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Report on the establishment of a Mediterranean Centre for Marine Industrial Technology

by

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REPORT ON THE ESTABLISHMENT OF A MEDITERRANEAN CENTRE FOR MARINE INDUSTRIAL TECHNOLOGY.

Introduction

The increasing depletion of traditional land-based resources of energy, food, materials and, for some countries, space, and increased requirements for transportation has resulted in a significantly increased use of the oceans. Technology for exploration and exploitation of the oceans has correspondingly developed rapidly, and continues to do so. Marine technological developments include the application of space technology for remote sensing of the sea surface and the near sub-surface, for accurate position fixing at sea, and for ship-to-ship and ship-to-land communication; sensing with acoustic devices: sensing and sampling with electronic devices which have increased the rate of data acquisition; platforms other than surface vessels such as moored and drifting instrument and equipment placed on the sea-bed; submersibles to carry humans or robots to any depth; new diving equipment; and data processing and computing equipment. As science continues to grow apace, new technological developments can be expected. However, scientific advances are unpredictable with each new discovery generating its own technological innovations. Marine technological developments will, therefore, be numerous and in unpredictable directions.

2. The pace of technological development is strikingly illustrated by the changes in the laws of the sea. In 1958, the Convention on the Continental Shelf defined the continental shelf as the sea-bed and subsoil of the sub-marine areas adjacent to the coast outside the territorial sea to a depth of 200 metres, or beyond that limit to where the depth of the superjacent waters admits of the exploitation of the natural resources. This definition reflected in part the state of technology at the time, as well as recognising that depths beyond 200 metres might become exploitable in the future.

3. The 1982 Convention on the Law of the Sea, on the other hand, referred to the continental shelf as extending to the outer edge of the continental margin or to 200 miles from territorial sea baselines, while more distant shelf areas may be claimed by the coastal state in certain circumstances. This increase in continental shelf jurisdiction undoubtedly reflected in part the substantially improved technological feasibility since 1958 to explore and exploit the adjacent waters, as did the establishment also in the 1982 Convention of an international regime to govern the non-living resources of the sea-bed beyond national jurisdiction. Accordingly, the Convention on the Law of the Sea particularly addresses transfer of technology through international co-operation (Articles 270-274) including the setting up of Regional Centres for the advancement of marine science and technology (Articles 276 and 277).

4. The further development of marine technology and the sharing of this technology is a necessary pre-condition for the optimum use of the sea and its resources. The developing countries are disadvantaged in the number of available marine technologists, facilities for the training of marine technicians, and in the availability of appropriate infrastructure such as laboratories, libraries, vessels and maintenance facilities. Most of these nations also lack the ability of commit adequate financial and manpower resources which can sustain marine technological development on a long-term basis. Regional co-operation through which manpower and financial resources, as well as infrastructural facilities like vessels, equipment and laboratories can be shared is, thus, a necessity for developing nations.

5. The impact of technological advance goes beyond exploration and exploitation of non-living resources, and there are few ocean uses that have remained unaffected by the advances that have occurred in marine technology. One consequence of these advances is the need for countries to decide from the choices available as to which particular technology is best suited to their circumstances. The rapid and unpredictable advances in marine technology, and variability in their applicability to developing countries which often lack the capabilities to adequately assess them, enhances the role that international and regional organisations, and their programmes, can play in enabling developing countries to take advantage of technological developments.

6. Technological advances have affected the exploration and exploitation of biological resources. New technologies, by improving location and capture techniques, have increased fish mortality whereby the maximum sustainable yields have been reached, and even exceeded, for many commercial fish species. Mariculture is a sphere in which considerable technological development is occurring and in conjunction with genetic engineering this is an area which offers considerable scope for the future. Improvements in stock assessment methodologies through the use of surveying technology such as side scanning sonar, echo sounders, acoustic surveys, radar direction-finding, aerial spotting and, possibly, even remote sensing would also impact on fishing techniques. The gradual evolution of aquaculture and fish farming in place of the present capture techniques is a distinct possibility in the coming decades.

7. Predictions of future developments in marine technology and their benefits are complex and uncertain. Much depends on the character of the technology itself and on advances in diverse, though related, fields such as information technology, micro-electronics, bio-engineering, remote sensing, robotics and the fast developing area of materials technology. Furthermore, the impact of technological change will differ considerabl from one country to another depending on particular circumstance and the impact of technological developments may not always be beneficial. This has already been a problem in the context of the Law of the Sea Conference where it was necessary to provide some protection to these countries

(principally developing) whose economies were heavily dependent on the export of minerals which could in the near future be obtained through sea-bed nodule mining. Other adverse impacts on the environment or particular economies could become apparent with the growth and advance of marine technology. Besides there is the possibility that rapid technological change could increase rather than diminish the technological gap between developed and developing countries with consequent impacts on the relative wealth of the two groups of nations.

8. For some time now the United Nations Industrial Development Organisation (UNIDO) has been assessing the impacts of the new emerging technologies on both the existing industrial structures of developing countries as well as on the future pattern of industrialisation. UNIDO sees in the changes taking place both a danger and an opportunity for developing countries - the danger of being marginalised in the world order, and the opportunity of developing an alternative path of technological growth based on the new emerging technologies and in the context of the concerned country's resource endowments.[1] UNIDO has also identified the promotion of international centres in the frontier technologies of micro-electronics, new materials, marine industrial technology and energy as a critical area calling for urgent action. The Executive Director of UNIDO felt that the mechanisms to be established should be innovative and involve the active co-operation of both the developing and the developed countries.[2]

The Mediterranean

8. The Mediterranean, may be defined as a semi-enclosed sea, meaning a

> ....sea surrounded by two or more States and connected to another sea or the ocean by a narrow outlet or consisting entirely or primarily of the territorial seas and exclusive economic zones of two or more coastal States[3].

The Mediterranean falls within the earlier definition of a semi-enclosed sea i.e. a sea connected to another ocean (Atlantic) by a narrow outlet (the straits of Gibraltar). This definition entails important juridical consequences that impinge on participation in regional processes. States bordering semi-enclosed seas are governed by a co-operative ethic and norms relating to the management, conservation, exploration and exploitation of the living resources of the sea, the protection and preservation of the marine environment, the co-ordination of scientific research policies and the undertaking of joint programmes of scientific research, and invitations to other interested States or international organisations to co-operate with them[4].

