States carrying out fishing in the zone. Article 62 of the Convention requires them, under the authorization and control of the coastal State, to conduct specified fisheries research programmes, including the sampling of catches, and also to admit observers or trainees of the coastal State on board their vessels operating in the exclusive economic zone of the coastal State. The Convention contains also specific provisions on conservation measures relevant to stocks occuring within the exclusive economic zones of two or more States (article 63), and special conservation and management

measures relating to some particular species, such as highly migratory species, anadromous stocks, marine mammals, etc.

Identical conservation and management measures are provided with regard to the living resources in the high seas. States are called upon to cooperate with each other in the conservation and rational management of living resources in the areas of the high seas, and exchange available scientific data and information. Special reference is made in article 120 on the applicability of conservation and management measures relating to marine mammals. Any marine scientific research, including research related to the living resources in the water column beyond the exclusive economic zone, but still above the continental shelf, and in the high seas, shall be conducted in accordance with the principle of the freedom of the high seas.

The new Convention contains several provisions on marine science and its application to the exploration, exploitation and management of the mineral resources of the seas and of new and renewable sources of energy. Article 56, defining the rights, jurisdiction and duties of the coastal State in the exclusive economic zone, stipulates that the coastal State has sovereign rights for the exploration, exploitation, conservation and management of all natural resources of the zone. This provision rests on a comprehensive notion of the term "natural resources", which refers to a very broad scope of rights with regard to the living and non-living resources of the marine environment, the production of energy from the water, currents and winds, and other activities for the economic exploration and exploitation of the zone.

To the sovereign rights of exploration, exploitation, conservation and management of natural resources, is added jurisdiction on the establishment and use of artificial islands, installations and structures, marine scientific research and protection and preservation of the marine environment.

There is a uniform régime for the conduct of marine scientific research related to mineral and other natural resources of the exclusive economic zone and the continental shelf, as provided for in article 246.

The conduct of oceanic investigation on the sea-bed and ocean floor beyond national jurisdiction, i.e. the international sea-bed area, is governed by the relevant provisions relating to marine scientific research. Of course, since that area and its resources have special legal status as the common heritage of mankind, as determined by article 137, the rules on scientific research are applied, subject to the international régime of the area and the powers of the International Sea-Bed Authority. Article 150 of the Convention envisages within the powers of the Authority"the development of the resources of the area and their management". The Assembly, as a principal organ of the Authority, in accordance with article 160, is entitled to consider and approve rules, regulations and procedures relating to prospecting, exploration, exploitation and management. The contribution of marine science and technology would be indispensable on these matters. Therefore, article 143 on marine scientific research in the international sea-bed area, while explicitly referring to Part XIII, at the same time provides that

the International Sea-Bed Authority may carry out scientific research concerning the international sea-bed area and its resources. The Authority may itself conduct scientific research or enter into contracts for that purpose. It could participate in international programmes for the promotion of scientific research, training of personnel, dissemination of results of the research, etc.

Furthermore, the Authority is competent to promote and encourage the conduct of marine scientific research and to coordinate and disseminate the results of such research. This region, however, does not affect the rights of all States to carry out marine scientific research in the international sea-bed area on the basis of the freedom of scientific research. The requirements provided for in article 246, based on the consent régime, are not applicable in the international sea-bed area, which is beyond the jurisdiction of any State. Nevertheless, it should be borne in mind that the exploration and exploitaion of the sea-bed in the international zone would involve large mining sites, and therefore, some limitations on scientific research may be expected, in the case of conflicting uses within the same area of the sea-bed.

The International Sea-bed Authority has certain other powers relating to marine science and technology. Article 144 stipulates that the Authority has the right "to acquire technology and scientific knowledge relating to activities in the Area", i.e. exploration, exploitation and management of the mineral resources of the sea-bed and ocean floor, and the subsoil thereof; to promote and encourage the transfer to developing States of such technology and scientific knowledge; to initiate and promote programmes for the transfer of technology to the Enterprise, which is an organ of the Authority for the exploration and exploitation of the mineral resources of the sea-bed. The Authority may take part in international programmes of technical assistance to developing countries aimed at strengthening their research capabilities in the field of marine science and its application.

The exercise of powers of such broad scope by the International Sea-bed Authority in the exploration, exploitation and management of the mineral resources, require a level of scientific knowledge which would make its activities economically viable. To this end the Convention contains certain provisions for the promotion of international cooperative efforts, undertaken jointly with States or competent international organizations. They refer not only to the principal organs of the Authority, but also to its Economic Planning Commission, the Legal and Technical Commission, and other subsidiary bodies. Thus, article 163, paragraph 13 of the Convention states that, "in the exercise of its functions, each Commission may, where appropriate, consult another commission, any competent organ of the United Nations or of its specialized agencies or any international organizations with competence in the subject-matter of such consultations". Article 169 on its part assigns such functions, i.e. consultations with competent international institutions, to the Secretary-General of the Authority, with the approval of the Council.

In Part XIV of the Convention there are some provisions on co-operation between the Authority and competent international organizations. According to article 273 the objective of such cooperation is "to encourage and facilitate the transfer to developing States, their nationals and to the Enterprise, of skills and marine technology with regard to activities in the Area". Since such cooperation involves important considerations of financial, technological and legal character, article 274 defines, in specific terms, the obligations of the Authority on this matter.

These provisions indicate that the contribution of international organizations like the Intergovernmental Oceanographic Commission, is indispensable. The new régime of marine scientific research, in general, and in respect to the research in the international sea-bed area, in particular, would inevitably stimulate the extension of the scope of activities of the competent international institutions. They could be involved in providing advice on policy matters, relevant to oceanographic investigation, the initiation, coordination and implementation of research projects, in the promotion of international agreements and in the elaboration of international rules, standards and recommended practices and proceedings relating to marine science and its application.

The provisions of the Convention on marine science and its application to natural ressources basically refers to the exploration, exploitaion, development and management of living ressources and minerals. However, some other, unconventional ressources should not be excluded. Ocean thermal energy conversion, ocean waves energy potential, ocean tides and other new and renewable sources of energy deserve special attention. 62/ As was pointed out, a general reference to this effect is contained in article 56, paragraph I of the Convention, which defines the sovereign rights of coastal States in the exclusive economic zone. This is a new field of the uses of the seas which needs extensive scientific studies and sophisticated technology.

The provisions of the Convention bearing upon oceanographic research as multidisciplinary studies and related experimental work may apply to some other areas of the uses of the sea, such as navigation, communications, weather forecasting, archeological explorations, recreational and other activities. There are articles which refer in more specific terms to these matters, while in other instances only general rules governing marine science and technology could be applied. The provisions on innocent passage through the territorial sea, the archipelagic waters or straits used for international navigation, contain specific reference to marine scientific research activities of any kind, including research related to the natural resources. 63/ Article 149 deals with the legal situation of archeological and historic objects found in the international sea-bed area; it should be submitted that some research activities have to be carried out in connection with the discovery and recovery of these objects.

The general review of the provisions bearing upon marine science and its application, should be conceived within the comprehensive framework of the régime for the conduct of marine scientific research, as provided for in the new Convention. In this connexion special emphasis should be given to the set of articles dealing with the operation of research activities (articles 248 to 255 and 258 to 262) and the relevant provisions relating to the development and transfer of technology (articles 266 and 278). The provisions on the duty of the researcher to provide information to the coastal State, the participation of the coastal State in the research project, the supply of information, including scientific data and samples, and some other requirements of operational nature, such as conditions for suspension or cessation of research activities, are confined to research in the exclusive economic zone and on the continental shelf, comprising research related to the exploration, exploitation and management of living and non-living resources.

The new régime of marine scientific research, provided by the provisions of the Convention, which have a bearing on marine science and its application, would be more effective it they are backed by coherent national legislation. Article 251 is particularly relevant in this connexion, providing as it does, that general criteria and guidelines should be established by States through competent international organizations, in order to assist in ascertaining the nature and implications of marine scientific research. The effective implementation of this provision would promote the establishment of international criteria, rules, standards and recommended practices, generally agreed upon, in order to ensure the basis for uniformity of the legal framework for oceanic research.

2.3 APPLICATION OF MARINE SCIENCE TO THE PROTECTION AND PRESERVATION OF THE MARINE ENVIRONMENT

The protection and preservation of the marine environment constitute a major area of marine scientific research. Besides the direct relevance of marine science to conservation and management measures, the scope of the interrelation between oceanic research and the quality of the marine environment has acquired much larger dimensions and significance. This important aspect of the role of scientific research for the protection and preservation of the environment, was emphasized already during the negotiations which took place on the Sea-Bed Committee. 64/ The efficiency of any measures aimed at protecting and preserving the marine environment depend greatly upon the level of understanding of oceanic processes and phenomena, the scientific methods for monitoring, assessing and analyzing the harmful effect of pollutants, as well as the predictability of potential dangers and forecasting of ecological hazards.

Large scale operations,in multiple uses of the seas, have made this dependence of preservation measures upon scientific knowledge absolutely essential. The intensification of navigation, fisheries, mining and other activities inevitably affect the ecosystems and the quality of the marine environment as a whole. The rapid expansion of deep-sea exploration and exploitation would have direct, as well as chronic impact on the marine environment with consequences which are far from being accurately evaluated at present. 65/ Taking these realities into consideration, it is obvious that environmental assessment, the establishment of international standards and regulations and the undertaking of preventive measures, should be preceeded by appropriate scientific research.

The new Convention endeavours to take into account the legitimate concern caused by the present and potential dangers to the marine environment, resulting from any source of pollution. There are many provisions which reflect the direct or indirect relation between scientific research and protection and preservation of the marine environment. Article 200 explicitly outlines the duty of States and international organizations to undertake studies, scientific research programmes and exchange of information about the pollution of the marine environment, in order to "acquire knowledge for the assessment of the nature and extent of the pollution, its

pathways, risks and remedies". The information and data acquired from these research activities should be used by States in order to establish "appropriate scientific criteria for the formulation and elaboration of rules, standards and recommended practices and procedures for the prevention, reduction and control of pollution of the marine environment", as provided for by article 201.

There are several provisions bearing upon marine science and its application against pollution. Article 204 enunciates the duty of States to use scientific methods for monitoring, assessing and analyzing the risks or effects of pollution of the marine environment. Article 145 provides for undertaking special measures for the protection of the marine environment in the international sea-bed area through appropriate rules, regulations and procedures, which should be based on scientific criteria. The provisions on scientific and technical assistance to developing countries, refer specifically to the role of marine science and technology for enhancing the research capabilities and creating the necessary scientific and technological infrastructures in developing States in the field of the protection and preservation of the marine environment. 66/

CONCLUSION

This general review of the provisions bearing upon marine science and its application may give some idea of the problems which scientific research may face under the new Convention and the opportunities it may offer.

Perhaps, the key problem would be: how to reconcile national claims and priorities with the long-term interests of the international community. An important condition for tackling such a problem would be a viable modus vivendi and accommodation between these two seemingly opposing trends. Practical and constructive resolution of the dilemma could require mutual trust between coastal and "researching" States, and common appreciation of the vital role of marine science for the optimum utilization of the oceans and their resources.

Taking into consideration this new reality, it becomes evident that one of the pressing objectives of international cooperation should be to improve the level of the research capabilities of more coastal States, particularly developing coastal States. The functioning of the consent régime requires sufficient scientific knowledge of coastal States, when exercising their discretion to grant or withold consent. In the absence of accurate and reliable information, the general presumption often would be that a denial might cause less harm to national interests than a precarious basis for an approval. The diversity in the state of oceanography and discrepancy in different countries and the gap between their scientific capabilities and scientific and technological infrastrucure, are among the important sources of concern and apprehension. Their impact on policies and attitudes of States of political and economic nature, vis-à-vis marine scientific research, could not be eliminated by treaty provisions alone. The intergration of the efforts of scientists from developed and developing States through international programmes and the development of the scientific and techno-

logical infrastructure of developing coastal States would provide practical grounds to this end.

The conclusion of bilateral and multilateral agreements and other arrangements would also be a way to move closer to the creation of favourable posture for scientific research. There is an urgent need to lay down uniform rules, regulations and standards designed to promote and facilitate oceanic investigation in areas under national jurisdiction. The Convention contains provisions to this effect. It provides also for the establishment of national rules and regulations. International rules, standards and procedures could provide the model for more homogeneous national legislation.

The provision contained in article 246 of the Convention regarding the establishment of rules and procedures to avoid unreasonable delays or refusals, provides some safeguards which have to be effective as soon as possible.

The trend towards a more restrictive régime for research could be challenged only be a viable régime with wide international adherence. It is disturbing that national legislation contemplated by some States may even be more stringent than the new Convention. Thus, a comprehensive Convention on the Law of the Sea, even with its deficiencies, would provide a better alternative than the existing situation in international law, or the one that could result from unilateral actions by States. Therefore, an early entry into force of the new Convention is at present a question of vital importance to the establishment of a viable régime over the oceans, including on marine scientific research.

When on 30 April 1982 UNCLOS-III adopted the Convention, a new page was being turned in the annals of the law of the sea. This was the accomplishment of a monumental task. The successful conclusion of difficult and complex negotiations was one of the greatest achievements of the United Nations in the codification and progressive development of international law. It is too early to appraise this contribution of UNCLOS-III to the establishment of effective and equitable legal order over the oceans. The impact of this great international venture would have to be assessed properly from now on, and especially, when the new régime becomes legally effective. Perhaps now is the time to search for constructive solutions - not outside, but within this new legal framework. Such a proposition may have great practical value also in respect of the régime for the conduct of marine scientific research.

NOTES

1/ Statement of the Secretary-General of the United Nations at the Sixth Session of UNCLOS-III on May 23rd, 1977. Third United Nations Conference on the Law of the Sea. Official Records, Vol. VII, p.3.

2/ See Third United Nations Conference on the Law of the Sea. Official Records, Vol. X, pp. 6-9, document A/CONF.62/62, containing "Organization of work: Decisions taken by the Conference at its 90th meeting on the Report of the General Committee", para. 8.

3/ In most instances oceanic research was undertaken through bilateral arrangements and "informal contacts with scientists in the coastal States". See in this connexion W.S. Scholz, Oceanic Research. International Law and National Legislation in Marine Policy, April 1980, p. 91; and J. Koldow, "Nature of present restrictions on oceanic research"; in W.S. Wooster, ed. Freedom of Oceanic Research, Krane, Russak, New York, 1973.

4/ Report of the International Law Commission covering the work of its Eighth Session, 23 April - 4 July, 1956. Official Records of the General Assembly: Eleventh Session, Supplement No. 9(A/3159), pp.2-45, containing the draft articles and the commentary thereto. See also: Yearbook of the International Law Commission, 1956, Vol. II, Document A/CN.4/97.

5/ Official Records of the General Assembly: Eleventh Session, Supplement No. 9(A/3159), p. 24.

6/ Ibid.

7/ Ibid.

8/ United Nations Conference on the Law of the Sea. Official Records, Volume IV: Second Committee (High Seas: General Régime), A/CONF.13/40, containing the statement of the representative of Lebanon, who suggested that "additional clauses might be added to article 27 providing for freedom of scientific research and exploration and other kinds of freedoms mentioned in the Commentary of the I.L.O. See also the Statement by the representative of Portugal who pointed out that "the Portugese delegation regarded article 27 as one of the most important in the International Law Commission's draft, and considered that it should be made as comprehensive as possible". (Ibid, pp. 20 and 38). Accordingly, the delegation of Portugal proposed a new text for that article.

9/ Ibid p.p. 55 and 117, document A/CONF.13/C.2/L.7

10/ See for example the joint UNESCO-IMCO report of 1962 on fixed oceanographic data stations, which emphasized that "freedom of the high seas includes the freedom of research in the high seas". (UNESCO Intergovernmental Oceanographic Commission, Preliminary Report of UNESCO and IMCO

on the Legal Status of Unmanned and Manned Fixed Oceanographic Stations (Document No.NS/IOC/INF/34). See also IOC/INF.108 of March 1967, where it is maintained that the freedom of scientific research "may be inferred from the general concept of freedom of the seas and from the known practice of States" (p.8). In the same document a conclusive argument in favour of the freedom of marine scientific research is based on article 6, paragraph 2 of the Geneva Convention on Fishing and Conservation of the Living Resources of the High Seas of 1958 which provides that "a coastal State is entitled to take part on an equal footing in any system of research and regulation for purposes of conservation of the living resources of the high seas in that area (i.e. "in any area of the high seas adjacent to its territorial sea") even though its nationals do not carry on fishing there". It was further asserted that the right to reasonable use of oceanographic research devices for the purpose of increasing knowledge of the physical and biological properties of the seas and the air space over the sea should be analogous to the recognized rights of navigation, fishing, laying submarine cables and pipelines and flying. In many respects, of course, the products of scientific research conducted from fixed oceanographic situations may be deemed to aid these specifically recognized aspects of the freedom of the seas and hence to form part of one or more of those rights" (Ibid). It may also be added that in the 1972 Report of the Committee on the Peaceful Uses of the Sea-Bed it was stated that "freedom of the high seas (emphasis added), was confirmed of long practice". At the same time the Report contained a differing view according to which "such freedom could in no way be implied by the language of article 2 of the High Seas Convention". (See Official Records of the General Assembly: Twenty seventh session, suppl. No. 21(A/8721), para. 243, p.60. See E. Menzel, Scientific Research on the Sea-Bed and its Régime, in Symposium on the International Régime of the Sea-Bed, ed. J. Stucki, Rome 1970, p. 646.

11/ Section III of Part II (High Seas) of the draft prepared by the International Law Commission was devoted to the continental shelf. It contained altogether 7 articles (articles 67 to 73); none of them referred to the conduct of marine scientific research on the continental shelf. See Official Records of the General Assembly: Eleventh Session, Supplement No. 9 (A/3159, pp.II and 40-45 and Yearbook of the International Law Commission, 1956, Volume II.

12/ See the resolutions of the International Council of the Scientific Unions of 1954 and of the Assembly of that Council of 1955; the resolutions of the International Union of Geodesy and Geophysics and of the International Union of Biological Sciences (Yearbook of the International Law Commission, 1956, Vol. II, paras. 54-55).

13/ See Official Records of the General Assembly: Eleventh Session, Supplement No. 9(A/3159), p.43. In the commentary (paragraph 10) it was acknowledged that "the proposals made by the Commission in its Report for 1953 caused some anxiety in scientific circles, where it was thought that freedom to conduct scientific research in the soil of the continental shelf and in the waters above would be endangered. Insofar as such researches are conducted in the waters above a continental shelf, this anxiety seems to be

unjustified since the freedom to conduct research in these waters - which still form part of the high seas - is in no way affected. The coastal State will not have the right to prohibit scientific research, in particular research on the conservation of the living resources of the sea. The consent of the State will only be required for research relating to the exploration or exploitation of the sea-bed or subsoil. It is to be expected that the coastal State will only refuse its consent exceptionally, and in cases in which it fears an impediment to its exclusive rights to explore and exploit the sea-bed and subsoil". (Ibid).

14/ On draft-article 68 and on others, relating to scientific research were made about 20 formal proposals. See United Nations Conference on the Law of the Sea: Official Records, Vol. VI, pp. 125-142. Some of them referred explicitly to the importance of marine science and the need to add a special provision stipulating the main purposes and requirements for the conduct of marine scientific research, such as for example, the proposals of Denmark (A/CONF.13/C.4/L.50), Indonesia (A/CONF.13/C.4/L.40 and A/CONF.13/C.4/L.53 Iran (A/CONF.13/C/L.50), Federal Republic of Germany (See Memorandum concerning draft-articles 67 to 73, contained in document A/CONF.13/C.4/L.58 and others.

15/ Suppra, Note 14.

16/ See United Nations Conference on the Law of the Sea, Official Records, Vol. VI, pp.143. Article 71 adopted by the Fourth Committee was much more elaborated than draft-article 71 proposed by the International Law Commission. Most of the additional provisions were related to the conduct of marine scientific research on the continental shelf. (Ibid, document A/CONF.13/L.12, annex). This text then was adopted by the plenary meeting of the Conference, with some drafting amendments, by 50 votes to none with 14 abstentions (See United Nations Conference on the Law of the Sea. Official Records Volume II: Plenary Meetings, p. 15).

17/ Official Records of the General Assembly: Eleventh Session, Supplement No. 9(A/3159), p.43.

18/ Apprehensions about the conditions for the conduct of marine scientific research were expressed also on earlier occasions before and during the 1958 Conference on the Law of the Sea. There were some views that the absence of the explicit inclusion of marine scientific research in the freedom of the high seas was an inadmissible underestimation of oceanic science and also that the requirements for consent for carrying out such research on the continental shelf were tantamount to a serious blow to marine scientific activities. See in this sense O. Freymond, Le Statut de la recherche scientifique marine en droit international, Genève, Librairie de l'Université, 1978. In connexion with the draft article on the continental shelf submitted by the International Law Commission the author states: "L'arrêt de mort de la liberté de la recherche scientifique était signé. Désormais, en effet, la recherche scientifique ne fut plus considérée comme une activité

privilégiée à laquelle il fallait consacrer un régime spécial, mais elle fut traitée en même temps que la navigation, la pêche et la conservation de ressources biologiques de la mer". (Op. cit., pp. 56-57). Perhaps less startling and gloomy but seriously preoccupied anticipations were expressed by many other writers. Professor Roger Revelle, referring to the experience of the American oceanographers in the late sixties, indicated that "the situation concerning freedom of marine scientific research on the continental shelf has rapidly worsened during the last few years. From 1963 to 1966, there were only six instances in which other nations refused requests from American flag vessels to conduct scientific research on their continental shelves or in their territorial seas. From January 1967 to September 1968, there were twelve such refusals. Outright refusal or permission is perhaps less serious than delays that may be interposed by unresponsible or reluctant governments". (See Dr. R. Revelle, Scientific Research on the Sea-Bed. International Co-operation in Scientific Research and Exploration, in Symposium of the International Régime of the Sea-Bed, in J. Stucki, Rome 1970, pp. 659-66)). See also Dr. L.J. Bouchez, The Legal Régime of Scientific Research on the Sea-Bed, in Symposium...pp.597-618; E. Menzel, (op. cit., p. 629 and 646-647); W.T. Burke: Towards a Better Use of the Oceans; Contemporary Legal Problems in Ocean Development. A SIPRI monograph, Stockholm, Almquist and Wiksell, 1969, p. 116, etc.

19/ The new Convention will enter into force in accordance with its article 308, 12 months after the deposit of the sixtieth instrument of ratification or accession. Until that time the Geneva Conventions will be the only multilateral treaty in the field of maritime law adopted under the auspices of the United Nations with a relatively large number of State-parties. For those States the Geneva Conventions and the régime established by them, including the régime on the conduct or marine scientific research, will, naturally, have legally binding force.

20/ The General Assembly established first the Ad Hoc Committee to Study the Peaceful Uses of the Sea-Bed and the Ocean Floor beyond the limits of National Jurisdiction by resolution 2340 (XXII) of 18 December 1967 (Official Records of the General Assembly: Twenty-Second Session, Suppl. No. 16 (A/6716), p.14).

The Ad Hoc Committee held three sessions in 1968. (See Official Records of the General Assembly: Twenty-second session document A/7230). It was substituted by the Committee on the Peaceful Uses of the Sea-Bed and the Ocean Floor beyond the Limits of Nations Jurisdiction (the Sea-Bed Committee), established by resolution 2467(XXIII) of 21 December 1968 (Official Records of the General Assembly: Twenty-third Session, Suppl. No. 18 (A/7218 p. 15). The Sea-Bed Committee was later instructed by the General Assembly resolution 2750(XXV) of 17 December 1970 to undertake preparatory work for the Third Conference of the United Nations on the Law of the Sea, including organizational arrangements related to the convening of the Conference and the preparation of draft-treaty articles on the law of the sea (See Official Records of the General Assembly: Twenty-fifth Session, Suppl. No. 28(A/802)

pp. 26-27). The last session of the Sea-Bed Committee was held from 2 July to 24 August 1973 when the Committee completed its preparatory work and submitted its report with recommendations to the Twenty-eighth session of the UN General Assembly (See Official Records of the General Assembly: Twenty-eigth session, Suppl. No. 21 (A/9021), Vol. VI. The first session of UNCLOS-III was held from 3 to 15 December 1973 in New York and was devoted to organizational matters, while the second - substantive session, was held from 20 June to 29 August 1974 in Caracas.

21/ The Convention on the High Seas came into force on 30 Sept. 1969; The Convention on the Continental Shelf - on 10 June 1964; and the Convention on Fishing and Conservation of the Living Ressources of the High Seas - on 20 March 1966.

22/ See resolution 2574-A(XXIV) of 15 December 1969 (Official Records of the General Assembly: Twenty-fourth session, Suppl. No. 30. (A/7630), p.10.

23/ See resolution 2750-C(XXV) of 17 December 1970 (Official Records of the General Assembly: Twenty-fifth session, Suppl. No. 28, (A/8028), p.26.

24/ Ibid, (A/8028) Res. 2750-C(XXV).

25/ Ibid.

26/ Ibid.

27/ In accordance with resolution 2760-C(XXV) the Sea-bed Committee approved on 18 August 1972 a "list of subjects and issues relating to the law of the sea", which did not pretend to be complete not did it establish the order of priority of their consideration. Nevertheless, the report pointed out that it had been prepared "following a comprehensive approach and attempts to embrace a wide range of possibilities". It may be added that the list contained altogether 96 items under 25 headings. (See Official Records of the General Assembly: Twenty-seventh Session, Suppl. No. 21 (A/8721), pp.4-8.

28/ The idea that the sea-bed and ocean floor and the subsoil thereof beyond the limits of national jurisdiction should be considered as the common heritage of mankind was mentioned by the representative of Malta in his statement at the Twenty-second session of the General Assembly in 1967, when introducing the item on the Sea-bed. In the report of the Ad Hoc Committee on the Sea-bed it was pointed out that a view to this effect was emphasized (See doc. A/7230, p.44). The first Report of the Sea-bed Committee in 1968 pointed out that this concept "was widely supported but not acceptable to all", (See document A/7622, p. 29). The Declaration of Principles Governing the Sea-bed and the Ocean Floor, and the Subsoil Thereof, beyond the limits of National Jurisdiction, adopted by the General Assembly in resolution 2749 (XXV) of 17 December 1970, solemnly declares this concept as a fundamental principle with the legal consequences deriving therefrom. It is now embodied in article 136 of the new Convention on the Law of the Sea.

29/ See the Report of the Sea-bed Committee on its work during 1970, containing several proposals on the conduct of marine scientific research, such as draft-resolution in document A/AC.138/SC.I/L.2, submitted by 15 developing countries; doc. A/AC.138/SC.I/L.4/Rev.I containing draft-resolution submitted by Norway; document A/AC.138/25, containing Draft United Nations Convention on the International Sea-Bed Area, working paper submitted by the United States. In the Study on International Machinery, prepared by the Secretariat, (doc.A/AC.138/23) there were also references to some functions of the International Sea-Bed Authority relating to scientific research concerning the Sea-bed (See Official Records of the General Assembly; Twenty-fifth Session, Suppl. No.21 (A/8021).

30/ See for example the last report of the Sea-bed Committee in 1972, where it was stated that "there was a need to formulate general principles governing oceanic research which, while acknowledging the unity of the marine environment must not ignore the diversity of the régime existing in different marine areas". (Official Records of the General Assembly: Twenty-seventh Session, Suppl. No. 21 (A/8721), p.60. The basic premise about the unity of the marine environment and the need to formulate principles applicable to the conduct of marine scientific research were reflected in the Working Paper on "Principles on Marine Scientific Research" (document A/AC.138/SC.III/L.18) submitted by Canada and the one on "Basic Principles Concerning International Cooperation in Marine Scientific Research" (doc. A/AC.138/SC.III/L.23 submitted by Bulgaria, the Ukrainian Soviet Socialist Republic and the Union of Soviet Socialist Republics (Ibid. pp.203-205 and 206-208, respectively).

31/ The question of consent with respect to the conduct of scientific research in the territorial sea did not raise difficulties in the negotiations, since it was generally recognized that in exercising its sovereign rights the coastal State is entitled to regulate all research activities, and, therefore, such activities could be carried out with its express consent.

32/ In the Report of the Sea-bed Committee in 1972, it was pointed out that "an attempt should be made to distinguish between fundamental oceanographic research and bona fide scientific research and the more practical applied aspects, particularly as they relate to commercial exploitation and military purposes" (Doc. A/8721, p.60, para.244). In 1973 the Report of the Sea-bed Committee containing variants of draft-articles relating to scientific research referred to the two types of research (See doc. A/9021, vol. I, p.71 and p. 123). During the second session of UNCLOS-III there were some proposals on draft-articles relating to scientific research in which the distinction between the two categories of research was implied or explicitly expressed (See United Nations Conference on the Law of the Sea, Official Records, Vol. III, p.267, doc. A/CONF.62/C.3/L.18. See also the Single Negotiating Text in doc. A/CONF.62/WP.8/Part III (Text presented by the Chairman of the Third Committee), articles 18, 19 and 25. UNCLOS-III: Official Records, Vol. IV, pp.177-179).

33/ A/8721, pp. 60-61, para. 245.

34/ Ibid.

35/ Ibid.

36/ A/9021, Vol. I, p. 123. The draft-article referred to was submitted as variant A.

37/ Ibid, Article 63 of variant B.

38/ Ibid, Draft-article 64 of variant B.

39 A/CONF.62/C.3/L.19, Rev. 2 (UNCLOS-III, Official Records, Vol. IV, p. 199).

40/ A/CONF.62/C.3/L.19 (UNCLOS-III, Vol. III, pp. 266-267).

41/ A/CONF.62/C.3/L.26 (UNCLOS-III, Vol. IV, p. 213).

42/ Ibid.

43/ A/CONF.62/C.3/L.29, submitted by Colombia, El Salvador, Mexico and Nigeria (UNCLOS-III, Vol. IV, p. 216).

44/ A/CONF.62/WP.8/Rev. I, Part III (Text presented by the Chairman of the Third Committee). See UNCLOS-III, Vol. V, p. 182.

45/ Ibid.

46/ Report of the Chairman of the Third Committee (UNCLOS-III) Vol. VI, p. 91.

47/ Ibid, p. 142

48/ Ibid.

49/ Paragraph 10 of the Declaration on the Principles Governing the Sea-Bed and Ocean Floor, and the Subsoil Thereof, beyond the Limits of National Jurisdiction, states that "the States shall promote international cooperation in scientific research exclusively for peaceful purposes". Other paragraphs contain more general formulations, relating to the sea-bed area itself, such as paragraph 5 which states that "the area shall be open to use exclusively for peaceful purposes by all States", and paragraph 8 which also declares that "the area shall be reserved exclusively for peaceful purposes". (See resolution 2749 (XXV) of 17 December 1970. Official Records of the General Assembly: Twenty-fifth Session, suppl. No. 28 (A/8028) pp.24-25). The question of the peaceful uses of the seas has been raised on many occasions in international conferences dealing with maritime or general political matters relating to disarmament and international security. This has been the case also with some conferences on the codification of international law. At the first Conference of the United Nations on the Law of the Sea

reference was made to the peaceful uses of the sea. Specific proposals were submitted on the continental shelf draft-articles. The revised amendment of Bulgaria of March 31, 1978 to draft article 71 reads as follows: "The coastal State shall not use the continental shelf for the purpose of building military bases or installations" (Doc. A/CONF.13/C.4 /L.41/Rev. in United Nations Conference on the Law of the Sea. Official Records Vol. VI: Fourth Committee (Continental Shelf) P. 137). Another similar amendment to the same draft-article was presented by India on 1 April 1978, which reads: "The continental shelf adjacent to any coastal State shall not be used by the coastal State or any other State for the purpose of building military bases or installations". (Doc. A/CONF.13/C.4/L.57, Ibid., p. 141). However, the most important development in the field of demilitarization of the ocean space, though partial as it is, was the adoption by the General Assembly on 7 December 1970 of the Treaty on the Prohibition of the Emplacement of Nuclear Weapons and Other Weapons of Mass Destruction on the Sea-bed and Ocean Floor and in the Subsoil Thereof (Resolution 2660 (XXV), Official Records of the General Assembly: Twenty-fifth Session, Suppl. No. 28, (A/8028) pp. II-13.

The principle of the peaceful purposes of marine scientific research, along with the other principles in article 240 of the Convention, was contained in a set of proposed draft-articles submitted by a group of Socialist States. In fact, draft-article 2 entitled "General conditions and principles of conduct of marine scientific research" of that proposal was the basis for the present article 240 (See document A/CONF.62/C.3/L.26), submitted by Bulgaria, the Byelorussian SSR, Czechoslovakia, German Democratic Republic, Hungary, Mongolia, Poland, Ukrainian SSR and the USSR: Draft-articles on marine scientific research (UNCLOS-III, Official Records, Vol. IV, p. 213).

50/ UNTS, Vol. 402, p. 71

51/ UNTS, Vol. 480, p. 43.

52/ Official Records of the General Assembly: Twenty-first Session, Suppl. No. 16 (A/6316), res. 2222(XXI) of 19 December, 1966

53/ Official Records of the General Assembly: Twenty-fifth Session Suppl. No. 28 (A/8028) Res. 2660 (XXV) pp. II-I3.

54/ Official Records of the Gerneral Assembly: Twenty-fifth Session Suppl. No. 28 (A/8028), pp. 121-124, resolution 2625 (XXV)) of 24 October, 1970.

55/ Ibid.

56/ Ibid.

57/ See for example articles 200, 201 and 202 on research programmes, scientific criteria for the establishment of rules, standards and practices for the protection and preservation of the marine environment, as well as the carrying out of programmes for scientific and technical assistance to developing countries; Article 123 on the cooperation in all fields of marine activities among States bordering enclosed and semi-enclosed seas; Article 255 on the duty to facilitate marine scientific research and assist research vessels; and other provisions relating to international cooperation;

58/ See articles 263 (on liability and responsibility), 264, 265, 297 and the relevant provisions of Part XV (Settlement of disputes); articles 55-56-58 and 61-67 (on the régime of the exclusive economic zone); article 74 (on the continental shelf) as well as the pertinent provisions in Part XIII of the Convention (articles 258 to 262 relating to scientific research installations and equipment in the marine environment);

59/ It may be pointed out that provisions of the Convention dealing with the legal status of various maritime zones, or the regulation of activities carried out therein, bear also upon the régime of scientific research. This is the case, for example, with articles 19, 21, 40, 52 and 54, on innocent passage in the territorial sea through the international straits or in the archipelagic waters, and other provisions of the new Convention;

60/ See Dr. Revelle, Op. cit., p. 650.

61/ A general estimate on the number of provisions dealing with marine science and its application would support this submission. Undoubtedly, figures alone, however impressive they might be, could not justify general appraisals. Nevertheless, it is to be noted that on the subject-matter under consideration there are about 15 articles in Part V (Exclusive Economic Zone), 12 articles in Part XI (The Area), 6 articles in Part VII (high Seas), 5 articles in Part VI (Continental shelf), and some provisions in other parts of the Convention. About 17 articles deal with the role of marine science in the protection and preservation of the marine environment;

62/ See document E/1980/68 containing the Report of the Secretary-General of the United Nations on the Uses of the Seas;

63/ See articles 19, 21, 39, 40, 45, 52 and 54 of the Convention.

64/ See the last Report of the Sea-bed Committee in 1972 (Official Records of the General Assembly: Twenty-seventh session Supplement No. 21 (A/8721), paras. 239-241, p. 59).

