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UNITED NATIONS ENVIRONMENT PROGRAMME

The State of the Marine and Coastal Environment in the Mediterranean Region

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Although this document was finalized at the beginning of 1996, some statistical information (e.g. Tables I, III & IV), obtained from various documents, covers the period from 1968 to 1990. For that reason, some data in this report are referred to as ex-Yugoslavia, unless data specific to any particular new country are available and used herein.

The body of this report was drafted by Ray C. Griffiths, based on the Mediterranean Action Plan and other technical documentation, with the cooperation of the staff of the MAP Coordinating Unit and of the MAP Regional Activity Centres; the boxes were prepared by the staff of the Coordinating Unit, the relevant RACs and two consultants, experts in their particular field. The whole text, including documents on the draft received fro the countries participating in the Mediterranean Action Plan, was technically and linguistically edited by Mr Griffiths.

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Contents

Executive Summary

The Contracting Parties to the Barcelona Convention require the Coordinating Unit for the Mediterranean Action Plan to provide periodic reviews of the state of the Mediterranean coastal and marine environment to assist them in determining the evolution of the Action Plan and possibly that of the Convention, its Protocols and the Common Measures already adopted.

The present document is the second review of this type, the previous one having been produced in 1989. It attempts to evaluate, as far as possible, trends in the state of the marine and coastal environment as a basis for dealing with new environmental problems, as and when they arise and are confirmed by scientific investigation.

The document has three main parts: (i) an introduction (section 1) giving the background, aims and objectives, and the geographical and ecological setting; (ii) the main body (sections 2 3 and 4) which outlines the major factors (human population pressure and economic activities, for example) involved in the generation of the main pollutants and the principal factors of environmental degradation; and (iii) an overall assessment of the situation and conclusions.

The Mediterranean, as a semi-enclosed sea, which occupies a major part of the basin area, presents a number of physical and geographical features that, in turn, determine which environmental factors play an important role in degrading the marine and coastal environment which makes up nearly the whole basin.

The presence of coastal mountains around most of the basin, hence the historical tendency for populations to settle around natural port areas relatively isolated from each other, has favoured maritime interchange, rapid fresh water/riverine run-off, hence strong soil erosion and sometimes heavy flooding in the few main river-basin plains (notably, the Ebro, the Rhone, the Po and the Nile), though depriving the basin, as a whole, of the possibility to stock large amounts of fresh water.

The generally pleasant climate (except possibly in mid-summer), in addition to the comparative isolation of coastal communities in the past, has helped to foster some of the world's greatest civilizations. Thus, the climate, the often spectacular landscape and sites of great historical, architectural and archæological interest have made the Mediterranean the objective of the world's most intensive tourism, and the coastal zone the objective of a large majority of the resident population (now around 130 million).

Although the growth in the human population, both resident and seasonal (international tourists), is continuing, the rate of growth overall is expected to decrease gradually into the next millennium, to a level of ~0.2% on the developed northern side, of ~1.5% in the Arabic countries and Turkey, and of ~1.2% in the remainder, by the year 2010. However, the relief that this decrease in pressure might be expected to bring to the environment cannot be relied upon to avert serious environmental problems in the region.

Of the economic and related activities that have the greatest impact now, and for the foreseeable future, the following are the most important:

- *Urbanization, which is intensive around the major port-cities and extensive along most of the coast, especially on the northern side of the basin, is a response to the high demand for residential and recreational facilities. Some 70% of the coastal strip between Barcelona and Naples is occupied, and parts of the Greek and Turkish coasts are following suit. This occupation is reducing the ecological space necessary to the survival of flora and fauna, hence to the maintenance of biological diversity. It is also taking land from agriculture. Urbanization is, after industry, the main cause and site of atmospheric pollution due to the increased number of motor vehicles; this number continues to grow steadily in the developed countries on the northern side and rapidly elsewhere in the basin. Air pollution, in particular though not exclusively, is damaging historic sites or architecturally valuable buildings. Vibration due to air and land traffic is another important factor due to urbanization. Intensive urbanization is also altering the drainage and sedimentation patterns in the coastal area with, sometimes, significant effects on fishery resources. Urbanization is increasing the demand for domestic drinking and washing water from a relatively precarious resource.*

  The treatment and disposal of urban solid and liquid wastes continues to constitute one of the major environmental factors, especially in the summer months when the population of many sea-side resort towns is increased several times relative to the stable resident population.

- *Industry, which generally becomes established around the main port-city conurbations or, for those industries requiring abundant cooling water and a relatively easy way to dispose of wastes, on the coastline or along the major rivers. Although the basin is not a major industrial area, the growth in industrial activity, especially on the southern and eastern sides is considerable and will continue for the foreseeable future. Nevertheless, Italy, France and Spain still account for some 87% of industrial production in the Mediterranean basin. From the environmental standpoint, the environmentally sound disposal of industrial solid and liquid wastes is one of the major factors in the consumption of land and coastal seas. Industry is also a major contributor to air pollution and is also having a significant adverse effect on the flora and fauna of the basin. Very often, these environmental risks are exacerbated by poor placement of industrial installations.*

The draft Protocol on the Prevention of Pollution of the Mediterranean Sea Resulting from the Transboundary Movements of Hazardous Wastes and their Disposal specifies 21 categories of hazardous substances, 27 elements or compounds that may render wastes hazardous, and 14 characteristics that could render any substance or material physically hazardous.

- *Energy generation and consumption, as a natural consequence of increased population and increased industrial activity, contributes mainly to atmospheric pollution in the region, through the burning of fossil fuel for vehicles and domestic heating, and to the degradation of aquatic ecosystems through the discharge of heated cooling water. The developed countries on the northern side produce only 38% of the energy they consume (of which, France and Italy alone occupy 70%), whereas the other countries in the basin produce over 1.8 times the amount of energy they use. The main energy sources are oil, nuclear power (in France, mainly), coal, natural gas and hydroelectric power. Significant quantities of lignite (brown coal) are burned in the eastern Mediterranean, notably Greece and Turkey. For environmental reasons, there is a tendency to reduce the use of coal, oil and lignite in favour of "cleaner" fuels, as natural gas. Nuclear power is, to a certain extent, used in the Mediterranean. Some effort is also going into the development of alternative sources, as solar radiation, wind and geothermal power, as well as biomass energy (where sufficient amounts of crop wastes, for example, exist). Energy production and consumption account for 90% of all sulphur* *oxides and lead released into the atmosphere, and a major proportion of nitrogen oxides, carbon oxides and volatile organic compounds. Energy-generating plants and hydroelectric generators, in particular, have a strong impact on the ecosystems in their vicinity. The exploitation of petroleum degrades the environment in its vicinity during the drilling stage and during maritime shipment insofar as oil tankers discharge dirty ballast water or clean their tanks in the Mediterranean. The increasing amount of refinement in the countries of origin, while not necessarily increasing the overall risk, spreads that risk over a greater number of sites (the refineries) and, likewise, multiplies the potential sources of environmental pollution (notably air pollution).*

- *Transportation systems, like energy generation and consumption, also as a response to increased population growth and demands, including those of tourism, are growing steadily, using up land and generating atmospheric pollutants and noise. These factors also have a significant adverse impact on historical buildings. The long-standing need to increase communication between the numerous coastal valleys has led to a considerable amount of tunnelling to create motorways running parallel to the coast and from the coast to the hinterland, to move people and goods. Major road-building has probably reached a peak in the northern countries of the basin, but will continue to grow elsewhere. The motor vehicle stock will, however, continue to grow - by about 12% (up to the year 2025) in the industrialized northern countries, by some 200% in the Arabic countries of the region, and by about 80% elsewhere. Roads use up valuable agricultural and horticultural land; an increase of 25% in land used for roads can be expected up to 2025. There is relatively little scope for the development of the railways in the basin. The Suez Canal and the Istanbul Strait also continue to ensure a high level of maritime shipping, with an increasing risk of accidents involving hazardous substances. There are some 2000 active ferry lines, 1500 cargo vessels and 2000 commercial vessels operating in the Mediterranean, but about 200,000 vessels transit the Mediterranean each year. The region has 305 ports of all sizes and purposes. The association of ports with urbanization is notable. The increasing industrialization and petroleum refining in the region will increase the amounts of hazardous substances transported by ships. However, oil, natural gas and petroleum products still account for the vast majority of the hazardous substances transported by ships, and for the risks due to shipping accidents, in the region. Air transport will grow along with growth in tourism, mainly, but also as a means of shipping produce of limited shelf life. This growth will ensure continuing air and noise pollution from this source, as well as their diffusion as the major nodal airports are increasingly by-passed in favour of more local airports closer to tourist and commercial destinations. The numbers of motor vehicles, ships and aircraft operating in the basin is growing, and faster even than the population.*

- *Tourism and recreation, although offering significant economic benefits to the "tourist-importing" countries (that is, most of the Mediterranean region), also creates significant social and environmental costs. The annual number of international tourists is expected to be about 200 million by the year 2000. In the summer peak period, many coastal resort towns must handle a population several times (3-5 or more) the normal. In spite of marked improvements, the task of handling the solid and liquid wastes in summer is overwhelming; sometimes, municipalities resort to removal of these wastes to places of much lower "visibility" (e.g., dumps away from tourist centres) without treatment, thus leaving the waste-management problem unresolved. Nevertheless, sewage-treatment capacity has generally increased in the region and bathing-beach quality has generally improved, although some beaches are still too strongly marked by litter left by users or by that dumped on the beach by the sea itself (jetsam).*

- *Agriculture, although occupying about 60% of available resources in terms of fertile land and water, contributes only about 20% of the GDP in the region and is aimed mainly at feeding the resident and tourist populations. Its growth is falling behind that of industry and of the economy in general. Agriculture is also losing, in terms of land space, to the above-mentioned factors, but the demand for agricultural products, mainly to meet the basin's needs, is also growing. The principal response is to intensify agricultural production, which places increasing demands on water resources for irrigation and on industry for pesticides, herbicides and fertilizers. The move to intensive horticultural production is continuing and is likely to grow, especially to meet the very high seasonal demand of the tourist population. Given the mountainous terrain in much of the region's coastal area, hillside stock-raising (sheep, goats) is an important element of the coastal agriculture, while pulses (e.g., peas, beans, lentils, chick peas), grains, sugar beet, tomatoes and fruits are grown in the major alluvial plains (notably, the Ebro, Rhone, Po and Nile) along with pig and/or cattle raising; on the relatively arid coastal slopes, olives, almonds, pistachios and grapes are predominant. However, husbandry of the coastal slopes has declined steadily with the increasing urbanization and road-building, thus increasing soil erosion, which, in many countries of the region, exceeds 50% of the erodible soil. More efficient and better adapted farming is considered necessary and feasible. At the same time, agriculture, intensive or otherwise, has led to a loss of specialized flora (garrigue, grassland, forests) that limit soil erosion. The demand for meat, and sometimes the shortage of suitable land, lead to overgrazing and destruction or degradation of significant areas of open land and of forests. The washing out of pollutants (pesticides and herbicides) and excess fertilizers to the sea, directly by land run-off or indirectly via rivers, creates a significant negative impact on coastal marine ecosystems. In the case of fertilizers (based mainly on nitrogen and phosphorus compounds), serious disturbance of the marine ecosystem, in the form of eutrophication, occurs in inshore coastal waters. Agriculture also strongly affects the endemic flora and fauna, not least by encouraging soil erosion as a result of inadequately adapted agricultural techniques.*

- *Fisheries are as much or more adversely affected by over-fishing as by environmental pollutants. The addition of the two factors together create a serious danger to fishery resources in the basin, particularly since the main habitat of the resources is the coastal/inshore sea and the continental shelf, which is relatively narrow in most areas because of the strongly sloping mountainous coastal terrain. The growth of mariculture (now supplying about 10% of the region's fish production) is a response to the demand for fish and the decreasing prospects for the capture fisheries (now remaining at about 1.1 million tons per year). Mariculture is a victim of environmental degradation (e.g., siltation) and pollution, wherever toxic wastes are discharged into coastal bays and lagoons. It is also a cause of such degradation in its vicinity insofar as the cleaning out or flushing of mariculture sites releases excess food material and, in some cases, chemicals (e.g., fungicides) used in mariculture.*

- *Forests in the region have traditionally provided or still provide the raw materials for shipbuilding, scaffolding, domestic fuel, industrial fuel (glass-making, metallurgy), paper-pulp, furniture, charcoal, buildings, handicrafts and tanning chemicals, and they are a source of cork, seeds and resins. They counteract soil erosion and, increasingly, offer sites for recreation and tourism (camping, hiking, birdwatching etc.). In many areas, forests support animal grazing. Forests are, however, subject to an increasing number of forest fires (an increase of about 250% over the 1970-75 numbers). Reforestation does not appear to be keeping up with the loss of forests from exploitation and fires. As forests are an important factor in soil conservation, their destruction or loss adds to this major environmental factor. Forest management in the Mediterranean basin is widely considered to be inadequate.*

- *Mining in the region is carried out mainly for oil and natural gas and for minerals (bauxite, chromite, boron, cement, phosphoriferous rocks, uranium, black coal and brown coal/*

lignite, for example). It is the cause of extensive eyesores due to the area of land surface destroyed, in open-cast mining for limestone, bentonite, lignite and asbestos, and to that occupied for the disposal of mine tailings and slurries; slurries and waste water are also discharged directly into the sea or into rivers discharging into the sea, usually ensuring the destruction of the local ecosystem. The negative effect of sea-bed mining for sand and gravel for building materials is relatively short-lived (a few weeks) once the dredging ceases; the heavy siltation in some areas helps to restore the sea bed and to re-establish benthic communities.