9. As already mentioned, the Convention also provides for the establishment of regional centres which can be set up by States in co-operation with competent international organisations, the Authority and national marine scientific and technological research centres, particularly in developing States, in order to stimulate and advance the conduct of marine scientific research by developing

States and to foster the transfer of marine technology[5]. The functions of such regional centres include, inter alia,

(a) training and educational programmes on various aspects of marine scientific and technological research;

(b) management studies;

(c) study programmes related to the marine environment and the prevention, reduction and control of pollution;

(d) organisation of regional conferences, seminars and symposia;

(e) acquisition and processing of marine scientific and technological data and information;

(f) prompt dissemination of results of marine scientific and technological research;

(g) publicising national policies with regard to the transfer of marine technology;

(h) compilation and systematization of information on the marketing of technology;

(i) technical co-operation with other States of the region[6].

10. The framework established by the 1982 Convention has been operative, in parts, in the Mediterranean for some time now. Marine regionalism made a first appearance in the establish of the International Commission for the Scientific Exploration of the Mediterranean Sea (ICSEM) by the International Geographical Union in 1908

and its consolidation in 1919. Among its aims are the promotion of co-operation among Mediterranean countries in marine scientific research. The efforts of several institutions and/or experts from various Mediterranean governments are often co-ordinated through ICSEM and through programmes established by the International Oceanographic Commission(IOC). Major advantages in operating within the framework of such a scientific co-ordinating body include intercalibrating the techniques for collecting and the methods of recording data, minimising the possibility of overlapping research, and maximising the exchange of technology, gear, and information[7].

11. At its Fourth Session in 1948, the Food and Agricultural Organisation (FAO) decided to establish a fisheries organisation for the Mediterranean. The General Fisheries Council for the Mediterranean(GFCM) formally came into existence in 1952 and since then the Council has served broad oceanographic functions including assessment, development and management of living resources, plus protection of these resources from the effects of pollution[8].

12. In recognition of the interdependence of scientific organisations in the Mediterranean, joint consultations led to the formation of the Co-operative Investigations in the Mediterranean (CIM). This is a product of the joint IOC/FAO(GFCM)/ ICSEM International Co-ordination Group(ICG) which has appointed a specialised panel to handle the technical co-ordination of CIM. The emphasis of CIM's programme concerns oceanography

and renewable aquatic resources.

13. And last, but not the least, is the United Nations Environment Programme (UNEP) Regional Seas Programme for the Mediterranean, which started with an Action Plan in 1975 and now consists of a complex network of policies, agreements, programmes, institutions and activities involving practically all the coastal States in the protection and preservation of the marine environment. Of the 18 Mediterranean coastal States, 17 participate in the Action Plan which consists of four principal elements, namely:

- Integrated Planning: to integrate planning of the development and management of the resources of the Mediterranean Basin;
- Scientific Activities: to co-ordinate a programme for research, monitoring and exchange of information and assessment of the State of pollution and of protective measures;
- Legal Action: to implement a framework convention and related protocols with their technical annexes for the Mediterranean environment;
- Institutional and financial arrangements.

14. Other programmes covering Mediterranean States are also in operation. These do not cover all the Mediterranean/ Coastal States. For example, the Arab League, which has economic and technological dimensions, covers most of the States of north Africa and the Middle East. The European Community has taken up the EUROMAR and EUREKA projects to take advantage of the

large European market and in an attempt to produce synergy by networking industrial research in different countries. In this system, enterprises (industrial firms) submit joint projects or proposals to their respective national government co-ordinators for preliminary study and evaluation. Selected proposals make their way up to the Conference of Ministers who take the final decision as to projects to be approved. On approval, half the cost of selected projects in borne by the participating enterprises and the other half is borne by the concerned countries and the EEC. The final technological output is the property of the concerned enterprises and is available to the countries and the EEC on normal terms.[10] Of the Mediterranean States, France, Greece, Italy, Spain and Turkey have taken up research ventures under EUREKA and EUROMAR.

15. Shared perspectives in both the environmental and economic fields has led the majority of Mediterranean countries to begin to lay the foundations for a framework of economic co-operation with the EEC. For example the EEC has co-operative agreements with Algeria, Morocco, Tunisia, Egypt, Lebanon and Syria; an agreement with Israel; association agreements with Cyprus, Malta and Turkey; and a framework of co-operation with Yugoslavia.[11] This desire for economic co-operation with the EEC has had impacts in the trade, scientific and technological fields, and flow of scientific and technological assistance from the developed North to the developing South.

Programmes in Research Institutions

16. There is considerable scientific and technological research activity in the Mediterranean. There is the environmental programme of UNEP which covers all the Mediterranean coastal States; the EUREKA/EUROMAR technology development framework which covers the states of the North; the Arab Maritime training programme which covers the states of north Africa and the Middle East; the various scientific research programmes of the different countries (details at Appendix I); the co-operative research programmes into the overall circulating patterns in the Mediterranean Sea under the auspices of IOC including chemical, physical, geological and biological oceanography; the fisheries management and aquaculture programme under FAO; and so on.

17. To simplify an extremely complicated regional situation it can be suggested that there are three levels of scientific and technological capabilities available in the Mediterranean area. There is a group of States with well-developed industrial capabilities (e.g. France, Italy and Spain), a large and variegated research establishment and a capability to go through the entire process of development from the laboratory to the shop floor. Even these countries, however, consider themselves to be somewhat inadequate in the high-tech areas of information technology, microelectronics, biotechnology, marine technology etc. and so are co-operating with each other, and other European nations, under the frameworks of ESPIRIT, EUREKA and EUROMAR.

18. There is another group of States whose industrial structure (and technological absorptive capacity) is somewhat lower than the first group but who have adequate manpower to undertake scientific and technological research in variegated fields. Yugoslavia, Greece, Turkey, Israel and, may be, Egypt would fall in this category. This group would need to develop enhanced capabilities in advisory and consultancy services, specialise in their science and technology efforts, and integrated their markets, products and technology.