It should be also mentioned that several proposals were submitted, which reflected the paramount importance of oceanic research for the effective national and international efforts to combat pollution of the marine environment (Ibid, Doc. A/AC.138/SC.III/L.25 and A/AC.138/SC.III/L.26);

65/ See for example C.E. Curtis and J.N. Barnes, Deep-sea Mining and the Environment, 3 August 1981, The Environmental Impact of Ocean Mining, Ocean Minerals Company, Deep Ocean Mining Environmental Study (DOMES), U.S. Dept. of Commerce;

66/ See for example articles 202, 203, 244, 266, 269, 272, 274, 276, 277 and others.

INTERNATIONAL COOPERATION IN MARINE SCIENTIFIC RESEARCH AND IN THE DEVELOPMENT AND TRANSFER OF MARINE SCIENCE AND TECHNOLOGY IN THE CONVENTION ON THE LAW OF THE SEA WITH PARTICULAR REFERENCE TO THE ATTENTION PAID TO THE INTERESTS OF DEVELOPING COUNTRIES

Maria Eduarda GONÇALVES

Junta Nacional de Investigaçao Científica
e Technológica (JNICT)
Lisbon
Portugal

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INTRODUCTION

The fundamental role of science and technology in the economic and social development of all countries is well recognized today. This is particularly so in the context of the general process underway within the United Nations for the establishment of a New International Economic Order.

Particularly significant in this regard is the Charter of Economic Rights and Duties of States - adopted with the declared purpose of promoting the establishment of such an Order 1/ - which determines that every State has the right to benefit from advances and developments in science and technology for the acceleration of its economic and social development (Art. 13, para. 1). Such a right should be understood as conditional on effective exercise of the right of States to full permanent sovereignty over their natural resources and economic activities stipulated by the same Charter (Art. 2).

The need for a New International Economic Order mainly arose from perception of the vast inequalities that exist in the distribution of wealth and power at world level, one of the characteristic features of which is the differences in scientific and technological capacities of States. Developed countries dominate the field of science and technology to the extent that around 95 per cent of all research is executed by them, while developing countries, which represent 70 per cent of the world's population, have only about 5 per cent of the world's research capacity 2/.

This is presumably the reason why the above-mentioned Charter, while establishing the general duty of States to engage in scientific and technological cooperation (Art. 13, para. 2, first part) provides for a special obligation for them to facilitate access of developing countries to the achievements of modern science and technology, transfer of technology and the creation of indigenous technology for the benefit of the developing countries in forms and in accordance with procedures which are suited to their economies and their needs (Art. 13, para. 2, second part). Without prejudice to the principle that the responsibility for the development of each country rests primarily upon itself (Preamble of the same Charter), developed States are especially called upon to cooperate with developing countries in the establishment, strengthening and development of their scientific and technological infrastructure and their scientific research and technological activities so as to help to expand and transform their economies (Art. 13, para. 3). The interests of these countries should also be taken fully into account in formulating guidelines and regulations for the transfer of technology (Art. 13, para. 4).

The 1982 Convention on the Law of the Sea should be viewed as part of the effort by the United Nations to give substance to a New International Economic Order.

The Preamble of the Convention reflects the underlying philosophy when it recognizes that the Convention aims at establishing "a legal order for the seas and oceans which would facilitate international communication and promote their peaceful uses, the equitable and efficient utilization of their resources, the study, protection and preservation of the living resources thereof" and considers that "the achievement of such goals will contribute to the realization of a just and equitable international economic order which would take into account the interests and needs of developing countries, whether coastal or land-locked...".

In this context, the consideration that access to marine science and technology is an essential condition for the effective exercise of the rights and the fulfilment of the responsibilities assigned to States under the Convention and ultimately, for their taking advantage of the new opportunities for economic and social development arising therefrom, led to special attention being paid to the role of such factors and associated aspects of international cooperation in the elaboration of the Convention.

The Convention reflects the concern for defining a juridical framework favourable to the creation of conditions for all States, and in particular, those that are developing, to participate in marine scientific research and to have access to marine scientific and technological knowledge, through the establishment of more just and equitable international relations in these fields insofar as is required for rational management, exploration and exploitation of the oceans and their resources. This becomes apparent particularly from provisions which deal with the general régime for marine scientific research and the development and transfer of marine technology and from those concerning both these issues in connection with the régime for the sea-bed area.

In this regard, it should be recalled that participation in marine scientific research and technological development activities cannot be seen independently from the promotion and reinforcement of national scientific and technological capabilities in the same fields. In fact, all these aspects are interdependent. From the standpoint of developing countries, transfer of science and technology should therefore not mean simply acquiring scientific and technological knowledge produced abroad, but obtaining an adequate degree of autonomous capability which may enable them to make their own choices in that regard, to adapt technologies to local conditions and, ultimately, to participate, on an equitable basis, in research and development relating to the oceans. Reference should be made in this respect to the resolution or development of national marine science, technology and ocean service infrastructures approved by the conference at its 11th session. 4/

Some international instruments have been adopted or are being negotiated in specialized fora of the United Nations which deal, in general terms, with the issues of the strengthening of scientific and techological capabilities and the transfer of technology. These are, for instance, the cases of the Vienna Programme of Action on Science and Technology for Development adopted by the United Nations Conference on Science and Technology for Development

(UNCSTD) 5/, and of the Code of Conduct on the International Transfer of Technology being negotiated under the auspices of the United Nations Conference on Trade and Development (UNCTAD) 6/. The content of such instruments should also be taken into account in the interpretation and application of the Convention on the Law of the Sea. One could point out, however, that, at least formally, the text approved by UNCLOS III will have stronger juridicial force.

I present here a general review of some relevant features of Parts XIII (Marine scientific research), XIV (Development and Transfer of Marine Technology) and XI (The Area) of the Convention on the Law of the Sea, taking especially into account the consideration given in the respective provisions to the creation of conditions for a reinforcement of the marine scientific and technological capabilities of developing countries, and to the role of international cooperation in the pursuance of these objectives.

1. MARINE SCIENTIFIC RESEARCH

As a complement to the sovereign rights of coastal States for the purpose of exploring and exploiting, conserving and managing the natural resources, whether living or non-living, as well as with regard to other activities for the economic exploration and exploitation of their exclusive economic zones (Art. 56) the jurisdiction which is conferred on coastal States with regard to marine scientific research may be understood as a means of enabling those States to exercise increased control over activities for the acquisition of knowledge of the characteristics of marine resources and ecosystems of those zones - such knowledge being decisive for an adequate exploitaion, management and utilization of resources therein. It may offer, particularly to developing countries, the opportunity for them to benefit directly or indirectly from foreign research conducted in areas undernational jurisdiction, either in terms of participation in such research activities or of access to the results, and thereby to contribute to reinforcing their scientific and technological capabilities.

In spite of the compromises reached at UNCLOS III between the interests of coastal and researching States (this being the principal dichotomy of interests in the context of negotiations on the régime for marine scientific research) the latter expressed their reservations as to the powers conferred on coastal States, which, according to the detractors of the régime, could authorize them to impose unacceptable conditions for research to be conducted by foreigners in areas under national jurisdiction 1/ . They argued that the régime to be adopted was likely to hamper not only the interests of researching States, but also the global interest of mankind in the progress of scientific knowledge.

One could argue, however, that the conflict between the interests of coastal and researching States is more apparent than real. Indeed the effective pursuance of the goals of coastal countries, particularly developing ones, under the new régime implies that conditions be created for the conduct of marine research in their exclusive economic zones and over their continental shelves. Yet, under the present circumstances, and at least for the immediate term, the industrialized, in this context, researching States are more likely to contribute a larger share of the effort to acquire relevant knowledge.

It thus appears that the reconciliation of the interests involved in the issue of marine scientific research is to a large extent dependent upon cooperation among the States concerned, based on their common interest in the conduct of marine scientific research in such areas 2/. This is explicitly recognized by the Convention, which includes one Section (Section II) in Part XIII, dealing specifically with "International cooperation" for marine scientific research.

Notwithstanding its essentially conciliatory nature, international cooperation, as it emerges from the relevant provisions of Part XIII of the Convention could be seen from two different angles, depending on the prior objectives to be pursued and the principle interests involved in such cooperation. One approach is to seek international cooperation with a view to creating conditions favourable for the conduct of marine research in the interest of the researching State and, theoretically at least, of all States or the international community as a whole (e.g. Arts. 243, 244, para. 1 and 255 para. 1); and the other is the international cooperation aimed at promoting the participation by coastal countries, particularly developing ones, in marine research activities, which implies that the facilities need to be provided for those countries to have access to the scientific and technological means (taking into account their human, material and financial components), to enable them to engage autonomously in such activities (e.g. Art. 244, par.2). The interests involved would, in the first approach, be mainly those of the researching and the coastal States, whereas in the second approach, those of the developing (coastal) and developed (researching) States. In the first case, the interest of the researching State would be the determinant one, while in the second case, preference should be accorded to the interest of the developing (coastal) State.

This should be understood simply as expressing two facets reflecting groups of interests and not as a dichotomy of categories of international cooperation; in fact, both aspects would in many cases go together, precisely as a condition for arriving at an accommodation of the interests involved in the issue of marine scientific research in areas under national jurisdiction. Seen in that perspective, some provisions of Part XIII, which follow the first approach, moderate the powers of coastal States with regard to marine scientific research activities to be conducted by foreigners in areas under national jurisdiction, in as much as they stipulate various obligations of States, whatever their level of development to cooperate through the provision of facilities for such activities.

This is the case, for instance, of their duty "to endeavour to adopt reasonable rules, regulations and procedures to promote and facilitate marine scientific research conducted in accordance with this Convention beyond the territorial sea" (Art. 255, para. 1) or, in a more general way, to facilitate international cooperation for the conduct of marine scientific research in the marine environment and to integrate the efforts of scientists in studying the essence of phenomena and processes occurring

in the marine environment and the relation between them"(Art. 243). At the same time the latter provision could be viewed as furthering the progress of marine research, and knowledge resulting therefrom, to benefit all countries, including those that are developing. One could also regard this as following from the injunction to States "to make available by publication and dissemination, information on proposed major programmes and their objectives as well as knowledge resulting from marine scientific research" (Art. 244, para. 1).

Provisions of Part XIII, which follow the second approach although aimed at expanding the opportunities for coastal States to participate in research and to receive scientific and technical assistance from external sources, may help in facilitating the coastal States' consent to foreign entities for research in areas under national jurisdiction.

For the purpose of the present analysis, this approach presents particular relevance. According to it, the main interest to be pursued through international cooperation would be that of coastal States, in particular developing ones, to participate in research activities and accede to the respective results and, simultaneously to further their capabilities, namely through education and training of their nationals for engaging in scientific and technological activities. Indeed the creation of favourable conditions for research in areas under national jurisdiction presupposes that special consideration be paid to the needs and interests of developing countries in view of the new rights and responsibilities with which they will be obliged to comply. Accordingly, the duty of States to actively promote, directly or through competent international organizations, the flow of scientific data and information and the transfer of knowledge resulting from marine scientific research, especially to developing States, is expressly recognized (Art. 244, para.2). One could argue that the obligation to disseminate scientific knowledge appears as a general duty of all States (in Art. 244, para. 1). However, if seen from the point of view of developing countries, the accent is put on "programmes to provide adequate education and training of their technical and scientific personnel in order to strengthen their autonomous marine scientific research capabilities" (Art. 244, para. 2).

Also in the context of the régime for marine scientific research in the exclusive economic zone and continental shelf, a possible accommodation of the potentially conflicting interests of the researching and the coastal States is sought through providing opportunities for these States to participate in research projects and to have access to scientific and technological knowledge and correlative external assistance, as conditions to be fulfilled by the researching States or organizations, when applying for the conduct of marine scientific research in such spaces.

So, the States or competent international organizations which intend to undertake scientific research activities in the exclusive economic zone or on the continental shelf of a coastal State jurisdiction shall provide this State with a full description of the project, including reference to the extent

to which it is considered that the coastal State should be able to participate or to be represented in the project (Art. 248 (f)). Moreover, when undertaking the project, the researching States or organizations shall (a) ensure the right of the coastal State if it so desires to participate or to be represented in the project, specially on board research vessels and other craft or scientific research installations, when practicable, without payment of any remuneration to the scientists of the coastal State and without obligation to contribute towards the costs of the project; (b) provide the coastal State at its request with preliminary reports as soon as practicable, and with the final results and conclusions after the completion of the research; (c) undertake to provide access for the coastal State at its request to all data and samples derived from the marine scientific research project and likewise to furnish it with data which may be copies and samples which may be divided, without detriment to their scientific value; (d) if requested, provide the coastal State with an assessment of such data, samples and research results or provide assistance in their assessment or interpretation (Art. 249, para. 1).

It should be pointed out, however, that from the opportunities open to the coastal States for participating in research activities conducted in marine spaces under national jurisdiction in conformity with Art. 248 and Art. 249, it does not necessarily follow that they intervene directly in the formulation of the research project in order to introduce adjustments in it which would virtually make it more consistent with the needs and interests of those States 3/ . Moreover, for the immediate term at least the possibilities for coastal States representatives to participate in research conducted by foreign entities will depend on their marine science capability. Both these factors seem to limit significantly the foreseeable scientific and technological impact of co-operation between researching and coastal States under Part XIII.

It is, nevertheless, possible to envisage that, in concrete situations, the conduct of research by foreigners would be facilitated by their acceptance of negotiating not only the participation by nationals of the coastal States in the research project under the best possible conditions, but other counterpart measures, such as assistance to education and training of nationals of these States and even association with the preparation of the content of the research project itself 4/

One could add that, if it is true that projects of a certain nature (e.g. those referred to in Art. 246, para 5(a)), are submitted to a strict régime of consent due to the direct interest of coastal States in controlling access to and reserving the knowledge resulting from marine scientific research in their national interest, such are, simultaneously, projects which the coastal State may be interested in stimulating, particularly through foreign participation, in view of the fact that it may not possess the means required.

However, it seems that, if the goals of developing coastal States are to be achieved fully, technical assistance not related to any particular cruise or the results thereof will, in any case, be necessary 5/ . Joint research programmes, especially on a bilateral or multilateral institutionalized, basis 6/ - as under the auspices of international organizations -

are more likely to contribute significantly to the objectives of those countries.

I conclude from this overview of the régime applicable to marine scientific research (Part XIII) and of the opportunities it may open for the promotion of scientific and technolgical capabilities of coastal developing countries, that the mechanisms provided for will tend to operate merely as complementary to national and international efforts aimed at that end. Technical assistance to be furnished in connection with foreign research projects conducted in the exclusive economic zone or on the continental shelf of developing coastal States would be part of the deal normally to facilitate access. Only as far as that would appear to be necessary for obtaining consent, and presumably without detriment to the original ends of the project, efforts might be sought to adjust the project to research priorities defined by the coastal State. In that context, cooperation would not be directed per se to the promotion of national scientific and technological capabilities of coastal States. 7/

2. DEVELOPMENT AND TRANSFER OF MARINE TECHNOLOGY

Part XIV of the Convention provides, in a specific and extensive way, for creation of the legal and institutional conditions for a more balanced distribution of marine science and technology at the world level, inasmuch as these factors constitute essential requirements for the exercise of all maritime activities, including marine scientific research itself.

In fact, provisions of Parts XIII and XIV are, to a certain extent, commplementary. This is so as far as access to appropriate technologies is required for conducting marine scientific research or, inversely, as far as the development and transfer of marine technology imply the facilitation of marine scientific research.

It should be pointed out in this regard that Part XIV of the Convention covers not only the transfer but also the development of technology 1/ . Indeed, in accordance with the goals of a New International Economic Order, what is envisaged is not only that developing countries acquire the technologies needed for carrying out maritime activities, in ameliorated terms and conditions, but also that they obtain an autonomous scientific and technological capability which may enable them to choose, to assimilate and to adapt imported technologies, as well as to produce new ones - this presupposing that they engage directly in scientific research 2/.

Therefore, an effective development and transfer of marine technology implies that a set of conditions is met from the point of view of the characteristics of the mechanisms for transferring technology, as well as from that of the capacities of recipients.

With regard to the first aspect, one could recall that, under the present circumstances, industrialized States, among which most producers and exporters of technology are to be found, agree simply to adhere to some general and flexible international engagements to initiate action concerning the trade of technologies. Indeed, recipient countries are generally those which have taken legislative and administrative measures on transfer of technology transactions 3/ . In contrast, developed States traditionally grant legal protection to producers and holders of technology through industrial property rights.

This may explain that the Convention limits itself to prescribing the duty of States "to endeavour to foster favourable economic and legal conditions for the transfer of marine technology for the benefit of all parties concerned on an equitable basis" (Art. 266, para. 3), or "to endeavour to promote favourable conditions for the conclusion of agreements, contracts and other similar arrangements under equitable and reasonable conditions" (Art. 269 (b)).

Such provisions should be viewed in connection with international instruments being elaborated in other United Nations Conferences, such as the UN Conference on the International Code of Conduct on the Transfer of Technology. Besides, the Convention on the Law of the Sea does not enter into details concerning certain issues which are the object of negotiation in that Conference such as national regulations on the transfer of technology transactions, restrictive businesss practices and guarantees, 4/. It should be noted, however, that according to Art. 271, States shall "promote the establishment of generally accepted guidelines, criteria and standards for the transfer of marine technology on a bilateral basis or within the framework of international organizations, and other fora, taking into account in particular the interests of developing States. This reflects concern with the characteristics of the transfer of technology process. On the basis of this provision, special agreements may be envisaged on the transfer of marine technology which could complement, through more precise language, the above-mentioned provisions.

In any case, the Convention limits itself, through very general, virtually non-binding, formulations, to encourage certain courses of action of States with regard to the commercial transactions on the transfer of technology. This reduces the potential effectiveness of the provisions in question. In spite of the formal juridical force of the Treaty in international law, no significant changes are thus to be expected in the present system of international trade relations affecting the transfer of marine technology.

It follows that it will presumably still be the degree of expertise and access to information, and the effective powers and means of States to intervene in the authorization and control of foreign investment and in the transfer of technology, which will determine the nature and effects of arrangements between suppliers and recipients of marine technology.

In view of the serious difficulties faced by developing countries which result from the characteristics of the market for technologies, together with the low level of their scientific and technological capabilities, mechanisms and procedures other that those of commercial nature are needed to enlarge the scope of scientific and technological knowledge available for the benefit of such countries, as well as for creating the foundations for strengthening their infrastructures in this field.

International cooperation, among States directly or through international organizations, is then called for to play a relevant role in the implementation of provisions of Part XIV of the Convention.

International cooperation under Part XIV could be regarded (similarly to what was suggested for international cooperation relating to marine scientific research) from two different points of view depending on whether the levels of development of the States involved are or not explicitly taken into account: international cooperation aimed at promoting the flow of marine science and technology, in general, and international cooperation aimed at the promotion of the development and transfer of marine science and technology specifically directed to the needs and interests of developing countries, thus implying the creation of the necessary human, material and institutional infrastructures.

Examples of the first approach may be found in Art. 266, para. 1 and, to a certain extent, in para. 3 of the same article. Art. 270 also refers to conditions for a more significant and effective international cooperation in this field, namely "expanded and new programmes", "particularly in new fields" and "appropriate international funding".

Of course, the "developing ideology" 5/ of the New International Economic Order should be taken into account in the interpretation of any provision of the Convention. The attention paid to the special situation of the developing States is also apparent from the introductory article of Part XIV (Art. 266, para. 1) from the prescription that the duty to cooperate, although being a general one, should be subject to the consideration of the capabilities of the States in question.

The second approach is explicitly reflected in Art. 268 and Art. 269 which determine, respectively, the "basic objectives" and the "measures to achieve the basic objectives" of the development and transfer of marine technology. These articles refer, in a non-exhaustive manner, to objectives and mechanisms which have been pursued or experienced in scientific and technological cooperation developed in the past, particularly in the framework of international organizations 6/. However, special emphasis is put on the urgency of an expansion and reinforcement of programmes and of the initiation of new programmes in view of the new needs faced by developing countries to answer adequately the challenges posed by the Convention.

International organizations appear together with direct bilateral and multilateral relations among States, as instrumental mechanisms for States to cope with their duties to cooperate. Indeed States are the subjects par excellence of international law 7/. Nevertheless, the wording of some articles of Part XIV could raise doubt as to whether such entities are subjects of rights and obligations 8/.

In fact, international organizations, particularly the Specialized Agencies of the United Nations, have mainly had a role of promoting and coordinating international cooperation in marine scientific research 9/ and in the development and transfer of marine science and technology through providing training and education, equipment and so on, assisting those States more in need in the development of their potentials in marine science and technology 10/. Whatever the case may be, the quantitative and qualitative importance of references to the functions of "competent international organizations" in the Convention is symptomatic of the increased role they are expected to play in the implementation of Part XIV. This is the case with respect to Arts. 268 and 269. The content of the Resolution on "Development of National Marine Sciences, Technology and Ocean Service Infrastructures" should also be taken into account when interpreting and applying those articles, particularly as it recommends that "all competent international organizations within the United Nations system expand programmes within their respective fields of competence for assistance to developing countries in the field of marine science technology and ocean services ...".

Of much relevance in this context are provisions on "National and Regional Marine Scientific and Technological Centres" (Section 3 of Part XIV), for the strengthening or establishment of which international organizations are expected to play a decisive role as well.

The multidisciplinary scope of such institutions is apparent from the relevant provisions (Arts. 275, 276 and 277). National centres are intended to stimulate and advance the conduct of marine scientific research by developing coastal States and to enhance their national capabilities to utilize and preserve their marine resources for their economic benefit. With that in view, States, through competent international organizations, shall give adequate support to providing advanced training facilities and necessary equipment, skills and know-how as well as technical experts in the various marine disciplines to such States which may need and request such assistance. The establishment is also foreseen of regional centres. These should maintain adequate links with national centres and be assigned a special task in the stimulation and advancement of the conduct of marine scientific research by developing States and the fostering of the transfer of marine technolgy. An obligation of all States of a region to cooperate with the regional centres therein is also stipulated.

It may also be noted that the Resolution referred to above considers that "national and regional marine scientific and technological centres would be principal institutions through which States, and, in particular, the developing countries, foster and conduct marine scientific research and receive and disseminate marine technology". It further recognizes the

"special role of the competent international organizations envisaged by the Convention on the Law of the Sea specially in relation to the establishment and development of national and regional marine scientific and technological centres".

Increasing demands from developing States are expected to be presented to international organizations, especially those that are part of the United Nations sytem. The situation emerging from the extension of the limits of national jurisdiction by coastal States is already lifting the level of the needs of international cooperation in this field because of the perception on the part of these States or the difficulties they face in fulfilling their responsibilities and exercising their rights in the newly created maritime zones.

A reinforcement of the efficiency of such institutions is therefore urgently needed for responding to the new demands, and this is particularly so in the fields which concern us here.

A final aspect to be emphasized in connection with international cooperation aimed at creating favourable conditions for such objectives to be pursued is brought in by the final provision of Part XIV of the Convention which deals with cooperation among international organizations (Art. 278) 11/. The need underlying this provision follows, on the one hand, from the multidisciplinary and interdisciplinary character of ocean affairs. On the other hand, reasons of economy and efficiency also imply the rationalization through more effective coordination at global and regional levels of the activities of the various international institutions with competence in the field of marine science and technology.

3. MARINE SCIENTIFIC RESEARCH AND DEVELOPMENT AND TRANSFER OF MARINE SCIENCE TECHNOLOGY RELATING TO ACTIVITIES IN THE SEA-BED AREA

The régime applicable under the new law of the sea to the development and transfer of marine science and technology, as well as to the promotion of the scientific and technological capabilities required for exploring and exploiting the mineral resources of the sea-bed beyond the limits of national jurisdiction, presents some special features. These follow from the legal status of the "Area" (Part XI), which is defined in the Convention on the Law of the Sea, as the "common heritage of mankind" (Art. 136) and particularly from the functions which, as a consequence, have been assigned to the International Sea-bed Authority, an international entity to be created for administering the Area on behalf of mankind (Arts. 137, para. 2 and 153, para. 1).

Although extensions of national jurisdiction provide at this time the strongest impetus for strengthening the marine sciences of coastal countries, the possibility of their participating actively in the peaceful investigation of the sea-bed and ocean floor and subsoil thereof beyond the limits of national jurisdiction must not be overlooked 1/. Such

participation constitutes a necessary condition for the expansion of opportunities for participation in the conduct of activities in the Area and namely for the effective participation of developing countries in such activities, as provided for in the Convention (Art. 150 (c) and Art. 148).

Only such a prospect appears to be compatible with an equitable utilization of the oceans and their resources as well as with the principle of the "common heritage of mankind" the exploration and exploitation of which shall be carried out for the benefit of mankind as a whole.

The Convention establishes the right of "States Parties" to carry out marine scientific research in the Area (Art. 143, para. 3). In spite of the apparently limitative character of the subjects of such right (only "States parties" would, according to a literal interpretation, be entitled to it), the provision that "marine scientific research shall be carried out in accordance with Part XIII(Art. 143, para. 1) leads us to admit, in conformity with Art. 238 of Part XIII, the existence of a right of "all States", to conduct marine scientific research in the Area.

The special nature of the régime for the Area led to special rights and responsibilities to be assigned to the International Sea-bed Authority in marine scientific research. Such rights and responsibilities should be viewed in connection with the competences of that Organization as administrator of activities to be conducted in the Area, as well as with the operational functions it shall carry out through the Enterprise (Art. 158, para. 2, Art. 170 and Annex IV, Statute of the Enterprise). The latter responsibilities, in particular, make it necessary for the Authority to take measures to acquire technology and scientific knowledge relating to activities in the Area.

The Authority is thus entitled to carry out marine scientific research concerning the Area and its resources, and to enter into contracts for that purpose. It shall promote and encourage the conduct of marine scientific research in the Area, and coordinate and disseminate the results of such research and analysis when available (Art. 143, para. 2). The Authority shall, in addition, encourage the conduct of prospecting in the Area (Annex III, Art. 2, para. 1(e)).

Activities in the Area shall be "organized, carried out and controlled" by the Authority. "Activities in the Area" mean, for the purposes of the Convention, simply "all activities of exploration for, and exploitation of, the resources of the Area (Art. 1, Use of Terms). They do not cover, therefore, marine scientific research not intended to be the basis for exploitation of the resources of the Area which is to remain free. It seems, neverthless, legitimate to admit that the legal nature of the Area and the régime resulting therefrom may impose at least moral duties on researchers, for purposes of cooperation and information exchange with a view to furthering the opportunities for the personnel of the Authority and of developing countries to participate in research activities in the Area and have access to knowledge resulting therefrom.

In addition, a general duty of promoting international cooperation in marine scientific research in the Area is imposed on States parties (Art. 143, para. 3), which shall participate in international programmes and ensure that programmes are developed through the Authority and other international organizations, and effectively disseminate the results of research and analysis (Art. 143, para. 3(a), (b) and (c)).

Access to technologies needed for exploring and exploiting the sea-bed raises problems of a special nature. Such technologies being of recent production by a limited number of enterprises in some highly industrialized countries, and not yet commercialized, apprehensions were expressed in the course of UNCLOS as to whether in the absence of compulsory mechanisms applicable to the relations between the Authority and national operators, the former would dispose of the required technology which would allow them to initiate exploitation of the mineral resources of the Area. Indeed, the feasibility of the régime for the Area could be in question.

Special provisions have consequently been inserted in the Convention which provide for special undertakings of national investors with a view to making available to the Enterprise the technology they use in carrying out activities in the Area under contracts concluded with the Authority 2/. Such provisions are intended to create conditions for the Authority to become a viable and effective international mechanism and so to give a real expression to the principle of the "common heritage of mankind". Accordingly, transfer of such technology to developing countries does not, in principle, deserve special consideration and is subject to the general provisions contained in Part XIV of the Convention, under which, as has been pointed out before, developing countries should benefit from a special treatment in view of their special needs in fields concerned. Art. 273 of Part XII mandates States to cooperate actively with competent international organizations and the Authority to encourage and facilitate the transfer to developing States and their nationals of skills and marine technology with regard to activities in the Area. One could emphasize in this respect that under Part XII, the subjects of the relationships to be established for the transfer of marine technology would normally be the Authority, on the one hand, and a private enterprise or a State, on the other, and only subsidiarily, two or more States.

A special situation is nevertheless foreseen in which national operators in the Area would be required to take the same measures as are prescribed for the transfer of technology to the Authority, for the benefit of a developing State or a group of developing States (Annex III, Art. 5, para. 3).

It is obvious that access to scientific and technological knowledge for exploring and exploiting the sea-bed is not a sufficient condition for the Authority to engage in the research and exploitation of sea-bed resources, as well as in the adminsitration and control of the whole of activities involved in a rational and effective manner 3/.

An essential additional requirement is the availability of manpower with the appropriate scientific, technological and managerial capabilities which may enable it not only to understand available scientific data and technologies, but to develop technologies further. The administrative and operational responsibilities incumbent upon the authority naturally call for special focus on education and training in deep sea mineral development. This should be seen in connection with the duty of the Authority to pay due attention to the importance of recruiting its staff on as wide a geographical basis as possible (Art. 167, para. 2).

Attention should also be paid in this regard to the fact that the Authority itself is charged with special responsibilities for furnishing technical assistance to developing countries through training in the managerial research and technical aspects of sea-bed mining and access to technical documentation on relevant equipment, machinery, devices and processes, facilitating their acquisition by developing countries and the acquisition by their nationals of the necessary skills and know-how including professional training (Art. 144 and Art. 274). One could also envisage that technologies transmitted to the Authority by national operators in the Area could be transferred to developing countries and their nationals with the cooperation of the latter.

Moreover, the Convention establishes general obligations for States to promote international cooperation in marine scientific research in the Area through participation in international programmes and encouragement of cooperation in marine scientific research by personnel of different countries and of the Authority; to ensure that programmes are developed through the Authority or other international organizations as appropriate for the benefit of developing States and technologically less developed States with a view to strengthening their research capabilities to train their personnel and the personnel of the Authority in the techniques and applications of research; to foster the employment of their qualified personnel in research in the Area and to effectively disseminate the results of research and analysis when available, through the Authority or other international channels when appropriate (Art. 143, para. 3). Obligations are also stipulated for all states to promote programmes for the transfer of technology to the Enterprise and to developing States with regard to activities in the Area, as well as measures directed towards the advancement of the technology of the Enterprise and the domestic technology of developing States, particularly by providing opportunities to personnel from the Enterprise and from developing States for training in marine sciences and technology and for their full participation in activities in the Area (Art. 144, para. 2). Specific engagements are incumbent upon operators in the Area to be defined in more precise terms in their plans of work concerning specifically the transfer of data (Annex III,Art. 14) and training (Annex III, Art. 15).

It follows that opportunities for creating national scientific and technological capabilities, in particular in developing countries, relating to activities in the Area, emerge from the Convention. However, in view of the international system constructed on the basis of the concept of the "common heritage of mankind", the relevant provisions are mainly directed to creating the scientific and technological conditions for the Authority to have the appropriate and necessary capabilities and for the Enterprise to have the required technologies to ensure the effective implementation of the objectives of Part XI of the Treaty.

CONCLUSION

Under the Convention on the Law of the Sea adopted by the Third United Nations Conference on the Law of the Sea, new rights and duties of States have been established in respect of major uses of the oceans and their resources, and related activities, including marine scientific research and the development and transfer of marine technology.

The Convention has been elaborated in the context of defining the objectives, instruments and principles of a New International Economic Order, implying a restructuring of present international relations through the replacement of the traditional rule of reciprocity by preferential treatment to be granted to developing countries in view of their special needs and interests. Accordingly, attention has been paid in the text of the Convention to creating conditions favouring access by developing countries to the scientific and technological means required by them to be able to exercise the rights, and comply with the duties, resulting from the Convention, and to participate on an equitable basis in maritime activities.

Provisions indeed have been included in Parts XIII (Marine Scientific Research) and XIV (Development and Transfer of Marine Technology) which reflect such concerns particularly in imposing duties on States to cooperate with each other, directly or through international organizations, in scientific research, in exchanging scientific information, and knowledge and in promoting the establishment of a national, regional and international infrastructure for the development and transfer of marine technology.

One should not overlook, however, that such provisions were the result of compromises built over underlying conflicting interests. So, under Part XIII, the principal dichotomy of interests puts coastal and researching States face to face. The facilitation of participation by the former in research activities conducted by the latter, or of their access to the results of research - including assistance in their interpretation and evaluation - is potentially made a condition for the concession by coastal States of their consent to projects to be carried out by researching States in their exclusive economic zones or on their continental shelves.

The researching States appear, in this context, as the "demanding" parties which may be required by coastal States to furnish certain kinds of technical assistance in return for their being authorized to conduct research in areas under the coastal State's jurisdiction. Marine science and technology would normally constitute part of the deal to facilitate access.

One should point out, however, that the dichotomy of interests in this issue does not coincide necessarily with that between developing and developed States. It seems, therefore, that only the goal of promoting national scientific and technological capabilities may be pursued under this framework only in a subsidiary manner.

In contrast, with regard to the question of the development and transfer of marine technology the interests which are in principle in contradiction are those of developed and developing countries, or, in other words, of holders and recipients of technology. Under Part XIV, the demanding nature of the position of developing States becomes more apparent. The relationship to be

established for the transfer of marine science and technology would, in normal circumstances, not be based on reciprocal counterparts from the parties, but would make special responsabilities incumbent upon developed States. Indeed the duties to cooperate which emerge from provisions of Part XIV are to be regarded in accordance with the different capabilities of the States involved. The Convention states this in Art. 266. This may explain the vague and general formulation of the corresponding provision, the only one the "donors" would be willing to accept.

As to the rules applicable to the Sea-bed Area (Part XI), the interests involved in marine scientific research and the transfer of marine technology relating to activities in the Area could be said to be those represented by the Authority and those of States and/or entities interested in operating in the Area. While the régime for marine scientific research in the Area does not seem to raise special difficulties in view of the relative freedom which has been accorded to States, the rules for the transfer of technology are still an object of controversy since they impose special obligations on operators in the Area for transferring technology to the Authority. These have been said by industrialized States to be unacceptable, in that they would put into question the present system of property rights.

As far as action for promoting the scientific and technological capabilities of the personnel of the Authority (and those of nationals of developing countries) is concerned the Authority is charged with special responsiabilities. This should be understood without prejudice to the general duties of States, particularly, developed ones, under Part XIV, for helping to build the capabilities of countries which need and request technical assistance in this field.

In all cases, international cooperation, which presupposes a spirit of solidarity and good faith, appears to be an essential condition for the compromises worked out by the Conference, to be made operative.

Cooperation may be undertaken directly among States concerned or through competent international organizations. The latter, particularly the Specialized Agencies of the United Nations, should be stressed as adequate frameworks for States to arrive at the identification of their common interests, for facilitating agreements which may promote scientific research, and especially for taking the action required for promoting the development and strengthening of scientific and technological infrastructures in developing countries.

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INTRODUCTION

1/ Charter of the Economic Rights and Duties of States adopted by Resolution 3281 (XXIX) of the General Assembly of the United Nations on 12 December 1974.

2/ The Vienna Programme of Action on Science and Technology for Development of the United Nations Conference on Science and Technology for Development, United Nations, New York, 1979, p.1.