Most of the above-mentioned economic activities are greatly influenced by, and in turn influence, water-resource management, in a region naturally unable to store large quantities of fresh water because of its high ratio of sea volume to drainage basin volume. The main inputs (rain and snow melt, accounting for over 1000km^3) are mainly confined to the northern side, and, in general, the evaporation and evapotranspiration are high, accounting for about the same quantity in water loss. The terrain ensures rapid run-off to the sea. Only six river basins discharge more than 10km^3 per year to the sea; the Nile has the biggest potential discharge at the level of the Aswan dam (~89km^3) but only discharges about 5km^3 into the Mediterranean, as a result of water withdrawals for irrigation, domestic use and fish farming. Many of the precipitous water courses and the karstic water-bearing rocks are difficult to manage and exploit because of the great range between peak and minimum loadings throughout the year. Water quality, though generally high in the region, suffers from high turbidity at times and hardness (due to the predominantly calcareous rock formations). Over-exploitation of some coastal aquifers has led to increased salination, which tends to occur on the southern side of the region as well as being a result of high evaporation and low rainfall.

Regarding the state of the coastal environment, the main determining factors are: (i) the relationship between the input of wastes and the flushing rate of the coastal seas and of the Mediterranean as a whole; (ii) the stratification, by water density, of the sea, which impedes downward flux of pollutants; (iii) the size of the human population, the land use and waste-generating activities. The flushing rate of the Mediterranean is comparatively slow overall, from about 80 years up to possibly 300 years (for the two major basins), and there is appreciable stratification at depth in the sea, though not at the surface (upper 100m, say). The human population of the Mediterranean countries is almost 400 million, of which about 130 million (35%) live in the coastal area; this percentage will increase considerably by the year 2025. It is difficult to measure the state of the urban environment, because such factors as air pollution, the amount of domestic waste or the area dedicated to urban green spaces vary appreciably from place to place and time to time. The dumping of industrial and urban wastes is an important use of the sea in the region and occurs mainly through direct discharge or via rivers or the atmosphere. Over 90% of the basin's population are served by waste-water collection systems (mainly municipal), while 46% have no primary municipal sewage treatment; 41% have secondary treatment facilities, the remainder having just preliminary or primary treatment. About 5% of the waste-water is re-used, of which about 95% is used for irrigation. It is not known what happens to most of the solid urban wastes; about a third of municipal sludge is discharged to rivers, land or sea; 10% is used for agricultural purposes. About 21% of solid wastes are disposed of by composting and 7% by incineration.

Chemically hazardous wastes are mainly of industrial origin, whereas microbiologically hazardous wastes are mainly of domestic origin, with detergents and lubricating oils being common to both sources. The environmental or health hazard depends greatly on the nature of the substance involved, the methods of handling and treatment and the quality of their application.

Soil degradation, desertification and forest fires are related factors in the coastal area environmental quality; desertification is the result of the other two processes (which includes commercial deforestation, in practice) and is a significant factor in the region. The increased sediment loading of rivers (and directly of coastal seas) adversely affects diadromous fishes, and shellfish, in the wild and under mariculture.

There are three aspects of air pollution in the region: the pollution of the air itself, with potentially serious consequences for human health, weather and climate; the atmosphere as a vehicle for pollutants from source to sea; and the role of sea itself as a source of atmospheric pollutants. A number of regional projects and the WMO Global Atmospheric Watch have attempted to determine levels of key pollutants in the air and their fluxes to the sea. The atmospheric pollutant load is very variable and the inputs to the sea are subject to several processes (as adsorption onto dust and soot particles, wet or dry deposition of particles or ærosols). The main pollutants transferred by the air to the sea are certain heavy metals (notably, lead, mercury, zinc, manganese, cadmium and copper), most organochlorines (as lindane, PCBs, DDT/DDE/DDD, in particular) and polycyclic aromatic hydrocarbons. Nitrogen and sulphur oxides also have a predominantly atmospheric pathway to the sea, mainly resulting from energy production and consumption and providing components for acid rain which attacks buildings and vegetation. The nitrogen input has a significant positive impact on the primary productivity of the sea. The sea itself can be a source of dimethyl sulphide, carbonyl sulphide, methane and nitrous oxide in the atmosphere, but little is known about them yet. The atmosphere is also the main pathway to the sea for carbon soot (from industry, domestic heating and motor vehicles) and for Saharan dust, both of which play a very important role in pollutant transfer from air to sea and from the sea to bottom sediments. Air pollution is a serious problem in the region, especially over the major conurbations. In some cases, the local meteorology is not favourable to the dispersion of this pollution, which arises from motor-vehicle exhausts, domestic heating systems, most industrial processes (especially metal smelting and refining) aided and abetted by carbon soot, Saharan dust and other solid particles in the atmosphere which provide a vehicle for many pollutants: metals, many organohalogens and hydrocarbons, in particular. Pollutants from sources well within Europe are known to reach the Mediterranean within 24-48 hours.

The sources of all the main marine pollutants, and their levels, in terms of the minimum and maximum values observed overall, in sea water, in biota and in marine sediments are, as far as reliable data are available, given in section 3 together with the main effects, as far as they have been observed, on the marine biota, on species of commercial interest and on human beings exposed to them through contact or through consumption of contaminated food. The data indicate that pollutant levels reported herein have not changed significantly for better or for worse since the previous assessment.

Under the Coordinated Mediterranean Pollution Monitoring and Research Programme (MED POL), eighteen countries in the region are measuring pollutant levels at hundreds of sampling stations. The main pollutants of concern are heavy metals, organochlorine pesticides, herbicides, organophosphorus compounds, hydrocarbons and pathogenic micro-organisms. The levels vary considerably from place to place, time to time and species to species (even within one taxonomic group). The main reasons for this are: inherent natural variations and variations due to quality assurance problems; the strong role of natural mobilization of certain elements; proximity of some sampling sites to point sources of given pollutants; changes in the physico-chemical forms in which some pollutants, especially metals, occur in the environment; and the adsorption of certain pollutants onto dust and soot particles or their chelation by organic molecules. In general, levels in sea water decrease with distance from the coast, and they are, also in general, greater in sediments and organisms than in sea water.

The occupation of the land and the pollution of the sea affect the distribution, abundance and survival of the related flora and fauna, and of the ecosystems into which they are organized; the human population nevertheless depends directly or indirectly on the survival and success of many of these species and ecosystems. In certain areas, this occupation of the land interferes seriously *with the seasonal migration of birds, and tourist pressure may also compromise the breeding of marine turtles and the monk seal.*

In the Mediterranean context, the main risks to human health arise from: consumption of sea food contaminated by heavy metals (e.g., mercury in tunas and related species, lead in mussels), in which the amount consumed and toxicity are important factors; consumption of sea food contaminated by certain bacteria (e.g., Salmonella, Shigella), virus (e.g., hepatitis A), fungi (e.g., Mucor) and phytoplankton toxins (e.g., from dinoflagellates, usually related to a 'red tide' condition); intake of pathogenic organisms (e.g., fæcal streptococci and coliform bacteria) from infected sea water and beach sand.

The main risks to marine community structure and to the reproduction and growth of marine organisms are due to chemical contaminants but also to sewage and other effluents which disturb the ecological balance.

Overfishing places a very dangerous stress on commercial fish stocks. In addition, the presence of contaminants and their bioaccumulation by marine organisms may also pose risks.

Marine and beach litter is an important factor in the sustainable growth of tourism in the region.

The discharge of nitrogen and phosphorus, mainly in the form of excess fertilizers, into the coastal sea produces eutrophication resulting in massive local phytoplankton blooms which kill fish or contaminate them with toxins that can adversely affect human health. The "red tides" are now frequent in certain parts of the region and may also adversely affect seaside resorts. However, if the phosphorus and nitrogen are fairly rapidly dispersed, the productivity offshore may be substantially enhanced.

Section 3.6 briefly describes the implications of climate change for the region; many of these changes spring from the air pollution, in the form of the "greenhouse" gases responsible for global warming: carbon dioxide, nitrous oxide, methane, for example, as well as water vapour.

The most likely consequences of global warming will be changes in: the wind field, particularly at the land-sea interface; air-sea interaction (exchange of energy, gases, water vapour and salt); the volume of the ocean, hence the mean sea level; the ocean's density distribution, hence its circulation patterns. These changes will, in turn, induce changes in ecosystems (e.g., vegetation patterns, soil state, animal distributions). Climate change may also contribute to the vulnerability of coastal communities and will be a factor in achieving sustainable development.

In view of the growing environmental pollution and parallel deterioration of biological diversity and its components, efforts have increased to establish protected areas and to preserve endangered and threatened species of wild flora and fauna. Some of these protected areas which are of biological, ecological, scientific, aesthetic, or educational interest are not fully welcomed by local populations due to a number of factors. These areas, in some cases are adversely affected by a series of activities, planned for the development of the area concerned. There are now 123 Specially Protected Areas designated under the SPA Protocol, but only 47 have a marine components. This number still fails to encompass at least one example of each of the main types of ecosystem in the region. The biotopes particularly subject to degradation, hence in need of protection, are: sand dunes (damaged by excessive numbers of sea bathers, coastal erosion and other causes); coastal lagoons, salt marshes and wetlands, which are vital to many species, especially birds, and are subject to infilling for construction, to drainage to create agricultural land, and sometimes simply to waste discharge; and the littoral zone (including turtle nesting beaches and Posidonia meadows which are subject to direct discharge of wastes via outfalls and to tourism/recreation). One hundred sites of historic, architectural or cultural interest have been identified as being in need of protection (from tourists, traffic, air pollution etc.) or rehabilitation to enhance their value to tourism and cultural heritage and to ensure their survival in the context of urban and coastal development.

The legal and institutional framework in which protected areas operate remains inadequate or very complex, with considerable overlap of responsibilities between national and *local entities, governmental or non-governmental.*

This situation is now less true for environmental management and coastal area development as a whole, since all the countries of the region have established some form of specific governmental structure with responsibility for such management and control. There is still, in most cases, too great a dispersion of responsibility, but the situation has evolved considerably in the last few years. Based on available information, Albania, Algeria, Croatia, Cyprus, Egypt, France, Greece, Israel, Italy, Lebanon, Libya, Malta, Morocco, Slovenia, Spain, Syria, Tunisia and Turkey have established specific governmental mechanisms to deal with the national environment. Many of the countries, though far from all, have ratified the major international conventions on environmental and wildlife protection.

The Barcelona Convention, its four Protocols and thirteen Common Measures provide the principal guidelines for, and the basis of national policy; also, the Mediterranean Action Plan is guided by these dispositions.

The regional mechanisms established under the Action Plan - the six Regional Activity Centres, the Mediterranean Pollution Monitoring and Research Programme (MED POL), and the Secretariat for the Protection of Coastal Historic Sites - with the continued support of the concerned UN agencies (FAO, UNESCO, WHO, WMO, IMO, IAEA, IOC, IBRD/WB), and with the collaboration of numerous non-governmental organizations, are meeting some of the requirements for establishing a basis for sustainable development in the region. The main approach to this objective, under MAP, is the Coastal Area Management Programmes, of which five were completed (Bay of Izmir, Kastela Bay, the Syrian coast, the Albanian coast and the Island of Rhodes), two are in progress (Fuka-Matruh and Sfax), and five are being initiated (Algerian coast, Israeli coast, Lebanese coast, Island of Malta and the Moroccan coast). The Action Plan for the Protection of the Marine Environment and the Sustainable Development of the Coastal Areas of the Mediterranean (MAP Phase II), which was approved by the Contracting Parties in June 1995, provides the necessary guidelines for the sustainable development in the Mediterranean coastal region.

There are strong indications that the general public, and particularly the tourist population (national and international), is becoming increasingly aware of the main environmental issues in the region.

1. Introduction

1.1 Background

The Coordinating Unit for the Mediterranean Action Plan is required to provide the Contracting Parties to the Barcelona Convention with a periodic review of the state of the marine and coastal environment in the Mediterranean Sea. A previous report on this subject was issued in 1990. These reviews contribute to the information base on which the Contracting Parties determine the evolution of the Action Plan and, possibly, that of the Barcelona Convention, its Protocols and the associated Common Measures. This evolution is currently embodied in the Barcelona Resolution, adopted at the Conference of Plenipotentiaries for the Protection of the Mediterranean Sea against Pollution and its Protocols, in Barcelona 9-10 June 1995, and expressed in Phase II of the Action Plan and in the Priority Fields of Activities for the Environment and Development in the Mediterranean Basin, 1996-2005, adopted as Appendixes to this Resolution.

The previous (Jeftic *et al.*, 1990) and the present document on the state of the Mediterranean environment are based primarily on information and/or data submitted to the Coordinating Unit by: (i) the Contracting Parties and their specialized environmental and marine scientific institutions; this information is itself basically that obtained in the context of MAP projects undertaken by the aforementioned institutions; (ii) the MAP Regional Activity Centres, through their regular activities, which are approved by the Contracting Parties; and (iii) UN agencies cooperating with UNEP. This document is based on information collected up to March 1995. In a few cases only, it contains information obtained after this date.

To assist the Action Plan Coordinating Unit in the preparation of the present report and for other relevant purposes, the countries were invited to submit national reports on their activities relating to the Plan. Israel, Malta, Monaco and Slovenia submitted responses based on the proposed structure of the document, while Albania, Croatia, Egypt, France, Greece, Italy, Lebanon, Morocco, Spain, Syria, Tunisia and Turkey submitted national documents with a relevant but wider purpose.

1.2 Aims and Objectives

The principal aim of a periodic review is to allow the Contracting Parties to evaluate, as far as possible, trends in the state of the marine and coastal environment, in general, to enable them to deal with new environmental problems, as and when they arise and are confirmed by the results of scientific investigation, monitoring and environmental impact assessment.

To determine the existence of trends and to identify new environmental problems at an early stage of their emergence requires the establishment of an effective and reliable environmental monitoring system, which is thus another important aim of the Mediterranean Action Plan. The objective of such a monitoring system is not only to determine levels of pollutants, but also to provide a basis for determining their effects. An additional aim is therefore to promote the necessary research to this end.