19. The rest of the Mediterranean countries (all of them from the developing South) have capabilities to carry out scientific research in oceanography but their total manpower resources are limited and so the work is spread thin on the ground. These countries would need to augment their manpower resources and the associated infrastructure in the form of research craft and laboratories, lay more stress on market forces which lead to the "demand pull" on technology, provide for adequate consultancy and advisory services, specialise in their activities in the science and technology sphere, concentrate the research efforts on clearly defined technology missions, and integrate their efforts at regional and other levels.[12]

20. The various countries of the Mediterranean region, thus, have differing capacities to take advantage of the opportunities arising out of the ongoing Marine Revolution.

This creates an asymmetrical pattern which would have its ramifications on the design and setting up of a Regional Centre for Marine Industrial Technology. In the context of even the most advanced States of the region having to co-operate in the area of high-tech and marine industrial technology there is much greater need for the developing countries, and those intermediate between them and the industrialised countries, getting together to pool their resources, markets and equipment so that a critical mass gets created and breakthrough in marine industrial technology made.

Marketing Possibilities

21. Much would depend, however, on the marketing possibilities of various technologies. The Mediterranean region, situated as it is on the crossroads of three continents - Asia, Africa, and Europe -- is an area of considerable global strategic and political significance. It is, perhaps, the only region in the world which includes both developing and developed nations, including some major Powers, and where different political and social systems - capitalist, socialist, non-alighned etc....co-exist. Being a semi-enclosed sea, the eighteen nations of the Mediterranean have shared perspectives in both the environmental and economic fields. So that inspite of a mosaic of conflicts and disputes in and around the Mediterranean (the Middle East, the Aegean Sea, Gibraltar, Cyprus) there has been determination on the part of the majority of Mediterranean States to strengthen security and co-operatin in the area. This can be seen from

the framework of UNEP's Regional Seas programme, the bilateral and multilateral economic and trade flows between the industrialised North and the industrialising South, and the inscription of the Mediterranean as an area deserving special consideration on the agenda of the United Nations General Assembly.

22. The area comprises the technologically advanced and oil-hungry Europe, the technologically lagging and oil producing countries of the Arab Maghreb (Tunisia, Algeria and Morocco), and the financially rich countries of the Middle East. The assymetry in their resource endowments creates many complementaries within their economies and produces a community of interests between them. The result has been the so-called Euro-Arab-African dialogue and the forging of a pattern of trade and economic ties between them. In a very loose sense, a "Mediterranean market" can be said to be very gradually emerging.

23. Some common elements of this "market" can be identified as a stress on (i) tourism, with the consequent emphasis on environmental methods of pollution control, (ii) the development of aquaculture and fishery management methodologies, (iii) desalination technologies which have a great potential market in north Africa, the Middle East and small islands both for the provision of potable drinking water and water as a feedstock for various kinds of industrial projects, and (iv) better resource management of the extended jurisdictions accruing to States under the provisions of the 1982 United Nations

Convention on the Law of the Sea. We will deal with the technological and marketing implications of each of these elements.

The Environment

24. A major programme of environmental management and pollution control is being proposed for the Mediterranean in the coming decade. Some estimates of its likely cost amount to US $ 15 billion. While some of this expenditure would be concerned with land-based pollution control measures, quite a lot would be concerned with measures at sea especially in the sphere of monitoring and control. The present system of monitoring is largely based on ship-based data collection techniques supplemented by work in the laboratories. Since ship-time tends to be a very costly item, these techniques many times are beyond the capacity of the poorer countries with the result that the activities of developing countries tend to be lower than the optimal requirement.

25. Advances in the technology of *in situ* and automated sensing devices could, to a large extent, help overcome this deficiency. Some possible future developments could be:

(a) Sensors capable of collecting data for many months and monitoring as many parameters as possible, especially low concentrations;

(b) upgraded sensitivity of sensors measuring temperature, currents, conductivity and waves - electromagnetic meters, sonar/accoustic current meters, floating buoys etc.

so as to be able to record low values;

(c) sensors capable of measuring turbidity (especially for long periods) as these are necessary for measurin sedimentation transport/pollution as well as possible erosion of beaches;

(d) resins which can filter water on the sea floor and thereby measure the chemical components of sea water and give an idea of the trends in chemical pollution;

(e) sensors which can measure trends in microbiological pollution;

(f) more efficient systems for transmission of the data to on-land processing facilities e.g. cableless systems by using space technology; use of buoys and drifting buoys with ~~accounstic~~ acoustic transmission; or antenna attached to submersibles which pierce the surface, transmit data and then retract to their normal depth of 40-50 metres so as not to interfere with shipping; and so on;

(g) use of VHF transmission systems for data transmission from near-shore coastal areas.

26. There are many other developments that can be thought of e.g. microbiological cleaning of the environment especially hydrocarbon and heavy metals, monitoring of the environment from space, invention of new materials and

composites which are environmentally safe, etc. Many of these would only be possible and economic if developed and used on a collective basis. Besides technological advance could ensure that the relatively poorer countries could operate environmental monitoring and control measures thereby improving the efficiency of the entire system. The market for improved environment monitoring and control measures is, therefore, potentially quite large and would extend beyond the Mediterranean to other seas and oceans as well.

Aquaculture

27. Fishery resources in the Mediterreanean are important. There are a number of fish species closely related to similar forms in the subtropical Atlantic; many demersal species such as hake, sole and red mullet are widely distributed in the Mediterranean. The narrow connection between the Atlantic and Mediterranean waters provided by the Straits of Gibraltar is apparently wide and deep enough to have permitted substantial fish migrations in the past. Of the 500 or so fish species in the Mediterranean, an abnormally large number, 120, are fished commercially. The fisheries are valuable, despite low stocks due to a slow rate of phytoplankton production. The low biological productivity is a consequence of low levels of nutrients in surface waters, little mixing between surface and deep waters, and few rivers (particularly in the eastern part) which would add nutrients.