3/ Convention on the Law of the Sea, adopted on 20 April 1982 at the Eleventh Session of the United Nations Conference on the Law of the Sea, Drafting Committee, Working Paper 1, 7 June 1982.

4/ Draft Resolution on Development of National Marine Science, Technology and Ocean Service Infrastructures, submitted by Peru on behalf of the Group of 77, A/CONF 62/L.127, 19 April 1982.

5/ Cf. note (2).

6/ Draft International Code of Conduct on the Transfer of Technology as of 10 April 1981, TD/CODE TOT/33, United Nations, Geneva, 12 May 1981.

1. MARINE SCIENTIFIC RESEARCH

1/ Cf. v.g. MUKHERJEE, P.K. The Consent Régime of Oceanic Research in the New Law of the Sea, Marine Policy, April 1981, p. 89 ff. WOOSTER. W. Ocean Research under Foreign Jurisdiction, Science, Vol. 212, 15 May 1981, p. 754. Exposé écrit présenté par la Délégation de la République Fédérale d'Allemagne, A/CONF 62/WS/16, 10 mars 1981, p. 5.

2/ WOOSTER, W. and REDFIELD, M. (Consequences of Regulating Research, in WOOSTER, W. , editor, Freedom of Oceanic Research, Crane, Russak, and Co., Inc., New York, 1973, p. 219 ff) stated that "the interests of the world community seem generally to be best served by a régime of free research. The coastal State, on the other hand, may benefit most directly if appropriate controls are applied over research in the "intermediate zone". Any satisfactory outcome of the Law of the Sea negotiations must include a balanced accommodation of those two sets of interests". In contrast, SOONS, A.H.A. (in The International Régime of Marine Scientific Research, Netherlands International Law Review, 1977, p. 39) writes: it does not seem reasonable to oppose, on the one hand, the need for increasing regulations of marine scientific research, taking into account that there will exist often a common interest in the conduct of research activities".

3/ It may happen that, in some cases, technical assistance becomes a sine qua non for research activities in water of developing coastal States (BYRNE, J.V. Ocean Science, Law of the Sea and Marine Technigal Assistance, in "International Cooperation in Marine Technology, Science and Fisheries: the Future of the US Role in Development, Proceedings of a Workshop, January

18-22 1981, Scripps Institution of Oceanography, National Academy Press, Washington DC, 1981, p. 109 ff.

4/ According to MEUNIER, R.E. (The Politics of International Development Assistance, The Evolving Context for Marine Technical Aid, in "The International Cooperation in Marine Technology, Science and Fisheries", op. cit., p. 94): "Trade-offs may become necessary between the scientific contents of research cruises and the conditions for entry into coastal States' waters".

5/ WOOSTER and REDFIELD seem to confirm this in the following statement, (cit., p. 231): "Controls are really not a suitable means of obtaining technical assistance of this sort oriented as they are toward individual cruises sponsored by individual institutions ... development of marine science capability, for example, would require not only opportunities for participation in cooperative research efforts by additional means, such as scholarships, grants of equipment and aid for construction of facilities, instruction in equipment usage and maintenance and so on".

6/ Bilateral agreements are regarded in industrialized States as a means for counteracting the uncertainties and ambiguities arising from the new Convention. (Cf. Bilateral Agreements for Marine Science, National Academy Press, Washington DC, 1981, p. 4. MANGONE, G., Effect of Extended Coastal State Jurisdiction over the EEZ upon Marine Scientific Research, Law of the Sea Institute 14th Annual Conference, October 1981, p. 20. VANDERPOOL, C.K. Issues of Development: a Decade of Uncertainty, in "International Cooperation in Marine Technology ...", op. cit., p. 94: "Developing countries are reacting strongly against research that is solely planned and executed by scientists from the developed world. They see such research as an example of continued dependency; it does not provide an opportunity for their own scientific communities to gain the expertise necessary to produce centres of excellence and often it does not address critical problems of development".

7/ It could be recalled in this regard that at an initial stage of UNCLOS III "technology transfer has been suggested as an attractive bargaining pool in negotiations concerning freedom of scientific research (WAGGENER, S. The Transfer of Marine Sciene Technology - Quid Pro Quo for Freedom of Scientific Research? S. Diego Law Review, Vol. 2(3) 1975, p. 3). WEISS, C. (Technology Transfer in the Oceans in "Law of the Sea. The Emerging Régime of the Oceans", Proceedings of the 6th Annual Conference of the Law of the Sea Institute, 1973, p. 81) points out, however, that "questions of technology transfer originally came to the attention of the Ocean Policy Committee largely because the scientific community wanted continued access to the coastal waters of developing countries for purposes of fundamental research. But the needs of developing countries for technology transfer and technical assistance go far beyond what developed countries would be willing to exchange for the assurance of freedom to conduct offshore research".

2. DEVELOPMENT AND TRANSFER OF MARINE TECHNOLOGY

1/ A definition of "technology" has been included in the Convention only for the purposes of Part XI and its Annexes (see Annex III, Art. 5, para. 8). This has presumably been considered necessary with a view to rendering the engagement of national operators in the Area more precise. Cf. Section IV of this paper.

2/ "Before marine technologies can be acquired several conditions have to be fulfilled, the most important being trained people on the proper disciplines and in adequate numbers, establishment of marine technologies, research and development institutions. Research and development capabilities are essential for the proper choice, acquisition and assimilation of marine technologies". (Ocean Economics and Technology Branch, Department of International Economic and Social Affairs, Report of the Expert Group Meeting on Links between Producers and Users of Marine Technologies, United Nations, New York, 14-17 December 1981, p. 19). See, in general, STREETEN, P. and LALL, S. Foreign Investment, Transnationals and Developing Countries. MacMillan, London, 1980, p. 73 ff.

3/ ZAPHIRIOU, An International Code of Conduct on Transfer of Technology, The International and Comparative Law Quarterly, 1977, p. 213. FIKENTSCHER, W. The Draft International Code of Conduct on the Transfer of Technology, IIC Studies published by the Max Planck Institute for Foreign and International Patent Copyright and Competition Law, Munich, Verlag, Chemie, Weinheim, 1980, p. 59.

4/ Draft International Code of Conduct, cit., Chapters 3, 4 and 5, respectively.

5/ FIKENTSCHER, op. cit., p. 63.

6/ CRAVEN, J.P. Ocean Technology and Development, in "International Cooperation in Marine Technology ..." op. cit., p. 154. REVELLE, R. (Marine Technical Cooperation in the 1980s: an Overview, in "International Cooperation in Marine Technology ...", op. cit., p. 25) presents a list of forms of marine technical cooperation which might be carried out, grouped in the following categories: professional education and training of marine technicians, provisions of equipment, spare parts and information, cooperative research, cooperation in institution building in developing countries.

7/ A special case is that of international organizations foreseen in Art. 350, para. 1(f) and Annex IX of the Convention of the Law of the Sea.

8/ One could further note that the implementation of provisions which in the framework of the régime for marine scientific research confer to competent international organizations the right to conduct marine scientific research activities (Art. 238 and following) is not envisaged in the near future by the organization most likely to have a statutory foundation for that (IOC - First Session of the Ad Hoc Task Team to study the Draft Convention on the Law of the Sea and any Future Text developed by UNCLOS and the Implications to the Commission, Summary Report, IOC/TT-LOSI-3, Paris, 25 November 1981, p.41). KINGHAM, J. and MCRAE, D. Competent International Organizations and the Law of the Sea, Marine Policy, April 1979, p. 110.

9/ Cf., in this respect, Art. 248 (Part XIII) which provides for a specific function to be undertaken by competent international organizations in the facilitation of the consent of coastal States to projects presented by foreigners for research to be conducted in the exclusive economic zone or continental shelf.

10/ Cf. RUIVO, M. and GONCALVES, M.E. Trends in Ocean Uses and Related Institutional Aspects, in Proceedings of "Pacem in Maribus VII", Alger, 1976. KINGHAM, J. and MCRAE, D., cit., p. 121 ff.

11/ IOC - First Session of the Ad Hoc Task Team to study the Draft Convention on the Law of the Sea ..., cit., p. 77 ff.
MILES, E. On the Roles of International Organizations in the New Ocean Régime, Rev. December 1980, prepared for the 14th Annual Conference on the Law of the Sea Institute, Kiel, October 1980, p. 35.

3. MARINE SCIENTIFIC RESEARCH AND DEVELOPMENT AND TRANSFER OF MARINE SCIENCE TECHNOLOGY RELATING TO ACTIVITIES IN THE SEA-BED AREA

1/ IOC - Marine Science and Ocean Services for Development: a Comprehensive Plan for a Major Assistance Programme to Enhance the Marine Science Capabilities of Developing Countries, IOC/EC-XV/8, Annex 5, Rev., Paris, 15 December 1981,pp. 14-15.

2/ These provisions have been said to establish a mandatory transfer of technology, which would be unacceptable by those enterprises which have invested important efforts and capital in R and D and in the production of technologies for exploring and exploiting the mineral resources of the sea-bed. Cf. United States Delegation to UNCLOS III: Approaches to problems in Part XI of the Draft Convention on the Law of the Sea, February 24, 1982, p. 22 ff. which adds "The mandatory transfer of private technology provided in the Draft may impede sea-bed development and could serve as an adverse precedent in other international negotiations", cf. also changes suggested by the Delegation of the United States of America, WG.21/Informal Paper 18, 10 March 1982,pp. 21, 29, 30; Exposé de la Délégation de la République Fédérale d'Allemagne, cit. A divergent opinion is expressed in "Memorandum on US Interests and Objectives furthered by the Law of the Sea", submitted by S.R.L. LEVERING et al., Marine Environmental Committee, Washington, DC, July 28, 1981.

3/ Declaration of M. ZULETA, Special Representative of the Secretary-General of the United Nations to the Third United Nations Conference on the Law of the Sea, Official Records, United Nations, New York, 1980, Vol. XI, p. 25; Official Records Vol. XII, p. 35. Manpower Requirements of the Authority and related Training Needs, Preliminary Report of the Secretary-General, A/CONF 62/82, 17 August 1979: "Few experts disagree that the most serious constraint on the transfer of technology will be the availability of managerial skills necessary to select technologies and put together and operate systems".

4/ LOWE, A.V. The International Seabed. A legacy of mistrust. Marine Policy, July 1981, p. 212.

CONVENTION OF THE LAW OF THE SEA AND THE NEW INTERNATIONAL ECONOMIC ORDER

René Jean DUPUY

Professor
Collège de France
Paris
France

and

Secretary General
Academy of International Law
The Hague
Netherlands

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INTRODUCTION

The Third United Nations Conference on the Law of the Sea practically started in Caracas in June 1974: that is to say, at the very time of the debates leading up to the adoption of the Charter of the Economic Rights and Responsibilities of States, in the same year as that in which the principles of the New International Economic Order were proclaimed. It was necessary, under the circumstances, to wait until the reopening of the issue of the law of the sea and the new definition of its standards, found their place in the search that the international community appeared to be undertaking with the aim of establishing a more justly based international economic system.

The philosophy of the New International Economic Order is inspired, in the developing countries, by two concerns: on the one hand to develop themselves by their own efforts, and, on the other hand, to develop themselves with the help of others.

The first leads a people to find its own identity and to make itself the effort to bring about a self-centred development; it inspires the actions that lead to self-reliance.

The second appeals to international solidarity. It starts from the idea that a people cannot be truly itself unless it has attained a certain standard of living; it is necessary to have more in order to be more. But this supplementary wealth must come from the efforts of the wealthy countries which must submit to international law for the purposes of social justice. This new juridical order should comprise codes of conduct that place obligations on developed countries to the benefit of those countries suffering from under-development. If one wanted to summarize in one sentence this dual aim of the New International Economic Order, one could say that the developing countries wish to nationalize what they already have and internationalize the activities of the rest. The first objective springs from the wish to recover their own resources, whether these have been taken from them by colonization or other forms of exploitation by foreigners, or whether again these have been, as is the case with living resources in their coastal waters, pillaged by foreign companies. For the developing countries, property and sovereignty are intermingled: it can even be said that empire is nothing without dominion. Yet, this recovery of its resources by a country is not only a matter of national rights; it must also be recognized by international law. This is why, after a period of unilateral claim and legislation, the recovery of resources finds itself enshrined in international law. It is exactly this process that has been followed in the law of the sea, as regards the extension of the rights of the coastal State not only over its exclusive economic zone but also its continental shelf.

On the other hand, for whatever is not related to the recovery of national riches but to the conduct of other States and especially industrialized countries, the developing countries have no other means at their

disposal than action, at the international level, with a view to obtaining, during multilateral negotiations, a code of conduct that obliges the rich countries to adopt certain approaches to their relations with poor countries. It is in this sense that UNCTAD conducts its affairs, whether it is dealing with a system of general preferences, the integrated programme on basic products, or codes of conduct governing the transfer of technology or the activities of multinational corporations. It is a question of putting an end to a régime of economic liberalism that favours the strongest. In the maritime field, this policy of the Third-World Countries was to concentrate on attacking the secular principle of the freedom of the high seas, but this battle was to find its chosen field in the vast marine depths beyond national jurisdiction. There they have the advantage of a new principle and, for them, an unexpected one: the qualification of this zone as "the common heritage of man", and the establishment of an International Authority charged with managing these riches in the interest of all, but paying particular attention to developing countries.

The Conference having reached its conclusion on 30 April last, it seems appropriate to raise the question to what extent the Convention adopted by the Conference embodies the principles of the New International Economic Order which the Conference set out to incorporate into the law of the sea.

1. THE NATIONALIZATION OF RESOURCES AND LAND, SEA AND AIR SPACE

It is often observed that the extension of coastal state powers over maritime zones goes back to the Truman Declaration and that the origin of this move lies therefore with one of the great industrial powers, and not with a developing country. That is incontestable, but it is necessary to realize that, immediately after this Declaration, some Latin-American countries advanced claims over not only the sea-bed and its sub-soil but also the overlying water column. If such was the position of countries bordering the Atlantic, as Brazil and the Argentine, those bordering the Pacific, as Chile, Peru and Ecuador, declared, in 1947, an even less precedented claim. In effect, not having a continental shelf in the geological sense of the term, these countries extended their sovereignty out to the 200-mile limit which allowed them to attain the Humboldt Current, the cool waters of which are rich in living organisms. Yet, the claims of these States were based on the need to ensure development based on accession to the resources and areas that they believed belonged to them. In place of the limited and functional sovereign rights invoked by the President of the United States, a territorialist conception was adopted which was marked by a dynamism which proved to be irresistible. It may be added that the Latin American Pacific coastal States also invoked an egalitarian argument: they intended to correct inequalities of natural origin as well as those generated by the bad organization of international society.

We know how the figure of 200 miles has acquired the status of a political, operational and dynamic legend which has spread across the other continents, and many are the developing countries that have claimed jurisdiction over this area even when they had no current like the Humboldt Current to be attained, yet all gave justifications based on the rights of

developing peoples. The fact that they had also invoked considerations of everyday management does not weaken this analysis in any way. A coastal State, in enacting regulations for the protection of species and of the environment, obviously acts out of more than self-interest, but it is the coastal State itself that obtains the first and major benefit.

The number of competences recognized by the Convention as lying with the coastal State has led to the conclusion that the coastal States triumphed at the Third Conference on the Law of the Sea. Having the power to take the fishing quotas authorized in its exclusive economic zone, and to determine its own fishing capacity, the coastal State apparently reigns supreme over the exploitation of the living resources. Moreover, the fact that the Convention gives to the sea-bed and the subsoil of the exclusive economic zone the juridical status of continental shelf has had the effect of attributing one to some States that considered themselves deprived by virtue of the criterion of depth accepted by the 1958 Geneva Convention. For example, a country on which the 200-metre depth conferred a continental shelf of 50 miles, was seen to be given a supplementary area 150 miles wide by virtue of the notion of economic zone. It thus appeared that the reach of the nationalization was impressive, but it may be asked whether it is sufficient to bring about the New International Economic Order of the sea.

1.1 EXTENT

The extent of nationalization results essentially from two factors: on the one hand, the economic zone extends out to sea from the baselines of the high seas, and, on the other hand, the rights of the coastal State over the resources seem inevitably bound to evolve in practice and become rights in the zone.

1.1.1 Industrial Nature of the Land

If the economic zone is not within the territorial seas, neither is it a part of the high seas. This double negative definition expresses the compromise which is at the base of the notion of exclusive economic zone. Those that have put this definition forward, be they moderate Latin American countries (Mexico, Venezuela, Colombia), under the name of "mar patrimonial", or the African countries, under the name of economic zone, intended thus to rally the major maritime powers by leaving out of the new concept the idea of territorialism which would have made them subject to the restrictive regime of innocent passage. This explains the retention, in the zone, of the freedom of navigation, of overflying, and of the laying of cables and pipelines. For all that, the coastal States as a whole rejected the idea that the economic zone could be considered as a part of the high seas. At the Conference it resulted in a complex debate on the juridical nature of the zone. This had, depending on the thesis being defended, major practical consequences. If the zone was considered to be a part of the high seas, that meant that the principle was one of freedom (of the high seas) and that the rights of coastal States, restrictively enumerated by the Convention, should be interpreted

as exceptions to the rule of freedom of the high seas. But, as every exception constitutes restrictive interpretation, it meant admitting that the prerogatives of the coastal State in the zone should be limited to a regime of an exceptional character.

On the opposite side, if one sees in the economic zone an idea sui generis, having nothing whatsoever to do with the high seas, the result is that the principle that should prevail is that of the competence of the coastal State. That is what must be assumed, and the freedom of navigation, of overflight and the laying of cables and pipelines can only be conceived as residual freedoms of an exceptional character. It is this latter view that has prevailed in the Convention. Article 86 regards the high seas as "all those parts of the sea not covered by the exclusive economic zone, the territorial seas or the internal waters of a State, nor the archipelagic waters of an archipelagic State". Here one really finds the idea that could be qualified as "zone of national jurisdiction" which comprises a zone of total sovereignty - the internal waters and territorial seas - and a zone of economc sovereignty - the exclusive economic zone - in which the rights of the coastal State refer to the resources.

The compromise thus established on the juridical status of the zone remains fragile. The logic of the New International Economic Order presses for the recovery of property not only in respect of resources but also of territory. The owner is never very much at ease if the resources he possesses are located on ground that does not belong to him. This reaction is even more naturally that of States that are moved by the territorial obsession.

1.1.2 Rights of the Coastal State

It would appear that, in time, the subtle compromises of the Conference will be powerless to prevent the outcome that the power of the Coastal State will not be brought to bear so much upon the zone as on its riches, as was inevitably the case for the continental shelf in spite of the precautions of the 1958 Convention which recognized only sovereign rights but not sovereignty. Territorial interest was the strongest: it is always irresistible. This development supposes a double action: the conversion of functional competence into territorial rights, and the recognition of discretionary powers of the coastal State.

1.1.2.1 The Conversion of Functional Competences into Territorial Rights

It should be stressed that it is not a matter of making a case against the Coastal State, but simply to look for the potential factors in this increase in its rights.

We observe immediately that certain of these lead naturally to the occupation of space; these are the ones that assume expropriation. Thus, Article 60 of the Convention attributes to coastal States the exclusive right to undertake construction, as well as to authorize and control in the economic zone, the installation, operation and use of artificial islands

and of devices. It states that these rights include regulation of customs, revenues, health, security and immigration. That is, the coastal State enjoys power of a spatial kind which it exercises as much with regard to its nationals as with corporations coming from other States. But it is in the field of environment that the spatial significance of these competences is even more clear-cut. Pollution combatting is more easily reconciled with the concept of rights over the zone than with that of rights over the resources. Obviously, it does not have, in this regard an exclusive competence to protect the marine environment against pollution from ships; the flag State is not completely deprived of its traditional rights. That is a logical consequence of the retention of freedom of navigation in the zone, but it does not get around the fact that henceforth in a zone considered hitherto as being of the high seas, the competence of the flag State will come into competition with that of the coastal State.

And finally, regarding scientific research, the coastal State exercises strict control and can suspend it at its convenience, whenever it is being conducted in the zone. As administrator of the economic zone, the coastal State is normally provided with coercive and repressive powers (Article 73).

Clearly, it is in the domain of fisheries that nationalization of resources has assumed its most notable form. It is known that, at present, nearly all areas of high fertility are covered by the economic zones. The result is a profound transformation of the world fishery regime. We can assess whatever is abstract in the analysis according to which the powers of the coastal State relate to the resources and not to the zone, when we see in the Convention the preponderant place it occupies therein as regards areas. This is confirmed when evaluating the situation of other fishing States with respect to the economic zone. It is true that Articles 63 and 69 confer upon third parties the possibilty of engaging in the exploitation of living resources in the zone, but this participation is conditional upon the conclusion of contracts with the coastal State. The conclusion of such contracts will not always be easy: it is scarcely possible to force the coastal State to sign one. The efforts of landlocked and geographically disadvantaged countries to submit disputes arising from this difficulty to the procedures laid down for the settlement of differences foreseen in the Convention have failed and they have had to be content with possible recourse to conciliation, the conclusions of which are not binding. The coastal States intended to remain in complete control of the definition of their fishery policy in their zone. In fact, their control within this zone is very close to sovereignty. A further example can be found in Article 72, according to which the rights accorded to landlocked States in the economic zone of a coastal State cannot be transferred to third-party States without the express consent of the coastal State, whether this refers to a transfer of a lease or the establishment of a joint enterprise. It can thus be seen that the coastal State has discretionary competences.

1.1.2.2 From Exclusive Competence to Discretionary Powers

In various cases the Convention itself recognizes such rights of the coastal State, whether with reference to the State itself, to the amounts of authorized catches and its own fishing capacity, or to determination of the conditions for the admission of foreign scientific researchers. In fact, it is sufficient to refer to Article 297 to determine the range of powers of the coastal State which, once one recognizes their discretionary character, fall outside the obligatory procedures for the settlement of differences (see particularly the dispositions of paragraphs 2 and 3).

Thus, the regime of the exclusive economic zone uncontestably embodies the nationalization of zones and of resources, and, from this point of view, satisfies one of the conditions for the establishment of the New International Economic Order.

Two observations should be made however.

(i) On the one hand, although the developing countries were the initiators of this recovery of national wealth, many industrialized countries took the view that they also possessed a fine maritime frontage and have themselves adopted an exclusive economic zone. In effect, we have witnessed a generalization, well before the end of the Conference, a blossoming of national legislation by which States assigned themselves such zones.

(ii) On the other hand, this generalization of the promotion of the coastal State has raised doubts about the conformity of this triumph to the equilibria required by the new economic order. Certainly, the latter requires above all else a reconsideration of the relations between developing and industrialized countries, but it also includes cooperation between the developing countries themselves. Is this properly foreseen and promoted by the Convention of 30 April 1982?

1.2 CO-OPERATION

The cooperation required between developing or industrial coastal countries and landlocked or geographically disadvantaged coastal States is certainly envisaged and advocated in the Convention, but it is contradicted by the fact that the rules of cooperation are abstract and general, whereas the States to which they are addressed are in highly specific particular situations. An important event resulted from this at the Conference: the rupture of the Group of 77 in the Second Commission. The States regrouped themselves in terms of their individual relations with the marine environment and no longer on the basis of geographic or socio-economic factors which normally determine groupings in the United Nations. Thus, two groups were formed: coastal States and landlocked, geographically disadvantaged States, each group comprising developing and developed countries. It is easy to understand the difficulty experienced in drawing up general rules based on compromise.

The determination of the extent of the continental shelf provides a particularly striking illustration of the impossibility of drawing up a general standard under an obligation to include particular cases. From the beginning of the negotiations it was apparent that the notion of exclusive economic zone would not absorb that of the continental shelf, contrary to the wishes of certain States, notably the oil-producers that did not have a shelf extending beyond 200 Miles. The States that do have one have been able to keep it. It remained only to fix the outer edge of the extended shelf. The debates were rendered very difficult by the confrontation of often complex situations under state control. Whereas, in 1958, a dual criterion of depth had sufficed, Article 76 of the Unofficial Composite Negotiating text, Rev. 2(3) contains no less than eight dispositions aimed at each of the different hypotheses: three principal rules, two supplementary rules, and three special cases, the last of which is a limiting case, the Convention legislating indirectly for a single State, Sri Lanka.

However, whatever the extent of the recognition of the individualism of the coastal State, the Convention has attempted to promote the international cooperation required by the New International Economic Order, which, in effect, as we have seen, postulates international regulation of the conduct of States in their economic relations. Many of the dispositions attempt to proscribe the juridical individualism that they wished to enjoy and to make them cooperate with third-party States. One sees here two sets of standards that mix the concern to place upon the more highly favoured in a given relationship, even though developing countries,some obligations towards their disadvantaged neighbours, with the concern to protect the objective interests of the historical international community through a rational management of fisheries. In that way, it is hoped to guarantee the maintenance of a certain marine food reserve for humanity and the protection of the marine environment.

Various rules, in the field of the exploitation of living resources, attempt to ensure a certain sharing of fish surpluses for the benefit of neighbours, especially those deprived of a coastline or considered as being geographically disadvantaged. This is explained by the general climate in which the negotiations are conducted as are otherwise all such negotiations carried on within or under the aegis of the United Nations. Each State, especially those that have certain shortcomings to complain about, appeals to others with the aim of inducing them to take into consideration their own situation, and to make the comparisons that will reveal the injustices and procure the remedies. The coastal States themselves have followed this line to justify appropriations of maritime areas required for their development. They have set the opulence of the maritime powers, itinerant sovereigns, against the exploitation and the poverty of which they were victims. It was to be expected that other countries, even more disadvantaged, because of their landlocked status or the poverty of their coasts, would turn to the coastal States to object to them over the iniquity of their condition. One thus finds this dialogue, even these mutual invectives, that make the international community, especially in a domain in which classical law, which knew nothing of it, allow each State the freedom to act for itself.

The Convention attempts to limit the individualism of the coastal State in three ways:

1. By foreseeing the recourse of the coastal State to qualified international subregional, regional or global organizations. Whether it is a question of fixing the authorized fish quota in its economic zone or of ensuring therein the protection of the environment, the coastal State must consult the institutions in which, hypothetically, third-party States, including concerned developing ones, meet.

2. The Convention has a special place for developing countries "having special characteristics" with respect to the exploitation of surplus fish catches in an economic zone (Article 70).

3. There has been an effort to go even further and place upon certain coastal States an obligation in the interest not only of their disadvantaged neighbours but also of the international community as a whole, the outcome of which depends upon development. Certainly, there has been no follow-up to the ambitious propositions presented at the beginning of the 1970s by certain movements or by Malta for setting up tax collection, by an "international mechanism" managing the common weal, on all maritime activities including those carried out on the high seas. There has remained, however, the idea that the States with a continental shelf extending beyond the 200 miles should, by way of compensation for this natural advantage, make a financial contribution or a contribution in kind from the profits made from the exploitation of the non-living resources on the extended part of the shelf (Article 32). After a delay of five years, the payment shall be made annually according to a rate that will move progressively over a period of seven years from 1 to 7% of the value or of the volume of production. This rate meets better the wishes of the 53, the preceding maximum value being only 5%. This contribution is tending to be organized like a tax from which certain States should be exempt: such is the case for a developing country that is an importer of a mineral resource mined on its shelf. The payments would be made to the Authority "which shares the product amongst the States parties to the Convention in accordance with equitable criteria of sharing", taking into account development needs and especially those of the least developed countries and of those without a coast.

These various dispositions are not considered adequate by land-locked or geographically disadvantaged developing countries which consider that the economic zone régime increases the inequality amongst States. Be that as it may, the conditions for the establishment of a new economic order appear to be better satisfied by the International Zone system for the sea-bed beyond national jurisdiction.

2. INTERNATIONAL SEA-BED ZONE AND NEW INTERNATIONAL ECONOMIC ORDER

2.1 DECLARATION OF THE DEEP SEA-BED AS THE COMMON HERITAGE OF MAN

In the First Commission, which was charged with the definition of this régime, the solidarity of the Group of 77 reasserted itself. It was without any doubt a matter of constructing one of the sectors of the new order. Even so, it presented itself under particularly favourable conditions, since the deep sea-bed had been declared the common heritage of man and the 1970 Declaration of Principles required that, in that context, the interests of the developing countries be given particular attention.

The idea of humanity is very rich and dynamic. It has an inter-spatial value, since it brings together all peoples of the world without discrimination. But it also has a transcendental dimension. Humanity goes beyond the living. It is already the bearer of future generations. As a result, the men who today manage the common heritage should not consider themselves as owners with the power to abuse it, but as keepers who should see that the domain is conserved and manage it in the interest of those who will follow.

The concept of humanity is not then static; it invites economic and social development. It has, in the eyes of the under-developed countries, a great price, for it prohibits the appropriation of the resources and of the areas included in the common heritage. Thus the concept of humanity guarantees to the poor, to those who still do not have the technology and financial means to exploit them themselves, the upholding of their right to participate themselves one day in such exploitation. The result is also that the industrial powers, if they go ahead with this exploitation, can do it only in the general interest and not merely for their own profit.

The system based on the concept of the common heritage of man is thus opposed to that set up in 1959 for the Antarctic and confirmed in 1980, that is, collective appropriation by a limited number of industrial countries. That is why, in 1979, the developing countries also demanded that the moon be declared part of the common heritage, and why they have made the same claim with respect to other resources as, in particular, the radio frequency spectrum.

Since then one can understand the affirmation made by the Charter of the Oceans and Seas: "The whole of humanity", on behalf of which the Authority acts and which is invested with all rights over the resources of the Area (Art. 137, paragraph 2, of the Convention). The behaviour of the States parties is entirely conditioned by the norms defining the Status and the purposes of the common heritage, to which Article 138 adds "the promotion of international cooperation and mutual understanding." This harmonizing vision is doubtless powerless to prevent or even to dissimulate the confrontations between States, especially between North and South. But nor should this lead us to deny the presence of the interests of the international community at the heart of the system governing the Area, since, beyond the contradictions between States, and without denying these, the régime established has as its objective to allow everyone to participate in the functioning of a public international

authority provided with operational powers on behalf of humanity. The idea of public service here takes on a concrete form, it being an integration mechanism. Obviously, it will not by itself put an end to the tensions or conflicts, but the community will live with one another inside it, as the Europeans do with their Community. Apart from bringing together a large number of highly disparate States, the Authority will have to overcome some even deeper contradictions and to put aside many obstacles in order to be able to find arrangements that draw a consensus. The community exists from the moment that, being no longer able to be ignored (and how could they ignore themselves in a system which they joined voluntarily?), the members of the system agree to work together to achieve their objectives.

Such is the process of establishing the New International Economic Order, except that, in the particular context of the Authority, there will be available an institutional set-up more effective than that of UNCTAD. Whereas the latter is especially a forum for negotiation with a view to reaching the formulation of principles, the Authority should be a power centre for the effective management of common resources.

One can rapidly see the features of the New International Economic Order in Part XI of the Convention, but it is convenient, to be realistic, to stress the failure of the Conference, on 30 April 1982, to get this system accepted by the majority of the industrialized States able to undertake the exploitation of nodules in the near future.

2.2 OBJECTIVES OF THE NEW INTERNATIONAL ECONOMIC ORDER

The concern to make Part XI an objective of the New International Economic Order is clear.

2.2.1 Exploitation Régime

The exploitation régime had, during previous sessions, produced often impassioned debates. It is enough to recall here that the 77 had got as far as limiting the guarantee of access to the sites: the activities in the Area would be carried out on behalf of the Authority, which had a real margin of discretion in the issuing of contracts. Their settlement is subordinated to certain prior commitments by those wishing to undertake exploitation, and bound by cerain obligations in the transfer of technology to the Enterprise. The guarantee of access could also be conditional upon the establishment of joint ventures with the Enterprise or with developing countries. These principles again led to bitter debates during the 9th session. The Group of 77, on the initiative of the Africans, proposed to place upon the contractor the obligation to transfer not only mining techniques but also nodule-treatment techniques. The potential operators are even more strongly confronted inasmuch as this text also envisages the discretionary power of the Authority to cancel or suspend a contract in the case that the contractor did not fulfil his obligations. The confrontations thus generated by Article 5 of Annex III are of the same type as those that can be observed in a highly integrating system in the sense that the negotiators get down to very detailed levels of control. Such is also the case of the régime of financial clauses in the contracts (Article 13 of Annex III) and the dispositions on the financing of the Enterprise.

On this last point the discussions have dwelt upon the obligation of industrial countries to provide the Enterprise with the resources to allow it to undertake its first operations, through loans and guarantees. Those who would have to bear these expenses called for a sufficiently precise ceiling. A compromise was finally reached.

2.2.2 Management Policy

It was also very difficult to get agreement to the principles by which the Authority would draw up a management policy, particularly the fixing of the rate of exploitation. One is aware of the vigour of the opposition, of the States already producing on land those minerals likely to be taken in the international Area, to this new production which could bring about a collapse of the commodity markets. When the concept of the common heritage was advanced, the Third World showed a certain preference for its exploitation; an analysis of the economic data has led it to revise its position. Putting aside the least developed countries that have no mineral resources, the great majority of the 77 is now guided by anti-production concerns. Certain industrial countries, such as Canada, share their wish to allow only highly controlled exploitation. From this fact, a whole array of very complex dispositions is envisaged to ensure that this exploitation does not come to affect national production.

The conflict of interests between the terrestrial producers and the potential operators may be seen in the perspective of the adoption of an acceptable regime based on flexible solutions ensuring equilibrium, subject to adaptations, amongst the parties concerned. A reading of Article 151 reveals the complexity of the dispositions destined to link the development of the submarine production to that of the consumption of nickel, and to limit the former to an amount corresponding to a growth of the latter at 3%, with, moreover, a safeguard clause favouring the terrestrial producers in the event there is very slow growth of consumption.

This community of the sea-bed Area, highly institutionalized and provided with regulatory powers will develop secondary rights, themselves based on the outcome of longstanding confrontations, but which will tend to consolidate the system.

The latter certainly seems, under the Convention, like a special arrangement. It envisages its own sanction provisions: suspension of the right to vote of States which fall in arrears in the payments of contributions; suspension of privileges and rights inherent in the quality of membership of the State that "infringes flagrantly and repeatedly the dispositions of the present section" (Part XI, Articles 184 and 185). Likewise, a review procedure is foreseen, different from that for the Convention itself; it concerns the dispositions governing the system of exploration and exploitation of the resources of the Area (Art. 155). A conference convened by the Assembly of the Authority, fifteen years after the start of the year in which the first commercial production was achieved, will examine whether the relevant dispositions have, in the light of experience, shown themselves to be profitable for the "whole of humanity" and for the "harmonious development of the world economy". It is clear that th se harmonizing formulae echo an informal arrangement that

arose following a declaration by Mr. Kissinger who, to get certain concessions accepted by the Group of 77, admitted that a revision of the regime of exploitation, after 25 years, had been foreseen. The developing countries have not only obtained a reduction in this period, but also a procedure that breaks with the pursuit of a consensus. In effect, if, five years after the opening of the Conference, agreement is not reached, the Conference can, in the following twelve months, decide by a two-thirds majority of the States parties to adopt and submit to ratification, adherence or acceptance, the modifications to the system it judges necessary and appropriate. It appears that this recourse to a vote is looked upon as an incitement to find a consensus before the expiry of the five possible years of negotiation, but also implies, after twenty years of operations, the "system" will have reached a point of no return and that the Area community will be sufficiently consolidated not to cut itself off from the minority: a calculation of which the conformation will depend on conditions still unforeseeable. It should be noted, however, that the envisaged majority was 3/4 and that the Group of 77 has got it reduced to 2/3.