However, what can be measured and where and when it can be measured (given the wide range of operational and analytical capabilities - normal in so large a region as the Mediterranean) makes it extremely difficult to monitor over a long period and a large area the numerous key pollutants in all the main environmental compartments (air, coastal land and rivers, sea water, sea bed, marine and littoral organisms). Moreover, the measurement or assessment of the effects, good as well as bad, of individual pollutants is still very much experimental, at best, and anthropocentric, at worst. And, finally, marine scientists are much less interested, if at all, in routine monitoring than in what might loosely be called marine environmental chemistry.

A subsidiary but still important aim of the Action Plan is to promote the establishment of mechanisms to ensure routine but reliable monitoring on a sound scientific basis.

It has not been possible in the present review to explore more than very superficially the scientific literature, except insofar as the available MAP documentation itself comprises specific reviews in particular areas or subjects.

At the same time, it is not simply an update of the report by Jeftic *et al.* (1990), partly because its structure is somewhat different. It attempts to summarize the main economic activities in the region, emphasizing those that are sources of the main pollutants and that therefore have a significant, and generally adverse, impact on the marine and coastal environment and the associated resources. It then indicates the levels of key pollutants or contaminants in the main environmental media (water, sediments, biota and air) and their main effects on the resources and on human beings.

In the last few years, a positive contribution to the observation and study of the environmental conditions and changes in the Mediterranean basin has been made by the application of advanced technologies that have proved highly effective in providing reliable and up-to-date information on many environmental issues. In this connection, the Geographic Information System (GIS) as well as the airborne and spaceborne remote sensing techniques and methods are expected to be more widely used in the years to come and to be increasingly helpful in achieving a better understanding and monitoring of the Mediterranean environment and its balance.

A particular effort has been made to relate human population pressure and economic activity to (i) the environment in which they are developing (and must continue to develop, in a sustainable way, if the region is to be saved from deep and long-lasting degradation); and (ii) the effects of the pollution that such activities generate. These effects are on the human population itself and on the animals and plants and the ecosystems into which they are organized for their survival, on which the human population so intimately depends for its own survival.

The general policy, legislative and institutional context is covered to show the framework in which the Mediterranean Action Plan operates; then the main conclusions and overall assessment of the state of the Mediterranean marine and coastal environment are exposed.

The immense complexity of the Mediterranean basin makes it virtually impossible to provide a simple, straightforward description of the state of the marine and coastal environment. An attempt has therefore been made to avoid providing a huge mass of diverse data, but rather to present an overall picture of the problems, even if most of these are familiar to all those involved in Mediterranean affairs. Some, however, are not so well known, and a few potential problems are also suggested. In any case, the danger of not dealing with such problems on the grounds that they are too complex or too variable from sub-region to sub-region, if not from place to place, must be avoided.

The basin as a whole was last "coordinated" under the Roman Empire, to serve the interests of that Empire. The Mediterranean Action Plan is a present attempt to engage a modern era of regional coordination, fundamentally in the interests of the whole human race.

1.3 Geographic and Ecological Setting

The geographical and ecological setting of the Mediterranean Sea has been suitably described in the Blue Plan (Grenon and Batisse, 1989) and by Jeftic *et al.* (1990), drawing on an abundant literature on these subjects. It is therefore only necessary to recall here some basic information, particularly that which is helpful in explaining the state of the Mediterranean coastal and marine environment as it is today and as it is evolving under the impact of human activity in this environment and in its immediate hinterland.

The Mediterranean Sea covers an area of some 2.5 million km^2, with an average depth of 1.5km and a volume of 3.7 million km^3. It is some 3800km wide, from west to east, and has a maximum N-S distance of 900km between France and Algeria. It comprises two main basins, the Western and the Eastern, connected principally by the Strait of Sicily, which is 150km wide and about 400m deep, at most. The Western Basin, covering an area of some 0.85 million km^2 at the sea surface, has a secondary basin: the Tyrrhenian Sea. The Eastern Basin covers an area of some 1.65 million km^2 (Fig. 1).

The Mediterranean is connected to the Atlantic Ocean by the Strait of Gibraltar, which has a sill 15km wide at maximum depth of 290m, and to the Sea of Marmara (and thus the Black Sea) by the Dardanelles Strait (Canakkale Bogazi), which has a width between 1.3km and 7km and an average depth of 55m. And, since the late-19th century, it has been connected to the Red Sea by the Suez Canal (120m wide and 12m deep).

The Mediterranean Sea is essentially a relic of the once great Tethys Sea that largely separated the Eurasian tectonic plate (continent), to the north, from the African plate (continent), to the south and west (originally, some 200 million years ago). The eastward, then northward, movement of the African plate allowed the Tethys Sea to link what are now the North Atlantic Ocean and the Indian Ocean (Mascle and Rehault, 1991).

With the further northward movement of the African plate towards the Eurasian plate, the embryonic Mediterranean Sea became separated completely from the Indian Ocean, probably some 50 million years ago, the "seal" being the present Levantine region. Such separation led inevitably to the virtually independent evolution, in the Mediterranean Sea and the Indian Ocean, of the species that once occupied the Tethys Sea.

At the western end of the Mediterranean, however, there has nearly always been a connection between the Mediterranean Sea and the North Atlantic Ocean, via the Strait of Gibraltar, except for a geologically short period some 5-6 million years ago that seems to have allowed the evolution of endemic Mediterranean species. The reopening of the connection has allowed some species, especially the naturally migratory ones to become common to the Mediterranean and the eastern Atlantic.

The impact of the African crustal plate against the Eurasian plate has raised mountain ranges all along the northern side: the Sierra Nevada (Spain); the Pyrenees (Spain-France); the Alps (France-Switzerland-Austria-Italy-Slovenia); the Apennines (Italy); the Dinaric Alps (ex-Yugoslavia); and the Taurus (Turkey). It has also led to the formation of the Atlas mountains in northwestern Africa, but, between Tunisia and the Near East, there is a vast mountainless desert. The main results of this tectonic activity (the subduction of the African plate under the Eurasian plate), which is of considerable relevance to the present-day marine and coastal environment, are: (i) the creation of a virtually enclosed sea; (ii) the high ratio of the area of the Mediterranean Sea to that of its drainage basin; (iii) marine basins of considerable maximum depth (>4000m); (iv) a great number of large and small islands; (v) the high level of volcanic and seismic activity; (vi) a much damped tidal regime; and (vii) a specific wind regime.

Factor (i) - enclosed sea - means a slow replacement of the sea water from the Atlantic and, to a much lesser extent, from the Black Sea, hence the means for the Mediterranean region to leave a very strong "imprint" (as very high salinity, due to high evaporation) on its sea water, which can be traced at depth (about 500m) throughout the central Atlantic Ocean

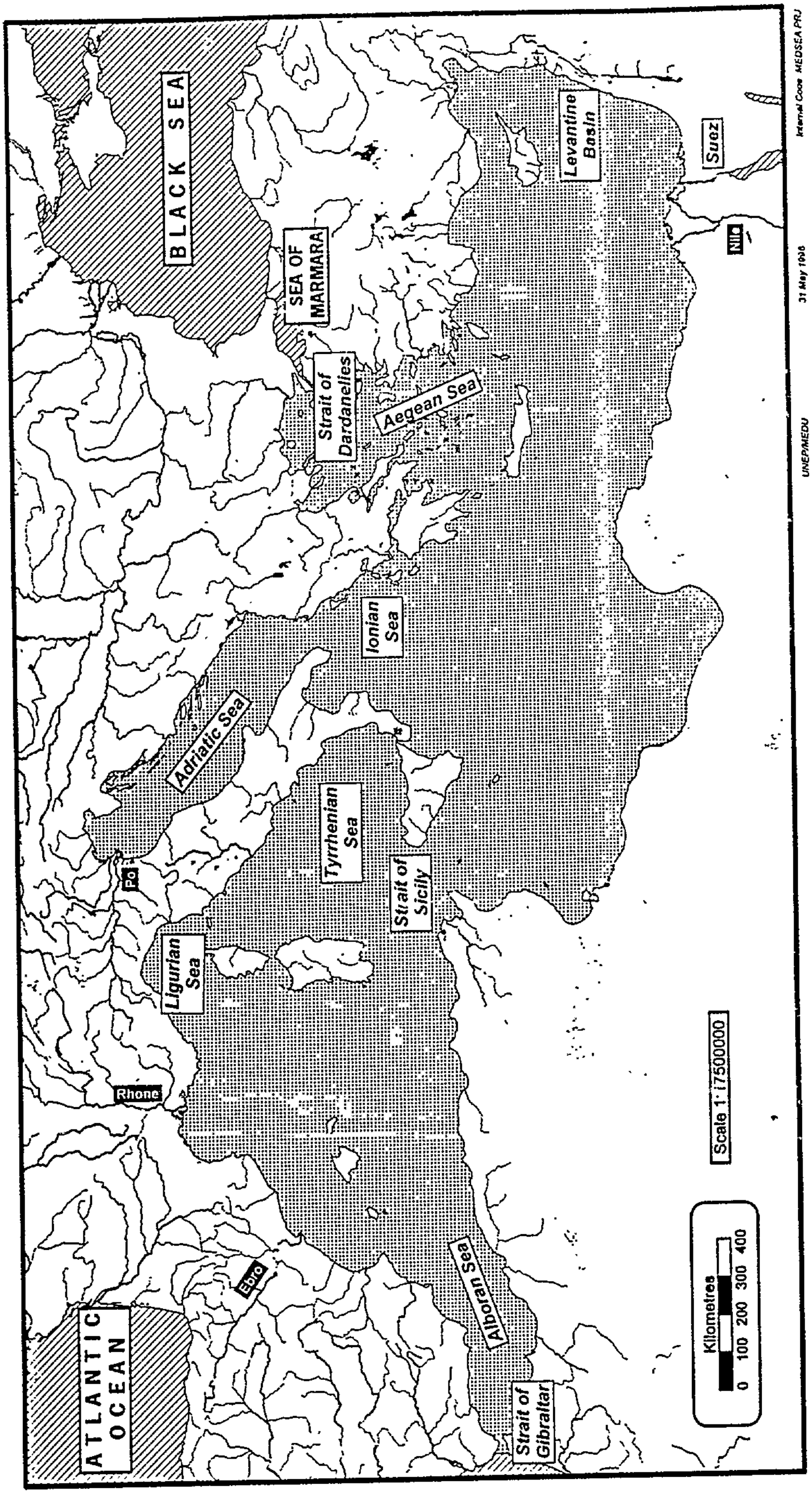

Fig. 1 The Mediterranean Sea

after having exited over the Gibraltar sill below the incoming Atlantic surface water.

Factor (ii) - small drainage basin - means that coastal mountains slope steeply into the sea, creating: a generally limited natural fresh water supply; a very narrow littoral zone (enhanced also by factor (vi)); a narrow continental shelf which leads to low volume of shelf sea water, hence a limited amount of marine resources, living and non-living, within easy reach of the human populations on land; and, until relatively recently, a certain isolation of coastal populations around ports themselves isolated by the same mountains. This isolation has disappeared, superficially at least, as a result of modern transport and communication systems, tourism etc., but remains ingrained in the culture of coastal populations which have traditionally shown considerable independence, hence resistance to coordination on a regional basis, but also a disposition to regional trade.

Factor (iii) - great basin depth - is essentially an obstacle to nature in the renewal of the sea water in these basin depths, and to Man in the exploitation of the resources thereof, as well as being an encouragement to their use as a place to dump, in one way or another, human waste (especially litter and garbage); a process of degradation of the deep water, comparable to, but potentially far more disastrous than, that of the Black Sea is probably under way and progressing.

Factor (iv) - many islands, large or small, resulting from the complex geology of the basin, characterize the Mediterranean Sea, particularly in its northern parts. These constitute a special problem for communications and trade and offer at the same time considerable opportunities for tourism (Brigand, 1991).

Factor (v) - high volcanic and seismic activity - speaks for itself: it represents, especially in the eastern Mediterranean, an ever present risk to the human population and to the natural resources of the region; it plays an important role in the biogeochemical cycles of the main elements on which life and human survival depend in subtle, long-term ways.

Factor (vi) - damped tidal regime - generally favours coastal stability, but reduces coastal faunal and floral diversity; it favours maritime trade and fishery, but slows the degradation and spread of floating or suspended marine pollutants such as oil.

Factor (vii) - specific wind regime - tends to act against factor (vi), notably maritime trade and fishery, and floating marine pollutants.

The northern mountain ranges present significant barriers to air movement which is channelled by the mountains, leading to strong wind systems; of these, the most notable are: the tramontane or cers, channelling air southeastwards across the Languedoc region in southwestern France north of the Pyrenees; the mistral, channelling air southwards down the Rhone valley; the bora, likewise, at the head of the Adriatic Sea; and the meltemi wind at the head of the Aegean Sea. These are essentially venting systems imposed by the local topography but related to the major high/low pressure fields competing over the European continent; these strong winds are of comparatively short duration, as well as being seasonal, mainly spring and summer.

On the other hand, the scirocco or the khamsin wind blows more persistently and northwards from the African or Arabian subcontinents bringing hot desert air (subsequently humidified while traversing the Mediterranean) and desert dust to the northern side of the region.

The same mountains play a major role in the rainfall patterns of the Mediterranean Sea, the northern side being subject to seasonally heavy rains in spring and autumn, the southern side, to annual rainfall of <200mm in certain regions, mainly in the winter. The mountains also ensure a rapid and sometimes disastrous run-off leading from time to time to heavy flooding in the main river plains and deltas, notably those of the Rhone and Po.

The water balance, hence mean sea level, of the Mediterranean is maintained by the input of water from the Atlantic Ocean (at the surface through the Strait of Gibraltar), from the Sea of Marmara (also at the surface, through the Dardanelles (Canakkale Bogazi)), from rivers and direct run-off from the land, and from rainfall, to replace the loss due to evaporation. The estimated contributions are summarized in section 2.2.8, below. The residence time of the water is often cited to be about 80 years which is actually the time it would take to fill an "empty" Mediterranean with the incoming water from the above-mentioned sources. However, it may be safely assumed that some of the incoming water that finds its way into the basin depths may take 100-300 years to return to the Atlantic Ocean or the Sea of Marmara, whereas some of it may exit in only a few decades. There are thus factors favouring the acquisition of typical Mediterranean water characteristics, including those relatable to specific pollutants, and others that may allow the incoming water to emerge much less affected. Local or sub-regional circulation patterns are therefore of considerable importance in determining the local state of the marine environment.