28. Despite these biologically unfavourable conditions the Mediterranean was estimated in 1970 to be able to support a fishery twice as valuable as that of any other ocean, and five times as valuable as the average for all the world's oceans taken together. This unusually high catch value is a product of traditional and cultural factors; fresh fish are considered a luxury in Mediterranean countries and fishing boats are traditionally small, making short trips and landing small catches. The high value of fish products and the generally easy work associated with Mediterranean fishing operations as compared to the north Atlantic, for instance, encourages overfishing and consequent depletion of fish stock.

29. Besides the population of the Mediterranean region is estimated to go up from the present approx. 350 million to 550-700 million by the year 2000 with the tourist traffic expected to go up from approx. 100 million today to 800 million in 2000. This would generate additional pressure on fishery resources. One way of meeting the demand and decreasing the pressure on natural fisheries seems to lie in the development of aquaculture. The growth of aquaculture depends on the development of technology and its sub-factors namely, culture technology and product technology, including the state-of-the-art methods for growing selected species, preparing or preserving the resulting products and delivering them to the customers in good condition. The impact of biotechnology is a growth area having implications for aquaculture. The development of floating barges, cages, etc. is another area of interest. Information dissemination,

training, and extension service activities are necessary components of aquaculture technology development. There is obviously widespread need for aquaculture technology in the Mediterranean States and, in fact, all the States are having research thrusts in this area.

Desalination

30. Water is required not only by dry countries but also by those countries that are rather well-watered: demand for water increases by about 4% a year while natural resources remain the same. An increasing imbalance, therefore, tends to be created between water resources and water needs. Under these conditions it becomes necessary to think of alternative sources which has led, in the past twenty years, to a rapid development of desalination technicues.

31. Desalination is one of the methods suitable for coastal states (like those of the Mediterranean) to meet their increasing water needs for:

- home uses which increase rapidly with the standard of living: the daily consumption per inhabitant may be estimated at 400 litres per day in the developed countries while it is as low as 50 litres per capita in the developed countries.
- industiral uses especially heavy metallurgy, chemical and thermal plants which are big consumers of water.
- agricultural uses since agricultural activities consume a lot of water.

32. There are a number of desalination technologies available which can be roughly divided into three categories as below:

(i) processes acting on chemical bonds: ion exchange;

(ii) processes using membranes : electrodialysis and reverse osmosis;

(iii) processes based on a change of state : freezing and distillation.

33. Ion-exchange resins are insoluble materials that are able to exchange some of their ions with those of the mineral salts dissolved in the solution with which they are in contact. Ion-exchange demineralisation allows a very pure water to be obtained if the salt content of the water is not too high. Regeneration of resins, which has to take place regularly in order to replace the ions fixed by the resin by those which composed it initially, needs chemical reagents. Their cost, added to the cost of resins which have to be replaced periodically, make this process somewhat expensive for seawater or brackish water desalination at present. Improvements in resin technology could, however, change the picture.

34. An electrodialysis cell consists of a large number of narrow compartments through which saline water is pumped. The compartments are separated by membranes into alternate cells permeable to positive ions and negative ions respectively. As the saline solution is pumped through the cells, due to electrical action, in alternate cells salt concentration decreases while

simultaneously increasing in the other ones. The process is economical for low salt concentrations. The other process, known as reverse osmosis, uses the known phenomena that if two compartments, one containing pure water and the other saline water, are seperated by a semi-permeable membrane, then pure water flows into the concentrated saline water. When a certain pressure, known as osmotic pressure, is applied to the container containing the salty water the flow of pure water is stopped. When pressures higher than the osmotic pressure are applied to the salty water the flow of water is reversed. Therefore the process is known as reverse osmosis and the development of new kinds of membranes (mainly in the US and Japan) has made this process more economical than other processes. The process also holds great promise for the future due to the rapidly advancing field of materials technology.

35. The processes based on change of state - freezing or evaporating - are basically heat exchange processes and the ones most in evidence today. The most efficient of the processes is the multi-stage flash distillation process which dominated the desalination field in the 60s and the 70s. The advances in membrane technology and the rise in the costs of energy have, however, tilted the scales in favour of the reverse osmosis process.

36. Desalination is likely to have great demand potential in the Mediterranean region due to increase

in population, economic growth and rising tourist potential. Research in membrane technology and reverse osmosis desalination technology would seem to meet the needs of a large number of countries of the region.

<u>Surveying Methodologies</u>

37. Extended national jurisdictions as provided by the 1982 United Nations Law of the Sea Convention have added to the management complexities of all states whether developed or developing. The extension of resource jurisdiction to 200 miles has meant considerable addition to the economic potential of states. To realise this potential it is necessary to:

- carry out hydrographic surveys so that navigational charts and inventories of coastal resources can be prepared;
- make coastal oceanographic measurements such as wave height and period, current strengths, water salinity and temperature, and phytoplankton concentration,
- initiate geological surveys for coastal and near-shore projects, particularly on the nature of the sea floor sediment movements, and effects on the neighbouring beaches,
- arrange for data exchange and information services through local and/or regional networks.

38. Oceanic surveys are very expensive due to high capital and operating costs of ships. Besides it has been estimated that the processing of data is also a very costly item. Improvements in hardware as well as related software in the sphere of marine surveying technologies are very necessary if work in the oceans is to be speeded up. In view of the heavy costs associated with ship time, attempts are under way to develop multiple data collection platforms and sensors capable of quick data acquisition of multifarious oceanic parameters.

39. For ocean forecasting of storms, surges etc. use of polar-orbiting satellites, along with surface-based observations and in situ measurements is being thought of. Synoptic measurements of ocean parameters like currents, swells, temperature, wind speed etc. (whether by satellites or other air-borne systems, e.g., lighter-than-air technology) over a long period of time is of assistance in making meteorological and weather forecasts. For studying the ocean floor, computerised "swath mapping" instruments are in great demand. These instruments are a combination of reflection, refraction and side-scanning techniques.[13]

40. Most of the expenditure on surveying and exploration work is on processing and interpretation of data. It has been estimated that only about 25 per cent of the total expenditure is on marine survey activities while the rest is on processing and interpretation. It is in this context that the question of software assumes great importance. Expert time being a costly and scarce commodity, advances

in computerised iterative methods of finding optimal solutions is a matter of importance to both the developing and developed states. Developments in technology, both in the hardware and software fields, which lead to more efficient acquisition and interpretation of data is, thus, necessary for the Mediterranean as well as for other oceanic regions. The demand for products developed in this field would be world-wide.