These few examples drawn from the Convention show the enormous difficulties which the efforts to establish a New International Economic Order have come against in the management of sea-bed resources. The new order supposes continuing negotiation. But the majority of the industrial countries which are capable of exploiting the nodules in the near future are afaid to be subject to a power controlled by the Group of 77.

One knows how long and uneasy were the debates on the structure of the Authority and especially on the decision-making within the Council. It appeared in August 1980 that everyone was agreed on the dispositions of Article 161. Later, these compromises were reopened for discussion.

2.2.3 Problem Area

The negative vote of the United States and the abstention of 17 States, including the Soviet Union, 8 Eastern countries and 6 Member States of the European Economic Community, will weigh heavily on the establishment of a régime for the International Area of the sea-bed.

The Conference has envisaged a transitional régime which gives rise to certain concerns consistent with the New International Economic Order, in the status of the Preparatory Commission and in the system of protection of preliminary investments (PPI). Particularly, the financial charges and obligations in matters of technology transfer, which will support the pioneer investors, will be rather heavy.

Nevertheless, the adoption by the major industrial powers of national legislation destined to cover the activity of the companies pertaining to them, coupled with their refusal to adhere to the Convention, deprives the Authority of a considerable financial contribution, since the States voting for the Convention provide 35% of the budget of the United Nations.

It would obviously be premature to conclude that there has been a complete halt to the attempt to set up a new international economic order in the field of the law of the sea. From the standpoint of the recovery of resources by coastal States as well as from that of the internationalization of the ocean basins in the scheme of humanity, results unthinkable twenty years ago have been achieved. But the road is still long and it is not possible to evaluate, so soon after the Third Conference, the time it will take to cover the greatest part of it.

CREATING FAVOURABLE CONDITIONS FOR THE INTERNATIONAL COOPERATION FOR THE TRANSFER OF MARINE SCIENCE AND TECHNOLOGY IN THE CONTEXT OF THE NEW OCEAN REGIME

Agustin AYALA-CASTANARES

Instituto de Ciencias del Mar y Limnología
Universidad Nacional Autónoma de México
México

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INTRODUCTION

I congratulate the United Nations University, the Secretariat of IOC and the Division of Marine Sciences of Unesco for the excellent idea of organizing this workshop as a forum for a free and concentrated debate to identify ways and means to improve international cooperation, and particularly more effective transfer of marine sciences and technology in the context of the New Ocean Régime.

Undoubtedly,for several reasons this is a due historical moment to organize such discussions trying to provide enough arguments for further actions searching for all alternative solutions to assist both the United Nations System and the States to face this important subject. Unquestionably the effect of marine science and technology will in the long-term be a critical element for the success or failure of the United Nations Convention on the Law of the Sea and the New Ocean Regime.

This important topic has attracted the attention in the last ten years of many scientists, lawyers, sociologists, etc. As a result, several studies have been made, and many papers presented and published.

This interest is, without any doubt, a clear demonstration that, during the last decade, the world community - particularly the underdeveloped countries - have recognized that the marine sciences and technologies are essential activities under the New Ocean Regime, if they can be properly used for the efficient study, monitoring and protection of the ocean and its environment, and to provide the basis for the adequate evaluation and rational administration of the natural resources, both renewable and non-renewable. The underdeveloped countries have realized the need to be prepared to take all the advantages, privileges and responsibilities of the United Nations Convention of the Law of the Sea that will be signed, late this year in Montego Bay, Jamaica, and of the already existing New Ocean Regime, established by unilateral decisions of several countries.

The topic of how to use research as a means to accelerate achievement of national goals and realization of national policy is fascinating. So, numerous discussions have been held with several colleagues concerning the challenge of defining effective ways to assist the countries to build their sciences and technologies and particularly marine sciences.

In this paper various aspects of the problem are considered and some suggestions are made. 1/

1/ This paper represents the follow-up of various documents and publications of the author on the same theme, presented successively at the Marine Science Workshop, Bologne, 1973; at the Second Session of the Working Committee of TEMA, IOC, 1977; at the International Colloquium on Science, Technology and Society Needs, Challenges and Limit actions, organized under the auspices of UNACAST, in Vienna, 1979; and several papers published in reference to the national marine science in Mexico; the most important published in Ciencia y Desarrollo,CONACYT, Mexico, 1982 under the title "Las Ciencias del Mar y el Desarrollo de México"; and another presented as a contribution to the consultative studies in connection with the analysis being made by the next government of Mexico for the definition of its policy on marine resources.

1. INITIAL CONSIDERATIONS

Scientific research is a creative activity of which the major objective is the understanding of nature. Technological research is primarily a transforming activity.

Both are closely related and, to a great extent, are interdependent. The best exercise of science and technology requires explicit goals with the concurrence of several factors: organizations, working atmosphere, academic freedom, highly qualified personnel, enough investment and the necessary connection with related sectors; all with flexibility and continuity of action.

The development of science and technology is a long, complex and continuous process. In order to obtain healthy scientific development, it is necessary to integrate the activities of the educator, the scientist, the technologist, the industrial promotor, the financier, and the politician, and besides, to assure firm and broad governmental support. Scientific advancement is desirable for a country only when it leads to socio-economic development and assures a proper distribution of wealth.

Socio-economic progress of developing countries should start with obtaining scientific data about their natural characteristics and resources, in order to establish the basis for their industrial transformation, satisfying the social need of the population. For this reason, the selective importation of scientific and technological know-how is necessary.

Such a policy calls for training a sufficient number of highly qualified personnel so as to reduce the dependence which imported technology imposes on development. This human potential must be capable of assimilating the latest scientific knowledge and methods while keeping constantly in mind the need to attain self-sufficiency. If this self-sufficiency is to be achieved it must be framed within an official scientific policy established by the government with the objective of promoting social and economic development, and hence of raising the standard of living of the inhabitants.

The universities are called upon to play an important role in the economic, social, scientific and technolgical progress of the developing countries, by training the necessary number of scientists and technicians. Furthermore, the university research programmes in science and technology in those countries, undoubtedly represent decisive factors for reaching the desired goals. All these statements are particularly valid in the case of the scientific and technological research related to the ocean.

As a consequence of the debates of the Third UN Conference on the Law of the Sea (UNCLOS), and with the establishment of a New Ocean Regime during the last decade, a great interest in "Ocean Affairs" has grown, particularly because of the growth of world population, the unequal distribution of wealth, the great scientific and technologic gap between developed and underdeveloped countries, and the urgent need to find new and better sources of food and energy.

The evolution of the ten periods of sessions of the UNCLOS - with the participation of more than 150 countries - clearly showed the decisive role that science and technology should play in enabling coastal states to enjoy the rights and advantages of exploring and exploiting the resources of the oceanic space, bottom and marine subbottom; and at the same time the coastal States are obliged to assume responsibilities towards the international community by maintaining the natural resources and preventing damage in the marine environment. However, it is also clear that the coastal states will have true sovereignty over their Exclusive Economic Zone only if they have the scientific and technological capability to explore, exploit and administer their seas and resources - and negotiate with other countries. This principle was accepted in the last session of the UNCLOS when the resolution "Development of national marine science, technology and ocean service infrastructure", proposed by the group of 77, was adopted and transmitted for consideration by the General Assembly of the United Nations.

2. GENERAL CONCEPTS OF THE OCEAN AND THE MARINE SCIENCES AND TECHNOLOGIES

The ocean is a broad and complicated system which should be approached multidisciplinarily, considering its origin and history, its physical, chemical, geological and biological processes, as well as its resources and its socio-economic importance. Thus, oceanography, or oceanology in its modern conception, does not form a science per se, but is a complex combination of those branches of science and technology dealing with the ocean; the marine sciences.

The common denominator of marine sciences and technologies is their multidisciplinary character which calls for constant cooperation, interrelation and communication between scientists of several disciplines as: mathematicians, meteorologists, physicists, chemists, geographers, geophysicists, geologists, biologists and engineers as well as lawyers, sociologists, economists, etc., particularly now when integral planning and coordination of "marine affairs" has become a must. At administrative level this need also transcends the sectorial organization of governments. The ocean and its resources can be properly understood only by an interdisciplinary and multisectorial approach to the assembly of the elements necessary for wise decisions for the proper use and management of resources.

During the last 25 years, substantial additions have been made to knowledge of the sea, its natural characteristics, uses and resources. At the same time technological capability has increased to such a degree that the ocean has become one of the most important and priority subjects to be studied; part of this interest is the influence of UNCLOS. As a result of this significant progress, sophisticated and complex methods of observation, measurement, sampling and processing have been developed. As a consequence, the ability to explore, evaluate and exploit the resources of the sea have experienced a revolutionary and accelerated trend, converting them into basic factors for world economy.

Marine scientific and technological research is expensive: it requires highly qualified human resources, great investment in specialized vessels and equipment, and high maintenance and operational costs. However, it should be considered a highly profitable mid- and long-term investment.

Even with the progress achieved, knowledge of the ocean is still insufficient, and there is a clear need for a substantial increase in fundamental, applied and technological research activities - in both the industrialized, and the underdeveloped countries - with the equitable international cooperation, at bilateral and multilateral levels. It is necessary to keep in mind that the ocean, more than any other subject of research, calls for international cooperation, as it is clear that marine processes do not recognize political frontiers. Intersectorial administrative cooperation is also needed at national level since marine processes do not distinguish administrative competences.

3. THE RESOURCES OF THE SEA

The enormous potential of the world's ocean resources is now fully recognized. The exploration and exploitation of these resources is increased day by day. Among non-renewable resources the raw materials for construction, minerals and hydrocarbons are essential; and among living resources, those exploited by fisheries - including aquaculture - and the marine organisms that identify and extract active substances -- toxins, hormones and antibiotics, useful for industry and pharmacology -- must be mentioned.

The coastal zone, considered in a broad sense, is a wide transitional area between continent and sea. This zone is vital for the socio-economic development of coastal states. Its rational management consists in the establishment of a balance between the competitive uses, trying to obtain the greatest short-medium- and long-term benefits. The management of the coastal zone includes respect for, and enhancement of, the quality of life in the broadest sense, with harmonious administration of the several resources and avoiding conflict between the different activities; for example fisheries, aquaculture, hydrocarbon exploration and exploitation, production of raw materials, mining, agriculture, infrastructure works, industry, urbanism, tourism, navigation, harbours, etc. The great variety of resources of the coastal zone makes it essential that the uses must be coordinated and harmonized in a suitable framework in order to avoid conflicts between them and the hinterland activities.

Marine transportation is still the cheapest way of moving materials in large quantities and in the last four years it has been tripled. From the standpoint of food supply, the ocean is one of the world's most important sources of proteins with an annual fish production near 100 million tons. The ocean also is a major source of energy: more than 30% of the world production of hydrocarbons is obtained from submarine continental shelves. With advanced marine technology the realizable energy potential has been increased by the utilization of tides and waves, as well as by ocean thermal energy conversion (OTEC) between surface and deep water layers. Also production of fresh water by desalinization is a reality.

As knowledge of ocean dynamics and climate improves, and the interaction with atmospheric climate is better understood, the systematic study of ocean dynamics and the climate is proving to be a major contributor to long-term prediction of climate, with unexpected implications in fisheries, protection of life, agriculture, etc.; for these reasons the production of raw

materials from ocean floor - minerals or building materials - is more frequent every day. Despite great advances in ocean engineering, the technological capability for the exploitation of the mineral resources of the deep ocean floor, has not yet been fully proven, in part due to the fact that the international legislation for this purpose is still undefined and it affects the interests of the highly industrialized countries. Among the minerals already being extracted are: sand, gravel, iron, charcoal, diamonds, nickel, tin, manganese, phosphorous, uranium and gold. The production of salt in large amounts is common, using the natural salt flats or by concentration and evaporation of the sea water.

The ocean is also a sink for waste disposal. The materials are of several kinds: domestic sewage, terrigenous materials, industrial products, hydrocarbons, fertilizers and insecticies, and radioactive substances. Practically all wastes of modern society go to the ocean. As a result, the pollution of the marine environment and particlarly from the coastal zone, is an important problem to be understood at world level. Finally, and unfortunately, the sea has also a great strategic value for the strong military countries.

The cases mentioned are only examples of the multiple uses and resources of the sea, in respect of which science and technology play an important role. These examples give an idea of the value and complexity of the ocean.

4. LIMITATIONS IN UNDERDEVELOPED COUNTRIES TO THE APPLICATION OF MARINE SCIENCES AND TECHNOLOGY TO ACHIEVEMENT OF NATIONAL SOCIO-ECONOMICS GOALS

The great gap in marine scientific capability existing between industrialized countries and those that are developing is evident. The most developed countries early recognized the importance of science and of the ocean; they invested large amounts in building a scientific infrastructure, and trained large numbers of highly qualified scientists and technicians, and invested in pure and applied research, in the universities, research institutes and governmental agencies. Their industries recognized the economic importance of science, in this case marine science, and made generous provision in their budgets for research and development, including instrumentation, related with the exploration and exploitation of marine resources. Also large amounts were dedicated to these activities for military purposes.

In contrast, underdeveloped countries, for many complex reasons, difficult to generalize and even to explain, failed to make that effort and, for that reason, their scientific and technological development remained incipient. Marine science and technology are good examples of this condition, perhaps more dramatic than other fields, and they do not help those countries substantially to reach their national goals.

It can be stated that, unfortunately, after the space sciences, marine sciences and technologies demonstrate the disparity between the great capacity of industrialized countries and the extreme limitations of underdeveloped nations.

Although as everybody agrees, the marine resources are abundant, they are limited. Consequently, unless a good knowledge of their magnitude is obtained and proper exploitation regimes are established, they can easily be over-exploited. Their exploitation must be managed to satisfy both economic and social objectives, since the achievement of the two is essential to the development process. This requires knowledge and information, technology, facilities and highly qualified human resources; it calls for national financial and legal commitments and a large amount of international cooperation. It also requires a science able to understand oceanic processes as well as to identify marine resources, and the utilization and administration of the ocean on a rational basis, for the long-term benefit of mankind.

The application of marine sciences and technologies for achievement of the national socio-economic goals of the so-called developing countries presents several limitations or obstacles that need to be analyzed and eventually solved.

Those limitations will change, and have different values, within the heterogeneous scientific, economic and political situations of the under-developed countries. Although among them, the following should be mentioned:

At the governmental level

1. Governments still give insufficient recognition to science and technology as factors for development.

2. Generally, the priority that should be given to the role of the ocean and its resources has not been properly identified within the context of national development. Therefore no policy for marine scientific and technological aspects has been established.

3. There is a general ignorance of the complexity and value of the ocean and its resources and the need to consider them by an integral approach. As a consequence, there is often a tendency to identify the broad and varied possibilities of oceanic uses and resources with only one of its activities, namely fisheries. This situation is more evident in the less developed nations.

4. In many cases marine sciences and technologies have even been ignored or misinterpreted. As a consequence, national organizations responsible for them are improperly located within the administration, and not clearly identified within the whole scientific and technological structure of the country.

5. Because of the multidisciplinary and intersectorial nature of marine matters they are often dealt with on a fragmentary basis, by a large number of governmental entities, without the necessary planning and coordination.

6. Communication and cooperation between different sectors dealing with marine affairs is weak, with the result that work is duplicated and the scattered available human, material and financial resources are ill-employed.

7. Furthermore, administrative inefficiency is frequent, often evident in the appointment of managerial staff who, if non-specialized, do not request the opinion of the experts and if specialized, tend to focus attention on their personal or disciplinary interests, rather than on the general aspects of their responsibility.

8. National legislation is obsolete in many countries and does not correspond to present national and international requirements.

9. International cooperation, both bilateral and multilateral, is under-utilized.

10. Very often, within the agencies of the United Nations system dealing with marine affairs, the position of a country is not laid down in a clear policy. This frequently results in confusion and gives rise to problems, sometimes leading to the adoption of inadequate - and even contradictory - resolutions and recommendations.

At the Scientific and Technological Level

1. A decisive and vigorous scientific and technological sector and the active participation of the scientific community are the elements sine qua non of achieving authentic progress in the proper use and exploitation of the sea and its resources.

2. Consequently, the existence of a solid infrastructure in marine science and technology is a basic component for such development.

3. In most underdeveloped countries, despite several efforts, marine sciences and technologies are weak; the main deficiencies are:

   a) very striking shortage of well-trained personnel in both marine science and marine technology;

   b) a poor academic situation in the universities, resulting in precarious research and, in many cases, the absence of necessary university marine science curricula for training post-graduate scientists and professors and highly qualified technicians in marine sciences;

   c) non existence of specialized programmes of training for marine technicians required for the different activities in government and private sectors;

   d) deficient installations;

   e) limited equipment, both sea-going and laboratory;

   f) ill-equipped and poorly organized libraries;

   g) lack of timely access to suitable vessels for their programmes (this does not necessarily mean that each institution or country need have its own research vessel);

   h) inadequate operational and maintenance budget;

   i) discontinuity in the activities.

4. As already mentioned, development of oceanography is an expensive operation. However, it should be considered a highly desirable investment in a medium long term. Unfortunately this is not the general situation in most of the underdeveloped countries where allocation of funds is insufficient.

5. In many cases, programmes are cancelled before achieving results. This lack of continuity is a serious problem, since in the end, in each case, it brings frustration and poor use of funds.

6. Knowledge of existing human and material resources often is not enough and as a consequence utilization of the available capability is improper.

7. The knowledge that most underdeveloped countries have of their own Exclusive Economic Zone is very limited. The deficiencies of infrastructure, particularly the shortage of specialists and the inadequate ability to participate in marine science - are serious restrictions; also the limited access to existing data, references, as well as instruments, makes it more difficult to realize the proper exploration of the ocean. Also they have difficulties analyzing and evaluating for their own benefit the relevant information to which they may, in theory, have access. These limitations frustrate aspirations and are a clear handicap to those countries.

8. The confusion existing on the oceans and the insufficiency of qualified people combined with the poor scientific and technological tradition, restricts the capacity of selecting proper actions to be undertaken. Frequently, attempts are made to provide simplistic solutions in the short term to marine questions, by applying pragmatic methods without qualified personnel and, trying to solve highly complicated problems which require a deep scientific knowledge. Obviously such efforts fail and lead to frustration and often, the participating scientists are considered responsible.

9. As result of the above deficiencies, national programming is limited, partial and fragmented, and scarcely reflected in authentic development. Furthermore, these deficiencies are obstacles to a country's becoming self-sufficient and capable of selecting or adopting technology suitable for its particular case.

10. Oceanic services, starting from basic cartography, data centres, information centres, etc., are very deficient and the responsibilities undefined.

11. In many cases, inadequate attention is given to the use of proper technologies and therefore existing technologies must be reviewed and adapted to the particular needs, or when necessary, replaced by others.

12. Technological dependence needs to be faced, considering a broad spectrum of activities from research to commercial aspects. In this context the deficient capability in instrumentation plays an important role and contributes to increasing the gap between the highly industrialized and the weak underdeveloped countries.

13. The mechanisms of communication and interaction between researchers of science and technology, and the link of research-application (government agencies or consultative firms) with the productive sector and the society, are often improper.

14. Governments do not establish mechanisms for translating scientific results or recommendations into action with official support.

15. The scientific community is only rarely consulted when decisions are made.

At socio-economical level

As already stated, the scientific and technological development of a nation is a long, complex and interrupted process. Few underdeveloped countries have a scientific tradition and in many of them, the more significant efforts have been made only in recent years. This situation prompts the question: what are science and technology? and what are their roles in society? The questions are still being debated.

Because of this lack of definition the scientific community has not been able to occupy its proper place in the society, and frequently faces problems and frustration; these make scientific development even more difficult. This aspect is probably most critical in the case of marine sciences, generally poorly understood, because of their complexity, multidisciplinary nature and recent evolution. It is also understandable considering how poorly informed the public is with regard to the sea.

Among the main problems with which a marine scientist must contend, in most underdeveloped countries, are:

a) Inadequate recognition of his status within the socio-cultural context, reflected in a general indifference to his work and uncertainty in his job;

b) Poor incentives, either in remuneration or in the means of carrying on his work;

c) Improper working environment or facilities;

d) Not being consulted when decisions are taken on subjects concerning him;

e) Difficulties in attending meetings where he would have opportunity to exchange ideas with colleagues from other countries; and

f) Difficulties to obtain bibliography in due time; lack of funds for publishing in international journals when convenient; and very limited and local or regional journals in which to report his results.

5. INTERNATIONAL COOPERATION

As pointed out, the ocean is considered more than any other single object of study a subject which requires international cooperation, as marine processes

do not observe any man-made frontiers. Substantial progress in marine sciences is scarcely conceivable, unless it is based on the benefits which cooperation, bilateral, regional, or multilateral, can provide.

Cooperation is vital in order to understand properly the world's oceanic processes in such a manner to permit the satisfaction of national and regional needs for the exploitation and administration of marine resources for the benefit of mankind.

For such cooperation to be valid and effective, it must take place in a bona fide spirit of equality, and certainly not under the auspices of the for-many-years-used and now unworkable philosophy known as technical assistance or aid. A friendly and harmonious atmosphere among scientists from different countries needs to be developed favourable to the acquisition of a more comprehensive knowledge of the ocean, to the solving of problems of interest to all states, especially to those in the process of development, leading to a real partnership.

Despite its importance, up to now only small serious efforts have been made towards international cooperation in marine science and technology.

5.1 BILATERAL COOPERATION

Historically, bilateral cooperation has not produced the expected results. For many years, a paternalistic attitude focussed on the solution of problems of interest only for researchers from industrialized countries, and were unilaterally formulated without regard for the needs and interests of the underdeveloped countries or their scientists.

Among the reasons why such cooperation has been limited are:

a) Underdeveloped countries have not realized the importance of the marine sciences and technologies as means of satisfying the basic needs of their population;

b) The virtually unrestricted freedom that existed until recently to engage in marine research activities in patrimonial waters of coastal states;

c) The great scientific and technological gap between states which offer few opportunities to scientists from developed countries to join projects with colleagues from the Third World.

5.2 MULTILATERAL COOPERATION

Marine science research activities are eminently multinational with tendency towards regional approaches. Hence, for a marine research project to produce positive results, close cooperation between the participating countries is necessary. Moreover, the fact that marine affairs are the concern of various international agencies - in particular those belonging to the United Nations System - has considerably increased the interest taken in them by a great number of countries.

These two considerations have led to the dynamic role which multilateral cooperation is already beginning to play in activities connected with the exploration, exploitation and conservation of marine resources and with the uses of the sea, both at regional and at global level.

Much has been accomplished in this connection in recent years, but limitations still exist and should be eliminated for the benefit of multilateral cooperation, particularly within the United Nations System.

Among these problems, the following stand out:

a) Despite the fact that reference is made in all organizations to the importance of the sea and its resources, budgetary allocations are still too small considering the magnitude of the work to be done, especially for manpower preparation and promotion and advisory services;

b) The various agencies still do not establish or follow all the adequate links in matters relating to the sea. This sometimes leads to overlapping or rival efforts, or to neglect of important aspects in various area of the ocean. To a large extent the problem is the responsibility of Member States;

c) Considerable progress has certainly been made in the matter of coordination - as for example the ICSPRO agreement - but this still has not achieved the desirable level. This explains why even with a great potential there are only few joint projects between the various agencies;

d) The participation of the scientific community of member countries is very restricted in the meetings of the governing bodies of the agencies which take decisions on this subject. This is because, on the one hand, governmental recognition of the marine scientists is incorrect, and on the other, the scientists show little interest in those matters.

e) Part of the responsibilities of the scientific community are assumed through its participation in non-governmental advisory bodies of the UN Systems.

f) Data, information and references have great importance and, if accessible to the scientific community, can be decisive means for reducing the gap between countries. Very useful data, and information and retrieval centres and systems have been established within the United Nations System. Nevertheless, they will produce the desired effect only when developing countries are involved and use the information and data available.

6. RECOMMENDATIONS

The need to create favourable conditions for the use of international cooperation for the adequate transfer of Marine Science and Technology in the context of the New Ocean Regime is clear. Based on the above analysis of the limitations of underdeveloped countries that militate against their creation of such conditions, the following recommendations are made:

1. define the priority assigned to the ocean within the national development policies of the countries.

2. strengthen the system of science and technology in order to develop the endogenous capability, fostering the idea of the "growth of national science and technology" and properly locate marine science and technologies within the system;

3. improve the information about, and give wider diffusion to measures of significance of the oceans and the need to approach it integrally;

4. establish mechanisms of internal coordination of the marine sciences, allocated within the science and technology sector with strong intersectorial links;

5. take steps to review national legislation relating to the oceans and up-date it in accordance with present international reality;

6. build the required marine scientific infrastructure comprizing, inter alia:

   a) a long term progamme of prepartion of manpower at all levels, both in the country and abroad.

   b) in parallel, a strong long-term programme of visiting scientists, to act as a catalytic agent for preparing the local scientists.

   c) assembly of a multidisciplinary group of well prepared marine scientists and technologists at the doctor's degree level, properly integrated and located, if possible, within the university system or in a research centre connected with educational institutions.

      This group should be strong enough to assume responsibility at the one time for starting essential research and initiating specialized university marine science teaching. This group should be a multiplying factor and the source of scientists and professors for the future. It can also play an important advisory role to the government when dealing with negotiations with other countries.

   d) strengthening of the universities, giving them funds, stability and all support required, including, facilities, libraries, equipment, access to vessels and security of funds.

   e) promote the establishment of close academic relations among universities or similar institutions, nationally, regionally and internationally.

   f) Attempts must be made to recruit existing highly qualified personnel to the study of those problems that require to be investigated in each country, making the maximum use of the available human resources, linking them to the goods and service sectors.

g) establish programmes for education of marine technicians at various levels, in order to satisfy the demand of personnel for the different marine activities in both the governmental and the private sectors. Attention should be given to the role that training in the job can play for improving the effectiveness of the technical and labour personnel.

7. orientate the work of laboratories of government agencies so that they will effectively assume their respective functions, mostly operative, in close cooperation with the scientific community so as to be able to use the results of the fundamental research.

8. optimize the use of existing research vessels (they are very expensive tools) making them available to the scientific and technological community of the country, and if possible, of the region.

9. make an effort, and allocate proper budgetary funds for the entire scope of scientific and technological aspects.

10. improve the mechanisms of programming in order to assure continuity of actions at all levels.

11. review the exising oceanic services and evaluate them in order to determine which of them should exist; which agency is responsible, and to assure that it is properly provided. The significance of data banks, information services, cartography, and communications systems, for the use of the scientific community, official sector, industry and the public, should be kept in mind.

12. When beginning marine programmes, efforts should concentrate on research and development in the coastal areas where the most important problems and resources are located, and where the easy access to these areas makes the costs of research and development relatively low.

13. Countries need to make special efforts to develop long-term programmes of exploration of their Exclusive Economic Zones. Since it is a complex and expensive project, agreements can be entered into by two or more national institutions to share personnel, costs, resources, ship time and results.

14. give particular attention to development of several aspects of ocean engineering, especially instrumentation to maintenance, calibration, repair, design and construction of different types of oceanographic instruments, either mechanical or electronic. Oceanographic instrumentation is one of the "bottle necks" that maintain technological dependence.

15. It is imperative for governments to define their strategy for international cooperation in marine affairs, at bilateral and multilateral levels. In the case of multilateral cooperation it is vital

that the order of priorities and funds for the programmes of the international agencies should be determined by the Member States themselves, since they make the decisions in the governing bodies of the agencies.

16. Each country should make a realistic diagnosis of the present situation of its marine sciences and seek for the proper steps to be taken to overcome its problems, using both internal and, as catalizer, external resources.

17. A National Oceanographic Committee or a similar body is required in each country, located with the science sector, to coordinate national scientific effort, particularly that related to international cooperation. All interested institutions from different sectors should be incorporated in such a body. This body can play an important role as advisor to government on International marine affairs as well as in defining the country's position in the UN System.

7. CLOSING REMARKS

At present various events underline the importance of international cooperation in marine affairs. A unique opportunity exists to use that cooperation as a means of assisting underdeveloped countries to meet the challenge to develop the marine science and technology that will permit them to use the rights and priviledges arising from the UNCLOS and the emerging New Ocean Regime for their own benefit and sovereignty and to assume their respective responsibilities.

Considering that developing countries - with a few exceptions - are extremely weak in marine sciences and technology , a major effort of international cooperation is required.

However, it is convenient to keep in mind that this effort must be always considered as a catalytic agent to assist national development, and that it does not in any sense replace national effort and commitment, which are basic elements.

The task is of great magnitude, complex and expensive. Its implementation calls for political decisions, and the use of all available financial resources, bilateral and multilateral cooperation, properly using all competent international organizations, particularly the United Nations system. This can be the best channel for facilitating international marine scientific research and to provide underdeveloped countries proper opportunities for the transfer of marine science and technology.

The results of UNCLOS and the already existing New Ocean Régime are steps forward towards establishment of a New International Economic Order. If it is still valid that without a scientific basis, there cannot be appropriate transfer of technology; then, without a sound technological basis, the New International Economic order will never come into being.

For all these reasons we must be creative and make a joint effort to suggest ways and means which may permit the underdeveloped countries to be able to have true sovereignty over their Exclusive Economic Zones, developing scientific and technological capability and using their marine resources for their own benefit, reaching their socio-economic goals, and for the benefit of mankind.

NEW OCEAN REGIME AND MARINE SCIENTIFIC RESEARCH

Syed Zahoor QASIM

Department of Ocean Development
Government of India
New Delhi
India

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INTRODUCTION

Parallel efforts over the last one decade to establish a new régime for the oceans (UNCLOS III[++]) and a new international economic order (NIEO), have a point of convergence at least in the perceptions of the Third World. Both hold immense promise of development for the deprived sections of the international community. The resources in marine areas which fall under national jurisdiction (e.g., the Exclusive Economic Zone - EEZ) and those in areas beyond national jurisdiction (i.e., under the proposed International Sea-bed Authority) are more than adequate to meet basic human needs for a long time.

But achieving this calls for the adoption of a proper blend of management, development and technology. If past experience can be taken as a guide, humanity has shown scant respect for managing and developing the resources, and has taken scant notice of the impact of technology on the marine ecosystem. A significant number of marine species is on the verge of extinction as a result of competitive exploitation, a process which Garret Hardin describes as the "tragedy of the commons". Vast stretches of the oceans have been laid waste by pollution through disposal of sewage, industrial wastes, land and sea-based oil spills, oil transportation, dumping and drilling.

The new charter of the oceans, adopted after nine long years of tortuous negotiations, seeks to arrest this destructive trend. It offers a positive framework of law and policy in which the resources of the oceans can be harnessed for the benefit of mankind. Through a series of do's and dont's, in the UNCLOS III Convention, mankind strives, first, to save the marine ecosystem - a prerequisite for managing the resources - and, second, to regulate the exploitation of the resources.

The scheme for saving the ecosystem is laid down in Part XII of the Convention, containing 11 sections and 46 articles. In one of the shortest articles (192), the Convention declares: "States have the obligation to protect and preserve the marine environment". To that end, states are required to use "the best practical means at their disposal". This part further identifies centres of responsibility and authority and formulates a clear design of enforcement. States are made liable for the damage caused by violation of their international obligations to combat marine pollution. States are also obliged to cooperate globally and regionally in formulating rules and standards of environmental protection, and to commit themselves to promote technical assistance to developing countries in this matter.

Protection and preservation of the marine environment entails scientific research. The rights and duties of the states in this field are spelled out in Part XIII of the Convention, containing 6 sections and 29 articles. States and competent international organisations are given the right to conduct marine scientific research subject to some conditions. There is a duty to cooperate amongst themselves, to pursue only peaceful goals, to create favourable conditions for, and to disseminate information and knowledge obtained from, such marine scientific research. The coastal state enjoys full powers to control and regulate research in its ter-

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[++] UNCLOS: United Nations Conference on the Law of the Sea

ritorial sea, and in the EEZ and on the continental shelf it is expected to grant its consent to requests for opportunity to conduct research designed to promote scientific knowledge for the benefit of all mankind provided it is peaceful and unrelated to resource exploitation.

Neither the preservation of the marine environment nor the promotion of scientific research is possible in the case of most developing countries, which lack a scientific base for these. The Convention therefore suggests a scheme for the development and transfer of marine technology (Part XIV, containing 3 sections with 13 articles). The provisions of the Convention impose a duty to cooperate "within their capabilities" in transferring marine technology "on fair and reasonable terms and conditions". The transfer is to be effected with due regard to the rights and duties of the holders, suppliers and recipients of marine technology. The developed states, in particular, are required to help developing states to establish national and regional centres, and to attain the stated objective through training, transfer of skills and equipment, dissemination of information, etc. Collaborative arrangements, joint ventures, symposia and seminars are some of the means suggested.

1. BACKGROUND INFORMATION

In 1950, only about 50 countries were interested in studies of various aspects of the oceans. This number increased to 91 in 1970 and 130 in 1975. There were only about 750 marine scientists in 1950 throughout the world. Their number became 5740 in 1970 and 12,000 in 1975. However, the increase in manpower largely occurred in developed countries.

Today, of the 165 countries in the world, 99 are maritime nations. There are about 93 developing countries. Of these, 15 are land-locked, 10 have adjacent shallow seas and the rest have open seas. About 20 of the developing countries have ocean-going survey research vessels and some have more than one research vessel.

At present only a few developing countries are able to participate in major international expeditions. In the International Indian Ocean Expedition (IIOE, 1960-65), 10 developing countries participated. In the recent Indian Ocean Programme of FGGE on the Monsoon Experiment (MONEX-79), only 3 developing countries participated.

During the last decade (1970-79), the developed countries filled gaps in knowledge of the less explored parts of the oceans. These studies were largely of environmental quality, environmental forecasting and seabed assessment. The developed nations concentrated more on ocean mining, ocean engineering and ocean technology than on the biological wealth of the sea. Thus, the interest is shifted from traditional fisheries to other activities and most of the developed countries have ceased to expand their fishery fleets. Marine science in some of the developed countries is the third largest area after atomic energy and space research. The developing countries, on the other hand are expanding mainly their fishing capabilities, increasing use of the ocean as a source of much-needed protein supplies. But some of the third world nations also have a strong interest in sea minerals, pollution control and energy from the sea.

2. THEME: PHYSICAL OCEANOGRAPHY

Physical oceanographic studies have been undertaken mainly on the composition, structure and motion of water, the interaction between atmosphere and ocean, and the processes related to ocean currents, upwelling, mid-ocean turbulence and atmospheric coupling. The main geographical regions of interest were the North Atlantic, North Pacific, Southern Ocean, and the eastern boundary currents of the Pacific and Atlantic.

In developing countries, marine physicists form less than 10% of the total marine scientific manpower, while in developing countries the proportion is up to 20%.

In general, physical oceanographic research has moved from exploration and descriptive field data to the testing of hypotheses. Much interest at present lies in the interaction of physics with the other sciences; interdisciplinary approach is preferred to the earlier specialised approaches. Current investigations can roughly be grouped into 5 types:

(a) Description and modelling of estuarine and shelf dynamics

(b) Continental shelf dynamics and shelf-ocean coupling

(c) Western boundary regional dynamics

(d) Mid-ocean dynamics

(e) Large-scale atmospheric and ocean coupling.

Modelling and ocean physics in conjunction with the other disciplines extended over a long period of time and covering large areas may help in understanding the problems of climatic changes induced by ocean circulation, disposal of nuclear wastes in the deep sea, pollution control and fishery management.