Non-indigenous species reach the Mediterranean mainly through the Suez canal. It is believed that about 350 species have reached the Mediterranean from the Red Sea. Even though they are largely confined to the Levant basin, some of them are found further west. Some of these species, especially herbivorous fishes and shrimps, are changing the species composition of benthic communities in the eastern Mediterranean, replacing endemic species in the fish catches. One of the recent immigrants in the region is *Caulerpa racemosa* which has been reported in Cyprus.

Species can also be introduced into the Mediterranean through tanker ballast water, aquaria, aquaculture etc. Aquaria were probably responsible for the introduction of the tropical green alga *Caulerpa taxifolia* which is making its presence felt rather uncomfortably in the northwestern Mediterranean.

Many of the world's major civilizations have been established or have flourished in the Mediterranean: Egyptian, Minoan, Greek (Myc nean, Hellenic), Etruscan, Phoenician, Roman, Arab, Ottoman, for example. And likewise, major religions: Judaism, Christianity, Islam. These various civilizations, many based on empire, have considerably modified the pristine environment by the same means, practically speaking, as those used today: the growth of cities and ports, agriculture, water exploitation, industry and recreation, if not tourism as well. They have also bequeathed us a major architectural wealth, now part of the World Heritage established under the auspices of UNESCO, and a history whose influence is still with us and will be for many centuries to come.

2. *Human Pressures and Economic Activities*

2.1 Population Growth and Distribution

The main population parameters for the Mediterranean countries as a group (total fertility rate, gross birth rate, gross death rate and rate of natural increase) have been discussed in the Blue Plan (Grenon and Batisse, 1989); the trends are all downwards, with a rate of natural increase expected to fall below 1% early in the next millennium. Three groups of countries with differing parameters within each group are distinguished, however: (i) Spain, France, Italy, (ex-)Yugoslavia and Greece, in which the natural rate of increase is expected to fall below 0.2% by 2010; (ii) Monaco, Malta, Albania, Cyprus, Lebanon and Israel, in which the rate is expected to fall to about 1.2% by 2010; and (iii) Turkey, Syria, Egypt, Libya, Tunisia, Algeria and Morocco, in which this rate is expected to fall below 1.5% around 2010.

The downward trends in population growth, taken alone, suggest that the pressure due to the human population (under a specific set of socio-economic conditions) will decrease, but the significant seasonal, though perennially persistent, increase in the tourist population must be added to this population pressure.

However, in view of the close relationship between population growth, whether perennial or seasonal, and coastal development, including coastal urbanization with the associated and serious problems of waste treatment, energy supply, transport, among others, there is a significant risk of a downturn in Mediterranean "international" tourist population as the "resources" - scenery, clean and long sandy beaches, clean and healthy bathing water - become degraded by the very development which tourism has largely induced.

Thus, there is a possible "qualitative" effect, not directly related to population growth, as well as the usual "quantitative" effect. Grenon and Batisse stress the likelihood of more and more "specialized" or "thematic" tourism, possibly involving fewer numbers paying higher amounts for the rewards sought (see section 2.2.4, below).

A distinction should perhaps be made between, on the one hand, tourists simply going from one Mediterranean country, where they reside, to another, where they holiday, and, on the other hand, those tourists from non-Mediterranean countries or, perhaps, from distant parts of certain Mediterranean countries; e.g., France, Spain. This is because the pressure on the Mediterranean basin coastal and marine environment as a whole is likely to be less affected simply by temporary population shifts within the basin than by massive "importation" of tourists from tourist-exporting countries. The data do not allow such distinctions to be easily made, and the problems are treated on the basis of the temporary, seasonal influx of non-residents to tourist resorts and sites. Grenon and Batisse (1989) distinguish between domestic and international tourists and project growth in the number of international tourists from their 1985 baseline, of about 120 million, to between 150 and 225 million at the turn of the millennium. This is to be compared with an estimated total of 308 to 409 million international plus domestic.

Regarding the distribution or redistribution of population in the basin, the main characteristics were or are: (i) the rural exodus, which reaches a natural climax, after which, the source "dries up", as is generally the case in the northern countries of the basin; (ii) in some cases, another kind of exodus, intra-regional migration, sometimes with an extra-legal component which tends to be associated with the "port of entry", is imposed on the rural exodus; (iii) industrialization, to the extent that it offers employment, is an important, but not the only, cause of the rural exodus (increase in agricultural efficiency being another factor favouring job losses in the rural society); not all industrialization has taken place in the coastal zone, however (see section 2.2.5).

2.2 Economic Activities and Coastal Development

There is a very close relationship between economic activity and coastal development. The former, even if conducted on an ideal sustainable basis, makes a number of demands on the environment, including the natural resources, in which it takes place. And, together with coastal development, it inevitably has effects on the human beings, who are the agents thereof, on the natural resources and the ecosystems into which such resources are normally organized. The coastal zone is subject to multiple uses by human beings; overall, a majority of them live near to or beside the sea, the main reason being the water, because of its very high heat capacity (it stores heat, thus alternately cooling the ambient air and warming it by evaporation, which cools the sea), and of its value as a solvent and as a sure source of salt.

The main uses of the coastal area, in no particular order of importance, are: construction of human habitations and related infrastructure; domestic waste disposal; industrial waste discharge and plant cooling; marine mining; tourism and recreation; fishing; mariculture; shipping. Sometimes, specific areas in the coastal zone may be declared protected areas or reserved for military use. The æsthetic pleasures of the sea along the seashore (waves, surf, sailing and fishing boats, marine odour, sea birds) are an additional "use".

Agriculture in the hinterland, if not a "use" of the coastal zone, has a significant impact, environmentally by way of release of pesticides and fertilizers, and, economically, by competing with certain fishery products (Caddy and Griffiths, 1995); this aspect is discussed in section 2.2.5.

There is also a relationship between economic policy and environmental degradation. This relationship is still not well understood, but the cornerstone is the inappropriate value that is still being attached to natural resources and their exploitation. This problem is discussed in WB-EIB (1990) from which the following very brief summary of ideas is largely taken.

In the fields of industry and energy (see sections 2.2.2 and 2.2.11, below), energy subsidies, for example, discourage efficient use of resources in energy-intensive industries (e.g., metallurgy, cement, chemicals, pulp and paper, and fertilizers), in which energy represents 20-30% of total costs. Industrial subsidies also tend to discourage the use of wastes for the manufacture of secondary products or for recovery (prevention of product loss). For example, effluents high in ammonia and ammonium nitrate from fertilizer plants could be usefully recovered if the original fertilizer product could be sold in a freer and higher pricing regime, but not where the price is kept artificially low. A cement plant may discharge several thousand tons of cement dust into the atmosphere every year, not only contributing to atmospheric pollution but losing money at the same time, if the cement price is kept artificially low - "to promote the building industry", perhaps. Low-quality fuel (e.g., high-sulphur coal or lignite), if used in a subsidised industry depending on it, promotes air pollution. Any form of overall price fixing (i.e., setting prices lower than that corresponding to real value), so as to deliver a product to the consumer at an artificially low price, discourages recovery of useful industrial discharges.

Water resources (see section 2.2.8, below) were, traditionally, regarded as free to the consumer, and this notion persists in the public mind, tempting or obliging governments or local authorities to subsidise the water supply; but this reduces incentives to conserve water, treat and re-use wastewater and prevent the contamination of water bodies. Irrigation water (occupying up to 90% of the demand in some Mediterranean countries) is widely subsidised to as low a level as 20% of real value, to promote or intensify agriculture.

Land is in a comparable position in many countries of the region; grazing and the collection of fuel wood are often free, as may be hunting and gathering minor forest products. There is therefore a reduced incentive to burn fuel wood frugally or reforest to meet future needs, to control grazing (hence its negative impact on vegetation). Even the value of timber is sometimes reduced, perhaps by failure of governmental authorities to monitor lumbering and to recover the initial value (price) of the timber from public forests.

Besides subsidies, many other economic instruments are applied to economic activities and the management of resources in the countries of the region as a means of limiting environmental impact, although, as noted above, the result is not always as expected. Economic instruments are discussed in UNEP (1994a,b) and include, besides subsidies: charges, artificial market creation, deposit-refund facilities, and financial enforcement incentives.

A number of difficulties are encountered in the application of economic instruments: insufficient cooperation between potential or actual polluters and the relevant authorities mainly because of poor organization and application of the system (failure to collect charges, monitor execution, insufficient level of fines for non-compliance etc.); lack of simplicity of application.

At the regional level, there is very little in the way of economic policy. The European Commission's Common Agricultural Policy obviously only applies to the four Mediterranean member countries. The Commission's Common Fisheries Policy is not, in practice, obligatory in the Mediterranean for these same countries. The FAO's General Fisheries Council for the Mediterranean has only advisory powers, although it has some influence on the shaping of national fishery policies.

Therefore, the relevant economic policies in the region are at the national level. To the extent that they are related to environmental policies, they are discussed, briefly, in sections 4.1.1 and 4.1.3, below.

An effort is made in the following sub-sections to stress the relationship between economic activity and environmental impact, although the latter, in terms of effects of pollutants, is discussed in more detail in section 3, on the state of the marine and coastal environment.

2.2.1 Urbanization

As already noted, the Mediterranean population has always been constrained in its physical expansion by its mountainous terrain, except for a few major river basins, so that human settlements have historically been concentrated in ports, either because of the difficulties of exploiting nearby mountainous terrain or because of the need to transport and trade the products of the hinterland (river basin) to other countries or quasi-landlocked towns and cities elsewhere along the coast. Major urban centres have therefore grown around the original coastal settlements and ports. This underlying factor, and the persistent downward trend in the agricultural population, noted in all industrial and post-industrial economies, towards a level of 3-5% of the national workforce, and the corresponding trend in the urban population, though upward, has contributed to continuing urbanization of the coastal area and all that flows from it: building and public works, energy generation and consumption, transport requirements, waste management, and so on, discussed in other sections of this report, with the corresponding pressures on natural living and non-living resources of the coastal zone.

These trends are obviously not uniform throughout the region; they are described in some detail in the Blue Plan (Grenon and Batisse, 1989) on the basis of three groupings of countries, as mentioned in section 2.1, above.

Urbanization involves, essentially, the construction and use of human habitation, public buildings, hospitals, roads, garages, petrol stations, sport facilities, marinas, and the associated public services (broadcasting and communications, water and energy supplies, waste treatment and disposal, transport); the creation or preservation of urban green spaces and other environmental amenities go hand in hand with successful urbanization.

In the Mediterranean, urbanization may be taken to encompass not only the growth of towns but also the occupation of the coastal strip between towns mainly as tourist accommodation or, in some countries, secondary residences for the citizens, whether local or from far inland, and recreation facilities. There is, for example, a heavy occupation (>70%) of the sea front from Barcelona to Naples, with relatively few untouched spaces, and other areas of the Mediterranean, such as Greece and Turkey, in certain places, are following suit.

The demands of urbanization on the environment, as those attributable to population growth, hence to economic activity in the Mediterranean region, are essentially as follows.

First, the use, in the horizontal dimension, of land that was rural and/or agricultural, compromising, in some cases, the local food supply for the increased population, or, in the coastal area, land needed to ensure the conservation of coastal resources and species of economic, ecological or social interest, or to provide sporting and other facilities for tourists. There is also the use of land, in the vertical direction, to build skyscrapers of ever-increasing size, leading to more intense water supply and sanitation problems and eventually to the creation of microclimates in large cities.

Urbanization, including tourist and recreation facilities, occupies a considerable amount of land surface in the Mediterranean basin. However, currently it is not feasible to specify an amount, mainly because of the lack of a precise definition of urbanization itself, which is only partly the occupation of land formerly unexploited or devoted exclusively to intensive agriculture, and partly the expansion and consolidation of pre-existing areas of "low-density" habitation; it may or may not include areas that remain essentially unchanged (e.g., sports stadia, cemeteries) even if engulfed in urban sprawl.

Second, in the management of water (see section 2.2.8), there is the problem of ensuring an adequate supply of water for human use and consumption, with some difficulties to supply the horizontal network (to keep up with urban sprawl) or the vertical network (to ensure supplies to the highest buildings): in short, the plumbing. There is also a potentially serious problem inasmuch as urbanization means the covering of substantial areas with impermeable concrete (for roads, building bases etc.) thus blocking rainwater from permeating the soil and filling natural subterranean water systems and greatly speeding run-off into rivers, themselves sometimes with concrete banks to channel discharge, and in turn leading to increased incidence of flooding. There appears to be no data available on the degree of this form of soil impermeabilization.

Third, the management of the drainage of sewage and other wastewaters, which suffers similar problems to those of domestic water supply, is made increasingly difficult unless the urbanization is rationally carried out. (See sections 3.1.1 and 3.1.2)

Fourth, the increased air pollution and noise associated with urbanization, due mainly to cars and buses, but also to industry, which tends to be established in the vicinity of conurbations. The quality of the air is, of course, greatly determined by the local meteorological conditions (winds, rainfall). (See section 3.2)

Urbanization and coastal development in general continue apace in the Mediterranean basin. The spread of uncontrolled, poorly managed or even illegal coastal development, particularly in the form of tourist accommodation and facilities, by creating increasing pressure on dwindling resources in terms of land and drinking water, also creates increasing pressure for some form of longer-term development policy in most coastal countries. Spain, France, Italy and Greece, in particular, partly under the pressure of the Commission of the European Union, are now paying considerable attention to improving bathing water and beach quality.

Regarding the effects, urbanization, in particular, and coastal construction, in general, by substantially modifying the coast itself, adversely affect local flora and fauna, displacing and reducing them to ever-shrinking land space of a suitable nature.