Possible Alternative Roles of the Regional Centre

41. The Regional Centre could have a number of alternative roles in the context of the politico-economic situation existing in the Mediterranean as well as the requiremnets of technology missions in the fields of environment, aquaculture, desalination and surveying methodologies. We have already noted the asymmetrical position prevailing among the Mediterranean states, all of whom have differing perceptions and needs from the proposed Regional Centre. If one was to try and work out what was of common interest to all the States the result would be a set of activities which almost certainly would leave out of consideration all areas and activities relatable to high-tech fields. On the other hand, if activities were to be those at the very frontiers of knowledge, the linkages would be more with northern European, and non-Mediterranean, States than within the Mediterranean region.

42. The answer would have to be a role somewhere in-between the above highly polarised situations. A number of such roles, in an interfacing and modular organisational

concept could be visualised. Some of them could be to:

(a) collect and disseminate information relating to marine science and technology as well as the associated high-tech fields of micro-electronics, robotics, computers (both hardware and software), space, lighter-than-air technology, space and materials technology;

(b) provide consultancy and advisory services to the developing countries;

(c) further technology development in the identified areas of environmental measures, aquaculture, desalination, and surveying methodogies by

- -acting as a catalyst
- -networking different research institutes
- -acting as a co-ordinator and synthesiser
- -promoting integrated technology transfer
- -developing the technology itself;

(d) promote development of scientific and technological skills through training programmes, symposia, seminars and conferences;

(e) promote the establishment of efficient, innovative and effective management systems in the field of research and development, environmental control and oceanic resource exploitation.

43. The Regional Centre should also have a link with the ESPIRIT, EUREKA and EURCMAR systems as well as with

the Mediterranean Action Plan of UNEP as by doing so it would be taking advantage of existing mechanisms of regional/sub-regional co-operation and thereby make the development of marine industrial technology part of an ongoing process. It would also have links with international centres in associated high-tech fields (e.g. the biotechnology centres at Delhi and Trieste, the International Space Agency etc.)

<u>Organisational Structures</u>

44. The Regional Centre could take up all the above roles in one large integrated organisation having capabilities related to (i) information collection, collation and dissemination, (ii) provision of advisory and consultancy services, (iii) promotion of technology, (iv) development of scientific and technological skills in the region, and (v) promotion of appropriate managerial systems. But since modern high-tech is very much dependent on a select and skilled labour force, the Regional Centre would have to employ and retain very large numbers of high quality manpower. This would be both difficult to obtain and costly to maintain and could raise expenses beyond acceptable limits.

45. A better strategy would be have a modular approach whereby new functions, and if necessary staff, can be grafted on to compatible organisation structures. The nucleus organisation module of the Regional Centre, for example, could be based on the role of the Centre as a collector, collator and disseminator of information.

For the purpose of performing this role, the Centre would not require more than 1 scientist/professional and 1/2 secretarial staff. The total cost could probably be contained within US $ 100,000 per annum.

46. The next function to be grafted on could relate to the holding of symposia and conferences. The staff of the "nucleus" could perform this function but some conferencing costs would be required. Travel costs could be met by the countries concerned.

47. Functions that could be grafted on later could relate to training and the provision of advisory services respectively. Both need not be on the regular budget of the Research Centre but could be met by grants on a case by case basis ffom UNDP, World Bank, EEC, national aid agencies etc. The job of the Centre would be to draw up proposals, training programmes etc. and help the developing countries in channeling their request to the right quarters. The Centre could also help in establishing laboratory-to-laboratory contacts so that scientists/technologists from developing countries could get on-the-job training in the institutions of the developed countries.

48. Functions relating to technology development could be also added on at the appropriate time. Different ad hoc project organisational teams for different technology missions, as and when approved and funded by the concerned governments, could be established after distributing the research work to the industries and institutions involved. Additional staff in case of each project could be limited to

a project leader and some supporting staff which also need not necessarily be on the Centre's pay-roll. The concerned States, or one of them, could retain and pay for the supervisory staff.

49. The modular concept of organisational development where compatible organisational modules are added-on, or detatched, as and when necessary is set in an organisational learning framework. The rate of growth of the Centre would be, thus, performance-oriented and dependent on the amount of confidence and trust it inspires in the States parties involved. It would also be in tune with the need of an organisational structure which is in harmony with the rapidly changing and complex environment created by technologies of the New Industrial Revolution.

Finances, Physical facilities and Manpower.

50. The requirements of finances, physical facilities and manpower would be dependent on the modules established in the Centre. The "nucleus" module dealing only with information would, as already noted, require only 2/3 persons and cost about US$ 100,000 a year.

51. For purposes of establishing benefit-cost ratios it may be advisable to leave out of consideration project staff required for different technology missions. The estimation of such staff is not only dependent on the size, nature and quantum of the mission involved but would also be included in the cost-benefit calculus of the concerned mission whenever it is approved. It can, therefore, safely be omitted at this stage.

52. In the context of the role of the Centre being the collection and dissemination of information, the holding of conferences symposia and seminars, the provision of consultancy and advisory services in the fields of management and research, and acting as a catalyst and promoter of marine technology, the permanent staff could be, say, 3 scientists/technologists/professionals and 2/3 secretariat staff. For advisory missions, where necessary, qualified consultants could be arranged for. Many of these could be funded through ongoing aid programmes of bodies like UNDP, EEC, bilateral aid agencies. Provision for some consultancy services could be made in the budget of the Centre.

53. On the assumption that the host government would provide the usual physical and other facilities, the annual cost of the Centre could be as under:

	US dollars
Salaries*	200,000 to 250,000
Travel costs	50,000
Rent, administrative costs etc.	50,000
Hiring of consultants	100,000
Miscellaneous	100,000
TOTAL	500,000 to 550,000

Note: *Salaries would depend on where the Centre is located and the costs of living prevalent there.