Modern work in physical oceanography is aided by sophisticated technologies involving satellites, large deep ocean moored buoys, surface ships and research submersibles. Data collection and processing techniques have been greatly changed by the use of satellite and aircraft systems, fast-moving surface vessels, towed instruments and ship-board computers.

The more modern methods of ocean research are available only to developed countries. Advanced vehicles like manned and tethered submersibles, cable-controlled and remotely controlled unmanned vehicles, sea-bed vehicles and towed unmanned vehicles, etc., are being used as tools of research in the developed world. Developing countries lack most such facilities.

Development of indigenous technologies within a developing country is quite possible, but it is slow, and technology soon becomes outdated. A short-cut in technological development, therefore, could only be achieved by close cooperation between the developed and developing countries. Once developing countries catch up in certain areas, further development becomes easier.

3. THEME: CHEMICAL OCEANOGRAPHY

The progress of chemical oceanography in developing countries, as in other areas of marine science, has been relatively slow. Inadequate facilities, lack of a multi-disciplinary approach and shortage of trained personnel are largely responsible for the slow development. Since sustained exploratory work in any oceanic area is carried out largely by the countries surrounding it, many parts of the coastal and offshore areas around the developing littoral states have remained poorly known.

Chemical oceanography deals with the various chemical processes taking place in the sea. These processes are of utmost importance, since they control both living and non-living resources. Exploitation of the oceans as an inexhaustible source of food, minerals and drugs calls for deep knowledge of the interactions and variations in various chemical constituents of the sea water in relation to physical, biological and geochemical factors. Chemical oceanographic studies have numerous applications. They help in delineating areas of high potential fertility and mineral deposits which may be of utmost economic importance. Such studies also help in assessing the state of marine pollution and the fate and pathways of various pollutants in the sea, including those which may have far-reaching effects. For example, the introduction of increasing amounts of carbon dioxide into the atmosphere by the burning of fossil fuels may result in a change of the climate of the earth, unless the carbon dioxide so produced is absorbed by the sea.

The bulk of research and developmental work in chemical oceanography has been carried out in the developed countries; only a few developing countries (e.g., India) have contributed significantly. The IIOE was very useful for the development of chemical oceanography in India, since it provided participating young scientists from the country with much-needed training and experience. The establishment of the National Institute of Oceanography, with a full-fledged division for chemical oceanographic research, and the subsequent commissioning of the Research Vessel Gaveshani, have contributed towards further development in this discipline. As a result, several interesting chemical processes occurring in the Indian Ocean, hitherto poorly-known, have been clarified.

For the transfer of technology in chemical oceanography, the following measures are suggested:

(a) Public interest should be generated in developing countries for the realisation of potential benefits that could be achieved from well-organised research in chemical oceanography.

(b) Chemical Oceanography should be taught at the university level in developing countries.

(c) Regular bilateral exchange of senior scientists within the region will help in the exchange of ideas and adoption of the latest techniques of analysis.

(d) Many developing countries do not possess research vessels essential for oceanographic work. So, joint exploration using one country's ship should be carried out in areas of mutually agreed scientific interest. This will provide the necessary ship-board experience to the scientists from one developing country and sharing the experience with the others. Some projects involving more than two countries could be taken up.

4. THEME: BIOLOGICAL OCEANOGRAPHY

Biological oceanography may be defined as the study of pelagic, nektonic and benthic communities in relation to processes occurring in the ocean. This discipline has a direct relevance to the exploitation of marine living resources (capture and culture fisheries) and to the conservation of living resources.

Physical and chemical conditions of the ocean are connected with the life in the ocean. While marine biological research dealing mainly with qualitative aspects, such as taxonomy and biogeography has a long tradition, biological oceanography, involving multidisciplinary approach to the environment, is particularly a feature of recent times.

In many developing countries there has been an increase in the economic exploitation of marine living resources. In some, such as Thailand, South Korea and Ghana, the increase has been exceptionally rapid. In others, e.g., some countries of the Middle East, the growth of fishing has been rather slow. Further, in some countries such as India and Malaysia, shrimps and tuna have become important items of export. However, to meet the projected demand, as shown by FAO's Agricultural Commodity Projections, fish production in developing countries has to be doubled in less than 20 years. Therefore, the various possible avenues of production require accelerated effort. Some problems of biological oceanography which demand attention are listed below:

(a) Estuarine research - The estuaries are of particular interest to biological oceanographers, both from the standpoint of their unique character and because they continue to be centres of intense human activity. High productivity in the estuarine environment of the tropical zone occurs practically throughout the year. The estuaries serve as areas of extensive fishing as well as nursery grounds for the young states of commercially important organisms.

(b) Estuarine pollution (both organic and inorganic) causes direct and catastrophic effects on the natural resources. In estuaries, there may also be an indirect effect of silt, dust, pulp wastes, fly ash or mining material in reducing the light penetration in the water column and thus decreasing productivity.

(c) Transfer of pollutants such as heavy metals, chlorinated hydrocarbons and polychlorinated biphenyls to marine organisms through the food chain.

(d) Quantitative aspects of marine food webs, with particular reference to the rate and magnitude of organic production, grazing rate, generation time, growth dynamics, mortality rate and ecological efficiency of conversion at different trophic levels.

(e) Role of microbes in the degradation of organic matter, release of nutrients and denaturing of pollutants.

(f) Dynamics of phytoplankton, macrophytes, zooplankton, benthos and nekton in marine and estuarine ecosystems.

(g) Environmental control of marine biota - assessment, monitoring and conservation.

(h) Aerial and remote sensing (satellite imagery) of biological variables such as chlorophyll and pelagic fish resources.

Much scientific effort is required to understand the fluctuations in fish catches. The characteristics of fisheries, such as the abundance of a species, including its seasonal variation, its geographical range of distribution and the factors that influence the aggregation or dispersion of a fishable stock, require continuous effort in the collection and interpretation of data. In tropical waters, attempts should be made to establish long-term relations between fish stocks and biotic and abiotic variables, such as winds, currents, temperature, plankton productivity and predators.

The major constraint in the growth and development of fisheries (capture and culture) is usually the lack of proper management and entrepreneurial abilities. Any attempt, therefore, to force the pace of development, where managerial skill is not up to the mark, will always have limited success.

5. THEME: MARINE GEOLOGY AND GEOPHYSICS

Marine geological and geophysical studies have contributed substantially to our knowledge of plate tectonics and the process of earth evolution, and have offered concepts of mineralisation of the sea-bed. These two sciences have become powerful tools for exploration and exploitation of non-living resources, including hydrocarbons. The developed countries have made considerable advances in the utilisation of these two specialised branches of science for gaining knowledge of mineral resources in the sea.

It is well-known that whatever minerals are found on land are also found in the sea; but the potential for exploiting all types of minerals from the sea is not the same everywhere. The recent energy crisis has accelerated the pace of oil and gas exploration throughout the world and today more than 80 countries are engaged in the exploration of oil in the sea-bed. Similarly, the demand for non-hydrocarbon minerals is increasing all over the world; production is expected to double by 1990.

Some of the non-hydrocarbon minerals, such as tin, monazite and ilmenite, are already being taken from the sea by developing countries, including India, Indonesia, Malaysia and Thailand. There is also a considerable interest in the much-publicised polymetallic nodules. The developed countries have contributed most significantly in the field of marine geology and geophysics, and the most spectacular advance in our knowledge in recent years has been of the deep sea mineral resources. In the developing countries, however, the various fields covered under this theme are : (a) bathymetry and topography of the continental shelf, (b) sedimentological studies, including the size distribution of sediment particles, carbonate content of the sediment, (c) foraminifera of the sediment, (d) phosphorus content of the sediment,

(e) mineralogy and geochemistry, including analysis of core samples for minerals, heavy metals, calcareous sand and quartz.

Specialised areas of geophysical studies for offshore mineral exploration include seismic, magnetic, gravity measurements, etc. These studies contribute significantly towards magnetic response of minerals deposits, and the interpretation of geophysical anomalies in terms of models to facilitate the assessment of mineral resources.

The stages involved in the transfer of technology for sea-bed mineral exploration can be worked out by planning and executing time-bound projects. To accelerate the programmes and facilitate their implementation would require development of expertise, infrastructure and services. Some of these can be listed as follows:

(a) Combined efforts, with utilisation of existing expertise, in the field of marine geology and geophysics to meet the challenging task of identifying mineral resources.

(b) Problem-oriented reconnaissance for general systematic mapping the sea-bed, and in greater detail later on, to identify the mineralised zones and hydrocarbon prospects.

(c) Establishment of proper base facilities, effective utilisation of ship-time, transfer of personnel from field to the base and quick processing and interpretation of geophysical data. These will also help in planning follow-up studies.

6. THEME: OFFSHORE AND DEEP SEA MINING

The most important considerations in offshore and deep sea mining are the overlying water and the physical state of the sea bottom. The technology of mining is basically the technology of dredging, so several types of dredges, such as bucket-ladder dredge, dragline dredge, wireline clam shell and hydraulic-cutter-suction-dredge have been developed. Dredging operations in shallow water close to the shore are relatively less hazardous than those carried out in deeper waters. Operations in deep water require oceanographic data on wave characteristics, current directions and the magnitude of biological and chemical characteristics of water to ensure safety and efficiency.

The extraction of any type of mineral from the sea-bed will involve the removal or redistribution of sediments and benthic organisms Re-suspension of sediments in the waters close to the bottom and a marked increase in the turbidity of surface water are some of the environmental consequences of offshore mining, because the material is transported in hopper barges from the mining site to the storage site.

Mining activity may affect the oceanic environment either favourably or adversely in the following ways:

(a) Disturbance or destruction of benthic organisms.

(b) Resettlement of stirred-up sediment and possible destruction of benthic animals, which may have a very slow reproductive cycle.

(c) Change in the chemistry of bottom water, since the water may retain in solution the compounds leached out from the recovered sediment.

(d) Increase in dissolved nutrients in the water resulting in increased biological productivity in the euphotic zone.

(e) Change in the light penetration of surface waters because of turbidity.

It is, therefore, necessary that baseline environmental conditions be studied before any mining operation, small or large, is undertaken. The following systematic plan for deep-sea mining of polymetallic nodules is suggested:

(a) Establishment of baseline conditions in the potential mining areas.

(b) Environmental monitoring of pilot and/or full scale mining operations.

(c) Documentation of changes caused in benthic and pelagic ecosystems by deep-sea mining and an evaluation of their implications in relation to current or potential marine resources.

(d) Recommendations for any necessary changes in mining methods and equipment.

(e) Formulation of environmental criteria and regulations for future mining operations to minimise harmful effects.

The plan suggested for polymetallic nodules is equally applicable to the mining operations on the continental shelf, and all the points noted above are of immediate relevance to developing countries.

Offshore oil production and transportation are often associated with oil spills, oil-well blowouts and discharge of oil into the sea during its transport. A mining operation can come into conflict, for example, with fishing operations; this is of importance in several areas in India where a large export-oriented prawn fishery is now thriving.

On 30 April 1982, the Third U.N. Conference on the Law of the Sea adopted a Resolution on preparatory investments in pioneer activities relating to polymetallic nodules. According to this Resolution, four countries, namely France, India, Japan and U.S.S.R. and four multi-national consortia (Kennecott Group with 5 mining companies; Ocean Mining Associates with 3 companies; Ocean Management Inc. with 4 companies and Ocean Mineral Company with 5 companies) all headed by U.S. groups were recognised as "Pioneer Investors". Each pioneer investor is by definition expected to sign the Convention stating that prior to 1 January 1983, the investor has expended an amount no less than U.S. $ 30 million in pioneering activities of deep-sea mining and has expended no less than 10 per cent of that amount in the location, survey and evaluation of a specific mining site. This site should be large enough to be later divided into two pioneer areas of equal estimated commercial value. The size of one pioneer area should not exceed 150,000 sq. km.

This development will accelerate the preparatory work connected with deep-sea mining. However, the technology for carrying out deep-sea mining is possessed today by only very few countries. No country or mining company has yet demonstrated a properly evaluated and economically viable system for mining polymetallic nodules.

7. THEME: MARINE INSTRUMENTATION

Marine instrumentation in developing counties is of recent origin and this field needs much encouragement and support, particularly because of the need for specialised instruments for oil exploration and the exploration of other minerals, including polymetallic nodules.

Marine Instruments can broadly be classified (as to their application) as follows:

(a) Physical: CTD/STD; current meters; data buoys; XBT.

(b) Chemical: pH meter; spectrophotometer; atomic absorption spectrophotometer; autosal; etc.

(c) Geological: magnetometer; side scan sonar; deep tow; MFESI XRF; sparker.

(d) Data Handling/Acquisition/ Processing: echosounders; navigation systems; microcomputers and peripherals; communication systems.

From the limitations of indigenously available marine instruments in developing countries, it is evident that those countries suffer an acute shortage of trained manpower (i) to service and maintain existing imported marine instruments (laboratory and ship-board), and (ii) for R and D capabilities.

India has already taken initial steps in the development of (i) marine communication sets, (ii) ship-borne equipment, such as echosounders, CTD, microprocessor-interface units, electronic bathythermograph (B-T), data buoys, wave data recorder, (iii) laboratory instruments, such as microcomputer controlled data processing systems, programme development aids, permanent oceanographic data storage devices, (iv) remote sensing from satellites for ocean colour, wave data, etc. Consequently it is felt that a coordinated effort in the field of instrumentation in the region (countries bordering the Indian Ocean) will speed up the progress of maintenance and proper use of oceanographic instruments.

In a developing country, any technology related to some product will have phases of introduction, growth, maturity, saturation and decline. The life cycle/time-frame ratio has to be determined as an initial planning step. Generally, technology transfer policy evolves after the existing industrial/ technological status has been studied. For example, Japan allowed free import of technology between 1950 and 1970, simultaneously spending 4 to 5 times the cost of technology imports to absorb and improve the design and improve the production techniques to suit the Japanese environment.

Procedures for transfer of technology in marine instrumentation should meet a number of criteria:

(a) The number of processes/procedural steps/hurdles should be small.

(b) The system should be designed in such a way that the objective is always kept in focus within the routine evaluation activity.

(c) There should be provision for "free transport of ideas and techniques" without the need to come back to the Government for approval at frequent intervals.

(d) A feedback mechanism should be designed to analyse the fulfilment of objectives at both macro and micro levels.

8. THEME: OCEAN ENGINEERING

Training requirements and technology transfer in different areas are as follows:

8.1 COASTAL ENGINEERING

(a) Hydrodynamic laboratory facility for simulating ocean waves, currents, tides and winds. Transfer of the technology of modelling, application of computer and hydraulic models in solving coastal engineering problems, including modern dredging techniques, offshore construction and operation techniques, optimisation of port operation and marine transportation systems. Design, layout and construction of deep-sea harbours and offshore terminals.

(b) Environmental modelling to study dispersion and transport of pollutants, development of capabilities for design, construction and maintenance of submarine pipelines and diffusers for safe disposal of effluents in coastal waters.

8.2 ACCURATE MEASUREMENT OF STRENGTH PROPERTIES OF THE SEA-BED SOILS

(a) Geotechnical capabilities required for the design and construction of submarine pipelines, offshore platforms, underwater storage tanks and sea-bed mining systems.

(b) Capabilities for shallow penetration sampling and *in situ* testing at different depths of waters.

(c) Deep penetration sampling

Capabilities of deep penetration sampling at sea under a wide range of water depths, sea state, depth of penetration and sample quality. Deep borings to be carried out from a geotechnical ship equipped with centre-well. (Wire-line samplers are generally used for sampling.) Special equipment and techniques for testing the sea-bed soil on board the ship as well as in a shore-based laboratory.

(d) In situ testing of sea-bed soils: uncertainty in the sample quality caused by sample disturbances, and an increasing need for more comprehensive and reliable data as input to sophisticated design analysis, have given impetus to the development of in situ testing of soil. Various types of remotely controlled underwater testing devices and submersibles are available in developed countries.

Transfer of the technology of using these items of equipment under different conditions, and analysis of data.

Submersibles and remote control vehicles are also available for underwater drilling, sampling and in situ testing of sea-bed soils.

Transfer of the technology of using submersibles for marine geotechnical engineering studies.

(e) Sea-bed foundation design and construction techniques for offshore structures, modelling of soil-pile system response and performance of pile driving systems.

8.3 OFFSHORE STRUCTURES

(a) Development of marine investigation capabilities for engineering design, construction and operations in the offshore areas.

(b) Modern techniques of data analysis and models for the derivation of design and operating parameters for offshore structures.

(c) Erection procedures and maintenance of offshore structures in the sea and their impact on design.

(d) Offshore management and logistics for optimising the construction, installation and operation of offshore structures.

(e) Deep-diving capabilities for underwater investigations, maintenance, repairs, underwater cutting and welding works, etc.

(f) Safety technology: with increasing offshore activities, there is an increasing need for suitable technology and capabilities to handle offshore accidents, such as blow-outs, collision of vessels, salvaging of structures and vessels, firefighting, computer and hydraulic modelling techniques for various stages of the development of a risk-prone deep-sea mining system.

8.4 EXTRACTION OF ENERGY FROM THE SEA: FEASIBILITY STUDIES

(a) Ocean thermal energy conversion plants: Design of heat exchangers, selection of working fluid, design of thermal turbine, electric generator, condenser system, pumps for drawing cold and warm water. Design of station-keeping platforms, design of moorings, cold water pipes, etc. Construction and operation techniques for OTEC plants: Environmental impact studies.

(b) Tidal power: Environmental data collection and analysis, mathematical modelling, design of various sub-systems.

(c) Wave power: Research and development on various devices and selection of the most appropriate design for a given condition.

3.5 DIVING AND UNDERWATER TECHNOLOGY AND RELATED FACILITIES

(a) Deep-sea diving outfit with helium-oxygen diver's helmet and complete accessories and technology transfer for training.

(b) Development of hyperbaric facility and capability for: (i) Underwater biomedical research and diving physiology. (ii) Testing of equipment and materials under simulated high pressure conditions.

8.6 OCEAN DATA BUOYS AND DATA ACQUISITION SYSTEMS

Transfer of the technology of fully equipped oceanographic and meteorological buoys; installation, operation and retrieval techniques, data transmission system through satellites to a central station for analysis, storage and re-transmission when desired. Hardware and software development; this includes development of systems for interfacing the satellite transmitters with the buoy data outputs and for on-line acquisition and processing of satellite data.

8.7 NUMERICAL COMPUTER MODELS

(a) Sea-state duration for planning offshore construction and operations.

(b) Computing storm-surges of a cyclone for estimating the possible inundation and flooding of coastal areas and likely damage.

(c) Estimating wave height and period from synoptic weather charts.

(d) Analysing satellite imageries for obtaining the sea-state conditions and other oceanographic features.

9. THEME: OCEANOGRAPHIC DATA AND INFORMATION SYSTEM

One of the requirements for furthering oceanographic research is that it should be able to provide information at the right time to the users.

Many agencies have been established for the exchange and dissemination of data and information, and almost every country has some kind of agency or organisation responsible for such services, but in developing coutries most of these agencies lack proper staff and facilities. The National Technical Information Service (NTIS), the Smithsonian Science Information Exchange (SSIE), the Environmental Data and Information Service (EDIS) and Environmental Protection Agency (EPA) for example all in the United States are major sources of information for the whole world.

Other international organizations such as ICES, ICSU, FAO and UNESCO have played their important roles in the exchange and transfer of information. At the end of the IGY, and on the recommendations of ICSU, many World Data Centres (WDC) in different subjects were established. The WDC-oceanography came into

existence - WDC-A in Washington and WDC-B in Moscow. These Centres acquire oceanographic data and information from all over the world and provide them, on request, to secondary users. In conformity with their policy, they supply information on an exchange basis. Small requests are attended to free of cost, while a charge is made for large and complicated retrievals. Similarly, Canada, Denmark, France, India, West Germany and U.K. have national data and information centres to meet their own requirements. In India, the Indian National Oceanographic Data Centre (INODC) of the National Institute of Oceanography is the only data centre at present engaged in the management of oceanographic data and information in the country.

In this field, the role played by Unesco is very commendable. The IOC established a Working Committee on International Oceanographic Data Exchange (IODE). IODE is largely responsible for the exchange of data and information at the international level between the Data Centres of the Members of IOC. On the recommendations of IODE, IOC has identified many types of centres such as Responsible National Oceanographic Data Centre (RNODC), Regional Oceanographic Data Centre (RODC), National Oceanographic Data Centre (NODC), Declared National Agency (DNA), etc., which are engaged not only in the collection but also in the processing and exchange of data. One can get many types of information from these centres which also sometimes act as training centres for data-and-information personnel. WC/IODE has developed a format (General Format-3) for the exchange of oceanographic data on magnetic tapes between various data centres.

Another important system developed by IOC is the Marine Environmental Data and Information Referral System (MEDI). The financial support for MEDI has been provided by UNEP and 8 international organisations participate in this system; these are: FAO, IAEA, ICES, IHO, Unesco (IOC), UNEP, WHO and WMO. MEDI proposes to create about 3500 data files from about 600 data centres in the fields of oceanography, fisheries, environmental pollution, meteorology, geology, geophysics, bathymetry, etc. The MEDI experts have developed a standard "input registration form" to acquire the information which is processed and computerised. MEDI then issues catalogues of data and information holdings and these are sent to various MEDI centres. When fully developed, MEDI will perhaps be the largest referral system in the world.

IOC, in collaboration with WMO, has also developed an IGOSS data processing and services system (IDPSS) to collect, process and disseminate marine environmental and oceanographic information.

In addition, IOC has recognised or established in many countries centres called "IOC depository centres" where all publications from IOC and FAO are available and which can be made available to the users on request.

FAO has, for a long time, been engaged in the compilation and distribution of data and information, particualrly in aquatic biology and fisheries. In 1975, FAO and IOC established a panel to develop an Aquatic Sciences and Fisheries Information System (ASFIS). This system is functioning in Rome and has various input centres in several countries. It is one of the biggest information systems for freshwater and marine sciences. ASFIS regularly publishes twelve series of information documents.

UNEP has also established a referral system with its main centre at Nairobi. This system, known as INFOTERRA, proposes to cover different types of scientific information on marine and terrestrial environments.

UNEP has launched 'Information Referral System' (INRES) under the technical cooperation among developing countries (TCDC). UNDP has distributed a series of forms for collecting information on research, capabilities, training, infrastructure, etc., from the institutes, for publication in the form of a directory for the benefit of all the developing countries. The information can be obtained from UNDP headquarters at New York or from country's resident representative.

Unfortunately, few of the international agencies have yet been fully utilised by the developing countries to build proper data and information bases for their own purposes. The result is that information from a particular region is lacking. Therefore, for an effective exchange of information, the following points are suggested:

(a) Identification and registration of agencies in each country.

(b) Periodic survey of user's needs to develop proper services and facilities.

(c) Evolving an easy acquisition system to facilitate the sources to supply information.

(d) Cooperation of the source institutions to feed the information centres.

(e) Preparation and distribution of inventories and catalogues.

(f) Linkage with the international organisations.

(g) Computerisation and development of data and information bases and provision of information freely to the agencies.

(h) Development of simple standard formats for storage and exchange.

(i) Development of software for retrieval which is compatible with various other agencies.

(j) Preparation of user's guides.

(k) Training of personnel in information management.

(l) Recognition and provision of equal career opportunities for information personnel to attract talented persons. At present this is lacking in most developing countries.

10. CONCLUSION

The foregoing account under the different themes of oceanography clearly indicates that the capability of many developing countries to explore and derive benefits from the oceans or to participate effectively in multi-national pro-

grammes of marine research and exploration is either limited or inadequate. The developing countries are aware of the existing situation and are trying to divert such resources as they can towards the development of appropriate infrastructure, services and manpower in marine science. Lack of proper evaluation of their vital needs, lack of expert advice and assistance, limited availability of research and training institutions, shortage of oceanographic equipment and other tools of research, including ships, are the main factors which undermine their enthusiasm.

The Convention has clearly indicated that these problems do exist, and therefore, the only way to overcome them is to encourage cooperation in the development and transfer of marine science and technology. Any country is free to cooperate with another country or an agency in any field of its interest to encourage development. However, cooperation can more effectively be organised through well-known international organisations dealing with the subject. Thus, the transfer of technology can be accomplished if there are national and regional centres and a network of research and service facilities to undertake the work during and after the transfer of technology.

The most prominent body in oceanography on the international scene is the Intergovernmental Oceanographic Commission (IOC). Its principal function is to promote and coordinate the study of oceanography throughout the world. The working arrangements for the transfer of technology can easily be made by using the existing mechanisms of IOC (largely through TEMA).

The other important agency which has much achievement to its credit in the field of awarding fellowships in marine science, conducting training programmes, seminars, workshops and symposia or building up infrastructures in several member states is the Division of Marine Sciences of Unesco.

There are several other international organisations devoted to promoting the means of cooperation in the transfer of science and technology in fields closely related to marine science.

The involvement of UNU in this workshop is particularly noteworthy because the entry of UNU in the marine sector will provide an important element in the implementation of teaching and training programmes in marine science.

11. VITAL NEEDS

Some of the vital needs of developing countries in the marine sector can be identified as follows:

(a) to create an awareness and appreciation of the role of marine science in the economic development of a country.

(b) to create a national marine science base.

(c) to develop marine science infrastructure and services.

(d) to obtain more research vessels.

(e) to obtain more manpower planning.

(f) to offer maximum protection to the marine environment and particularly to the estuarine and coastal waters which are especially vulnerable to man-made changes.

(g) to encourage cooperation between the countries of a particular geographical region.

(h) to use international agencies for effective cooperation.

(i) to transfer technology through national and regional centres.

(j) to generate productive employment in the marine sector.

12. A POLICY

To meet the vital needs noted above, it would be necessary to formulate a policy giving the details of an action plan so that maximum benefits could flow between member states. This policy document should be based on the Convention and the discussions emerging from this workshop.

13. STRATEGY FOR IMPLEMENTATION

Having formulated a policy, it would be necessary to develop a proper mechanism for its implementation and for this the following plan is suggested:

(a) The policy document should be introduced in the next Session of the IOC Assembly for discussion, and should be accepted by the member states with the modifications suggested by them.

(b) Acceptance of the document would constitute a commitment on the part of the member states towards the implementation of the policy framework.

(c) Each state should earmark sufficient funds for development and for transfer of marine technology.

(d) There should be a clear recognition on the part of developing member states that the sea is an important resource generating sector.

(e) Developmental activities involving the multiple use of the sea should be carefully planned so that one form of resource exploitation should not affect others, and the sea should continue to meet our economic and recreational needs for a long time to come.

(f) Protection of the environment and conservation of marine resources should form the most important components of the implementation of the policy.

(g) Each state should largely provide the necessary managerial capabilities within their own resources.

14. THE INDIAN EXAMPLE

The seas around India constitute a natural frontier. For time immemorial, the inhabitants of India used the seas for transport and communication, for trade and food. As a result of these activities, quite a few interesting characteristics of our seas became known to our ancestors, and their impressions were recorded in the days of the Vedas and the Puranas (mainly the Matsya and the Vishnu). In Kautilya's Arthasatra (ca. 300 B.C.) and on some of the Pillar Edicts of Asoka, references to fish have clearly been made. Descriptions of a maritime code are found in Jataka Mala (Ist Century A.D.). These helped Indians to establish a sea-faring tradition which was strengthened further as the sea became better known.

Several physical features of the seas around India were known since ancient times. Althouth the Indians did not have a proper understanding of phenomena such as currents, tides and winds, they utilized their empirical knowledge, based on experience and visual observations,for practical purposes. For instance, the biannual reversal of the direction of winds has been known to Indians and to the Arabs for centuries. This knowledge they cleverly used for crossing the Arabian Sea to trade. Similarly, as early as the Indus Valley Civilization period, our ancestors were fully aware of the phenomena of ebb and flood tides. This is evidenced by the remains of an excellent dockyard at Lothal which the Harappans constructed to receive ships at high tides. Studies of this dockyard suggest that the Harappan engineers possessed sufficient knowledge of the tidal range, periodicity and the effects of tides. The Indians also had some knowledge of the animal life in the sea. This is clearly reflected in the Ain-e- Akbari and the Memoirs of several kings of the medieval period which give information on the fish and fisheries of Hindostan.

The origin of oceanography in India can be traced back to 1871 when an officer of the Indian Museum, Dr. J. Wood-Mason, was sent to the Andamans to explore the fauna and flora of that region. He was perhaps the first person to carry out biological work in deeper waters off Andamans, working on board S.S. Undaunted. The Marine Survey of India was inaugurated a year later about the time that H.M.S. Challenger sailed on her famous round-the-world cruise.

Stimulated by the success of Challenger, the Royal Asiatic Society of Bengal persuaded the Government of India to create a post of Surgeon-Naturalist to carry out in Indian waters work similar to that carried out by Challenger. Dr. J. Armstrong was appointed in 1875 as the first Surgeon-Naturalist. In 1881, the 580 ton survey vessel R.I.M.S. Investigator I was commissioned by the Marine Survey of India. On the request of the Government of India, the Admiralty agreed to give some of the equipment used on board Challenger for use on Investigator I and thus the "oceanographic studies" in India began. These were mainly biological collections, although occasionally observations on sea water temperature and bottom deposits were also made. Investigator I was scrapped in 1908 and replaced by Investigator II, a 1078 ton vessel with a higher cruising speed. However, it was not until 1910, when Col. R.B.S. Sewell took over as the Surgeon-Naturalist, that observations in oceanography, other than biological studies, were started. These included the measurement of salinity and temperature of sea water, and some meteorological variables such as barometric pressure, air temperature using wet and dry bulb thermometers and

velocity and direction of the winds. Because of the First World War, this work was suspended from 1914 to 1921. However, the surveys carried out in the Arabian Sea, Bay of Bengal, Andamans and Laccadive Sea, revealed a wealth of knowledge of the marine animal and plant life in waters of the Indian coast, all described in publications of the Royal Asiatic Society of Bengal.

Oceanographic data continued to be collected by research vessels which crossed the Indian Ocean during their global expeditions. These included the Dana Expedition (1928-30), the John Murray Expedition (1933) and the Galathea Expedition (1950-52). As a result of these expeditions, many interesting features of the Indian Ocean became known.

After independence in 1947, the need for maximum utilisation of the resources of the seas around India began to be realised. Early efforts were evidently directed to getting food from the sea. Thus, the Central Marine Fisheries Research Institute was established in 1947 to carry out research related to fish and fisheries. In the following years, analysis of sea water samples collected by the various naval and merchant ships was also included in the research programmes. The Indian Navy established a Naval Oceanographic Laboratory at Cochin for research on defence-oriented problems. At the same time, teaching of oceanography and marine biology started, at post-graduate level in some universities. Commendable work on physical oceanography and meteorology was carried out at the Andhra University during the period 1952-58 and research in other disciplines of oceanography, such as geology and geophysics, began to be undertaken for the first time in Indian waters. A Physical Oceanographic Wing was formed by the Central Board of Geophysics to carry out work on the physical aspects of oceanography.

However, thus far, a systematic approach to co-ordination and expansion of oceanographic work in India, according to the country's needs, was lacking. Therefore, in 1960, the Government of India established the Indian National Committee on Ocean Research (INCOR) to meet some of the planning and coordination needs.

14.1 THE INTERNATIONAL INDIAN OCEAN EXPEDITION

Of all the world oceans, the Indian Ocean is the least studied, even today. Most countries bordering the Indian Ocean are highly populous and at a low stage of economic development. It was, therefore, considered important to start this expedition, so that new food and mineral resources could be explored for the benefit of these countries. Besides, the Indian Ocean poses several problems which are totally different from those of the other oceans. The land-locked nature of the Indian Ocean on its northern boundary and the bi-annual reversal of the direction of the monsoons are the unique characteristics of this ocean. These considerations led to development of the multinational IIOE by SCOR, later co-ordinated by IOC. Forty ships from twenty countries took part in this expedition. A large amount of oceanographic data was collected from different parts of the Indian Ocean. This helped in closing gaps in our knowledge of the seas around India. Because of the geographical position of India and the scientific manpower it possessed, India was naturally one of the active participants in the IIOE and played host to

research vessels and scientists from many other countries. Four ships from India took part in the Indian programme of IIOE: I.N.S. Kistna, R.V. Varuna, R.V. Conch and M.F.V. Bangada. However, the bulk of the data from the Indian ships came from Kistna, a 90-metre frigate of the Indian Navy refitted for oceanographic work. Scientists from different disciplines went regularly on board. As a result of this expedition, the country became aware of modern oceanography and developed a team of young trained scientists by the time the expedition came to an end. The expedition gave a firm base for future oceanographic work in the country.

With the support of UNESCO and IOC, the Indian Ocean Biological Centre (IOBC) was established in 1962 at Cochin, for the study of zooplankton collected during the IIOE. The primary task of the IOBC was to sort about 2,000 zooplankton samples into various taxonomic components to be studied by specialists all over the world. It was also responsible for storing and maintaining the archives of samples. These tasks were successfully completed and the station data and displacement volumes of zooplankton samples were published in the form of several handbooks which also included the associated environmental data and research papers. The 10 atlases published by the IOBC summarize the distribution of the different planktonic groups in the Indian Ocean. These have been in demand throughout the world. The credit for most of the work done during the IIOE largly goes to the late Dr. N.K. Panikkar, former Director of the National Institute of Oceanography (NIO), who can be called the founder of modern oceanography in India.

14.2 THE NATIONAL INSTITUTE OF OCEANOGRAPHY

The scope of the Indian National Committee on Oceanographic Research, which was initially set up by the Government of India to plan and coordinate the Indian programme of IIOE, was subsequently enlarged to cover all types of oceanographic activities in the country. This Committee strongly recommended that it would be in the national interest to consolidate the valuable experience gained from our participation in the IIOE and that an institute having the status of a national laboratory be established in the country. The Government agreed to this proposal and thus the National Institute of Oceanography (NIO) came into existence on 1 January 1966 as one of the national laboratories under the Council for Scientific Research (CSIR). With its temporary headquarters in New Delhi, the NIO took over all the activities which were previously under the Directorate of the Indian Ocean Expedition. Over the years the NIO has grown into a large organisation with a staff of 500. Its Headquarters is in Goa and it has three regional centres at Bombay, Cochin and Waltair. Today NIO has seven divisions which cover Physical Oceanography, Chemical Oceanography, Biological Oceanography, Geological and Geophysical Oceanography, Marine Instrumentation, Ocean Engineering and Planning and Data processing.

The greatest impact on Indian Oceanography came with the commissioning of the first oceanographic research vessel, the R V Gaveshani, on 31 December 1975. This ship has a displacement of 1900 tonnes and is equipped with some of the most modern oceanographic instruments.

To date, Gaveshani has completed 115 cruises in the Arabian Sea, Bay of Bengal and Central Indian Ocean resulting in the collection of a large volume of data and information on the seas around India which have contributed much to our knowledge of the Indian Ocean.

During the last few years, NIO has fully utilised the expertise and indigenous technology available at the Institute and has provided service and support to a number of industries and public sector undertakings in as many as 150 sponsored projects in areas such as resources survey, harbour development, submarine pipeline surveys, pollution control and protection of coast from erosion. These sponsored projects are of direct interest to the user community.