Given the concentration of human population and urbanization around natural and long-established harbours and ports, as well as the continued development of the civil infrastructure in such areas, the historic and natural heritage of these ports are particularly threatened by urban economic development (see section 3.5). Present efforts to improve and modernize all the European ports will cause serious damage, historically and ecologically, in these areas which have been occupied by Man since ancient times. It will therefore be necessary to compile systematic and ongoing inventories of the flora and fauna and urban and port structures of historic significance.

Urbanization and coastal construction may not themselves directly affect fishermen who stand to benefit, at least initially, from the correspondingly increased demand for their catches from the increased human population, but significantly impact the local marine ecosystems, particularly by altering the drainage and sedimentation pattern in the coastal zone, and often force fishermen to change their gear/methods and target species. The traditional practice, in many coastal countries, of landing fish directly on the beach and selling the catch directly to the public and to the seaside restaurants may be no longer feasible; fishermen may be forced to go farther to reach the nearest fishing port, for example, which may force an "improvement" in mechanization of the fishing boats and in the marketing of the fish, but often leads to higher costs for the fishermen and the need to increase fishing effort to meet these higher costs.

Thus coastal construction may improve the capacity of seaside resorts to receive visitors or new residents while making it harder to feed them, as far as the sea-food component of their diet is concerned.

Post-industrialization - the shift to a service and communication economy - requiring a generally high level of education and specialized skills in its employees, hence generally drawing them from the industrialized-urbanized population, and not being so limited physically to a particular place - has, together with the increased transport facilities (see section 2.2.3), led to a spread in urbanization away from (or at least to the suburbs of) the major urban centres, but with a possible preference for the coastal zone insofar as this zone offers pleasant living conditions for a sophisticated workforce. In this case, it is often the smaller towns that grow the fastest, since the major urban centres generally have fewer physical and administrative possibilities for great expansion. There is some sign that, in some countries, the promise of industrialization, if not post-industrialization, has led to substantial movement of population from rural areas to urban centres in advance of the industrialization that elsewhere had constituted a justification for the migration.

The mass migration of populations towards the major urban centres has obviously, in some countries, if not in all to some degree, quite overstrained the labour and housing markets and the associated public services (water, roads, sanitation, transport), as well as efforts to conserve the historical, cultural and architectural heritage (see section 3.5). In countries with a marked mountainous coastal terrain, the physical possibilities for expansion are limited and add to the intensity of the problem in some cases.

2.2.2 Industry

Those industries preferring the coastal zone as a location generally do so because of a marked need for cooling water or for receiving water for wastes created by the industrial processes involved, the inland rivers and water bodies being already over-used, over-protected for their flora and fauna or with too low a capacity to dilute and transport away the generated heat or waste quickly enough. Power-generating plants are often established along rivers or in the coastal zone for such reasons. Desalination plants, by definition, are sited at the coast; besides heat, they may discharge hot brines which modify the local ecosystem.

The development and present level of industrialization in the Mediterranean are reviewed in Fascicule 4 of the Blue Plan (Giri *et al.*, 1991).

There was exceptional development between 1950 and 1980. This development was, however, mainly concentrated on the northern side, especially in France and Italy, followed by a notable though more modest development in Spain and Turkey and in Syria and Egypt; in the Maghreb countries, marked industrial development occurred in the 1970s, while recession hit the main northern countries.

In the 1980s, however, industry, especially on the northern side of the basin, underwent a substantial transformation. Thus, steelmaking, which had previously become established in the Mediterranean basin, the cement industry, oil refining and the associated petrochemicals industry entered a period of firm and lasting recession. On the southern-eastern side, industrial development slackened less but nevertheless became irregular and variable from country to country depending, to a marked extent, on indigenous adaptability to the industrial evolution of this period and on a considerable loss of revenue from oil exports which declined in value as Europe recovered from the oil crisis of the mid-1970s.

At the end of the 1980s, the gap in industrial development between the northern and southern-eastern sides of the basin remained considerable, although it has narrowed since 1950. In terms of added value in the manufacturing industries (which are much more important than the extractive industries), France and Italy together account for 72%, followed by Spain (15%), ex-Yugoslavia and Turkey (3.6%, each), and the rest (6%), out of a total of 506 billion dollars. At 7.3% of the world population, the basin contributed 16% of the world production.

Within the Mediterranean basin proper, these figures are significantly modified, since much of the manufacturing capacity of Spain, France and Turkey, in particular, is located outside the basin itself. Thus, in descending order, the corresponding values are: Italy (64%), France (13%), Spain (10%), Algeria, ex-Yugoslavia and Greece (~3%, each), and the rest (~4%). The overwhelming industrial predominance of Spain, France and Italy, together, remains unchanged at 87% over the rest of the Mediterranean countries. This value is only slightly reduced, to 82%, if the calculations are limited strictly to the coastal provinces of each country; in this case, the shares of these three countries become: Italy (52%), Spain (19%), France (8%), followed by ex-Yugoslavia, Greece and Algeria (with ~4%, each) and the rest (9%).

Industry, besides occupying land area, may also use the land to receive solid wastes, possibly in the form of land fill; this is particularly true of mining (see section 2.2.10, below), but may include the ash of processes such as steel-making. Industry also discharges wastewaters, more or less directly to rivers (thence to the sea) or to the sea through coastal outfalls; these constitute an important use of the sea (see below). The pollutants arising from industrial processes are discussed in section 3.3.1.

There is usually a conflict between industry and human habitation, on the one hand, and between industry and local inshore fishery or faunal/floral conservation, on the other.

The main conclusions, from the environmental standpoint, are: the important contribution of manufacturing industry to the so-called littoralization of the coast (i.e., human implantation in the coastal zone); the problems posed by industry as a principal land-based source of pollutants, especially the problems relating to the management and reduction of industrial wastes in general and of hazardous wastes in particular; and the inappropriate siting of industrial installations.

2.2.3 Transport

Transport is a corollary of coastal urbanization and industry; it has three main forms (land, sea and air), and two main purposes (transport of human beings and animals; transport of raw materials of industry and goods of commerce). A further consideration is the transport of hazardous substances, discussed later in this section.

Land transport of people, animals, raw materials and goods is effected mainly by road, but also by rail. Modern boring techniques have allowed places once practically isolated by local mountainous terrain to be linked by motorway and coastal road. Although major road-building has probably reached a peak in most of the northern Mediterranean countries, there is still scope for considerable increase in the southern countries.

The Mediterranean has never been attractive from the standpoint of railways, again because of the mountainous terrain, and the main modern development is that of high-speed trains from the hinterland (the major inland cities) to the coast, notably in France and Spain.

The maritime transportation of people and, on a smaller scale, animals is mainly by ferry between mainland countries and offshore islands or between neighbouring countries. According to REMPEC (1994a), some 200 ferries and passenger vessels are at sea in the Mediterranean at any one time; no figures are available on the number of passengers. Likewise, there are about 1500 cargo vessels of >150 gross registered tons (GRT) and 2000 commercial vessels of >100GRT. Around 200,000 vessels ply the Mediterranean annually, of which, the large majority are simply in transit (i.e., do not put into a Mediterranean port).

In terms of Flag State registrations, Greece, Cyprus and Malta, together, account for over 70% of the gross registered tonnage.

Merchant vessels in the basin come from or go to 305 ports therein (approximately 1 port for every 150km of coastline). The ports fall into three categories: (i) small ports that, nevertheless, contribute to national economy; (ii) single-user complexes owned/operated by a major industrial entity (public or private); (iii) multi-purpose ports.

Most Mediterranean ports are focuses of significant urbanization (primary examples are Barcelona, Marseilles, Genoa, Naples, Piraeus, Limassol, Alexandria, Tunis and Algiers).

Grenon and Batisse (1989) observe that general cargo transfer accounts for a majority of port operations. Another notable feature is the slow penetration of container shipping into intra-basin maritime transport, whereas roll-on/roll-off traffic has increased considerably.

Air transport refers mainly to the movement of people, notably tourists between their countries of origin and of Mediterranean destination, as well as to intra-regional traffic, although there is an increasing tendency to move certain products by air freight, notably marine and short-lived agricultural products. It still suffers from the continuing need to pass through the major gateway airports, such as Madrid, Paris, Frankfurt, Geneva and Zurich, and the major regional airports, such as Barcelona, Marseilles, Nice, Rome, Athens, Istanbul, Cairo and Tel-Aviv, but smaller, more "local" air transport nodes are also developing. New trends in transport favour the development of intermodal systems combining particularly maritime and terrestrial transport along the coastlines (Reynaud, 1996).

Regarding the effects of developing transport systems, the transport of people has meant, and will continue to mean, more cars and buses, hence more roads, petrol stations and garages (for car parking and car repair) and more air pollution from exhaust gases and more terrestrial and marine pollution from the uncontrolled disposal of lubricating oils. The roads include motorways, especially those running parallel and near to the coastline, as well as those leading to the main urban centres in the hinterland. Growth in motor-vehicle stock is expected to increase considerably overall between now and 2025, by about 12% in Spain, France, Italy and Greece, about 80% in ex-Yugoslavia, Turkey, Cyprus, Malta and Israel, and about 200% in Syria, Lebanon, Egypt, Libya, Tunisia, Algeria and Morocco, according to the Average Scenario of Grenon and Batisse (1989).

Roads use up valuable agricultural or horticultural land and disturb, for a long time if not permanently, local flora and fauna; roads also lead inevitably to growth in hotel accommodation, shops, petrol stations etc. Under most reasonable hypotheses of growth, an increase in land use for roads of at least 25% can be expected by 2025 (Grenon and Batisse, 1989).

Railways have effects on the environment comparable to those of roads, consuming and partitioning valuable agricultural/horticultural land. Nevertheless, from the environmental standpoint, rail transport is the least polluting and the most economical in energy use.

Busy commercial shipping routes may impede commercial fishing. Oil tankers and other commercial vessels, as well as pleasure craft, contribute to the deterioration of the marine environment, shorelines and ports by the discharge, albeit illegally, of garbage, litter and, sometimes, hazardous substances; tankers may wash out their oil tanks (also illegally) thus giving rise to a form of oil pollution that degrades the marine environment, restricting the full use of the sea shore for recreation, tainting fish flesh, oiling fishing gear, especially nets, etc. Major oil spills may be local catastrophes from the recreation and fishery standpoints; however, on the whole, oil and gas transport is not, in itself, a major threat to fishery, and few are ready to argue the greater economic importance of fishing over oil/gas extraction and trade.

The main effects of air transport are additional air pollution, noise (which can be a serious nuisance not only for human beings, but also for local fauna and domestic and farm animals in the vicinity of airports) and used lubricating oils.

Regarding the transport of hazardous substances, there is likely to be a drop in the transport of crude oil as a result of an increase in the proportion of crude oil being refined in the countries of origin, hence also, probably, in the amount of oil derivative products. It therefore seems likely that the amount of potentially hazardous substances transported, besides crude oil, will rise, increasing the risk of environmental damage from spills and accidents. This trend is slowly being accompanied by the installation of more portside facilities to handle dangerous cargoes, including deballasting facilities.

REMPEC (1994a), provides some details of the transport of hazardous substances in the Mediterranean basin. In 1990 about 130×10^7 metric tons of goods were handled (loaded/unloaded) in Mediterranean ports, of which, about 57×10^7 metric tons were crude oil and 17×10^7 metric tons, refined oil products. (The figures are overestimates since they include goods handled by Mediterranean ports but found/located outside the region).

In 1989, the amount of natural gas imported/exported by France, Italy, Spain, ex-Yugoslavia, Algeria, Tunisia and Libya, together, was about $97 \times 10^9 m^3$.

Insufficient data are available to quantify the transport of specific chemicals, but ethylene, propane, propylene, vinyl chloride, ammonia, methanol, benzene, toluene, glycols, styrene, sulphuric and phosphoric acids and caustic soda are known to be transported by ship in significant (hence significantly dangerous) quantities, in some cases, as are ores (e.g., alumina, barite, bauxite, bentonite, magnesite, potash, pyrites), coal and grain, the latter two being imported mainly. Annex II of the MARPOL Convention (see sections 4.1.1 and 4.1.4) covers the carriage of hazardous and noxious liquids in bulk and indicates the substances considered to fall into these two categories.

In the period between January 1990 and December 1995, the Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea reported twenty-nine major marine accidents (out of 145 maritime accidents reported, in all); (REMPEC, 1992a; 1994b), of which, 9 were due to sinking, 9 were due to collision, 8 were due to operational failures (rupture of pumping hoses during unloading or tank cleaning, or leakage from vessel or pipeline), 2 were due to fire or explosion and one was due to grounding. The predominant cargo involved was oil (crude oil, fuel oil or gas oil), while accidents causing or likely to cause pollution by hazardous substances other than oil included: acetylonitrile, ammonia, barite, dichloroethane, potash, propylene, sulphuric acid, terephthalic acid.

There are several increasing trends in the structure and operation of world manufacturing and trade that suggest that there will be an increase in the transport, by ship, of more or less hazardous substances, hence in the risks to which the marine environment will be exposed.

Such trends are: the globalization/relocation of manufacturing (the competition between low labour costs, raw material delivery and low transportation and distribution costs); changes in production techniques (e.g., "just-in-time" delivery of raw materials and chemicals, rather than accumulation of high inventories at the production site); integration of regional markets (leading to an increased flow of goods, even if the mass is stable); value-adding at source (e.g., increased oil refining by the oil producer). However, an increasing conservation and environmental concern may lead to improvements in tanker design, maritime traffic schemes, and emergency response facilities.

REMPEC provided various kinds of assistance from its own limited resources, promoted international assistance or activated the Mediterranean Assistance Unit (MAU), which are summarized in REMPEC (1992b; 1994c). A detailed MAU Mission Report is provided in REMPEC (1994c); such reports, which include firm recommendations drawn from the experience of each mission, go a long way to helping national authorities to face similar accidents better in the future.

2.2.4 Tourism and recreation

The recreation of residents and tourists is a major economic activity in many countries, whether rich or poor. With respect to the coastal zone, wherever clean beaches, calm seas, high levels of sunlight and all the attendant local infrastructure (hotels, places of entertainment, good sanitary installations, banks, post offices, shops, tennis courts, golf clubs etc.) can be found, human beings who can afford to do so will go there and will pay money to do so.