54. The likely benefits of the above approach cannot be easily quantified. The main functions of the Centre

would relate to:

- information collection and dissemination
- promoting networking of research institutions
- acting as a catalyst for promoting high-tech.

55. Work regarding the value of information and the synergistic impacts of networking different research institutions is as yet in a very preliminary stage. The realisation that information is a scarce factor along with the traditionally recognised factors of land, labour and capital has led some economists to try and formally include it in the production possibility frontier and the production function. The beneficial synergistic impacts of R&D networking are also intuitively accepted[14] but have not yet been placed in a formal model capable of empirical verifiability. But in a qualitative sense it is apparent that even the impacts of the spread of information (and disregarding training and possible technological breakthroughs or improvements) could, in the context of the likely expenditure of US$ 15 billion in the environmental field in the next decade, raise efficiencies in technological decision-making and choice sufficiently to justify the approx. US$ 5 million expenditure on the Centre in the next 10 years. Besides the bridging of the technological gap between the developed and developing world would contribute significantly to peace and stability in the Mediterranean.

REFERENCES

1. UNIDO, "Special Report of the Executive Director to the Fourth General Conference of UNIDO", mimeo, Doc.No.ID/319, August 1984, pp.14-16.

2. *Ibid.*, P.25.

3. Article 122, UN Convention on the Law of the Sea, 1982.

4. Article 123, UN Convention on the Law of the Sea, 1982.

5. Article 276, UN Convention on the Law of the Sea, 1982.

6. Article 277, UN Convention on the Law of the Sea, 1982.

7. Lewis M. Alexander, "Regional Arrangements in Ocean Affairs", mimeo, Final Report under Contract N0014-75-C-1165, Fleet Analysis and Support Division, Office of Naval Research, Washington D.C., May 1977, pp.304-5.

8. Alexander, *op.cit.*, pp.302-4.

9. UNEP Doc. UNEP/WG.2/5, p.1.

10. UNLOS, "The International Venture", Doc.LOS/PCN/SCN.2/WP.14 and Add.1, March 1987.

11. Abdelkader K. Abbadi, "Security and Co-operation in the Mediterranean Basin", in Budislav Vukas, ed., *Essays on the New Law of the Sea*, Zagreb, 1985, p.455.

12. See for example UNIDO, "Types of necessary and desirable changes in institutions and structures in developing countries in order to accept the challenges of new technologies", by Vlastimir Matijic, Doc.No.ID/WG.401/2, July 1983, pp.10-11, 16-17, 19.

13. For some of these techniques see, United Nations, "Acquisition of Marine Surveying Technologies", Publication ST/ESA/178, New York, 1987.

14. See for example, Crow and Emmet, "Interorganisational Management of R&D", in Barry Bozeman, Michael Crow and Albert Link, eds., *Strategic Management of Industrial R&D*, Lexington Books, D.C. Heath & Co., Lexington, Mass., 1984.

Appendix I

Overview of ongoing programmes in the marine research institutions in the Mediterranean.

Methodology

The International Director of Marine Scientists, Third Edition, published by the UN, FAO and IOC in 1983 was used as a starting point for the survey of scientific institutions and scientists in the Mediterranean region. A questionnaire was sent to the concerned institutions and scientists for the purpose of updating the information contained in the Directory. On the basis of the replies received, visits to some institutions and discussions with scientists (list at Annex A), and the information contained in the publication Marine Environmental Centres: Mediterranean published by UNEP and FAO in 1985 the following country-wise overview has been prepared. It may be noted, however, that the overview is selective and does not purport to give a complete picture of activities in the countries covered. Basically significant elements concerning technology missions in the fields of exclusive economic zone surveys, aquaculture, desalination and pollution monitoring and control have been covered.

Algeria

The Institute of Oceanographic Sciences, which has 3 research vessels, 7 laboratories, 33 scientific personnel and 24 scientific technicians has been conducting research in marine biology and pollution. Some of the areas being covered by the Institute relate to the impact of chemical factors on productivity, sedimentology, aquaculture, microbiology, pollution etc. Co-ordinate activities are also being conducted in the Science and Technological University at Bab-ezzour.

The Institute also conducts studies in primary productivity of marine living resources and methods of estimating stocks; physical oceanography; benthic studies; and so on. There is ongoing co-operation with UNESCO/IOC, FAO, ICSEM and CNRS (France) in matters relating to scientific research. It also carries out work for UNEP under the Mediterranean Action Plan and the Long Term Pollution Monitoring and Research Programme.

CYPRUS

The Department of Fisheries and the Geological Survey Department of the Government of Cyprus carry out research in oceanography, fisheries management and development, aquaculture, crustaceans, ecological sciences, turtles, benthos, pollution etc. They have at their disposal three research vessels and within the framework of UNEP's Long Term Pollution Monitoring and Research Programme (MED POL) they carry out monitoring of halogenated carbons and metals in sea water and sediments as well as study of littoral, benthic and fish communities with the help of 12 scientific and 32 professional staff. There is ongoing co-operation with MAP/UNEP (MED POL) and FAO/UNDP (MEDRAP).

EGYPT.

Research is being conducted by the Institute of Oceanography and Fisheries and the University of Alexandria into the chemistry of coastal waters,primary productivity and phytoplankton biomass,hydrography and nutrient chemistry of the Nile delta,biological equilibrium of the south-eastern Mediterranean etc. Over 200 scientific personnel are involved in the Oceanographic Institute alone while the total staff component is over 800. The University of Alexandria Research Centre (UNARC) carries out industrial consultancy as well as research projects for national and international organisations besides training graduate students. It has departments of environmental studies, material science,information technology and bio-technology.

Alexandria also has a Maritime Transport Academy which besides training maritime personnel also provides research and consultancy services in all matters connected with the maritime industry. There is ongoing co-operation with MED POL,MEDRAP and ICSEM.

FRANCE.

France is the 'super power' of oceanic research in the Mediterranean. It has a large number of organisations involved in all aspects of marine science including,interalia,mariculture, aquaculture engineering,marine pollution,transfer of pollutants in biological chains,fishery technology,underwater techniques, marine corrosion,brackish water biology,deepwater equipment, technology and industrial development.

oceanic data management, instrumentation, teledetection, sedimentology, radioecology, toxicology, reef ecology, marine geology and geophysics, impact assessment, population dynamics and management.