Under the project "Food from the sea", NIO has located several rich fishing grounds, has mapped seaweed resources and has developed sea-farming technology (mariculture). Under the project "Coastal development", one of the most important contributions of NIO has been the survey of the 160 kilometre submarine oil pipeline route from Bombay High to Bombay for the Oil and Natural Gas Commission in India (ONGC). This pipeline has already been laid along the route given by NIO through which the crude from the Bombay High (offshore oilfield) flows. Two other surveys for the submarine oil pipeline routes have also been completed. These are from Bassein oilfields to Hajira (220 km) and from Bassein to Tarapur (120 km). These surveys are the first of their kind by an Indian agency and are entirely based on indigenous technology. They have not only saved valuable foreign exchange but have given confidence and self-reliance to the country.

The problem of oil pollution along the coastline of India has become alarming in recent years. Large quantities of crude oil are transported across the Arabian Sea from the Middle East to the Far East and other places. A part of this oil gets into the sea through accidental oil spills or by unlawful dumping of residual oil or bildge from the oil tankers. When the volatile fractions of the crude oil evaporate, the residue acquires a form of tar-like lumps or balls. These tar-balls find their way to the coast and adversely affect the recreational value of our beaches. Since oil pollution is a world-wide problem, it is essential for the international agencies to develop proper conventions, so that suitable measures can be taken to reduce this problem.

Besides NIO, several other organisations are engaged in specific area or research in oceanography, meteorology, marine biology and fisheries. Teaching and training are being done in the universities of Andhra, Annamalai, Cochin and Kerala. Sea fisheries research is being undertaken by the Central Marine Fisheries Research Institute, Cochin.

In recent years, the India Meteorological Department (IMD) has undertaken a series of observations of the monsoon phenomenon in collaboration with the USSR. Preliminary studies conducted in 1973, known as the Indo-Soviet Monsoon Experiments (ISMEX), gave very interesting results. These have been followed up by studies on a much larger scale. The project, called Monsoon Experiments (MONEX), in which several countries including U.S. and

U.S.S.R. were involved, will help in understanding the phenomenon of the monsoon, the appearance and disappearance of which have so far puzzled meteorologists. In 1977, India carried out the Monsoon Experiment jointly with the USSR, and Gaveshani undertook six cruises in the Arabian Sea and Bay of Bengal as contribution to MONEX-1979.

14.3 SURVEY OF POLYMETALLIC NODULES

On 26 January 1981 Gaveshani hauled her first sample of polymetallic nodules from the sea-bed, at about 4 km. depth, and thus India made her entry to the previously exculsive preserves of developed countries. The nodules were collected during the 86th cruise of Gaveshani on her way to Mauritius. On her return journey to Goa, (87th cruise), the ship collected more samples of nodules. On some parts of the sea-bed, the density of nodules was nearly 5 kg per square metre, which appears to be economically attractive. In 1982 (March to May), Gaveshani undertook 3 more cruises in the Central Indian Ocean, obtaining fairly large samples of nodules. Other suitable ships are being chartered to identify the most promising mining sites in the Indian Ocean. Towards the end of January 1983, two mining sites of 150,000 sq. km. each and of almost equal value have been identified as a prerequisite to India's recognition as a "Pioneer Investor" and the details of the mining sites will shortly be submitted to the Preparatory Commission formed by decision of the third UNCLOS.

14.4 ANTARCTIC EXPEDITION

Another important landmark in Indian Oceanography occurred on 9 January 1982 when the first Indian Expedition successfully landed on Anarctica. The Indian team came from seven institutions of the country and included oceanographers, meteorologists, geologists, a geophysicist, a radio communications expert and naval personnel. The 77-day long expedition started from Goa on 6 December 1981, went to Antarctica via Mauritius, and returned to Goa on 22 February 1982. Many scientific studies were carried out during the sea journey to Antarctica. On reaching the landmass of the frozen continent, observations were made of magnetic intensity, glaciology and radiowave propagation. Rocks were collected from the foothills of Antarctica for further geological and geophysical studies. An unmanned station, named "Dakshin Gangotri", was established on Antarctica for continuous recording of weather data. It is intended that the scientific information to be published on Antarctica and its adjoining Southern Ocean will be of the highest standard.

14.5 THE FUTURE

Oceanography, the collective entity of all sciences, is relatively a young science for India. Considerable work has been done in a short period of about 16 years, during which most of the infrastructure and manpower requirements have been built up. However, whatever has been done is a small fraction of what remains to be achieved. With the declaration of 200 nautical miles of Exclusive Economic Zone, India has added a very large area, about 1/3 of the total land area, to its economic boundaries. This area needs to be intensively explored for the living and non-living resources. India's future oceanographic programmes are being carefully planned to suit many urgent needs.

It is known that most of the conventional sources of energy (fossil fuel) are exhaustible and hence many countries of the world are now seeking alternative sources of energy which will be unconventional and inexhaustible. Significant progress has been made in several countries, including India, for the utilisation of the energy of tides, waves, currents and temperature gradient in the sea. Preliminary studies indicate that some area in India are very promising for harnessing tidal energy. Researches on this important aspect are likely to draw more and more attention in coming years.

The most significant contribution India could make during the next decade or so would be in becoming self-reliant in undertaking the different challenging tasks of exploiting the sea and its resources for the benefit of its people. India will also provide support and expertise to many developing countries of the world in the transfer of ocean science and technology. The oceans will thus continue to hold the promise of meeting man's ever growing needs for food, minerals, energy, chemicals, water, living space and climate. The new age into which we are moving is not only the age of atoms, the electron and space, it is also the new age of the sea.

FLOW OF SCIENTIFIC DATA AND INFORMATION AND THE TRANSFER OF KNOWLEDGE TO DEVELOPING COUNTRIES

Geoffrey L. KESTEVEN

Hurtville
Australia

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INTRODUCTION

Data, information, knowledge, marine science and technology, cooperation, and developing countries -- if whole books can be written on each of these terms, how much might be written on them all, as they stand together in the title assigned to this paper and in the subject of the workshop? Clearly, some strict rules of selection must be observed in assembling material under the assigned title, to contribute to the task of the Workshop. But it will not be enough to have rules of merely editorial effect. The rules should indicate what is relevant to the theme of the Workshop and the logic to be observed in examining issues expected to be debated by the participants. The formulation of such rules, by each author, is part of the pre-sessional activity of a workshop; it is accomplished by stating one's understanding of what it is one is expected to offer in one's paper, by presenting definitions and setting out assumptions. If this formulation is well done the analysis of the workshop subject, made by its organizers, will be deepened and the terrain over which discussion must move will be more clearly perceivable.

Thus, I believe that the task assigned to me, in preparing this paper, is to show how

(1) through international cooperation
(2) the flow of scientific data and information
and
the transfer of knowledge to developing countries
(3) might be promoted, to the end that
(4) (a) marine sciences might be developed
and
(b) marine technology might be transferred,
(5) as has become necessary by virtue of the New Ocean Régime.

(The numbering and lettering of these lines is made for purposes of identification of points for discussion, but the proposition should be read straight through, disregarding numbers and letters, from "to show" to "Régime".)

The phrase "to show how" is not to be taken to mean an undertaking to describe a complete set of procedures, with appropriate technology, by which to accomplish all that follows; it is a shorthand expression to stand for: "give some account of the procedures with respect to (2) that are employed in (1), and, in accordance with (3), of how these might be improved and others adopted, for the purposes of (4) and (5)".

The above formulation emphasizes that the two principal terms of the title for this paper are not to be considered for themselves, in a merely intellectual exercise. They are to be seen as elements of a strategy which the organizers hope will be drawn up by the Workshop.

However, although this formulation may establish the main intention of the assignment -- in a general way, some aspects remain unclear. For example, it might be thought, on first reading, that "transfer of knowledge" and "transfer of technology" had been meant to refer to a single activity and that the writing of "knowledge" in one place and of "technology" in the other was only stylistic variation, or a slip of the pen. The phrase "transfer of technology", however, although it does denote transfer of know-how (which, of course, is knowledge), in current usage denotes a wider range of activities; these include: transfer of instruments and equipment, training in the use of these items, creation of enterprises to make use of

them, training in management, and the development of infra-strucure. All this is quite distinct from "transfer of knowledge" as part of scientific activity. Therefore, information flow and knowledge transfer (2) are to be seen as part of a strategy towards development of marine sciences and transfer of technology and something quite different. Perhaps it is advisable also to note that "marine technology" does not denote the technology, as instrumentation, of marine sciences, even though much use may be made of that instrumentation in the application of the results of research in marine sciences.

Finally, within this exercise of definition, attention must be directed upon the words 'data' and 'information'. In current usage each of these words lives a double life. Most generally, 'information' stands for "that of which one is apprised or told; intelligence, news", and even in legal action it plays essentially the same part. In communication theory it stands for what is transmitted through a communication system, and it can be said in that theory that "The fact that a message may have a meaning is irrelevant to the engineering problem /of the communication system/". Similarly, while "datum" in common usage still stands for "a thing given or granted; something known or assumed as fact, and made the basis of reasoning or calculation" it most often now stands in scientific literature for a number; that is, if ever it is used in the singular, for mostly it is spoken or written as the plural, "data", but treated as a collective noun, and quite clearly the intention is to speak of "numerate information". Yet, despite the intention, the "data" referred to are never only numbers; each piece of numerate information is accompanied by circumstantial information as to place and time, method and material; except in mathematics, figures without circumstantial information are meaningless. Thus, when we speak of a flow of data we must bear in mind that we are talking about a movement of words, or of symbols standing for them, as well as of figures 1/.

To go beyond this in a search for a taxonomy of informations is neither permissible here (for reasons of space) nor necessary: I simply announce that in this paper I shall write of data in both senses; I shall sometimes intend sets of numerate information circumstantially identified, and at other times I shall intend the classical sense of "a given piece of information". Generally my meaning will be clear but wherever it may be in doubt I shall specify the meaning I intend. In general I shall write of information in it's broad sense and, for convenience, to cover both terms; that is, I shall hereafter write "data and information" only when it is advisable to do so, because of a direct relation of the text with the subject title.

Of Knowledge and Understanding

The importance of the distinctions noted in the preceding paragraphs will become clearer, I trust, as the argument of this paper develops, but something more of their nature can be seen in the following schema:

Datum = fact	=	a formulation, in numbers of words, written or spoken, of a sense-perception of an object or event, whether perception is direct or intermediated by instruments.
Information	=	a statement in which one or more data are assembled with such grammatic and syntactic apparatus as may be needed to convey an intelligible message.
Knowledge	=	one or more statements which together constitute a description of an object or account of a phenomenon.
Understanding	=	apprehension of the meaning or import of what is presented as knowledge.

In practical terms, data are the record of observations and measurements made in the course of field and laboratory work; information is the developed account of the results obtained, in report or paper; knowledge then is that part of communicated information that is accepted by the scientific community; understanding is that which is achieved by each individual through the exercise of judgment. The schema is founded on the requirement of a doctorate thesis, that it should be an original contribution to knowledge and understanding 2/.

1. SCIENTIFIC INFORMATION

1.1 FLOW OF SCIENTIFIC DATA AND INFORMATION

The flow of information can be discussed in at least three aspects which I designate (1) the technological, (2) the semiotic, and (3) the epistemological.

The Technological aspect: A flow of data and information is accomplished by operation of communication systems, and can be discussed in terms of transmitters and receivers, media, messages, and bits of information. At this level, transmitted information, as signal, can be a physical cause.

The Semiotic aspect: The flow of information, in general, can also be discussed in terms of the nature of a message passed, its semantic content, the intention of the originator of the message, and the response made, by those who receive the message, either to their perception of the arrival of a message (as, for example, the fear that assails many people on seeing a messenger arrive with a telegram) or to their understanding of the content of the message. At this level transmitted information is not a physical cause.

The Epistemological Aspect: The flow of information may be discussed with regard to what happens to the information when it is so moving; in this case we need to think of a nexus of lines of communication with pieces of information moving backwards and forwards along single lines, with the possibility of it's being modified by a receiver before being returned.

The flow of scientific information must be discussed with regard to all three of these aspects. The first of these aspects will perhaps occupy much of the attention of this Workshop since with respect to it we must discuss the modes of communication -- publications, meetings, training courses, data centres, and similar matters -- and thus deal with much of the repertoire of activities of aid programmes. The second aspect, involving questions of translation, thesauruses, standardisation of terminology, and similar matters, will be closely related and of much importance to discussion of the first aspect. The third aspect is certainly of equal if not of greater importance. Above all else that it might be, science is an epistemological activity and in it communication is of the very essence. The exposure of results to criticism is one of the most powerful elements of scientific procedures; it has been said that unpublished science is no science. A discussion of this aspect must deal with the nature of the messages being passed; it must deal with the rules that hold with regard to obtaining information, that give it scientific character; and it must deal with other rules which, operating at the receiver end, direct the scrutiny of received messages and, in the ultimate, determine their acceptability as scientific material.

1.1.1 The Modes of Scientific Communication

By a simple approach, the modes -- as techniques, means and occasions -- of communication may be classifed as follows:

- Personal (written or spoken)
- Public
  - Verbal
    - Meetings, Conferences, etc.
    - Workshops, Seminars, etc.
    - School-, college-, and university classes
    - Training courses
  - Recorded
    - By print
      - Primary
        - Periodicals
          - Secondary
          - Bibliographies
    - By film/video
    - Electronically
      - Information and bibliographic services
      - Taped messages
      - Data trasfer and storage

These modes are used in different ways, for different purposes: for popularisation, for teaching, for the servicing of research, and for substantive scientific communication. The modes thus do not, in the majority, carry distinct classes of information; the notable exceptions are bibliographies and data transfer and storage. Also we note that a great part of what is communicated verbally is also recorded.

Each of these modes can be discussed with respect to each of the three aspects -- technological, semiotic and epistemological -- discussed above. In this section I consider only the first of these aspects.

Under the term technology I refer, in respect of these modes, to all the practices and equipment employed in organizing and conducting meetings, classes and training courses, in publishing documents, preparing films and other audio-visual material, and in providing bibliographic and data services. The actual techniques of producing material or arranging events need not be discussed here: what is more important is to discuss the availability of each of these modes and the efficiency of use of them. Primarily we are concerned with the access that scientists have to information, through these different modes, and with the factors that influence that access, for good or ill. But we are also concerned with the efficiency with which these modes are employed, assessing efficiency in respect of how the conduct of marine science is served by them.

With these matters we become involved in some of the great social issues of the contemporary world, namely the concentrated location and ownership of equipment for gathering, storing, processing and disseminating information, and the high price of gaining access to that equipment in its operation and to its output. The International Commission for the Study of Communication Problems, set up by UNESCO, said of this matter: "there is a relatively small number of predominant corporations which integrate all aspects of production and distribution, which are based in the leading developed countries and which have become transnational in their operations. Concentration of resources and infrastructures is not only a growing trend, but also a worrying phenomenon which may adversely affect the freedom and democratization of communication." 3/

Whereas, most scientific publishing at the turn of the century was effected by scientific institutions and learned societies whose libraries could be kept up-to-date through exchange arrangements, today a large proportion of scientific literature is produced by publishing companies conducted strictly as business enterprises. It may be supposed that in the case of many a publication the price is set by dividing the cost of its production (plus some margin) by the number of institutions and libraries which can be relied upon to purchase it, and that the edition is of that number plus a proportion for eventual purchasers, estimated by the publisher on the basis of experience. In effect, such works are produced essentially for well-off institutions, and freedom of access to scientific information has become subject to the principle of "the open doors of the Waldorf Astoria".

These problems could be reduced in part by formulation and application of a revised code of scientific publication. As a general rule, each scientific contribution can be assigned a place in the following classification:

(i) Those that add items to the inventory of objects and phenomena, with such description of each of these as may be required by the principles of classification;

(ii) Those that identify and analyse a system and present a description of it with respect to its structure and dynamics, with particular attention to identification and evaluation of the relations that hold within the system, between its parts, and those that hold between the system and other parts of the larger system of which the studied system is itself part;

(iii) Those that are directed to development of the logical and physical apparatus employed in research of the preceding categories.

The rules of publication already differentiate between these categories, to some degree, but could be developed further and applied more rigorously. The basic principle that would be observed in a new set of rules would be that a clear distinction would be made between works that qualified as "contribution to knowledge and understanding" and those that added data, enlarging our stock of descriptive information but requiring analysis and interpretation. Material of the latter kind would not appear in general publications but would pass directly into appropriate stores. Thus, in category A, new records of distribution of a species would go into one of the many botanical and zoological records now maintained by international arrangements. Similarly with regard to category B; new instances of an already described type of system would not have a place in the substantive body of scientific literature; archives would be established for such records. Again, the principal results in papers of category C which described technical modifications of already described equipment, method or model, would be added, in standard form, to the registered specification. As remarked above, this differentiation is already made, but the application of the principle varies from periodical to periodical and the arrangements for storage of material are still rudimentary.

Application of this rule would frequently require the splitting of a paper into two parts, one, of data for storage in archive, the other, constituting the original contribution, for substantive publication.

The fundamental rationale of this proposal is that a very large amount of material now published does not need to be disseminated widely, although its availability should be made known to all who might be able to make use of it. To put it in another way, scientific literature need not be burdened with keeping the accounts of the currency of research, namely its raw data and common facts. The storage systems (archives) would of course need to be internationally organised, and conducted according to rules set by bodies composed of scientists; the world and national oceanographic data centres probably give a good lead in this matter.

An important obstacle to adoption of such rules and practices is the familiar dogma "publish or perish". Some institutions, when making appointments and promotions, seek to avoid the pernicious effects of observance of this rule by taking into consideration only those papers that have been published in refereed journals; but this precaution becomes ineffective when, as does happen, referees and editors fall down on their job. Adoption of new rules therefore would have to be supported by arrangements by which credit would be given for evidence of material having been deposited in proper archives. Such credits presumably would not have the same weight as that given to a substantive publication.

Another principle which should be observed is that second publication should not be permitted in substantive scientific literature.

Similar considerations hold with respect to the holding of meetings, running of workshops, and the conduct of training courses. More care could be taken, and greater skill displayed, in choosing subjects, deciding upon participants, choosing the time for each event, and in setting rules of procedure.

1.1.2 The Semiotics of Communication

Leaving to one side the matter of response to a transmitted message, in order to concentrate on understanding of it, we immediately encounter the problem of language. The simple facts, that something like 60% of all scientific communication is conduced in English, and that, although of the 3,500 identified languages only relatively few are written, there are some 200 languages with written and literary traditions (UNESCO, 1980), means that much translation must be effected in order that scientific information should flow intelligibly to all potential users; and, considering the enormous volume of current scientific literature and not overlooking the need to have access to the vast accumulation of such literature from the past, the amount of translation which appears to be needed is very considerable. Moreover, considering that "it is estimated that every year some two million scientists, technicians and specialists participate in international congresses" (ibid) means that the task of interpretation 4/ is similarly formidable. But, these two tasks relate to identified events and publications, while beyond them lie the great amount of informal communication and the immense amount of time spent in language teaching and learning.

Accomplishment of these several tasks, referred simply to estimates of the quantity of literature and of the numbers of scientists and meetings, implies an enormous expenditure of effort and a very great cost to society. Apparently we may expect that translation by computer will become a reality in the relatively new future and will accelerate the preparation of translations, even if we cannot be confident that they will then be any cheaper. However, development of the soft-ware and establishment of centres for computer translation will not be sufficient; indeed, of themselves they would probably vastly expand the volume of literature and other materials. The potential translation load itself could be reduced by standardisation of terminology, by modification of the rules of publication (as discussed above), and by formulating and adopting rules for effective selective translation -- obviously it is not necessary to translate everything into all languages.

1.1.3 The Epistemology of Communication

Whereas in the previous two sections we have been concerned chiefly with the techniques of effecting communication, in this section we turn to what happens to information in its movement backwards and forwards through communication channels. In particular we are here concerned with the operation of those intellectual procedures of science that variously interpret, evaluate, and modify communicated information, with the effect of creating knowledge or at least of certifying information as acceptable within the reach of current comprehension, or, as some may prefer to put it, verifiable by currently available techniques. Thus, we are here concerned with the role of scientific communication in the growth of knowledge and enlargement of understanding.

In this section of the workshop, however, our concern is not so much with the general increase in scientific knowledge and understanding as with the effect on individuals, and hence on centres of scientific research, or participation in these procedures. This effect is twofold: on the one hand, it modulates an individual's command of knowledge and deepens his understanding of the systems he is studying; on the other hand, it may provoke him to escape from a commitment to convergent research. To put the latter point in simpler terms, research-workers in isolation are at risk of continuing in an automatic application of techniques in which they have been trained, and in uncritical accumulation of data which had once been of value, but for a model which has become outmoded. Even if informed of new developments, they may be unable to escape from this situation because, having had no part in the thinking that led to development, they are unable to grasp its import; they then have to undertake re-education.

1.2 TRANSFER OF KNOWLEDGE TO DEVELOPING COUNTRIES

Knowledge is not a commodity which can be parcelled up and transported from one country to another. Shipment of crates of books, periodicals, tapes and films to a developing country can be only a preliminary, practical step toward what we must mean when we speak of the transfer of knowledge. These artefacts, in themselves, are records of information which, having been read (by seeing or hearing), becomes knowledge to the reader. But we can insist that even this is still not enough: transfer of knowledge must include achievement of an understanding of what is transferred, for the objective cannot be just the "transfer of knowledge" for itself, much less, merely the transfer of information, but the cultural, technical and economic effects, in the recipient country, of <u>understanding</u> in a deep way what has been transferred. Therefore we should begin, I suggest, with a discussion of what we mean to this effect by this term. The analysis we shall make will provide a frame upon which to set out proposals for action.

I propose that the discussion should start with an examination of the two approaches through which this process operates. One is by inculcation of the ability to learn knowledge and to gain an understanding of it; this is a major objective of education generally, but in a particular field it includes an elucidation of the current research paradigm. The other is by providing

material and opportunity for the exercise of an existing ability to learn and understand so as to facilitate and promote participation in what I have described above as the epistemological role of scientific communication. In my view the latter is the more important, and urgent, because it is essential, immediately, to the conduct of research, but also for the orientation it can give to the training of recruits to the field.

2. INFORMATION FLOW AND KNOWLEDGE TRANSFER IN THE MARINE SCIENCES PROGRAMME

2.1 PROMOTION OF MARINE SCIENCE AND TECHNOLOGY

Marine science may be undertaken with any one or more of several objectives in view, from the pursuit of knowledge for its own sake and the satisfaction of curiosity, to the solution of practical problems encountered in the exploitation of resources. Promotion of it may have similar motivation, but it is also at risk of being a response to political intention. Coupling marine technology with marine science may or may not be intended to narrow the nomination of objectives to those of technical and economic nature, leaving concern about a pursuit of knowledge to others. A reference to the new oceanic regime, however, indicates an intention to concentrate on questions concerning how marine science and marine technology might be promoted with a view to coping with problems arising out of a new distribution of rights and responsibilities with respect to oceanic space. The reference to developing countries, that marks this section of the workshop, could signify a further restraint; but objectives set in this respect, whatever they might be, would certainly not be well served by concentrating solely on promoting marine sciences and marine technology in developing countries. The situation calls for promotion in these fields generally, while activities directed towards bringing the developing countries to a level of full participation in and benefit from marine science is a necessary part of that effort, as well as being desirable for other reasons.

We may understand that promotion of marine science and marine technology is intended to have effects such as:

- development of the research paradigm so that marine systems will be more accurately identified, delimited, and analysed and their behaviour will be the more reliably predicted;

- enlargement of the programmes of research - to obtain a greater coverage, in time and space, of a wider range of phenomena, and orientation of them more precisely to current needs;

- development of technological equipment and practices.

Production of these effects calls, in each case, for a particular set of activities, among which international action has a part, necessarily, by virtue of the nature of the field of research. It is our task to describe the special characteristics of information flow and knowledge transfer as components of that international action, with special reference to the needs of developing countries, and to the role they can play, in the context of the new ocean regime.

Development of a research paradigm is the task of those engaged in the research, it is not something into which outsiders can put themselves, to push it along. Creativity is not to be commanded; impulse to it can sometimes be given by making demands for results beyond the reach of the current paradigm, but otherwise promotional programmes must be directed at ensuring that the research climate is favourable to creativity. Such programmes can include actions such as improving the conditions under which the research is carried out, and providing better means for the execution of programmes, but the matter is by no means straightforward; creativity often thrives on frugal fare and often is stifled by affluence -- by a prodigious array of gadgets, a superfluity of organization. Alternative courses, not without their own hazards, are to facilitate communication, and to promote development in other disciplines from which logical and conceptual contributions may be drawn to the particular field.

Among these items, facilitation of communication, in the execution of research and development of its paradigm, is probably the most effective course to take and probably that which offers best opportunity for international action; moreover it is especially apt to marine sciences and to the transfer of knowledge to developing countries. The argument in favour of the last proposition can be set out as follows:

(i) full development of marine sciences calls for a study of all phenomena of all oceanic areas;

(ii) the study of oceanic areas over which developing countries have rights and carry responsibilities should be effected through active participation of (if not entirely by) scientists of those countries;

(iii) in order that scientists of developing countries should be able to carry out their work effectively, so that their results will be compatible with results from elsewhere and contribute to development of marine sciences, they must be conversant with the current paradigm and acquainted with the results of on-going research;

(iv) a flow of information to and from the developing countries is necessary for development of marine sciences in those countries, and for development of marine sciences in general.

The practices to be adopted for this particular purpose will in part be generalised, but provision must be made for tailoring particular projects to the circumstances of individual countries and regions.

Enlargement of marine science programmes can presumably be approached directly in terms of staff and equipment and promoted by aid programmes. However, each aid project must be requested by the recipient country and, to be effective, requires support from the government, in counterpart contributions of kind and money, through provision of infra-structure, and through attention to its results. The approach, therefore, cannot be as direct as one might have

thought: it needs to be based on an appraisal of the state of marine sciences, in each country and region, and accompanied, if not preceded by, programmes to assist policy-makers to understand the nature of the problems involved in exercise of the rights gained through the new ocean regime and discharge of the responsibilities brought by that regime. A preparatory approach of this kind is especially relevant to the matter of orientation of research programmes to current needs: unless the problems are well understood and policy is clearly formulated (even if left unannounced) support to Marine Sciences, even if generous, is unlikely to be well directed.

2.2 THE NEW OCEAN REGIME

I assume that a review of the provisions of the Law of the Seas Treaty, in order to identify items with respect to which international cooperation will be important, is a task for other sections of this workshop and need not be attempted here. Whatever may be the outcome de jure with respect to the present treaty, de facto the present regime is greatly different from the regime that held twenty five years ago, and is unlikely to revert to the previous form. While, in juridic circles, the term 'ocean regime' may be taken to signify only the system of rights, obligations and responsibilities generally observed in the conduct of marine activites, we shall find it convenient not so to restrict its connotation but to intend by it also the activities themselves, regulated and controlled as these activities may be by legal provisions. After all, it is with those activities that we are concerned and for which oceanic research is carried out. Legal clauses tell us nothing about the seas, incorporate from marine science little more that its terminology, and give us no indication of what we may get from or should do about marine resources; they merely enunciate agreement as to how we should conduct ourselves in our relations with one another 5/. Thus, in speaking of changes which have taken place in the ocean regime our attention will be most usefully directed upon changes in the pattern of activities. The dramatic advances in marine technology, of the past few decades, for the extraction of oil, gas and minerals, for the building of coastal works, in naval architecture and in the technical fitting of fishing vessels (only to name major areas) have greatly changed the economics and politics of marine activities, regardless of what is or what eventually may be established as the legal regime. And the need for marine science corresponds to the reality of this situation, and, as stipulated above, holds over all the oceans, not neglecting in any way the seas off the coasts of developing countries.

That marine research in oceanic areas over which coastal states now claim enlarged rights, and accept heavier responsibilities, should be conducted by those states or at least with their active participation, is another matter and one, be it noted very clearly, which holds for all such states, developed and developing. The case for coastal-state conduct of marine research is surely very strong. It holds under any legal regime but is strongly supported by the Treaty, which endorses the claims of those countries while imposing responsibilities and requiring the observance of definite obligations; the arguments of the case relate to matters of sovereignty, strength in negotiation, and authority in management.

Furthermore, that developing countries are in need of assistance in strengthening or even, in some cases, in creating marine science programmes is still another matter.

2.3 INTERNATIONAL COOPERATION IN MARINE SCIENCES

From the foregoing,

1. the nature of marine systems and phenomena is such that the sciences concerned with them must be conducted with a considerable exchange of information, of observational record, of concept, and about method; in order that messages passed through such exchanges should be unambiguous, there is a need for standardisation of terminology and intercalibration of instruments and methods;

2. the need for marine research has greatly increased because of the new regime (of activities) and therefore ways should be found of achieving a distribution of effort between geographic areas, specialisations, and different categories of research, which would correspond well to immediate needs, and to needs of medium and long term so far as these can be identified;

3. for economic and political reasons, reinforced by the new legal regime, much importance attaches to coastal-state conduct of marine research;

4. for reasons which have their origin largely in events of the past, developing countries are in need of assistance in the conduct of marine research.

In principle, marine science is not placed differently from some other fields of research (notably meteorology) with respect to the first of these points, but its history differs, which is the sense of item 2. It differs even more, however, in respect of the equipment required for it (especially the special platforms that must be provided, from which to make observations) and the conditions under which its work must be conducted, all of which represent considerable costs. This consideration is of especial weight with respect to item 4, as a special case of item 3.

Each of these items carries particular implications with regard to institutional arrangements. The affairs signified by item 1 are a charge upon the marine science community itself and in their international aspect are now serviced by a complex set of international arrangements: much of the task is accomplished by the international associations and unions, integrated by ICSU, and supported by UNESCO and, through ICSPRO, by other UN agencies. I see IOC as being charged largely with tasks that come as a consequence of the changed regime of activities (item 2), and with those relating to the situation of developing countries (item 4); which is not to say, however, that it has no concern with the matters to which item 1 refers. Item 4 receives attention from UN specialized agencies, such FAO, UNEP, and UNIDO, with regard to the need for marine science in connection with economic developments and protection of the environment, and is supported by the UNDP and national aid programes.

CONCLUSION

In respect of a need for the flow of information that is a fundamental part of creative science, marine science doesn't differ from any other. But in an operational sense, with due regard for the nature of the systems studied by it, marine science can develop its full effectiveness only if furnished with an international system for the flow and storage of observational data; and having regard for the special equipment employed in marine research at great cost, there is need, not only to obtain the fullest array of data from each observational opportunity and to ensure accuracy of observation and record, but also to ensure that when data are communicated they are neither corrupted in transmission nor misunderstood on reception. For these reasons intercalibration of instruments and standardisation of terminology, at international level, is desirable. Promotion of marine science in respect of the matters discussed in this paragraph are very much the concern of international scientific associations.

Development of information flow for marine science is required simply for the successful conduct of its studies as well as for development of its paradigm. This requirement holds globally. The situation of the developing countries is a special case which exists for a variety of reasons. Whatever may be those reasons, or however one interprets the situation, it is to be dealt with through the procedures of knowledge transfer proper to science, not merely by gifts of literature and equipment to, and especially not by carrying out research for, the developimg countries.

NOTES

1/ Precision would be added to much scientific writing if authors would reserve their use of 'data' (and 'datum' for the singular) for reference truly to data, and write 'figures' or 'numbers' when in fact they are describing mathematical operations on numbers.

2/ Obviously the schema is thoroughly pragmatic. In particular, it stipulates that fact is not the thing itself, or event; a fact is what we say or write to communicate our perception of thing or event. Our perception may be accurate and complete, or inaccurate and/or incomplete. Our report of what we have perceived may accurately and completely set out all the characteristics of our perception so that someone to whom we pass on our fact may know as much as we did, at the moment of perception, of the perceived object or event; but we can fail in this and our report of our perception, let alone of the thing or event, may be inaccurate and incomplete. Our audience then is given "facts" which in some cases are misinformation, from error either of formulation or of perception or of both. This distinction, between 'fact' and that of which it speaks, is the same as the distinction made by statisticians between the evaluation value of a statistic, such as mean and standard deviation, and the estimate they can make of that statistic.

3/ UNESCO, 1980: Many Voices One World.
Kogan Page, London/unipub, New York/Unesco, Paris

4/ It is perhaps necessary to point out that the word 'interpretation' is written here with the sense given it by professional translators and interpreters, signifying the verbal exposition in one language of what is being said in another; this is in distinction from 'translation', which is written exposition.

5/ In speaking of behaviour towards one another I include our behaviour with regard to our habitat which affects the life of others of present and future generations.

DEVELOPING THE MARINE SCIENTIFIC AND TECHNOLOGICAL CAPACITY OF STATES

Inocencio A. RONQUILLO

Bureau of Fisheries
and Aquatic Researches
Manila
Philippines

and

Ulf LIE

University of Bergen
Bergen
Norway

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Marine scientific research has traditionally been undertaken by industrialized states, small in number, which have been able to benefit from their knowledge of marine science and technology in exploiting living and non-living resources. Such research is expensive; it requires laboratories and specialized equipment, research vessels and highly trained scientific and technical personnel. Furthermore, marine sciences are interdisciplinary and multidisciplinary, and therefore rest upon a solid foundation of basic natural sciences. Development of marine sciences therefore entails expenditures on such scale that governments of few developing countries have been able to assign a sufficiently high priority to marine sciences and technology in their plans for national development.

During the past few decades we have witnessed a dramatic change in this general state of affairs. A number of developing countries have included marine sciences in their lists of priorities for national development, and international organizations with competence in marine affairs have shown increasing concern for assistance programmes . This development has come partly because developing States have become aware of the need for knowledge about marine systems and phenomena in order to achieve a rational management of marine resources and to prevent destruction of the environment by pollution, and partly because of the new emphasis on science for development and on scientific aspects of the new ocean regime emanating from the Third United Nations Conference on the Law of the Sea (UNCLOS).

The United Nations Conference on Science and Technology for Development (UNCSTD) in Vienna in August 1979 stressed the close links between scientific and technological capabilities and national development. The resulting Vienna Programme of Action identified eight programme areas in its Operational Plan. These cover policy development, strengthening of infrastructure and training of personnel, information systems, the benefits of regional and global cooperation, and specific plans for financing of development programmes in science and technology. A particular point was made of the need to link science and technology development to economic production.

These proposals were made for development of science and technology in general, but all the programme areas of the Vienna Programme of Action are applicable to development of national capabilities in marine science and technology.

The UNCLOS has probably been the single most important factor in the new emphasis on marine sciences in the international community. The Law of the Sea Convention gives Goastal States

> "the right to regulate, authorize and conduct marine scientific research in their exclusive economic zone" (Article 246), but the same article states that the "Coastal States shall, in normal circumstances, grant their consent for marine scientific research by other States or competent international organizations in their exclusive economic zone or on their continental shelf to be carried

> out in accordance with this Convention exclusively for peaceful purposes and in order to increase scientific knowledge of the marine environment for the benefit of all mankind".

The Convention nevertheless specifies areas of marine research from which States may withhold their consent. In order to exercise this right Coastal States must have access to qualified advice on marine sciences.

The Convention further gives a coastal state the right to participate in scientific research conducted by other States in its exclusive economic zone, and thus be able to benefit from such cooperative research in its own national development. This participation, however, depends on the availability of properly trained personnel as well as on supporting infrastructure in order to be useful for the coastal state, and not constitute merely a token participation.