The Mediterranean basin offers a wide variety of possibilities for recreation, from skiing (mainly in the Alps and the Pyrenees), via mountaineering and rambling, tennis and golf, to the customary "water" sports: swimming/ sunbathing, surfing, water-skiing, snorkelling and submarine diving (whether for spear-hunting or for amateur archæology), yachting/sailing, marine angling (from the beach or from pleasure cruisers offshore).

Tourism and recreation are a key element in coastal development because they force many aspects of urbanization, notably the construction of hotels, restaurants, shopping centres, sport facilities, marinas, public services and buildings. Many a coastal resort's resident population will be multiplied several (3-5, if not more) times during the holiday season. This situation places a heavy burden on local authorities who are faced with the difficult choice of whether to install waste- and sewage-treatment capacity for the peak population, knowing that this capacity will only be half (or less than half) used outside the seasonal peak, or to deal with peak output (of sewage and waste) on an *ad hoc* basis with the risk of creating local environmental catastrophes precisely during the peak holiday season. If the authorities do not provide facilities or services, especially to deal with the increased waste, the coastal sea is relied upon to handle that which cannot be treated. While the sea's capacity to do so may be considerable, it may depend quite heavily on the rate at which the local sea is changed (flushed) by local currents. Untreated-waste discharge leads to increased litter in the sea and on the sea bed, and to higher than usual incidence of potentially dangerous micro-organisms (especially bacteria and viruses; see section 3.3.1).

So-called eco-tourism and eco-recreation are increasingly placing emphasis on the persistence of unchanged and unexploited (i.e., conserved) ecosystems; examples are bird-watching, in particular, and wildlife-watching, in general, including photography in all its forms (still, video, cinema) and bird-call recording, butterfly watching and collecting, landscape art, submarine exploration. However, even these activities are not sustainable in the face of unlimited access. Conservation of marine habitat, even if only for such purposes, is progressively being associated by the public with conservation of ecosystem complexity and biodiversity, and the intangible benefits of conservation are receiving an increasingly higher profile as the public becomes more aware of impacts on marine and coastal wildlife.

An upward evaluation of this non-exploitive use is to be expected. Moreover, some habitats, suitably conserved, play a natural role in pollution abatement and the mitigation of natural environmental impacts on coastal systems.

With the currently increasing trends in resident population size and density, and the likelihood of similar trends in the non-resident, tourist population, access to modern sanitation services has considerably improved. And as the demand for increased quality, particularly in food and accommodation, has increased in the "tourist-exporting" countries, so it has been progressively better supplied in the "tourist- importing" countries.

Regarding effects, the occupation of land surface for tourism and recreation means, essentially, a loss of habitat for many wildlife species, even if there may be signs that some species (especially birds) adapt to these changes and establish a reasonable co-habitation with human beings in recreational and residential areas. It also implies a diffusion of sources of waste (notably litter) and a consequent cost of maintaining ski domains, golf courses, beaches, tennis courts and mountain pathways free of such waste, for æsthetic, ecological and sanitary reasons.

Tourism is a sensitive sector which easily suffers from economic or political instability. However, it is bound to expand considerably in the long run in view of the cultural and natural amenities of the region and since it represents the main source of foreign income for most of the coastal States (Grenon and Batisse, 1989; Lanquar, 1995).

The occupation of the sea space is very much restricted to the littoral zone, since most activities take place on the beach or within 50m seawards, except for yachting/sailing or offshore marine angling. Nevertheless, the effect on the local species is, even if not well known, almost certainly considerable. One of the impacts is due to the litter left on beaches or thrown directly into the sea along the beach. It is possible that certain plastic or metal objects (bottles, cans, containers etc.) on the sea bed may, at a particular density, serve as niches for certain kinds of marine organisms, whereas, at a higher density, may simply act as a bar to such organisms. Little is known of this aspect of sea-bed litter, but, in view of the importance of the littoral zone for marine wildlife, its importance cannot be discounted (See also section 3.3).

2.2.5 Agriculture

Given that the present report deals with the coastal and marine environment, agriculture is not itself a predominant economic activity in this narrow zone. The Blue Plan (Grenon and Batisse, 1989) describes succinctly the state of agriculture in the Mediterranean basin, as well as its prospects.

The principal economic aim of agriculture in the Mediterranean drainage basin is to meet the food demand of the resident and, as necessary, the tourist populations. In this respect it resembles the Mediterranean fisheries for the most part. The present percentage of agriculture in the Gross Domestic Product of the basin as a whole is under 20% and food supply from domestic agriculture is falling behind population growth in the basin; moreover, agricultural growth is also falling behind that of industry and of economic growth in general. Agricultural productivity also varies widely throughout the basin (Table I).

Agriculture is strongly conditioned by the basin's terrain: mountains, hence extensive hillside stock raising (sheep, goats); few alluvial plains (Ebro, Rhone, Po and Nile) for more classical agriculture/horticulture (pulses, grains, sugar beet, tomatoes, citrus and other fruits, beans, chick peas, in particular) or intensive pig and beef raising, the mainstays of the cow-milk, beef, veal, pork and delicatessen trade. Elsewhere, often in relatively narrow coastal valleys and on coastal slopes, generally fairly arid, the main crops are olives, almonds, pistachios and grapes.

Agriculture, *sensu lato*, in the coastal zone has generally declined in the face of urbanization, mainly, and of some forms of industry. Thus, the traditional task of preventing soil loss to the sea, by terracing coastal slopes and by physical transport of topsoil upland, has greatly weakened; and, as agro-industry has developed in the main river valleys and plains, also not without competition from urbanization, the husbandry of the coastal slopes has steadily decreased and continues to do so, adding to soil erosion.

Table I. Agricultural Resources and Inputs in Mediterranean Countries, 1968-1970 and 1988-1990 (mean annual values)

Country	Fertilizer consumption				Arable land			Irrigated land			
	Total (10^3 t/yr)		Per cropping area (10^3 kg/ha/yr)		Potential area (10^3 ha)	Actual area, 1988-90		Area (10^3 ha)		As % of arable land	
	1968-70	1988-90	1968-70	1988-90		(10^3 ha)	(% of total)	1968-70	1988-70	1968-70	1988-90
Albania	39	102	66.8	143.3	-	709	-	263	422	45.0	59.4
Algeria	83	138	12.2	18.2	7,700	7,606	99	237	336	3.5	4.4
Cyprus	26.0(*)	22.2(*)	163.6(*)	142.5(*)	400	156	39	30	34	18.9	22.0
Egypt	347	990	122.9	381.9	2,900	2,591	89	2,826	2,591	100.0	100.0
France	4,300	5,929	223.7	309.9	-	19,133	-	740	1,159	3.8	6.1
Greece	325	674	83.1	171.3	-	3,933	-	718	1,190	18.4	30.3
Israel	52	106	127.8	244.4	-	435	-	167	213	40.9	48.9
Italy	1,243	1,897	82.6	157.8	-	12,023	-	2,537	3,100	16.9	25.8
Lebanon	34	25	105.3	83.7	300	301	100	68	86	21.2	28.6
Libya	10	81	5.2	37.9	2,100	2,150	102	170	242	8.4	11.3
Malta	1	1	37.7	47.7	-	13	-	1	1	7.1	7.7
Morocco	93	315	12.5	34.8	7,700	9,056	118	915	1,265	12.3	14.0
Spain	1,132	2,041	55.0	100.3	-	20,345	-	2,376	3,358	11.6	16.5
Syria	33	278	5.7	49.9	6,000	5,563	93	491	671	8.3	12.1
Tunisia	34	96	7.7	20.8	4,600	4,613	100	85	273	1.9	5.9
Turkey	419	1,766	15.4	63.4	28,000	27,853	99	1,700	2,340	6.2	8.4
ex-Yugoslavia	589	893	71.5	115.2	-	7,755	-	126	176	1.5	2.3

(*) From 1974 onwards data refer to part of the country only.

(Adapted from UNEP, 1993)

The proportion of erodible soil in the Mediterranean basin is more than half in a large majority of the riparian countries; the relevant values are summarized in UNEP (1987a).

There has also been a steady growth of covered or semi-covered horticulture which occupies space (agricultural and peri-urban) but, being an intensive and more or less closed system, does not contribute to soil erosion. It is, however, demanding of fresh water supply, fertilizers and pesticides.

Agriculture and horticulture occupy by far the greatest amount of land surface, and make the heaviest demand on fresh water resources of all current land uses, generally occupying 60% or more of the available resources (UNEP, 1994c).

The intensification of Mediterranean agriculture is strongly constrained by the need for improved irrigation (in a context of relatively scarce and uneven fresh water supply), by soil erosion due to the heavy but seasonal rain aided by the general decline in husbandry of the coastal slopes as coastal urbanization has encroached on agricultural land farther and farther up the slope, and by the need for fertilizers and pesticides. The terrain also often makes mechanization of the agriculture problematical, as does the traditional preference for small landholdings. Nevertheless, Grenon and Batisse (1989) indicate potential increases of 2- to 5-fold or more for most vegetables and fruits and for some meat and dairy products, if modern and well adapted farming methods are widely adopted throughout the basin.

Regarding effects, agriculture itself has (with urbanization and industry) contributed to a loss of the specialized flora (e.g., garrigue, grassland and forests) that went a long way to preventing soil erosion, since agricultural crops are, in many cases (e.g., sugar beet), planted, grown and removed annually, thus not creating a soil structure resistant to erosion by wind and rain.

Protective (erosion-abating) plant cover has not only been progressively and sometimes severely reduced by growing demand for food, hence by intensive agriculture and overgrazing, but also by a progressive parcelling of the land for the many uses already evoked. This parcelling, however, makes it increasingly difficult to ensure soil conservation on an ecosystem basis, since the coordinated action of a large number of land owners or exploiters is much harder to achieve than it might be for a few owners. Yet, even where centralized government and public ownership might have guaranteed some hope of success, the means for, and public acceptance of, a sub-regional management scheme can rarely be assured, and the more so if prior environmental impact assessments are thought essential to such a scheme.

Agriculture, as a source of (excess) pesticides and fertilizers, in the hinterland, as well as in the coastal zone itself, may have a substantial effect on the coastal area environment, but also on the coastal zone economy through the competition of its products with other food products, notably fish and fish products.

Pesticides, which are often over-applied, may be washed by rain from the cultivated land surface directly into the sea, or indirectly via rivers debouching into the sea, with sometimes adverse affects on the coastal marine fauna and species of fishery interest. Pesticides also put pressure on human health standards for drinking water and for shellfish-growing water (see section 3.3.2).

Fertilizers (often over-applied in agriculture) are washed or discharged into the sea. The effects of fertilizers and pesticides are discussed in section 3.3.2.

Products of agriculture compete with those of a fishery in a national economy, so that, in the long term, fishermen and, even less, fish processors and marketers, cannot remain indifferent to agriculture. Consumers may prefer meat to fish, or vice versa, on their dinner table, but at market the lower cost product may win the battle for the consumers' money, other things (such as freshness, appeal etc.) being equal.

2.2.6 Fisheries and mariculture

The physical features of the Mediterranean, which largely determine the composition of the living resources, have been generally described in section 1.3, above.

From the fishery standpoint, the two main basins (the Eastern and the Western Mediterranean Basins), being relatively deep (maximum depth in excess of 4000m), are not exploited; nor are they likely to be, for three main reasons: (i) the cost, in physical and financial terms, of operating fishing gear at considerable depth cannot easily be justified, at least under present and foreseeable economic and technical circumstances; even the exploitation of the continental slope is not currently cost-effective; (ii) the slow replacement (probably 100-300 years) of the deep water of these basins implies very low levels of dissolved oxygen, hence a scarcity of suitable living resources at depth; (iii) the steady accumulation of non-degradable litter in these basins, while initially being possibly advantageous (by providing microniches for various species) must eventually render the sea bed uninhabitable by species of fishery or ecological interest, even if conditions (i) and (ii) are not operative.

The main features of the Mediterranean fisheries have been described in Fascicule 1 of the Blue Plan (Charbonnier *et al.*, 1990) and the trends in catches and landings, from 1972 to 1991, have been summarized by Stamatopoulos (1993).

The principal species groups, as defined by FAO for its Fisheries Yearbooks (FAO, 1993), that are the object of commercial or extensive artisanal fishery are given in Table II.

The data given by Stamatopoulos (1993) for 1972, 1982 and 1991 show also that, in the Mediterranean, as well as in the Black Sea, there was a steady growth (roughly a doubling) in overall catch in the first of these two decades, and a marked decline (of roughly 28% in the Mediterranean and of roughly 70% in the Black Sea) in the second decade. These may be considered as representing the expansion of the fisheries (in line with population growth - resident and non-resident/tourist - and improving living standards), followed by a decline due mainly to over-fishing and increasing marine environmental pollution. They have been accompanied by an increase in mariculture which, in 1990, produced almost 120,000 metric tons (Stamatopoulos, 1993).

The principal fish, shellfish and other species exploited by the marine capture fisheries in the Mediterranean are given by Charbonnier *et al.* (1990). Detailed descriptions of the Mediterranean marine fauna and the marine aquatic flora may be found in Fischer *et al.* (1987).

The main fishing nations, with respect to the Mediterranean Sea, are Italy, Spain, Greece, Tunisia, France, Algeria and ex-Yugoslavia. There is no immediate prospect of markedly increasing the current total catch of marine capture fisheries, if only because such an increase would have to come from small pelagic species which are not, at this time, in high demand as sea food, whether for direct consumption or as fish products (canned, smoked, frozen etc.).

Capture fisheries are limited by the relative narrowness, in most places, of the continental shelf, the general and persistent overfishing of the natural stocks and the general lack of coordination between countries in the management of those stocks (the majority) that overlap national jurisdictions.