France is also the moving spirit behind EUREKA being involved in over half the projects taken up. It is also involved in all the EUROMAR projects taken up so far. There is ongoing co-operation with ICSEM, MEDRAP, MED POL and ICG.

GREECE

The Institute of Oceanographic and Fisheries Research, with a research vessel and 33 scientific and 12 technical staff is engaged in research on oceanography, fishing technology, pollution, technology transfer, ecological sciences, aquaculture, halogenated hydrocarbons etc. The Universities of Athens and Thessalonika are engaged in co-ordinate research in the marine sciences while also carrying out graduate and post-graduate training programmes. There is also a large maritime fleet and matching infrastructure facilities in the form of shipyards, repair facilities, training of maritime personnel etc. There are co-operative programmes with marine research centres in France, Federal Republic of Germany and Yugoslavia. The organisations work within the framework of MED POL of UNEP, MEDRAP, ICSEM and ICG.

ISRAEL.

The Oceanographic and Limnological Research Ltd., has three main units, namely the National Institute of Oceanography, Haifa, the National Centre of Mariculture, Elat and the Limnological Laboratory, Tabgha with 3 research vessels, 47 scientific and 50 technical staff. Research and Monitoring is being carried on in physical, chemical, geological and biological oceanography, in limnology and in mariculture, in marine coastal processes, and metal pollution in coastal waters. It has cooperative programmes with a large number of universities and research institutions in the USA, France, FR of Germany etc. It has contacts with UNEP, ICSEM, CNEXO(France) while in its training programme it has graduate students working for Msc and Phd degrees.

There are a large number of other institutions engaged in co-ordinate research in bio-technology, food technology, fishery products, geology and geophysics, molecular biology and so on. Multi-disciplinary training for post graduates is available in many institutions.

ITALY.

Italy is another 'superpower' in marine research with a large number of institutions and universities engaged in research in aquaculture, pollution research including impacts on biological life, sedimentology, seawater dessalination, inverse osmosis desalination process including the appropriate marine technology, fouling of brackish lagoons, genetics and microbiology, oceanography, fishing technology etc. With a large number of research craft work is being carried out from Trieste, Venice, Bologna, Sicily, Pisa, Naples, Rome etc. Italian industries are also involved in the EUREKA programme and there are co-operative programmes under way with Yugoslavia, France, UNEP, FAO and IOC.

LEBANON

The Marine Research Centre at Jounieh is carrying out research in marine botany, fish parasitology, marine pollution, fisheries biology, marine geology, aquaculture and microbiology. The Research Centre has one research vessel and 10 scientific, and 9 technical, staff. Work in the University is being carried on in heavy metal pollution, trace metal analysis, marine environmental monitoring instrumentation and bottom sediment pollution. The Research Centre is co-operating with MED POL programme of UNEP.

LIBYA

The Marine Research Centre at Tripoli has 2 research craft, 15 scientific, and 5 technical, staff. Its main activities are in biological sciences, fishing technology, oceanography, pollution, ecological sciences, aquaculture and chemical oceanography. Co-ordinate work is also being done in the University of AL-FATEH in its marine biological research institute at Tajoura. The University's Marine Biology Research Centre has a scientific staff of 19 and 9 technical staff. It co-operates with MED POL, MEDRAP and ICSEM.

MALTA

The University of Malta, Department of Mathematics and Science, carries out research on effects of heavy metals and hydrocarbons on selected marine organisms and the environment. The Department has 15 scientific and 7 technical staff.

Malta also has one of the largest dockyards capable of building speciality craft like yachts, oceanographic vessels, fibre glass boats, ferrocencrete boats, computerised sailing boats etc. It has ongoing co-operation with IOC, FAO and UNEP.

MOROCCO

The Institute for Marine Fisheries at Casablanca has one research vessel and a staff complement of 90. It is engaged in research in oceanography, ecology, aquaculture, pollution, fishery technology. It monitors the impact of hydrocarbons on primary productivity and the marine biological ecosystem. Its speciality is development of aquaculture and the impact of pesticides, industrialisation and hydrocarbons on the marine environment.

Co-ordinate research is carried on in the Department of Sciences, Mohammed V University at Rabat in oceanography, sedimentology and chemical processes. The Veterinary Institute at Rabat has activities in the sphere of microbiology, aquaculture, management of resources, ecology, oceanography and pollution. There is co-operation with institutions in Spain, Norway and Japan as well as with IOC, FAO and UNEP.

SPAIN

The Spanish Institute of Oceanography through its research centres at Barcelona, Cadiz, Vigo, Malaga, Baleares and Murcia operates a large number of research vessels and staff to conduct research in aquaculture, chemical oceanography, marine biology, marine pollution, microbiology, electronics, phytoplankton, food technology, sedimentology, fisheries biology, marine physics, mariculture, hydrographic engineering etc. A number of other institutions and universities are engaged in co-ordinate research activities.

Spanish industries are involved in almost 20% of EUREKA projects while an expanded biotechnology plan (including aquaculture) accounts for nearly 10% of a greatly expanded science and technology programme. There is ongoing co-operation with UNEP, IOC and FAO.

SYRIA

The Marine Research Centre in Damascus has 26 scientific and 17 technical staff. It is engaged in research in aquaculture, microbiology, oceanography, ecological sciences, geology and sedimentology. The University of Damascus is engaged in co-ordinate research in fisheries, crustaceans, zoology, nematodes and sponges. There is ongoing collaboration with the Universities of Quebec (Canada) and Genova (Italy) as well as with UNEP, FAO and IOC.

TUNISIA

The National Scientific and Technology Institute in Oceanography and Fisheries at Sallambo with 2 research vessels and a staff of 45 scientific and technical personnel is engaged in research in aquaculture, chemistry, ecology, management of resources, oceanography, ecology, pollution and fishing technology. The Pasteur Institute has 18 scientists and 98 technicians. It also carries out training programmes. It co-operates with MEDRAP, MED POL, ICSEM.