During the UNCLOS developing states became increasingly aware that they might possess potential resources in their EEZs which could contribute significantly to national development, but whose exploration and exploitation would depend on national capacity for marine science and technology. Developing states also noticed the considerable gap in capacity for marine science and technology between industrial states and developing states, and realized that they must try to bridge this gap in order to be able to benefit from their ocean resources. The matter is urgent, because if the Convention is ratified during 1983, it is possible that it will enter into force by 1985 or 1986. Realizing the urgency of the situation the developing countries in the "Group of 77" at the UNCLOs introduced a Resolution calling on UN Member States to determine appropriate priorities for marine science and technology in their development plans and to establish cooperative programmes for such recommending activities, and that industrialized states, international funding agencies and competent international organizations assist in the preparation, funding and implementation of programmes aimed at strengthening the capacity of developing States in the fields of marine science, technology and ocean services.

Unesco, as the UN specialized Agency responsible for science and education, and with special competence in the area of marine sciences through its Division of Marine Sciences (OCE) and the Intergovernmental Oceanographic Commission (IOC), reacted to the need to enhance the marine sciences capacity of Developing States as expressed at the UNCLOS, by adopting Resolution 2/06 at its Twenty-first Session of the General Conference in Belgrade, September-October 1980. The resolution

> "Recommends that the Director-General give special attention in this transition phase to the need to strengthen the inter-governmental programme in the marine sciences and ocean services in order to assist Member States, in particular developing countries, to cope with the demands placed on them in connection with the new ocean regime from the Third United Nations Conference on the Law of the Sea".

On the basis of a recommendation from the Third meeting of the Working Committee for Training, Education and Mutual Assistance in Buenos Aires, April 1980, the IOC Executive Council at its Thirteenth meeting in Paris, June 1980, the IOC Executive Council at its Thirteenth meeting in Paris, June 1980, adopted resolution EC-XIII.15, which, inter alia,

> "Decides that a comprehensive plan for a major assistance programme aimed at strengthening the marine science infrastructures in developing Member States be developed to enable them to achieve their national goals in the field of ocean affairs, and to participate fully in global, regional and sub-regional oceanographic research programmes of the Commission,"

and which further instructs the Secretary of IOC to prepare a document giving the outline for such a plan with guidelines for a strategy for its implementation. The document (IOC/EC-XV/8 Annex 5 Rev.) was reviewed by the Fifteenth meeting of the IOC Executive Council in March 1982, which in its Resolution EC-XV.5 recommended that the IOC Assembly consider the adoption of the comprehensive plan for major assistance to enhance the marine science capabilities of developing countries.

The realization of the importance of science and technology for national development, the awareness of States of the need for national capacity in marine science and technology in order to benefit from the new ocean regime and the rights granted them by the UNCLOS Convention, and the steps already taken by developing states and by competent international organizations, demonstrate that the stage is set for a major effort directed to bridging the gap in marine science and technology between industrial and developing states. The remaining questions are: who should take the initiative for further action, what is the nature of the concrete programmes and projects which constitute a major plan for enhancing the marine science capacity of developing states, and what are the possibilities of and existing mechanisms for funding and implementing such a plan?

Clearly, the major part of the burden will be on the developing states themselves. Governments must be prepared to assign appropriate priorities to marine science and technology development in their national programmes and to commit themselves to such development. It is also foreseen that competent international organizations will be engaged in the formulation and implementation of projects, and that funding will be provided by international funding sources or in bilateral cooperation or assistance programmes between developing and industrial states. However, the IOC will be in a position to be the leading agency in development of a comprehensive plan to enhance the marine science capacity of developing States. The majority of developing coastal states are members of IOC, and thereby it is in a position to serve as a forum for those states to report their needs and express their aspirations in marine science and technology development. Furthermore, the IOC, as the coordinating body among the UN Specialized Agencies with competence in marine affairs, is in a position to coordinate and harmonize the efforts of the Agencies towards a balanced development in the interest of all parties concerned. We feel therefore that the IOC should be commended for the initiative it has already taken, and strongly encouraged to further development and implementation of its comprehensive plan.

IOC's plan for a major assistance programme to enhance the marine science capabilities of developing countries, in its present stage of development, does not include detail as to specific action to be taken in its implementation, nor does it specify financial arrangements. These matters obviously will vary with national needs and goals, as well as with the extent and nature of each State's participation in global, regional and bilateral programmes of cooperation. However, on the basis of the experience of recent decades in transfer of technology and in training and education in marine science and technology, some general trends with regard to needs, problems and solutions have emerged.

The present paper is an attempt to summarize and highlight some of these trends as a contribution towards further development of IOC's plan for a major assistance programme.

2. PRESENT STATUS IN MARINE SCIENCE AND TECHNOLOGY

There is a wide range in the level of marine science and technology development among coastal states. The most advanced industrial states have specialized institutions for all aspects of marine affairs and university programmes in marine sciences and technology at undergraduate and graduate levels; consequently, scientific concepts and methods are continually developing and applications of science in the economy are being found. At the other extreme, some countries have practically no marine science and technology infrastrctures at all, and the majority of coastal states are at present at varying degrees of development between the extremes. The general trend is that development of marine sciences and technology parallels scientific, economic and technological development generally, but there are some distinct exceptions. Some States which ordinarily are considered developing countries are more advanced in marine science and technology than some industrial states. The obvious reason for this is the difference among states in their dependence on the oceans for transportation or for exploitation of its resources, and the consequent differences in maritime traditions.

The Convention makes no distinction between industrial and developing states with regard to rights and obligations under the new ocean regime, and consequently, the States with the least developed marine science and technology will be at a distinct disadvantage in exercising their rights. The benefits for those States of a major international effort directed towards enhancing the marine science and technology capacities seem obvious. However, there is also general interest in a more equitable distribution of marine science and technology to all coastal states. The continuous nature of the oceans results in exploitation of shared resources and in common environmental problems which call for negotiations between Governments on the basis of competent scientific advice. Finally, physical, chemical, biological and geological processes in the oceans are general and universal phenomena, whose study in one region of the world increases the understanding of such processes in the rest of the world's oceans. It is therefore in the best interest of the general advancement of ocean sciences that such research be performed on a truly global basis, and that as of now untapped human resources and talents in the third world be mobilized for the understanding of ocean phenomena and for the sub-

sequent rational management of its resources. Thus, a major assistance programme aimed at enhancing the marine science and technology capacity of developing coastal states is in the best interest of all states, regardless of their present levels of development.

We do not intend to leave the impression that we are now only at the beginning of an accelerating phase of marine science and technology development; on the contrary, there has been a spectacular increase during the last two decades. An analysis by Dr. Dale Krause, Division of Marine Sciences, Unesco[1], shows that the number of marine scientists in the world increased from about 750 in 1950 to more that 11,000 in 1975, and the number doubled from 1970 to 1975. A mere increase in the number of marine scientists does not per se reflect a more equitable distribution of scientists among the countries of the world, but it is encouraging fact that the number of States with marine scientists during the same period increased from 48 to 130, and 13% of the marine scientists of the world in 1975 were based in scientific institutions in developing States.

A further demonstration of the increased emphasis on marine science and technology is to be found in the escalation of Unesco's budget for marine science from extrabudgetary sources, i.e. UNDP and Funds-In-Trust. In 1979-80 such funds had reached a level of $ 11,000,000 from $ 480,000 in 1971-72. The programmes are aimed at training of personnel and development of national marine science infrastructure such as laboratories, instruments and equipment, libraries and books, and ships.

In spite of these encouraging developments, it is the conclusion of many observers from developing countries that the traditional approach is insufficient at present, as expressed by the "Group of 77" in the UNCLOS Resolution

> "Noting that present efforts undertaken within the United Nations system in training, education and assistance in the field of marine science and technology and ocean services are far below current requirements and would be particularly inadequate to meet the demands generated through operation of the Convention on the Law of the Sea."

The rate of change of knowledge and methodology in marine science and technology is so rapid that the gap between industrial and developing states may in fact be widening.

The IOC is now in the process of developing scientific programmes which require international research cooperation on problems related to climate,

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1 Dale C. Krause: International Cooperation in Marine Science Development. In Proceedings of the Workshop on International Cooperation in Marine Technology, Science and Fisheries. La Jolla, California. National Academy Press, 391 pp. Washington D.C. 1981.

living resources and non-living resources. All of these programmes will be of particular importance for developing states, but the present lack of trained personnel and adequate facilities prevent a truly global participation in the programmes.

3. MARINE SCIENCE AND TECHNOLOGY DEVELOPMENT IN RELATION TO THE GENERAL NATIONAL CAPABILITIES IN SCIENCE AND TECHNOLOGY

Marine sciences are multidisciplinary in the sense that they consist of distinct scientific sub-divisions each of which requires specialized personnel and facilities. Normally these specialized areas are physical, chemical, biological and geological oceanography, but in addition there are specialized aspects of applied sciences such as fisheries biology and marine meteorology. Each of the disciplines is considered a post-graduate specialization which rests on a solid foundation in the basic sciences such as mathematics, physics, chemistry, earth sciences and biology. In that sense marine sciences are interdisciplinary. A Unesco Workshop on university curricula in marine sciences[2] in 1973 recommended that

> "Training of marine scientists should begin in graduate schools and be given to students holding at least a B.Sc. degree or equivalent in one of the natural sciences."

The same arguments are applicable to developments of marine technology, which includes a number of highly specialized fields such as harbour construction, shore-line protection, ship-building and construction of structures for exploitation of offshore resources, food-technology, etc. All of these specializations are based on a high general level of technological training.

The arguments above might lead to the conclusion that only the states with well developed high-level educational systems in science and technology will be able to benefit from a major programme aimed at enhancing the marine science and technology level of developing states. However, in our opinion such a programme must be concerned with the needs of all developing states, regardless of their present level of science and technology development. This means that such a programme must be sufficiently flexible to be of benefit to all coastal states, taking into account the general level of science and technology in individual states.

The majority of developing coastal states have already the required level of basic science and technology training, as well as marine science

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2 Marine Science Teaching at the University Level. Report of the Unesco Workshop on University Curricula. Unesco technical papers in Marine Science No. 19. Unesco 1974

institutions and personnel. The purpose of the major assistance programme in those countries will be to upgrade and expand the existing facilities in order to enable the states to manage their marine resources within their areas of national jurisdiction, and to participate in sub-regional, regional and global programmes in marine science and technology. It is assumed that most of these states also will develop adequate educational programmes aimed at training their own personnel, and thus achieve self-reliance in the field of marine science and technology.

In some of the smaller and less developed states the required level of science and technology may not be present, and the limited resources of those countries may prevent the development of national institutions for research and education in marine sciences, even in the long term. Initially, such states will need advice both with regard to immediate actions to protect national interests in ocean affairs, and to formulating long-term policies in marine science and technology. Personnel for such advice need not necessarily be active marine scientists. Training in marine affairs in a broader sense, as provided by some United States universities, might be particularly useful in this context. On a more permanent basis those smaller states might decide to engage in regional cooperation in marine science and technology research and education, as the most efficient way to fulfill national goals.

4. ELEMENTS OF A MAJOR ASSISTANCE PROGRAMME TO ENHANCE THE MARINE SCIENCE AND TECHNOLOGY CAPACITY OF DEVELOPING STATES

4.1 MARINE SCIENCE COUNTRY PROFILES

Information about existing facilities and availability of trained personnel, as well as identification of the needs and the aspirations in marine science and technology of individual states, are basic requirements for the formualtion of concrete assistance programmes. In the past, IOC has tried to obtain such information particularly through its Working Committee for TEMA. During 1974-78 regional TEMA meetings were organized in various regions of the world, in which the IOC Member States were invited to present information about their levels of marine science development, to review national needs, and to discuss ways and means to meet those needs. Subsequently, attempts were made to identify components of the needs specific for the region, which could serve as bases for concrete regional programmes in training and education and mutual assistance in marine sciences.

These IOC-TEMA activities were only partly successful. In particular, it was not possible to obtain the required information about marine science infrastructure and activities of all IOC Member States. As a result, the proposed training activities were not necessarily related to the highest priorities in all the states of a region.

One of the more important aspects of the proposed IOC plan to enhance the marine science capacity of developing states, is the Marine Science Country Profile scheme. The purpose of this scheme is to collect, in a systematic fashion, information about the marine science and technology infrastructure, the general

scientific, technological, economic and social structures to which the marine affairs relate, and general demographic, geographic and economic information. In addition, the Profiles should contain information about bilateral and multilateral activities in marine affairs in the broadest sense, in which the states are engaged. The collection and selection of such information must be undertaken by the states themselves, with the assistance of competent international organizations. The information will be stored in an international data-bank, and should be accessible to international organizations and to agencies providing assistance under bilateral agreements, as well as to individual states. It should be sufficiently detailed to provide users with the data needed for an evaluation of the levels of marine science and technology development in coastal states.

It is the responsibility and prerogative of individual states to identify their needs in marine science and technology, and to take the required actions in order to alleviate those needs. In the execution of this responsibility, it is foreseeen that states would benefit from access to the proposed Marine Science Country Profiles.

4.2 NATIONAL OCEANOGRAPHIC COMMITTEES

In the formulation of marine science and technology policy and in the execution of activities directed towards enhancing the national capacity, Governments need advice which represents the interests of all aspects of marine affairs in order to ensure a balanced development. Such advice could be obtained from a National Oceanographic Committee or equivalent body, with representation of Ministries with interests in marine affairs, research institutions and universities, information and data-centres, maritime organizations, etc. The composition of,and the terms of reference,for such bodies will vary from country to country, depending on internal political, social and economic structures, but there are some general features which seem essential for such bodies to be useful.

Marine Oceanographic Committees must be high-level bodies affiliated with Research Councils, Ministries of economic planning, or other Government structures which can ensure a real influence on formulation, coordination and execution of marine science policy. Furthermore, the Committees should maintain effective relations with universities, and with Government institutions in marine science and services, and should be active in directing funds and encouraging recruitment into marine science and technology.

An additional responsibility of a National Oceanographic Committee would be to interact, on behalf of the State, with international organizations or bilateral agencies engaged in marine science and technology activities, and to serve as counterpart for such organizations in the formulation and execution of assistance programmes.

4.3 TRAINING AND EDUCATION

4.3.1 On-the-job Training

An important aspect of training in marine sciences and technology is related to the application of specific techniques and the use of particular instruments. Such training does not require extensive theoretical education, but rather experience in the application of scientific methods in research projects. Methods are often universal in the sense that they do not relate to a specific geographic area, and training can therefore be carried out inside or outside the home country of the trainee. It is important that each trainee should get an opportunity to apply modern methods during his training, but it is equally important that such methods also be made available for his work when training is completed. Advanced research and technology institutions in industrial states should make short-term training opportunities available for scientists and technicians from developing countries, and such laboratories should develop a systematic training programme which would guarantee a high level of performance.

4.3.2 Ship-board Training

Ship-board training is a special case of on-the-job training. Such training is widespread, and a number of countries advertise the availability of berths on their research vessels for scientists from developing countries.

A scientist from a developing country who joins a research vessel for a few weeks cruise will often experience difficulties which in a considerable degree limit the value of the ship-board training. He has often little or no time to study the scientific programme in which the research vessel is engaged, he may encounter problems related to cross-culture interaction, such as language and unfamiliar food, and he may suffer from the special problems of life on board a ship, such as the cramped living quarters and sea sickness. These problems are probably enhanced with the distance between home country of the trainee and the area of research. An additional limitation to the success of ship-board training is the lack of opportunity for the trainee to be engaged in the post-cruise research activity and in the analysis and publication of the results.

Ship-board training is obviously necessary, since field experience is an important item of qualification of any marine scientist. It is therefore necessary to increase the availability of such training, but in order to achieve the maximum benefit, the organizers should take the following into account:

1) Trainees should have an opportunity to discuss the objectives and methods of the planned research with the foreign scientists, and therefore at least two weeks pre-cruise stay in the home laboratory of the research vessel should be arranged.

2) After the cruise the trainees should be in close contact with the scientific establishment organizing the cruise, and as far as possible

participate in analysis of data and publication of results. Such follow-up of the ship-board activities may require additional visits to the home institution of the research vessel.

3) On-board the ship the trainees must be given opportunity to take an active part in the cruise, i.e. they must be given practical experience with instruments and gears, and they must be given equal responsibility for duties on board.

It is probable that scientists from developing states relate particularly well to scientific problems of their own area, problems which are real in a national and cultural context. The best ship-board training is therefore probably on ships doing research in the waters of the trainees' own home country.

Today it is customary for research vessels engaged in oceanographic research within the economic zone of a coastal state to provide ship-board training opportunities to scientists from the host country. Such training should be particularly encouraged and expanded, and funding agencies in developed countries should be prepared to provide additional funds for it.

4.3.3 Training Courses

In some cases, short-term training can be particularly well suited for group training in the form of training courses of 1-2 months duration. The topics particularly well suited for training courses are introduction to general techniques and methodologies (similar to the on-the-job training) and introduction to specific and rather limited topics and concepts in marine sciences.

If the topics of a training course are related to general methodology or to universal concepts, it is conceivable that the most useful training might take place in a developed country where the appropriate instrumentation exists and where, the methods can be demonstrated as applied in specific research programmes. However, it has been the experience of many trainees from developing countries that instruments such as those used during a training course, do not exist in the laboratories of the trainees' home country. This may lead to frustration and in fact increase the danger of brain drain from developing countries. The solution to the problem is not easy. It would be unfair to limit training to trainees from laboratories where a high level instrumentation already exists, and it would not be in the best interest for the advance of science to introduce trainees to second rate instruments. The solution is a development of training in balance with infrastructure such as laboratory facilities and instruments.

A particularly useful strategy to meet these problems is to conduct courses of which the subject matter is drawn from studies of phenomena or environmental problems in the geographic area of the trainees. Such training is often given in regional training courses of which the topics are decided upon in negotiations between sponsors of the course, from developed states, and scientists from the host country or region with knowledge of the needs and existing facilities of the area.

All training courses, whether performed in the home area of the trainees or not, serve a particularly useful purpose by bringing together scientists from different cultural, national and scientific backgrounds, and thereby demonstrating the advantage of such plurality to the application of science to real problems.

4.3.4 Fellowships

In most developing coastal states there is a pressing need for scientific personnel with higher degrees at M.Sc. or at Ph.D. levels who can take the lead in research and education in national marine science and technology programmes and serve in an advisory capacity to Governments. Such education is normally obtained through fellowships programmes for marine science education in foreign countries.

Fellowships are at present offered particularly under bilateral assistance programmes, and to a lesser degree by international organizations. An analysis and evaluation of the Unesco fellowships programme[3] led to the conclusion that the programme achieved the formulated goals and that a high proportion of the fellowship-holders had returned to their home countries and become active in marine scientific research. It was observed that a large proportion or applications for fellowship were directed towards a small number of high level institutions in industrial states, and that countries with marine science fellowship components in their UNDP Country Programmes had particularly many applicants.

The availability of fellowships from international or bilateral sources falls very far short of the needs expressed by Developing States in international marine science meetings, and therefore special efforts should be made in the proposed IOC programme aimed at enhancing the marine science capacity of developing states to increase the total number of fellowships. In the execution of the programme the IOC must take specific actions to ensure that fellowships will be distributed in an equitable manner among developing states, and that the topics chosen for specialized education are in agreement with stated national present and future needs. Thus, the existing dominance in the training of marine biologists and fisheries biologists will probably continue in view of the importance of living resources for developing countries, but a change in the emphasis towards obtaining expertise on non-living resources and marine technology must be expected.

4.3.5 Foreign Experts

In the long run many developing coastal states will find it unsatisfactory to have all their marine science personnel trained abroad, and may decide to develop their own marine science educational programme at national universities. To a large extent, such programmes will employ national experts, but during an initial phase it may be necessary to engage foreign experts for research guidance and teaching on topics which are inadequately developed. In a number or projects directed towards marine infrastructure development in coastal states, implemented in cooperation with international organizations or bilateral agencies for assistance, foreign experts play an important part both in research and education. In the IOC Comprehensive Plan for marine science development in

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3 Analysis and evaluation of the Unesco Marine Science Fellowship Programme from 1950 through 1975 MARINF/33, Paris 1981

coastal states, funds must be provided for the employment of foreign experts in the majority of the projects. Preferably, each expert should be familiar with the language and cultural situation of his host country, and if he is not so initially, he will be fully effective only if he remains in the country for at least 2-3 years.

Foreign experts may also be engaged in regional projects, and thus assist in research and education in several States by travelling among them. An added advantage of this scheme would be that the expert may assist in integrating the capacities of individual States to solve regional needs.

Foreign experts in general are high level, experienced scientists, engaged in projects as leaders, university professors, etc., much of whose time is taken up with administrative or bureaucratic matters. This may create a need for a lower level foreign expert, who could assist the expert in his duties and be engaged full-time in advising and tutoring students in marine sciences. Such lower level experts -- Associate Experts -- would be young scientists with recent experience in thesis research and university instruction in marine sciences, who thereby would be particularly suited for fruitful interaction with students. The Associate Expert scheme is especially useful in bilateral assistance programmes, and industrial states should therefore be strongly encouraged to increase the number of Associate Experts in marine sciences in their cooperation activities with developing states.

The Convention gives the coastal state the right to authorize marine scientific research in the area of national jurisdiction, and thereby to receive information about research interests and educational experience of the visiting scientists. Educational institutions in developing countries should take advantage of this opportunity for short-term guest lecturers, and funding agencies of industrial states should be encouraged to provide additional funds for prolongation of a visiting scientist's residence in the host country.

4.3.6 Marine Sciences in Secondary Schools

Awareness by the general public of the need for conservation and rational management of marine resources and for protection of the marine environment, will provide a strong stimulus for concrete and positive political action by appropriate national authorities. Introducing marine sciences into secondary school curricula may serve as a useful means of generating such awareness while at the same time broadening the scope of general science teaching. Coastal states should be strongly encouraged to include marine science subjects in the curricula of secondary schools, and as a guide and a detailed source of information on the subject we recommend the report of a Unesco workshop on secondary school curricula in marine sciences[4].

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[4] Marine science syllabus for secondary schools. Report of an IOC workshop held at United World College of the Atlantic, 5-9 June 1978. Unesco Reports in Marine Science No. 5, Unesco 1979.

4.3.7 Marine Science Administrators

Ministries engaged in marine affairs, research councils, research institutions and universities in Coastal States, employ administrative personnel charged with the responsibility of making decisions on budgets and programmes, which have strong impact on the conduct of marine science and education. Such administrators as a rule have a specialist marine science, law or economics background, but in discharge of their duties they have to make decisions which affect marine affairs in the broadest sense. The importance of training marine-science administrators in all aspects of marine affairs has been stressed by developing countries in previous meetings of the IOC Working Committee for TEMA, and IOC has been involved in the selection of trainees for marine affairs programmes in the United States. We strongly urge that these programmes be expanded and that sufficient funds for them be provided under the IOC Comprehensive Plan for a major assistance programme to enhance the marine science capacity of developing states.

In spite of the obvious advantage of having broadly trained marine science administrators, we see the possibility of creating powerful bureaucracies which may be tempted to make decisions beyond their field of competence. Clearly, educational programmes in marine affairs do not make a scientist a lawyer or a lawyer a scientist, and the existence of broadly trained marine science administrators in a coastal state should not in any way reduce the influence of scientists on the national marine science and technology policy through the National Oceanographic Committee.

4.3.8 University-to-university Cooperation

Many universities of industrial and developing states are today engaged in university-to-university cooperation on research and education in marine science and technology. Such cooperation involves participation of students and scientists in joint research projects, and this often leads to exchange of personnel between the participating universities. The basis for such activities is the mutual benefit resulting from the research projects, and this scheme is therefore a cooperative rather than a technical-assistance activity.

Experience with university-to-university cooperation has been very favourable: it stimulates research in both participating universities, and can be executed with a minimum of bureaucratic interference. Universities in industrial and developing states with marine science and technology activities should therefore be encouraged to seek partners for cooperation in concrete scientific or educational projects. Such cooperation is inexpensive. It usually requires special funding for travel and subsistance allowances and for some provision of supplies and equipment. Such programmes are well suited for funding under bilateral programmes.

University-to-university cooperation is an important means of infrastructure development. It is therefore important that it be provided for in the national policy for marine science and technology development. This might be achieved by university participation in advisory bodies such as National Oceanographic Committees.

4.4 RESEARCH INSTITUTIONS AND SCIENTIFIC EQUIPMENT

Most coastal states have institutions for marine scientific research -- fisheries laboratories or marine biological stations. Those institutions could serve as nuclei for further develpment of marine sciences. The construction of laboratories should largely be a matter for national funding, but international organizations should be prepared to offer expert advice on the most efficient construction, maintenance and operation of specialized laboratories.

Similar advice must be provided for the acquisition of scientific equipment for field sampling and laboratory analyses. The selection of such equipment depends on experience in its operation in the country for which it is intended, and must be made with due regard to the specific needs of and to the existence of maintenance facilities in that country. Naturally, scientists of developing states must have access to modern and efficient equipment, but one should keep in mind that the justification for advanced equipment does not necessarily hold in the situation of a developing state; modern scientific equipment may improve the cost-efficiency of sample analyses without necessarily improving the quality and accuracy of the analyses, and in view of its cost, complexity and problems of maintenance, should not automatically replace standard and traditional equipment.

Some sophisticated equipment will be necessary, however, because there are variables of importance in marine scientific research which cannot otherwise be measured. Maintenance of such equipment is a major problem in developing states, where local facilities do not exist, and where distance from the sites of production makes the shipment of equipment for repair both complex and costly. Developing states have, in IOC meetings, recommended regional facilities for maintenance of advanced marine science equipment, and IOC should look into ways and means of establishing such facilities, possibly in cooperation with companies producing scientific equipment.

4.5 RESEARCH VESSELS

In order to carry out marine scientific research it is essential to have access to ships for collecting scientific samples, but the acquisition of a research vessel for a national marine science programme requires thorough analysis of needs and of the problems related to operation of the ship. Often insufficient attention is paid to the cost and complexity of operating large research vessels, and problems arising from the lack of maintenance and docking facilities are neglected. As a result a number of large and medium sized vessels, of both industrial and developing states are not optimally utilized.

Research ships are, however, sometimes too small to be useful, partly because their operation is severely restricted by sea- and weather conditions, and partly because they cannot accomodate the number of students and scientists required on educational and scientific cruises.

In view of the importance of effective ship-operation for the success or failure of marine science programmes, the IOC should be prepared to provide advice to developing states on the acquisition and operation of research vessels, taking national needs and sources of financing into account.

We assume that all States engaged in marine scientific research will need a research vessel for studies in coastal and inshore waters. The operation of a ship may require coordination by an appropriate national body, e.g. National Oceanographic Committee, in order to ensure ship-time opportunities for all institutions with marine science programmes. Relatively large research vessels are required for investigations in offshore or deep water areas, and States may decide to operate such ships jointly as a regional facility.

4.6 DATA CENTRES AND INFORMATION FACILITIES

Scientific progress results from analyses of scientific data, and in view of the speed and efficiency of modern equipment for provision of data in the field or in the laboratory, it is absolutely necessary to design efficient systems for acquisition and retrieval of oceanographic data. Such handling of data is carried out in data centres, which may be operated on an institutional, national or global basis. Coastal states planning to enhance their marine science capacity should at an early stage consider the establishment of a national oceanographic data centre. The IOC Working Committee on International Oceanographic Data Exchange has already produced a manual on the establishment of national oceanographic data centres[5], and the IOC should be prepared to give further advice to coastal states under its Comprehensive Plan.

Equally important for the progress of marine science is easy access to information at the international level in the state-of-the-art and development of methodology, such as that published in scientific books and journals. The situation in many laboratories in developing states is, however, that adequate library facilities cannot be maintained because the cost exceeds their means and thus the working scientist is denied access to necessary scientific information. IOC should pay particular attention to the problem of information in its Comprehensive Plan, and seek solutions which guarantee continuous upgrading of information facilities. One solution may be found in bilateral assistance programmes comparable with the university-to-university cooperation scheme.

5. DEVELOPMENT AND IMPLEMENTATION OF THE IOC COMPREHENSIVE PLAN FOR A MAJOR ASSISTANCE PROGRAMME TO ENHANCE THE MARINE SCIENCE CAPABILITY OF DEVELOPING COUNTRIES

5.1 THE RESPONSIBILITY OF STATES

The success of the Comprehensive Plan depends primarily on the attitude of states towards the programme. If developing states find the Plan to be in their best interests, they may promote its success by assuming the responsibility assigned to states in the programme, and by calling for the implementation of the Plan in meetings of the governing bodies of UN organizations with competence

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[5] Guide for establishing a national oceanographic data centre. Intergovernmental Oceanographic Commission, Unesco 1975.

in marine science and technology, and in their negotiations with partners in bilateral programmes in cooperation and technical assistance in marine science and technology. Industrial states may analyze the Plan and determine to what extent their own cooperation and assistance programmes in marine science and technology with developing states would benefit from the concerted action provided by the Plan.

5.2 THE INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION

If the Plan meets the approval of the IOC Assembly the following actions should be considered:

(i) IOC should assign a high priority to the Plan among its programmes, and ensure adequate funding for further development of the Plan. The funds should primarily be sought from external sources, and in the initial phase of the programme they should be used for advisory consultant missions, implementation of the Marine Science Country Profiles scheme, and for providing the additional staff needed to ensure an effective implementation of the Plan.

(ii) Ths subsidiary bodies of IOC should analyze the needs of developing states within their specific areas of competence, and recommend concrete actions to meet those needs, as components of the Plan.

(iii) In cooperation with coastal states and with competent international organizations, IOC should submit project proposals for funding of a few regional projects as pilot projects before embarking on the full-scale implementation of the Plan.

(iv) IOC should at an early stage contact the major international funding agencies, as well as those providing funds under bilateral programmes, and discuss with them the possibilities for funding the Plan.

5.3 THE UNESCO DIVISION OF MARINE SCIENCES

The Division has much experience with marine science and technolgy infrastructure development in developing states, and maintains close contact with advisory non-governmental organizations such as SCOR and ECOR. Thus, the Division can provide highly qualified assistance to the implementation of the Plan. The Division has also considerable experience with implementation of concrete assistance projects, and it would therefore be a valuable contribution to the assistance programme if the Division and other Unesco offices be engaged in the implementation of the projects.

5.4 THE ICSPRO AGENCIES

The United Nations Specialized Agencies cooperating under the ICSPRO agreement have competence in specific areas of marine affairs, and the comprehensive nature of the proposed IOC Plan therefore requires the cooperation of those agencies. These should therefore maintain close contacts with the IOC during the further development and implementation of the Plan, in order to offer their expert advice and to ensure that it be executed in the interest of all parties concerned.

6. FUNDING OF THE COMPREHENSIVE PLAN

The implementation of the Plan requires funding at a level which greatly exceeds the IOC budget allocated for such activities. The success of the Plan is therefore totally dependent upon funding from external sources. It is foreseen that the implementation of the Plan requires a significant increase in the total funds allocated to marine science and technology development, but it also offers a concerted action which would benefit the programmes of all agencies active in marine affairs.

The major international funding agencies should review the Plan and discuss with the IOC the expected extent of their participation in the programmes, taking into account the 10-15 year time-frame of the Plan. It the Plan receives favourable consideration by the major international funding agencies, the idea of forming a consortium among them should be considered, in order to ensure adequate funding and harmonious development and implementation of the Plan.

The agencies of Industrial States providing assistance under bilateral programmes should also review the Plan, and consider how participation in the Plan would benefit their own programmes. It would be a valuable immediate action if industrial states would significantly increase their fellowship programmes in marine science and technology, and make these fellowhips available to students from developing countries under the IOC Voluntary Assistance Programme.

PROMOTING MARINE SCIENTIFIC RESEARCH
CENTRES AND NETWORKS

Sidney HOLT

Rye
East Sussex
United Kingdom

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INTRODUCTION

Although the title I have been given by the organiser of this Workshop is a general one, my ideas will be considered under the Agenda sub-Item dealing with regional cooperation. I therefore restrict myself to that scale. I have been asked to examine only the matter of scientific research centres, but note the documents sent out by the Secretariat make no reference to any companion speakers or papers on technology. I hope I am not expected to cover the latter because I am not competent to do so.

Part XIII of the new Convention on the Law of the Sea, dealing with Marine Scientific Research, contains no reference to regional questions. In this it is in contrast with the following Part XIV, Development and Transfer of Marine Technology. There we see in Art. 268, Basic Objectives, that States shall promote international cooperation "particularly at the regional, subregional and bilateral levels"; several references to "regional programmes" follow this. However, in this Part we do find in Section 3 Articles 276 and 277 which are concerned respectively with the Establishment and Functions of regional centres for "marine scientific and technological research". The syntax nowhere tells us to what extent the Conference on the Law of the Sea had in mind centres for scientific research and technological research separately or together; the context suggests the latter. Furthermore, the functions which regional centres shall include, inter alia, go beyond research, as far as marine technology is concerned. They include, for example, "publicizing national policies with regard to the transfer of marine technology and comparative study of these policies" and compiling information on the marketing of technology. A first question might be whether the necessary conditions for successful regional actions of these kinds are the same for science and for technology or even for technological research. I shall suggest that in general they are not. First, however, we need briefly to examine the concept of "region" in this context.

1. REGIONS

As far as I can see "regions" is not defined in the convention. It is not mentioned in Article 1. The Articles in the special Section on "Global and Regional Cooperation" -- in Part XII "Protection and Preservation of the Marine Environment" -- are unhelpful. Nowhere is there a clue as to what is meant in Article 268 by "subregional" or by these terms in Article 69, "Right of land-locked States" (of access to living resources of exclusive economic zones). Dr. Maria Eduarda Gonçalves concluded, in the study she made for FAO, it is "unpracticable to develop a general theory with regard to the applications of the concept of 'natural (biological) region' and 'institutional region'".[1]

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[1] "Analysis of the concept of 'region' in the Informal Composite Negotiating Text." FAO/COFI/78/Inf. 10. May 1978.

The review on Regional Co-operation in Marine Science by Dr. Lewis M. Alexander[2] showed that many different criteria for regional definition have been adopted in various places, for various purposes, at different times, both for ad hoc regional activities and in creating continuing international instruments. Even geographical factors may differ for different purposes in the same general area, and in addition historical, cultural, linguistic, logistic (transportation and access) and bureaucratic (procedures of parent bodies in a hierarchy) factors are nearly always important and can be over-riding. In determining appropriate conglomerations of states as participants in regional technological centres we might expect economic and political factors to be particularly important; their purpose is economic gain for the participants. For scientific research these factors are likely to be less dominant. This difference, with the other heterogeneities noted by Alexander,means that regional marine scientific and technological centres should not be forced into the same mould, using the Convention as the press.

The regional centres envisaged by Article 276 are, as regards science, to be established

- particularly in developing states
- to stimulate and advance research by developing states.

However, all States of a region are required to cooperate with them. Among the functions specified in Article 277 are technical cooperation with other States of the region. It seems, therefore, that the Conference envisaged some definition of a region (as an area, or a group of States, or both) within which some or all the developing states would establish one or more centres, which would inter alia cooperate with (all) "developed" states in that region and with those developing states that did not choose directly to participate in any particular centre.

The functions of regional centres in the realm of science must apparently include, according to Article 277,

- training and education at all levels
- studies related to protection and preservation of the marine environment
- organization of regional conferences, seminars and symposia
- acquisition and processing of data
- prompt dissemination of results in readily available publications
- cooperation with other States of the region.