The great variety of fish (and shellfish) species taken in the Mediterranean fisheries means that similar species are sometimes confounded in the statistics or attributed to one or the other species only. This variety also makes reliable assessments of the state of the stocks difficult, especially since the majority of stocks overlap national jurisdictions, and international cooperation in the collection and analysis of relevant data is still not adequate to allow effective stock assessments to be made to determine the state of each stock, especially as regards saturation fishing or biological overfishing.

Judging from the average size of the fish caught relative to the "maximum" size, for each species of concern, the majority of demersal fish stocks are over-exploited, so that no fishery in this situation is covering its investments (nor,

Table II. Nominal catches (in metric tons) of the principal commercial species groups (as defined by FAO) in the Mediterranean and Black Seas for 1989 and 1992 (FAO, 1993) with an estimate for the overall Mediterranean catch *

FAO group code	Description of nominal catch groups	Nominal catches for 1989	Nominal catches for 1992
11	Fresh water: carps, barbels, other cyprinids	1 016	755
13	Miscellaneous fresh water fishes	1 555	907
21	Sturgeons, paddlefishes	602	1 050
22	River eels	3 679	3 386
24	Shads	40 750	9 514
31	Flounders, halibuts, soles	14 939	13 901
32	Cods, hakes, haddocks	74 927	84 669
33	Redfishes, basses, congers	164 369	178 458
34	Jacks, mullets, sauries	198 147	125 133
35	Herrings, sardines, anchovies	645 763	567 070
36	Tunas, bonitos, billfishes	61 474	56 064
37	Mackerels, snoeks, cutlassfishes	43 999	42 101
38	Sharks, rays, chimæras	20 011	20 713
39	Miscellaneous marine fishes	107 675	83 542
42	Sea-spiders, crabs	2 003	1 777
43	Lobsters, spiny/rock lobsters	7 727	8 605
45	Shrimps, prawns	31 545	31 358
47	Miscellaneous marine crustacea	8 538	9 986
52	Abalones, winkles, conches	0	14
53	Oysters	17 233	19 524
54	Mussels	127 623	137 900
55	Scallops, pectens	1	0
56	Clams, cockles, arkshells	47 570	83 360
57	Squids, cuttlefishes, octopuses	76 920	72 684
58	Miscellaneous marine molluscs	22 779	17 202
72	Turtles	100	3
74	Sea squirts, other tunicates	35	164
76	Sea urchins, other echinoderms	237	390
	Total nominal catch	1 721 217	1 570 302
	Estimated total nominal catch for Mediterranean *	1 463 034	1 434 757

* Since these statistics are given for the Mediterranean + Black Sea (FAO Statistical Area 37), an estimation for the Mediterranean catches is based here on data given by Stamatopoulos (1993) for the total Mediterranean catches for 1991 in which about 85% of the total (Mediterranean + Black Sea) catch of marine and diadromous fishes, and nearly 100% of crustaceans and molluscs correspond to the Mediterranean; the same factor (85%) has been applied to the 1989 catches.

sometimes, even its expenses) from its own financial resources.

Another sign is the predominance of relatively short-lived pelagic species in the overall landings; this may be partly explained by the fact, already noted, that bottom trawling is largely limited to the rather narrow continental shelf, but, here too, a trend has developed in which the high-seas trawlers have been fishing closer to shore in recent years, for lack of adequate offshore stocks, often causing conflicts with inshore artisanal trawl fishermen and other inshore users of the marine environment. In 1991, the European pilchard and the European anchovy, together, out of the top 28 species of fishes and shellfishes, occupied nearly 30% of the total landings (Stamatopoulos, 1993), although this proportion has been high at least since 1972.

It should be noted, in the present context, that the use of technical measures (e.g., obligatory mesh sizes) and Total Allowable Catches (TACs) for a given fish stock, as a policy for limiting fishing pressure, does not allow regulation of catch capacities and even encourages increases in catch capacity through excessive investment in more and more efficient fishing vessels and gear (CEC, 1994). Also, as long as consumers will pay the price, fishermen will be encouraged to catch the fish, even against all conservation and environmental wisdom.

Mariculture (or marine aquaculture) is providing a solution to the shortage of high-priced species in high demand, which cannot be supplied by traditional capture fisheries.

The species that are principally the object of mariculture are the gilthead sea bream (*Sparus aurata*), the sea bass (*Dicentrarchus labrax*), Mediterranean mussel (*Mytilus galloprovincialis*), flathead grey mullet (*Mugil cephalus*), carpet shells (*Tapes* sp.) and European flat oyster (*Ostrea edulis*), but other species are also the object of growing interest: the European eel (*Anguilla anguilla*); rainbow trout (*Oncorhynchus mykiss*) and, occasionally, the sea trout (*Salmo trutta*); the Atlantic salmon (*Salmo salar*) and Pacific salmon of the genus *Oncorhynchus*; the Pacific cupped oyster (*Crassostrea gigas*); and Japanese clams (*Venerupis japonica*). Egypt specializes in tilapias (*Oreochromis* spp.), in the context of more traditional fresh water culture (aquaculture).

The intensive rearing of seabream increased its output by approximately five times over the last five years reaching a figure of 29,000 tons in 1994. The forecast for 1996 is close to 40,000 (CIHEAM, 1995). Production of fry was equally impressive, increasing at an annual rate of approximately 25% during the period 1991-94. The use of this production is not limited to the restaurant trade and the local market but is also exported within the region.

The culture of species of interest is sometimes based on natural stock entrapped in a lagoon or bay and then fed in enclosures until commercial size (especially for the restaurant trade in areas of high tourism).

It is not feasible yet to assess the effect on fish stocks of the discharge of wastes (harmful or otherwise) from the land to the coastal sea. There is a reasonable belief that nutrients (notably nitrate and phosphate) increase the production of phytoplankton, which occupy the bottom of the food chain, hence, in time, the zooplankton and small fishes, then larger fishes, but it is mainly a question of "dose". If eutrophication is induced (see section 3.3.2), it may have a serious adverse effect on some fishes; however, the adverse effects caused inshore in the vicinity of the discharge may be mitigated and then removed as the nutrient levels are reduced by turbulent mixing into deeper waters offshore where higher, but no longer excessive, concentrations may have a beneficial effect. The measurement of the relationships involved is not an easy matter, however (Caddy and Griffiths, 1995). The effects of the main marine pollutants are also discussed in section 3.3.2.

Also, intensive mariculture (in cages or tanks) uses substantial amounts of chemicals to control parasitic and fungal infections in the cultured species, and this may cause local but serious environmental disturbance, sometimes at the expense of local capture fisheries which suffer from a loss or dispersion of local wild stocks.

As breeding and biotechnological techniques are increasingly used to produce specific varieties for mariculture purposes, there is a serious potential danger of unforeseen negative effects of interbreeding of these culture species with their wild counterparts as a result of escapement (often accidental during coastal storms, but perhaps also intentional) (see section 3.4.2).

Needless to say, fisheries and mariculture in the coastal zone are mainly in conflict with water sports and yachting marinas, both of which tend also to prefer coastal bays and lagoons; moreover, the stocks that are the object of fishery or mariculture are prejudiced also by uncontrolled/untreated waste discharge. At the same time, mariculture is a user of supplementary fish feeds to speed the "fattening" (i.e., rapid growth) of the cultured species and so may contribute to local eutrophication due to loss of such feed to the surrounding environment, perhaps causing plankton blooms (see section 3.3.2).

GESAMP (1991) has considered ways of reducing the environmental impact of coastal aquaculture. The environmental aspects of aquaculture have also been reviewed by UNEP (1987b; 1994d), the latter with respect to shellfish culture in particular.

2.2.7 Forestry

The state of the Mediterranean forests and their prospects under the impact of human activities have been reviewed in detail in Fascicule 2 of the Blue Plan (Marchand *et al.*, 1990).

The natural pristine Mediterranean forest prevailing up to about 14,000 years ago was dense and extensive. During the neolithic revolution, some 6,000 years ago, first at the eastern end of the basin, then at the western end, there was a rapid growth of the human population, and an agricultural economy replaced the hunting-gathering economy, thus creating a demand for arable land. This led to the very beginnings of human industrial activity, which created a demand for wood for combustion. Shipping also began to expand, creating demand for vessel construction. Nevertheless, in Greek and Roman times there was already some effort at forest conservation and even at reforestation.

Till the mid-19th century, the basin's population was relatively stable, mainly as a result of wars and epidemics, which allowed some recovery of the basin's forests, although the demand for wood for shipbuilding, mine-shaft scaffolding, metallurgy, glass-making, domestic fuel, charcoal production etc. continued to place considerable stress on the forest resources.

The roots of today's problem - loss and degradation of the basin's forest resources - therefore go very deep. Yet, it is not only a question of loss and degradation.

Forests stabilize soil distribution, thus counteracting erosion, conserve genetic resources by offering a relatively protected, semi-enclosed ecosystem. Besides wood for burning as domestic fuel, they also supply the raw material of wood products, such as furniture, building materials, cork, resin, seeds and handicrafts, and tanning chemicals. Imported Australian eucalyptus and American pine have helped to establish industrial plantations, especially for paper-pulp. As agriculture has become more intensive and, particularly on the northern side, has abandoned marginally exploitable land area, reforestation has been carried out. This, has, however, with increased tourism and recreation (forests being a significant attraction - camping, hiking etc.), contributed to an increase in the incidence of forest fires (see section 3.1.3). Forests also play an important part in stock raising, by serving as grazing areas.

The principal types of pristine forest in the basin are:

- Sclerophytic laurifoliate forests, in hot-temperate or hot zones, comprising two main types of tree: (i) oil-bearing, of small to medium size, of which the best known are the olive tree (*Olea europæa*), the carob tree (*Ceratonia siliqua*) and the mastic tree (*Pistacia lentiscus*), which are widely distributed; (ii) shrub oaks, of which the main species are, in the west, the holm oak (*Quercus ilex*) and the cork oak (*Q. suber*), and, in the east, the Palestine oak (*Q. calliprinos*).

- Resinous forests, comprising four main types: (i) on low-lying terrain, Aleppo pine (*Pinus halepensis*), in the west and central sub-regions, and the Calabrian cluster pine or Pyrenean pine (*Pinus brutia*, taxonomically synonymous with *P. halepensis* or, at best, a sub-species), in the east, sometimes mixed with *P. mesogeensis*, *P. pinea* and *Cupressus sempervirens*; (ii) in the foothills of mountain ranges, black pine (*Pinus nigra*), and sometimes Scotch pine (*Pinus sylvestris*); (iii) in the highlands, fir (*Abies* spp.) and cedar (*Cedrus* spp.) forests, usually separate but occasionally mixed; (iv) on mountains, junipers (*Juniperus thurifera* and *J. excelsa*, among others).

- Deciduous forests, at middle altitudes and where rainfall is greatest, comprising: the deciduous oaks (*Q. faginea, Q. infectoria, Q. cerris, Q. œgilops, Q. ithaburensis*, among others); European hornbeam (*Ostrya carpinifolia*) and yoke-elm (*Carpinus orientalis*); flowering ash (*Fraxinus ornus*); beeches (*Fagus silvatica*, *F. orientalis*).

The actual tree stands that may be encountered may, for many reasons, differ from the basic formations mentioned above. There are also degraded forests, classified as scrub forests (maquis, garrigue, matorral) which occupy the major part of the forested surface of the basin, notably in Spain, Turkey, ex-Yugoslavia, Albania and France.

The classification of the vegetation and the forestry of the whole Mediterranean area has been recently carried out by applying remote sensing techniques. A database for a permanent monitoring system has been set up to observe and to study their condition and changes in time and space. The project has been developed by the MAP Regional Activity Centre for Environment Remote Sensing.

2.2.8 Water resources and management

The water resources and their management have been well described in Fascicule 6 of the Blue Plan (Margat, 1992).

The natural input of fresh water to the Mediterranean basin is directly by rainfall (and its indirect form, snow). There are two main seasons: a weak, spring season, and a strong autumn season, separated by a hot and dry summer season. Rainfall is commonly heavy but of short duration, leading to catastrophic flash flooding. Rainfall percolates through soil and permeable rocks, supplying rivers, lakes and subterranean aquifers. After removal of water by Man, rivers and some aquifers discharge their water into the sea.

River basins in the Mediterranean are all small, except that of the Nile whose water is mainly supplied by tropical rainfall (and subsequently stored in the Aswan reservoir; the non-Egyptian part of the Nile - the upper Nile - is not included in the present consideration). Only five river basins exceed an area of $50x10^6km^2$. Nevertheless, nearly 60% of the land area of the Mediterranean basin is occupied by river valleys of less than 10^4km^2 individual area. The broken geomorphology of the Mediterranean basin, especially on its northern, south-eastern and eastern parts, ensures relatively rapid riverine run-off.

The main annual average river discharges (>$5km^3$/year) are from the Rhone (54), Po (47), Ebro (17), Neretva (12), Drin (11), Meric-Evros/Ergene (10), Seyhan (8), Tiber (7), Ceyhan (7), and Adige (7). The Nile has a discharge of $89km^3$/year at the level of the Aswan dam, but that at its interface with the sea (~$5km^3$/year) is greatly reduced by the high level of withdrawals (mainly for irrigation, domestic use and fish farming).

Subterranean water bodies, or aquifers, and the related subterranean water courses are also affected by this particular geomorphology and are, therefore, generally of small size. There are two main types, corresponding to their matrical rock: karstic (e.g., Ebro valley, Jura and Apennine mountains, Dalmatia, Greece, southern Turkey, Levant, northern Egypt, northern Libya, Atlas mountains); and alluvial (e.g., Rhone, Po, Nile valleys). There are, however, often close connections between aquifers of the two types. Numerous coastal aquifers may be independent and submarine. Mediterranean aquifers show considerable variability and irregularity, depending on geological situation, rainfall patterns and snow melt (in the Alps). Minimum output (monthly average) may be as low as 1% of maximum output (over the year), although the overall average ratio is about 20%.

There is some importation of fresh water from outside the basin, to the north (about 29km^3/year) and to the south (about 56km^3/year, from the upper Nile via the Aswan dam).