TURKEY

The Institute of Marine Science and Technology, Dokuz Eylyl University with 3 research craft and a staff of 71 is engaged in fundamental and applied research, and post-graduate education in marine sciences and technology, including, inter alia, aquaculture, oceanography, fishing technology, pollution, sedimentology and offshore technology and engineering. The Institute of Marine Sciences, attached to the Middle East Technical University (with 3 research craft and a staff of 34), the Hydrobiology Research Centre of EGE University, the Ministry of Agriculture, Department of Fisheries, and departments of the University of Ankara are also carrying out research in aquaculture, pollution, fishery technology etc.

Turkey is also taking part in the EUREKA programme and is cooperating with the University of Hamburg, F.R. Germany, the Woods Hole Oceanographic Institute, USA, the Netherlands Institute of Sea Research, UNEP, FAO and IOC.

YUGOSLAVIA

The Institute of Oceanography and Fisheries, Split (2 research vessels and a staff of 73), the Biological Institute, Dubrovnik (3 research craft and a staff of 43), the Centre of Marine Research, Rovinj (2 research craft and a staff of 59), and the Marine Research and Training Centre, Piran (2 research craft and 17 staff) carry out research in most areas of oceanographic, fisheries and ecological sciences including aquaculture, pollution, molecular biology etc. In addition the Rudjer Boskovic Institute, Zagreb (*6 personnel) and the Institute Jozef Stefan, Ljubljana (400 persons) carry on research in materials science, bio-technology etc. There are co-operative arrangements of the Rudjer Boskovic Institute with several institutions in Italy, Poland and Czechoslovakia and with agencies participating in the governmental programmes between Yugoslavia and USA and the FR of Germany. Co-operation is also there with UNEP, FAO and IOC.

Annex A

List of persons and institutions with whom discussions took place.

Alexandria

Capt. Assad, Deputy Director General, Arab Maritime Transport Agency.

Dr. Raafat Sarkis, Arab Maritime Agency.

Dr. M.A. Fauzi, Marine Pollution Expert.

Dr. E.N. El-Sayed, Maritime Research & Consultation Centre(MR

Adm. Eng.(Rtd) Abd El-Kader Gadalla, Head of Technical Research, MRCC.

Eng. Mohamed F. Naserredin, MRCC.

Prof. M. El-Raey, Head, Department of Environmental Studies, University of Alexandria.

Capt. M. Nagik Sharif, Arab Petroleum Pipelines Co.

Mr. Mohammed Y. El-Shazly, Operations Services, Manager, Arab Petroleum Pipelines Co.

Athens

Dr. Alexandros V. Bouscleno̧as, Director National Centre for Marine Research.

Dr. Aldo Manue, UNEP

Capt. Dimitris C. Mitsados, Hellenic Marine Environment Protection Agency.

Belgrade

Mr. Fedja Starcevic, Counsellor Ministry of Foreign Affairs.

Mr. Miroslav Spasojevic, Chief of Section for Scientific and Technical Co-operation with Developing Countrie and International Organisations.

Prof. Borut Bohte, Chief Legal Adviser, Ministry of Foreign Affairs.

Dr. Ilija Jankovic, Assistant President, Federal Committee for Science and Technology.

Cairo

Dr. Elmahamadi Eid, Chairman Environmental Affairs Agency, Council of Ministers.

Prof. Mohd. Kassas, University of Cairo.

Prof. Abou-el-Fatouh, Deputy President, Academy of Scientific Research and Technology (former Head, Institute of Oceanography)

Dr. Sami E. Salim, Consultant to Cabinet of Ministers.

Ljubljana

Mr. Mitja Skercet, Sales Manager, Iskra Delta

Mr. Andrej Subelj, Senior Research Engineer, Kining Institute.

Dr. Skrk Mirjam, Asst. Prof. of Law, University of Ljubljana.

Dr. Ziga Vedusek, Executive Director, International Centre for Public Enterprises.

Dr. Rasto Macus, Senior Adviser, International Centre for Public Enterprises.

Madrid

Dr. Vicente Larraga, Secretary General of the Commission for Science and Technology.

Dr. Jaime Torroja, Managing Director, SENERMAR

Dr. Ramon Robles Zarzoza, Naval Engineer, SENERMAR.

Malta

Mr. Fenech Adami, Prime Minister

Prof. Salvino Busuttil, Director General, Foundation for International Studies.

Mr. P. Scicluna, Prime Minister's Office.

Mr. Antoine Riolo, Prime Minister's Office.

Mr. Saviour G. Grincat, Chairman Malta Ship Building Co.Ltd.

Mr. Grinco, Production Manager, Malta Dry Docks.

Mr. Mifsud, Head, Deptt. of Mechanical Engineering, Malta University.

Father Peter Inglott, Rector Malta University.

Mr. Ivan Fsadni, Ministry of Foreign Affairs.

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New York

Mr. Satya N. Nandan, Under Secretary, General and Special Representative of the Secretary General, U.N.

Mr. Pierre Levy, Deputy to the Special Representative of the Secretary General, UN.

Paris

Mr. Mario Ruivo, Secretary, Inter-governmental Oceanographic Commission.

Mr. Michel Gauthier, IFREMER

Mr. Francois Madelan, Chief Environmental Services, IFREMER

Mr. P.J. Hart, Chief Fishery Resources, IFREMER

Mr. Francis Murat, Director Sidem (Desalination firm).

Rome

Mr. H. Francis Henderson, Chief Aquaculture, FAO.

Mr. Mirko Notari, Foreign Relations Deptt., ENI.

Mrs. Giorgio Franchetto Pardo, Ministry of Foreign Affairs.

Vienna

Dr. Venkataraman, UNIDO

Mr. Antony Bromley, UNIDO

Mr. Nickolay Popov, UNIDO

Zagreb

Dr. Sergije Kveder, Director Institute Rudjer Boskovic.

Dr. Velimir Pravdic, Centre for Marine Research, Rudjer Boskovic Institute.

Prof. Pavlovich, Rudjer Boskovic Institute.

Dr. Budislav Vukas, Faculty of Law.

Mr. Stjepan Lisjak, Vice-President of the Managing Board, Industrija Nafte (INA).