Priority in training and education is to be given to marine biology (including the, presumably scientific aspects of, conservation and management of living resources) and oceanography (I suppose meaning the fields of physics, chemistry, and geology) -- that is, as far as I can see, to everything! Taken literally it seems that regional centres are to be schools and colleges, research laboratories, data centres, publishing houses and conference centres. I suggest that in practice these functions will inevitably be to some extent separated, physically

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2 Report prepared for IOC, UN, FAO. December 1978

and/or institutionally. Since the development of "regional" training activities and data centres has been underway for several years, and innumerable regional conferences, seminars and symposia are organized without benefit of consideration as to modalities by workshops such as this one, we might gain most here by discussing primarily the functions of acquiring and processing data. But before making my suggestions in that regard I feel I must say something about the "networks" referred to in my title.

2. NETWORKS

I have not found the word in the text of the Convention (will someone produce a concordance?!). It describes, I think, non-hierarchical arrangements by which information (including information about decisions made or to be made) is transmitted to all participating units ("nodes" in the net) and through which also consensus or agreement may be reached. They are arrangements which are essentially "democratic" and decentralised. They are sometimes efficient. They are usually cheap to run. How can they be "promoted"?

Networks of this kind, involving collaboration among many, often disparate, units (people, institutions, organizations) are rarely constructed. Rather, they come into being because a few of the potential collaborators get together, decide thus to act, and invite others to join in. They usually have to make five principle supplementary decisions, in addition to that as to the subject scope of the information they will exchange. These are:

- shall the network be "open" or "closed"?
  (A subsidiary question is what links shall be established with other networks?)

- how can weaker participants be assisted, perhaps collectively, to contribute adequately to the information flow?

- what, if any, new units need to be created to complete the network or to make it more efficient?

- what exactly shall be the means of moving the information?

- is it desirable, or even essential, that without transforming the network into a hierarchy, one unit (node) be designated as a focal point? Such a point may be one through which (but not only through which) it is agreed that all information should flow. Whether or not that is decided a focal point may serve a function of maintaining the performance of the network.

Many participants in new networks have participated in existing ones. They bring an invaluable experience regarding procedures to adopt and to avoid. Some of the information moving in networks is about networks as such.

I hope this doesnot all sound too academic. Nearly everyone thinks he or she understands and has something to contribute to economics and to military strategy. Likewise, most of us think we know what really needs to be known about shifting information. Unfortunately experience closely examined shows this not to be true. Hence the need for those who wish to promote networks, to move specific types of information, to seek help from those who have been active in successful ones. If that need is recognized, and action taken accordingly, then "promotion" involves:

- drawing the attention of a few bodies who had not yet apparently realised it to the possibility that a new network might improve the performance of all or most of them;

- encouraging and/or assisting groups of such bodies to come together and take the decisions I have listed above;

- suggesting to its participants ways in which an existing network might be arranged to be more efficient;

- assisting with the creation or support of new elements deemed necessary (by participants) and with the designation and functioning of focal points (where they seem needed).

Some networks of global coverage now seem to be working quite well in the field of marine science. (This workshop may show me to be wrong in this presumption.) I think, for example, of the oceanographic data system and the ASFIS. Leading developers of, and participants in, these may have much useful advice to give regarding the promotion of regional networks for other categories of information. The experience of some other networks connected with the U.N. system might be useful. An example is the Environment Liaison Centre in Nairobi.

3. CENTRES

To the extent that regional centres are supposed to organise conferences, etc. and promptly to disseminate the results of research, they will inevitably be participants in networks and may tend to be natural focal points within them. They might even be important in the promotion of networks. One can envisage a situation in which a global body, such as IOC, is initially the promoter of regional networks, then leaves that function to the centres it has itself helped to create. The centres in various regions might usefully form a network among themselves (global assistance could obviously be useful). So we should add the networking function to those listed in Article 277.

A global body such as IOC, which is associated closely with others wider in scope -- Unesco, and the organisations participating in ICSPRO -- has an opportunity to draw upon their wider experience in deciding how to act as a promoter of centres and networks. I suspect that is done to only a slight extent; from my short experience as its Secretary I can understand why that has been, but nevertheless, with this new stimulus given by the Convention, it might be timely to reconsider some of the priorities of secretariat and officers' time in this respect.

To turn to what I regard as the key function of "acquisition and processing of...data and information", what do these terms imply, especially in association with the function of disseminating results promptly and efficiently? Acquisition of data means, I presume, both (i) acquiring existing information, particularly from outside the "region", and from countries in the region which are not partners in the centre, and (ii) finding out new facts about the sea, particularly, but not, I suppose, exclusively, in the geographical region if such be defined (for example, one might envisage a centre supported by a number of, say, Arab States, engaged inter alia on some aspect or research concerning, say, the Southern Ocean). The two types of "acquisition" call for entirely different sets of actions. It could be imagined that they could be taken separately, and even so taken with advantage. However, when acquisition is linked with processing of data, and those with dissemination not of data but of results, such separation may be undesirable, even impractical. I suppose we could understand processing to mean, rather trivially, compiling tables, plotting charts, applying standard corrections to observations, making routine cross checks, even putting numerical data through standard computer programmes. But such a restricted interpretation is hardly compatible with a function of acquiring new data. Thus if data acquisition includes seeking to discover new facts, the nature of scientific research is such that "processing" must cover all stages and aspects of analysing and interpreting data. Similarly "results" means not merely streams of raw or even "processed" data, but criticism, hypothesis, theory and indeed scientific argument in its full array. Anything less would harldy contribute very substantially "to advance the conduct of research" as required by Article 276.

If I have understood them correctly, then, Articles 276 and 277 provide a strong mandate in the field of marine science for what have been called "centres of excellence" in developing states, primarily for their benefit, as regional entities. Proposals for such entities have been made in the years since the U.N. system was created, but few have come to fruition. In the early days of Unesco's involvement in oceanography, opposition to international research facilities (including a "Unesco" research ship) came mainly from administrations in technically advanced countries and scientists who already had ready access to ocean-going vessels. They said it would be more efficient if scientists from developing, especially newly independent, countries would work aboard their ships, and learn in their laboratories. Later, this surely well-meaning but essentially paternalistic attitude was replaced by the determination of the developing countries each to enhance their national capacities in this field. This, to a degree, they have succeeded in doing, though much more remains to be done and the IOC is embarked on a new programme to ensure that more is done. Three things are, however, evident. First, many small and/or relatively poor countries cannot reasonably expect ever to acquire a national capability in marine science even "to ensure full or optimal utilization and preservation of their marine resources" as Article 275 enjoins; still less to contribute substantially to the world corpus of scientific knowledge about the ocean, its contents, properties, processes. Secondly, there are types of marine scientific investigations in which the citizens of developing countries should participate if they are not forever to be second or third class partners in the global scientific enterprise, but in which even the largest and/or richest of them have not the funds, scientific manpower, facilities and access to technology to engage themselves. International centres perhaps offer solutions to both problems. Thirdly, the pace of development of marine science cannot exceed the overall pace of growth of science and availability of related technology in the countries concerned.

International centres to serve these purposes could in principle be either "global" or "regional" in structure. In either case a major question is the degree to which, even if they do contribute to science as a whole, they will assist or impede the process of developing national scientific capbabilities. But we should not expect the answer to be simple. We note that the Convention does not encourage the creation of global centres.

4. MODELS

In considering in what ways regional "centres of excellence" might fulfil the requirements of Articles 276 and 277 the UNU, the IOC, Unesco and the other U.N. organisations directly associated with the IOC could usefully examine the history, achievements and problems of international scientific centres in other fields. Although it is not a regional centre, and is not physically located in a developing country, the International Centre for Theoretical Physics in Trieste, Italy seems to have been the archetype of such bodies. I am not sure of its present status (it was reported in 1980 to be having serious financial difficulties). It was (is?) funded by the host country and at least one other country as well as by IAEA and Unesco, and was strongly oriented to the problems of physics in developing countries. Professor Abdus Salam, founder of the Trieste Centre, has helped to plan and found other international centres, and these activities have created much interest in Latin America and in OPEC. I understand that scientific centres now existing or planned include:

* International Centre for Mathematics (Udine, Italy)
* International Centre for Pure and Applied Mathematics (Nice, France)
* International Centre for Physics (Mexico City)
* International Institute for post-graduate studies by scientists from developing countries (Venezuela - OPEC)
* Multiciencias Centre for advanced studies (Cusco, Peru)
* a centre for alternative energy sources (Brazil)
* a centre for mineral technology (Peru)
* a centre for solar energy (Colombia)
* a centre for new energy sources (AOPEC - Italy)

Then, India has recently suggested the establishment by and for developing countries of a centre or agency for space research and technology.

Several of these models are global in scope rather than "regional". This comes in part from the nature of the chosen subject fields -- indoor rather than outdoor investigations, even extra-terrestrial rather than planetary. This broad scope might also have the advantages of not leaving out, pro tem, any worthy beneficiaries, and being able to draw, initially, from the largest possible pool of collaborators. Marine science does however, now have practitioners in fair numbers in most parts of the world and investigations sponsored by an international centre, as those by major laboratories in the rich countries, would naturally tend to give more attention to those parts of the world ocean readily accessible to it than others. Global coverage and world-wide participation might therefore be achieved by a number -- quite a small number, I think -- of linked "regional" centres. Each would have its own research and support facilities, some of similar

nature to those in other centres and some complementary to others. For example, although all such centres would need to have use of surface vessels, perhaps only one would engage in underwater studies by mobile submersibles.

Regional centres would need to have, in addition to platforms for observation at, over and under-sea, and shore laboratories, specialized service facilities such as library, documentation and data centres, workshops, and computer systems. These facilities, while serving scientific workers located (mostly temporarily) at the Centres, could also provide some services to national research centres, especially in their "region", as does or will (I presume) the Latin American Regional Centre for Calibration and Standardization of Oceanographic Methods and Techniques (IOC Resolution XI:30, 1979), and as have, in the past, international biological sorting centres.

5. STATUTORY BASIS, GOVERNING AND LOCATION OF REGIONAL CENTRES

In theory it would be possible for regional research centres to be established under the aegis of existing inter-governmental regional bodies concerned with one or other aspects of marine research. As far as I know none have done so, although the idea has been discussed in several of them from time to time. One difficulty, recognised for several years, is that marine science is fragmented among many bodies, even in a particular region, each of which is concerned with one particular aspect of use of, and management of activities in, the marine environment. The definitions of "region" overlap but are rarely identical; those that are dependent on larger organizations are governed by those organizations in incompatible ways, their headquarters are in different locations, and so on. These bodies have continuing difficulties in collaborating effectively, which could make it difficult for them jointly to support regional centres. But not, I hope, impossible.

In his Report, Alexander briefly looked at some of these problems as far as the U.N. system is concerned. He concluded that there was no advantage in such suggested actions as harmonizing regional definitions and locating all or several regional secretariats in one place. Neither of these would be prerequisites for decisions to create regional institutions, so we need not consider them as such here. However, regarding the latter option I find it difficult to accept Alexander's argument that offices bring income to cities and that therefore they should be spread around so that income is distributed, and also in order to avoid having to make hard decisions about where joint offices should be located. (I suspect prestige is more usually the issue than economics). Following his argument, the "Founding Fathers" of the USA might have decided to put the Department of State in Virginia, the Department of Commerce in Massachusetts, and so on -- probably with disastrous results for a young State. Similar arguments have been made about the location of regional centres, and it has greatest validity when national centres exist but are still weak. I suggest, however, that at the present time when, for whatever reasons, the idea of international (including regional) science centres seems at last to be taking off, the problem of location can be simplified by considering together all the centres in each "region". Thus, if one country hosts a centre for geology, another would host a marine science centre, an so on. This has obvious implications for the manner in which IOC and its associates might set about promoting regional centres.

Another possibility is that marine science centres might be established as "departments" or subsidiaries of regional centres of wider scope. I do not know the precise scope and modus operandi of the centre being set up in Venezuela, but perhaps it could spawn and nurture a marine science entity, just as national universities have created some of the great marine institutions. I leave others at this meeting to tell us how UNU could be involved further in this process; also what, if any, substantive role ICSU and its organs could play.

It seems to me that there is no fixed pattern to be recommended. My guess is that if regional centres such as I envisage do come into being and are successful, it will be essentially as autonomous international organizations, each with several generous "godparents". IOC, especially its secretariat and its officers, is in the best position to find and open the difficult route from the idea to the reality.

THE IOI TRAINING PROGRAMME ON THE MANAGEMENT AND CONSERVATION OF MARINE RESOURCES

A CASE STUDY

Elizabeth MANN BORGESE
Department of Political Science
Dalhousie University
Halifax, N.S.
Canada

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INTRODUCTION

On April 30, 1982, the Third United Nations Conference on the Law of the Sea adopted, together with the Convention, a Resolution (A/Conf. 62/L.127) which appeals to all States, developed and developing, to all competent organizations within the United Nations system, to the Secretary General, and to the World Bank, to cooperate in enhancing the development of marine science, technology and ocean services in developing countries.

This Resolution culminates a long series of manifestations of a newly felt need for training in marine sciences as a basis for the rational management of the marine environment and its resources.

Several interrelated developments have triggered off this new need:

(1) New scientific discoveries in the geophysics of the oceans;

(2) the penetration of the industrial revolution into the oceans;

(3) the growing importance of the oceans in the economy of the world community and of each individual State, whether coastal or landlocked;

(4) the ongoing transition from a system of laissez-faire in the oceans to a system of management, comprised of two components:

(a) extended areas under national jurisdiction, adding a new dimension to national development strategies;

(b) an international area in whose management all States may participate

- both established by the Convention on the Law of the Sea.

Even before the Convention comes into force, States are already heavily engaged in implementing it through national legislation and the establishment of national infrastructure, to explore and exploit the potential of ocean management and optimize benefits from the new Law of the Sea.

The United Nations and those of its organizations which are basically involved with the oceans (Unesco/IOC, FAO/COFI, IMO, UNEP) and others, more marginally concerned with the oceans, have responded to the need by (i) making studies and monitoring developments; (ii) providing information; (iii) conducting short seminars for experts; (iv) organizing training programmes and providing scholarships. "Conscious that the problems of ocean space are closely interrelated and need to be considered as a whole", the United Nations system has begun to create integrating mechanisms, such as ICSPRO and TEMA, to enhance these activities. These efforts to enhance the development of ocean management capacity in developing countries on a comprehensive integrated basis, will undoubtedly continue and expand. Such efforts include the intergovernmental as well as the nongovernmental sector.

This paper presents a case study of a nongovernmental effort in the training of Third-World personnel in ocean management and conservation. It shows how this programme is being carried out in close cooperation with national Governments and the United Nations and indicates some areas in which this cooperation could be strengthened to improve the effectiveness of the Programme.

1. THE IOI TRAINING PROGRAMME ON THE MANAGEMENT AND CONSERVATION OF MARINE RESOURCES

1.1 BACKGROUND

The International Ocean Institute (IOI) is an independent, non-governmental, international, nonprofit organization. It is governed by a Board of Trustees and a Planning Council (see Annex 1). A small staff conducts operations in Malta. The Institute's activities are highly decentralised and take place in all parts of the world.

The purpose of the Institute, as defined in its Statute, is "to promote research on the peaceful uses of ocean space and its resources, including the regulation of such uses", and to that end, "...convene Pacem in Maribus Convocations, courses, seminars and the like; award fellowships in ocean studies; and undertake such other regional and global activities as may be determined by the Coucil".

The concept of the training programme arose in the context of the Law of the Sea negotiations.

Already the early drafts of the negotiating texts made extraordinarily high demands on the qualifications of experts to be elected or appointed as members of various organs of the future Seabed Authority, such as the Governing Board and the Staff of the Enterprise, the Commission of the Council, the Council itself, or the Seabed Chamber of the Tribunal. It was difficult to imagine that developing countries could provide such highly trained personnel in sufficient numbers to fill their quotas and participate as equals in the management and decision-making of the Authority.

The IOI presented a training project proposal at Pacem in Maribus VIII in Mexico in 1977 and Pacem in Maribus IX, in Yaounde, the following year. The proposal was extremely well received. The Summit of the Organization for African Unity, which met immediately after Pacem in Maribus IX, adopted a Resolution in favour of training programmes, with particular reference to the IOI project. The OAU Resolution went to the Plenary of UNCLOS, which endorsed it. The Government of Sweden provided funds through the Swedish International Development Agency (SIDA) for an initial workshop to draw up a detailed syllabus for an interdisciplinary programme on ocean mining and get it started. The first course in Malta took place in the spring of 1980. Nineteen Government-appointed participants from 11 developing countries attended the 12-week course. Scholarships were made available by the Federal Republic of Germany, the Netherlands,

Mexico, and the European Economic Community. The programme was far from perfect. The organizers learned at least as much as the participants. For the IOI, it was a real-time feasibility study.

Following the advice of representatives of the Canadian Government, the United Nations, and others, the IOI immediately began to enlarge the programme by planning a second annual course, Course B, devoted to all aspects of Economic Zone management. A workshop, to draw up a detailed syllabus, was funded by CIDA (Canada). The first Class B programme was held in Malta in the autumn of 1980. There were 19 participants from 16 developing countries.

Each of the two courses has been held three times during these first three years. Over 100 participants from 41 developing countries have received diplomas. The curricula for both courses have been vastly improved during this period; the Class A programme has been strengthened by moving the technical part to the Technical University of Aachen with its splendid technological infrastructure; while the Class B programme has greatly benefited from association with Dalhousie University and the cooperation of other educational industrial, and governmental entities in the Maritime Provinces of Canada.

Thanks to the initiative of the Government of India, a third programme, Class C, has been added. Class C is a regional programme. It combines the curricula of Class A and Class B, but focuses them on the needs and problems, the resources and infrastructures available in one particular region. In 1982, Class C will take place in Goa, India, in cooperation with the Ministry for External Affairs and the Department for Ocean Development of the Government of India, the National Institute of Oceanography in Goa, and UNEP. There will be 25 participants from 14 countries in South and South-East Asia. For 1983, two Class C programmes are planned: one in Algeria, for francophone Africans; the other in the Solomon Islands, for the small island States of the South Pacific. Also for 1984, in response to special demands, two Class C programmes are planned: one in Mexico, the other in Thailand, while Classes A and B will continue regularly, in Malta/Aachen and at Dalhousie.

1.2 PURPOSE AND SCOPE

The purpose of the programme is to deepen the understanding of the ever-increasing importance of the oceans and their resources in world politics and world economics; to assist developing countries in the formation of a core of decision-makers fully aware of the complex issues of ocean management; and to maximize the benefits to be derived from the proper integration of ocean management into national and international development strategy.

Class A focuses on the importance of ocean mining in the context of global economics, on technological and organizational developments. It should assist developing countries to optimize benefits from contract negotiations and to enable them to participate effectively in international undertakings in ocean mining so as to assure their fair share in the common heritage of mankind.

The main emphasis of the Class B programme is on the harmonization of all uses of the EEZ to maximize economic benefit and minimize ecological damage; on integrated water management; on the requisite national legislation and institutional infrastructure and its interaction with regional and global institutions.

The Class C programme focuses on regional problems and regional cooperation, not only in the management of living resources, the marine environment, and scientific research, but even, where appropriate, in the form of joint undertakings in oil and mineral exploration.

All three programmes stress the importance of the marine sciences as a basis for ocean management and offer in-depth discussion on scientific methodology, including data collection, data storage, data transfer and the monitoring of the ocean environment. The state-of-the art of each one of the basic marine sciences is presented by the best experts in the field, and the direct relevance of each science for resource management is explored.

All three programmes are interdisciplinary, ranging from the scientific and technological to the economic, legal and political aspects of ocean management and attempting to integrate all this material in a new "ideology", as it were: an ecological worldview, stressing cooperation rather than competition, communality of interests rather than conflict and viewing cultural evolution - including technology - and natural evolution as continuous, not antagonistic developments. The programme attempts to convey the kind of philosophy that should underly the building of a New International Economic Order.

This is what distinguishes the programme from other programmes, most of which are more narrowly technical and specialized. The IOI programme thus should be considered as complementary, not as a duplication of other ongoing efforts, such as undertaken by the UN institutions, singly or jointly, or by specialized technical institutions.

1.3 STRUCTURE OF THE PROGRAMME

1.3.1 Curriculum Formation

The curriculum for each course is prepared by a two-day workshop. A draft curriculum, drawing on past experience, is prepared by the IOI staff and serves as a basis for discussion for the workshop.

The workshop is attended by 3-4 members of the IOI staff and governing bodies, a few experts in the various sectors to be covered, and representatives of U.N. institutions participating in the programme. There has been one such workshop each for the Class A and Class B programmes. After three years, a thorough evaluation of the programme is being undertaken. Class A will be reviewed, evaluated, and revised by a workshop in Berlin, sponsored by the Carl Duisberg Gesellschaft, next month. An evaluaton session for Class B will take place in Dubrovnik, sometime next spring, sponsored by UNEP.

Each of the Class C courses is preceded, about 4-6 months prior to the beginning of the course, by a special regional workshop to assure that the programme responds to the particular needs and problems of the region.

Each programme consists of a series of lectures, numerous field trips providing opportunity for direct observation and participation in marine activities, laboratory work, and a final symposium where the participants present and discuss the result of their work. These results are published as IOI Occasional Papers and are used as background material for subsequent programmes.

1.3.2 Teaching Staff

The choice of lecturers/discussion leaders and the drafting of the curriculum are closely related; the preparatory workshop deals with both. A list of recommended lecturers/discussion leaders is compiled by each workshop. The course director chooses the teaching staff for each course from this list. At the end of each course, the course participants are asked to give an evaluation of the performance of each lectuerer/discussion leader. With the help of the workshop and the course evaluations, the IOI has begun to build up a remarkable global network of lecturers/discussion leaders.

It should be stressed that the programme reduces differences between "participants" and "lecturers" to a minimum. The participants are competent specialists in their own fields, and their active involvement in the programme is encouraged. The lecturer's function is more like that of a "resource person" in a seminary. Participants in one course may be invited to serve as "lecturers" in subsequent courses.

1.3.3 The Participants

The participants are "mid-career civil servants" from developing countries in all parts of the world. This is not meant to exclude participants from developed countries, if a Government of a developed country wishes to nominate any, and provided their scholarships are paid by that country. Obviously, the IOI cannot provide scholarships for participants from developed countries.

The preferred age of participants is between 25 and 35, but there have been older as well as younger ones among them. IOI requires that they have at least one University degree (B.A. or whatever the equivalent in different countries); many of the participants hold Ph.D.s IOI also requires that they have at least two years working experience in Government or in a scientific institution.

All participants are nominated by their Governments. They come from Departments of Agriculture and Fisheries, Energy and Mines, Shipping, Navy and Coastguards, Science and Technology, Economic Planning, Environment, or Foreign Affairs. Nominations are usually coordinated by the Ministry of Foreign Affairs. The final selection is made by the IOI.

Our scholarship scheme (see below) requires that nominations are made by Governments. This gives the programme an unusual status - somewhere between an intergovernmental and nongovernmental activity.

1.3.4 Financing

The cost of each programme is generally around $180,000. This includes the overseas air fares, economy class, of all participants; 10 weeks of full room and board; field trips, pocket allowance, sickness insurance and teaching materials. It also includes the travel costs of lecturers, their room and board while in residence, as well as their honoraria; the salary for the course director for four months, and the printing of material that emerges from the course.

These funds are raised in the form of scholarships which are calculated as $7,500 plus overseas air fare as follows:

Accommodations, 10 weeks	$1299.45
Food allowance	587.85
Living allowance	359.00
Local transportation	133.90
Teaching materials and Lab. costs	338.00
Course fee (including fees to lecturers, telecommunications, administrative overheads, etc.)	4781.80
	$7500.00
Average airfare	1500.00
Total	9000.00

The budget breaks even with twenty scholarships.

The main and most constant supporters of the IOI training programme have been CIDA (Canada), the Commonwealth Secretariat, and the OPEC Fund. Other contributions have come from the Netherlands, the Federal Republic of Germany, Mexico, Nigeria, India, the EEC, UNDP/FAO, IOC and UNEP. UNEP, Unesco, FAO, UNCTAD, the UN Secretariat, IMO, ILO, WMO, IAEA, have contributed lecturers free of charge, which is a form both of substantial and financial contribution.

1.3.5 Follow-up activities

Effects of programmes of this type would be cumulative. To treat them as "one-time-happenings" would be an enormous waste of time, energy, and funds. Continuity is of the essence. This continuity has several aspects. Courses have to be repeated at regular intervals, each one building on the experience of the past ones. Thus a unique network of teachers and funders, and a stock of teaching materials can be built up over time. Secondly, contacts with former course participants must be maintained. The award of an IOI diploma means the termination of one type of relationship and the beginning of another. Relations with former

participants are maintained through (a) IOI efforts to secure additional scholarships who wish to continue their studies in a particular field; (b) the publication of a Newsletter (see Annex 2) to which former participants and lecturers contribute and which is sent to all former participants; (c) the enlistment of former participants as lecturers in subsequent courses; (d) refresher seminars for former participants. This can be done most effectively in connection with regional Class C programmes: symposia are being planned, in conclusion of each one of these programmes, to which all former participants from the particular region will be invited, and which provide an occasion for keeping up to date with the latest developments. The organization of such symposia has been discussed with, and favourably considered by, the Director General of Unesco, who has indicated his willingness to contribute financially to such symposia.

1.4 PROBLEMS ENCOUNTERED

The problems encountered in building a programme as comprehensive and, in many ways, as innovative as the IOI training programme are obviously numerous. In many ways, the programme itself is an ongoing "case study", or "feasibility study" and the organizers are learning at least as much as the participants.

On the substantive side, considerable difficulties arose from the interdisciplinary nature of the programme. Conceptually, the need for "managers" or "administrators" in ocean affairs, who should be at home both in the social sciences (especially economics, law, administration) and in the natural sciences (all marine sciences and technologies) has been stressed by many specialists in development economics. To help form this new type of manager at the practical level is quite another matter. Interdisciplinary teaching is relatively easy at the undergraduate level; at the graduate level, difficulties begin to arise; at the level of civil servants with considerable expertise in one particular field (e.g., fisheries, or law) and no experience, and no natural interest in any field, this becomes very difficult indeed, and, especially during the early programmes, experts in various fields would find themselves lecturing before a group half of which would be responsive while the other half would be yawning. The IOI has done a considerable amount of experimenting, and has gained some experience, in the ways and means of interweaving different disciplines and different segments of the programme. The latest experiment - largely successful - has been to build a two-week "crash course" in a special, technical field, into the 10-week interdisciplinary programme of the Class B course.

Other problems arose from the length of the courses - which were found to be too long by some, too short by others. As regards the choice of venue, Malta, as undoubtedly many other developing countries, lacks a technical infrastructure. In developed countries, like Germany, this infrastructure, and the related problems, may be so different from those arising in developing countries as to make their study irrelevant. Yet another set of problems arose in connection with food habits, climates, and life styles. These are familiar to the organizers of any programme of this sort.

On the whole, however, it seems that the IOI has succeeded in responding to a felt need, and has created a new pattern, and the courses are establishing themselves firmly. Thus one former participant recently wrote to the IOI:

"The Treaty and Legal Department is being charged with duty to draft Thailand national legislation for its maritime zones, taking into account all the relevant matters of various subjects specified in the new Convention. To this effect a committee was set up and vested with powers to draft such legislation. And I was appointed a member of this Committee. I would like to state here that the knowledge which I gained from the IOI course in Malta 1980 has helped me in giving the best contribution to the work of the said committee".

Another participant wrote:

"I was appointed by National Aquatic Resources Agency (NARA) to a committee to plan an offshore survey around Sri Lanka and I feel full of confidence in assisting the committee after attending the course".

Yet another participant wrote:

"The Halifax experience was a very useful one indeed and each day at work I see the fruits of that endeavour. Sometimes I wonder how I did (my job) before".

These testimonies are just a sampling from many received.

1.5 COOPERATION WITH THE UN AGENCIES

Each one of the UN organizations basically involved with marine activities has evolved considerable expertise in its own specialized field as well as the capacity to advise developing coastal and landlocked States and to conduct training programmes, usually in a specialized field, and of short duration. The IOI programme is constantly being enriched by these activities of the specialized organizations. On the other hand, it can make a valid contribution to all of them by integrating, in cooperation with the organizations concerned, the several specialized sectors into one integrated whole. As already mentioned, the IOI programme, thus conceived, is complementary to TEMA, which is restricted to Marine Sciences, and ICSPRO, which focuses on pollution.

Cooperation with the Agencies has taken place on three levels:

(1) All of the Agencies have participated in one or the other of the IOI workshops preparing syllabi/curricula. This contribution has been highly useful, both to each of the Agencies concerned, which can assure, through its direct input, that the programme contributes to its own efforts on a given subject or in a given region, and to the IOI, which needs this kind of input;

(2) All the Agencies have contributed teachers and teaching materials to the IOI programme. The contacts between expert staff members of the Agencies and the civil servants from developing countries who participate in the IOI programmes have been fruitful and may have spin-offs and after-effects way beyond the classroom;

(3) Putting together (1) and (2) above, the IOI is now working out curriculum schemes in which an Agency may take an entire week, integrating its own special programme into the comprehensive whole. Such an arrangement has been made with UNEP in the Goa programme and appears to constitute an ideal form of cooperation. It simplifies the technical task of IOI and enables the Agency to run a programme of its own at very little cost and no overhead;

(4) Most of the Agencies have, in the past, nominated candidates and provided scholarships for one course or another. This has been highly beneficial to the programme and alleviated the burden of securing adequate financing.

The IOI would like to expand these forms of cooperation and, if possible, shift them, perhaps through ICSPRO and in conjunction with TEMA, from an ad hoc basis to a regular and systematic one.

1.6 FURTHER DEVELOPMENT OF THE PROGRAMME

The IOI training programme has been a fast growing one. Starting in 1979 with the preparation, and funding, of a single programme, the IOI moved rapidly to two annual programmes in 1980 and 1981, and three in 1982. Demands for regional programmes reach the IOI from many places. While three programmes had been planned for 1983 and 1984, there have been requests for a fourth in each of these years. The request to organize a Class C programme in the South Pacific came from the Commonwealth Secretariat and the FFA in the Solomon Islands. The programme is fully funded by the Commonwealth Secretariat and CIDA. The Director of the programme will be Dr. Geoffrey Kesteven of Australia.

The request for a fourth programme in 1984 came from Thailand. If funding is made available, we shall be glad to cooperate.

Another request came from anglophone Africa - but our plate is presently too full to consider additional programmes at this time.

With the development of a network of funders, cooperating organizations and scientific and technical institutions, and teachers, the task of organizing these programmes is becoming easier in some ways. On the other hand, the tasks and responsibilities for follow-up activities become heavier the more participants go through the programme. Four programmes a year is probably the maximum burden the IOI can carry. Of these, Class A, devoted to ocean mining, will remain located in Malta for the theoretical part, at the Technical University in Aachen, for the technical aspects. Class B, on EEZ management, will continue to be carried out in Halifax in cooperation with Dalhousie University and, when the time comes, with the International Centre for Ocean Development (ICOD) initiated by the Federal Government of Canada. Two Class C programmes will be conducted in different regions, in cooperation with a host country Government, with regional organizations, and, hopefully, the competent UN agencies and organizations.

ANNEX 1

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Assistant Director

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Maritime Technology Consultants Ltd.
Canada

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Wendell Mordy, President
N. Danelius, Vice-President
Aaron Kozak, Treasurer

LIST OF PARTICIPANTS

INVITED SPEAKERS

AUSTRALIA	Dr. G. L. Kesteven 12 O'Brien's Road Hurtville N.S.W. 2200
BULGARIA	Prof. A. Yankov Ministry of Foreign Affairs and University of Sofia Sofia
FRANCE	Prof. R. J. Dupuy Collège de France 24, rue du Regard 75006 Paris
MEXICO	Dr. A. A. Castanares Director Instituto de Ciencias del Mar y Limnología Universidad Nacional Autónoma de México México 20, D.F.
NORWAY	Prof. U. Lie Institute of Marine Biology N-5065 Blomsterdalen
PHILIPPINES	Prof. I. A. Ronquillo Chief Division of Research Bureau of Fisheries and Aquatic Resources P. O. Box 623 Manila
PORTUGAL	Dr. M. E. Gonçalves Juriste Junta Nacional de Investigaçao Cientifica e Tecnologica (JNICT) Av. D. Carlos I, 126/2 Lisbon 1200
UNITED KINGDOM	Dr. S. Holt 2 Meryon Court Rye East Sussex

PARTICIPANTS

BRAZIL	Dr. P. Soares Moreira Director Oceanographic Institute University of Sao Paulo Sao Paulo
CANADA	Prof. E. Mann Borgese Department of Political Science Dalhousie University Halifax, N.S.
COSTA RICA	Prof. N. M. Murillo (Chairman) Centro de Ciencias del Mar y Limnología Universidad de Costa Rica Ciudad Universitaria 'Rodrigo Facio' San José
FRANCE	Prof. P. Lasserre Institut de Biologie Marine 2, rue du Professeur Jolyvet 33120 Arcachon
FEDERAL REPUBLIC OF GERMANY	Dr. G. Giermann Alfred Wegener Institute for Polar Research Columbus Centre D-2850 Bremerhaven
FEDERAL REPUBLIC OF GERMANY	Prof. Dr. H. U. Roll President German Committee for Marine Research Rogenfeld 34 D-2000 Hamburg 67
INDIA	Dr. S. Z. Qasim Secretary Department of Ocean Development Government of India Mahasagar Bhavan, Block No. 12 CGO Complex, Lodi Road New Delhi 11003
JAPAN	Dr. M. Omori Tokyo University of Fisheries Research Laboratory of Fisheries Resources 4-5-7 Konan, Minota-ku Tokyo 108

JAPAN

Dr. K. Ruddle
Research Scholar and UNU Project Co-ordinator
National Museum of Ethnology
Senri Expo Park Suita
Osaka

NORWAY

Dr. G. Saetersdal
Director
Institute of Marine Research
P. O. Box 1870
5011 Bergen Nordnes

TANZANIA

Prof. A. S. Msangi
Director
Institute of Marine Sciences
University of Dar es Salaam
P. O. Box 668
Zanzibar

U.S.A.

Prof. J. A. Knauss
Provost for Marine Affairs and Dean
Graduate School of Oceanography
University of Rhode Island
Kingston, Rhode Island 02881

INTERNATIONAL ORGANIZATIONS

UNITED NATIONS UNIVERSITY

Prof. Dr. W. Manshard
Geographisches Institut
Universität Freiburg
Werderring 4
D-7800 Freiburg i. Br.
Federal Republic of Germany

SECRETARIATS

INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION

Dr. M. Ruivo
Secretary of IOC
IOC, Unesco
Place de Fontenoy
75700 Paris, France

Dr. S. M. Haq
Assistant Secretary of IOC (Technical Secretary)
IOC, Unesco
Place de Fontenoy
75700 Paris, France

Dr. K. Kitazawa
Assistant Secretary of IOC
IOC, Unesco
Place de Fontenoy
75700 Paris, France

UNESCO

Dr. D. Krause
Director, Unesco Division of Marine Sciences
Place de Fontenoy
75700 Paris, France

Dr. D. Troost
Programme Specialist, Unesco Division of Marine Sciences
Place de Fontenoy
75700 Paris, France

Dr. A. El Garafi
Consultant, Unesco Division of Marine Sciences
Place de Fontenoy
75700 Paris, France