The mass balance for the Mediterranean basin can be briefly summarized by the approximate "balance sheet" (drawn up in km^3/year) presented below.

This simple balance sheet hides the considerable differences between the northern and southern sides of the basin, which are analysed in some detail by Margat (1992). It also hides the possibilities for exploitation by Man, since not all water sources and courses, nor many karstic reservoirs, can be controlled and managed.

Nevertheless, the management and exploitation of fresh water in the basin has been practised since time immemorial and by all the numerous civilizations that have been established or have flourished around the basin. The basin, as we now know it, and not least the water cycle thereof, has therefore been shaped by Man.

The principal factors have certainly been irrigation and domestic consumption, but deforestation has played a major role in modifying the hydrological regime by encouraging soil erosion and introducing irregularity into the natural system of run-off. Deforestation (to provide wood for fuel, buildings, ships, bridges; to make room for human habitation, industry and other facilities; and to allow expansion of stock-raising and agriculture) has also had a major impact on the vegetation now typical of the basin; over-grazing by sheep and goats has, in turn, led mainly to the destruction of the ancient oak forests and their replacement by scrub vegetation (garrigue and maquis), thus closing a major loop in the system of degradation.

Water quality varies considerably, locally, but is generally adequate for the principal uses; there are two negative factors, however: (i) there is frequent turbidity during periods of peak flow, due to the very active soil/rock erosion (water courses have generally high slope owing to mountainous terrain). Sediment load over an average year is about 0.66kg/m^3; (ii) high water hardness due to extensive calcareous terrain and a shortfall in purity due to often poor filtration by karstic-type terrain, itself often receiving surface water.

Also, subterranean aquifers in coastal areas are often invaded by sea water, especially when they are not kept full by the fresh water supply; on the southern side of the basin, the arid climate also raises the salinity of subterranean water.

"Profits"			**"Losses"**	
Rainfall and snow melt		1 100	Evapotranspiration	580
Importation:	via the Nile	56	Evaporation	20
	from north	29	Surface run-off to the sea	475
	underground	1	Underground run-off to the sea	30
Water return (after use)		85	Water use	165
Total		1 271		1 270

Land and water are intimately related in Mediterranean littoral areas as a result of formation of coastal lagoons and of ponds in deltaic areas.

2.2.9 Oil and natural gas

At present, the extraction of oil and gas, for energy and for chemical transformation, is the most important submarine activity. It takes place off the eastern Spanish coast, the eastern Italian coast, in the Gulf of Taranto, off southern Sicily, the Ionian Sea and northern Aegean Sea coasts of Greece, off Egypt, Libya, eastern Tunisia, and off eastern Algeria.

Oil drilling produces, at best, dirty wastewater and oil which is dumped onto the land, to rivers and to the sea. From the oil-industry point of view, this is a use of the land and/or sea that is hard to avoid; however, as soon as drilling has been completed and wells connected to the distribution system, this form of mining generally occupies little space and produces relatively little environmental nuisance, except when a major accident occurs, which is relatively rare on land (see also section 2.2.11).

2.2.10 Mining

Land mining is a major use of the land, mainly for: oil and natural gas (notably Algeria, Egypt, Libya and Syria, and Italy for natural gas); metallic ores, such as bauxite (notably France, ex-Yugoslavia and Greece), iron (Spain), chromite (Turkey), boron (Turkey); cement (notably Italy, Spain, Greece and Egypt), phosphate-bearing rock formations (Tunisia and Jordan), uranium ores (notably France, Algeria, Spain); lignite (Greece). Land mining often involves the dumping of mine tailings (coal slag heaps, for example) and ore slurry to the land, to rivers (hence to the sea) or to the sea directly. The use of the land for mining is vertical (coal pits) or horizontal (open-cast mining and quarrying for limestone, bentonite, lignite, asbestos).

Submarine mining in the Mediterranean comprises mainly drilling for oil and gas and dredging of gravel and sand. In fact, most sea-bed mining is more costly than land mining, so that this particular type of activity is at a relatively early stage of development. As already noted, the narrow continental shelf in the Mediterranean also limits the possibilities for sea-bed mining. A special form of marine mining is salt extraction by evaporation in coastal salt beds.

In countries where building materials are in short supply or expensive, coastal sea-bed dredging for gravel and sand is often an important marine activity to provide such materials (ICES, 1992a; Campbell, 1993). Such activities sometimes exceed limits and seriously harm natural structures of sensitive ecosystems.

2.2.11 Energy generation and consumption

The role of energy generation and use in determining environmental quality is discussed in detail in Fascicule 7 of the Blue Plan (Grenon *et al.*, 1993).

Since energy production (Table III), in particular, cannot be easily dealt with simply on a basin basis and statistics on consumption, on the same basis, are not readily available, these aspects of the energy question have been dealt with on a national basis. A distinction is made between the large and developed countries on the northern side (Spain, France, Italy, ex-Yugoslavia and Greece) and those on the southern and eastern sides (Turkey, Syria, Israel, Egypt, Libya, Tunisia, Algeria and Morocco).

For the northern group, the primary energy consumption, in 1990, in terms of oil equivalents in millions of tons, was 550MtOE (million tons of oil equivalents), of which France and Italy alone accounted for 70%, based on (in descending order of quantity): oil, nuclear power (predominantly French), coal, natural gas, hydroelectric power.

For the southern-eastern group, the corresponding consumption was 144MtOE, based on (also in descending order of importance): oil, natural gas, coal, hydroelectric power (no nuclear power). The leading consumers were Turkey, Egypt and Algeria. The difference between the two groups of countries is declining steadily, however.

Table III. Production and consumption of commercial energy for Mediterranean countries, for 1993

Country	Primary energy production (10^{15} J)					Energy consumption (10^{16} J and 10^{9} J per caput)						P/C ratio[a]
	Total	Solids	Liquids	Gas	Electricity	Total	Solids	Liquids	Gas	Electricity	Per caput	
Albania	44	5	23	4	12	43	12	18	4	10	13	1.02
Algeria	4 584	1	2 481	2 102	1	1 183	42	411	734	3	44	3.87
Bosnia and Herzegovina	14	-	-	-	14	29	-	-	15	15	8	0.48
Croatia	179	3	90	70	16	965	330	316	159	160	109	0.19
Cyprus	-	-	-	-	-	63	1	62	-	-	87	-
Egypt	2 435	-	2 028	376	31	1 226	37	783	376	31	20	1.99
France [b]	4 746	263	136	94	4 253	9 153	610	3 204	1 307	4 032	159	0.52
Greece	352	315	24	4	9	989	357	616	4	12	95	0.36
Israel	1	-		1	0	505	166	340	1	1	96	0.00
Italy [c]	1 126	11	194	730	292	6 749	452	3 912	1 952	434	118	0.17
Lebanon	1	-	-	-	1	12	0	119	-	1	43	0.08
Libya	3 054	-	2 806	248	-	457	0	271	186	-	91	6.68
Malta	-	0	-	-	-	24	8	16	-	-	66	-
Morocco	21	18	0	1	2	297	49	243	1	5	11	0.07
Slovenia	86	31	0	0	54	194	37	84	25	49	100	0.44
Spain	1 204	427	47	27	703	3 359	764	1 621	267	708	85	0.36
Syria	1 234	-	1 134	76	24	565	0	465	76	24	41	2.18
Tunisia	209	-	196	13	0	218	3	165	50	0	25	0.96
Turkey	779	484	163	7	125	1 979	680	998	178	124	33	0.39

a. Production/comsumption ratio; b. Includes Monaco; c. Includes San Marino

(United Nations Energy Statistics Yearbook, 1993)

Regarding primary energy production (as of 1990), the northern group produced only 208MtOE (~38% of its consumption needs, in which France predominated); the main sources (in descending order) were: nuclear power (again, mainly France), coal, hydroelectric, natural gas, oil. In contrast, the southern-eastern group produced 264MtOE (~183% of its consumption needs, in which Morocco, Tunisia and Libya predominated); the main sources (in descending order) were: oil, natural gas, coal, hydroelectric power, (no nuclear power).

Mainly for economic and, increasingly, environmental reasons, there is a shift away from coal and oil (relatively "dirty" sources) to natural gas (relatively "clean"); and perhaps, in due course, nuclear power (which is relatively "clean" environmentally, if the problem of the safe disposal of waste nuclear fuel can be solved, but which also presents a number of strategic and political problems of national security).

Grenon *et al.* (1993) also outline the prospects for the so-called renewable sources of energy (i.e., depending more or less directly on the relatively constant input of solar energy to the Earth).

An increase in hydroelectric power production may be feasible in Morocco, Spain, ex-Yugoslavia and Turkey, although the construction of dams always raises important environmental conflicts which will be better understood as experience of previous installations is better assessed (the effects of the Aswan dam providing a particular example). Under Turkish Environmental Impact Assessment Regulations, EIAs have to be prepared for big dams, and in the related reports the probable impacts are examined and measurements then taken to minimize negative impacts.

Geothermal energy sources are still only poorly known and exploited in the Mediterranean basin, although it is, in principal, an "active" region in this respect; distribution of this form of energy (mainly as hot subterranean water) presents some serious practical difficulties of distribution, however.

The possibilities for developing wind energy are obviously restricted to the windiest areas: notably France (Atlantic and the mistral winds), Greece (the meltemi wind) and Morocco (also Atlantic wind), but also the Ebro valley and Andalucia, Sardinia and Sicily. This source of energy seems likely to supply only local electricity needs, but this could be important on islands (e.g., Crete) where winds are strong and persistent enough; a common use of wind power is to pump subterranean water to the surface.

Solar energy obeys some of the same constraints, being potentially useful, especially for local use (house heating, hot domestic water, for example), in the southern and eastern countries of the basin that have a high level of direct solar radiation.

Sources of biomass energy principally take the form of firewood, rural (crop) wastes and, partially, urban wastes. However, the possibilities of exploitation vary considerably from country to country, depending on such factors as the existing forest volume and potential biomass (if reforestation were practised assiduously), the nature and size of the local agriculture as a source of fermentable crop leftovers, and, similarly, for urban wastes, this source of thermal energy being related to urban population size and consumption, hence to the levels and nature of these wastes.

According to the OECD (Grenon *et al.*, 1993), energy production, transformation and consumption by Man account for 90% of all sulphur oxides and of lead released into the atmosphere; these pollutants are followed by nitrogen oxides (85%, and 60-75% for nitrous oxide alone), carbon dioxide (55-80%), volatile organic compounds (55%), particles (40%), carbon monoxide (30-40%), and man-made methane (15-40%).

The main toxic substances emitted during the generation, transformation and consumption of energy by human beings are: benzene and other aromatic hydrocarbons, from crude-oil processing; heavy metals, notably lead from consumption of leaded petrol (although there is now a tendency to reduce such consumption); and even radioactive substances from the burning of coal and heavy fuels.

3. *State of the Marine and Coastal Environment*

3.1 Coastal Zone

Caddy and Griffiths (1995) have summarized the main impacts of human activities on enclosed and semi-enclosed seas. The susceptibility of enclosed and semi-enclosed seas to human activities can be summarized under four headings (adapted from Caddy, 1993): (i) the scale of riverine, atmospheric and coastal (direct terrestrial run-off) inputs relative to the rate of flushing to the ocean (the Atlantic, in the present case), and the catchment area and its rainfall relative to the area of the semi-enclosed sea; (ii) the extent to which sills or basins modify the exchange of water with the ocean and within the semi-enclosed sea itself; (iii) the latitude, depth and consequently, to a significant extent, the temperature and stratification of the water mass; and (iv) the size of the human populations residing along the littoral and within the catchment basin, the level of human activities and the land use practices. A growing problem, however, globally as well as in the Mediterranean, is due to increased water withdrawals for human activities on land, which is often accompanied by increased loadings of nutrients and other materials in the remaining discharge; this changes the nature of marine aquatic systems in general and estuarine systems in particular.

Ever since it was established, the Mediterranean Action Plan has stressed the need to apply integrated management to the coastal zone and integrated planning to the environmental protection thereof. During its first decade, MAP concentrated on monitoring the state of the Mediterranean Sea and on interventions aimed at improving the state of the natural system. The understanding emerged that pollutant sources were mostly (80%) on land, and that there was a need for the harmonization of development with the receptive capacity of the environment; this calls for permanent integrated planning and rational management of the region's resources. This led MAP to concentrate on the coastal area and on meeting the requirements of the Land-Based Sources Protocol of the Barcelona Convention (Jeftic, 1994). To this end, a first survey of such sources was completed in 1984 (UNEP/ECE/ UNIDO/FAO/UNESCO/WHO/IAEA, 1984); also, eighteen assessments of key pollutants (from the list in Annex I to the Protocol) have now been carried out, and have been used in the preparation of the present report.

The integration of environment and resource management policies with those on coastal area development must therefore be based on the identification of complementary objectives and the use of policy instruments that are at once compatible and efficient (cost effective). In terms of coastal area development, macro-economic policies must take into account, from their conception, their net impact on the planning and management of coastal area development, tourism etc.

MAP's contribution to this end has been focused on the identification, evaluation and setting up of appropriate institutional, technical or policy-making mechanisms. Experience in this direction has shown that such integrated planning has not yet been fully applied to the coastal zone. Modern methods for this purpose have not been widely adopted and most of the plans already drawn up fail to take into account the roles of the atmosphere, the inshore and offshore sea use and human activities in the hinterland. The underlying objective must be to ensure a comprehensive coverage of a whole range of activities in a given coastal area. Basic information on coastal areas and resources for Mediterranean countries is presented in Table IV.

3.1.1 Urban environment

In the Mediterranean, the human coastal population is about 130 million, although this figure depends very much on where the boundaries of the coastal zone are drawn. Grenon and Batisse (1989) used, *faute de mieux*, the administrative units bordering the sea in each country, although the areas of these units, in most cases, well exceed the usual idea of the coastal area as a strip of a few hundred to just a few thousand metres on either side of the coastline (sea-land interface); however, these units also tend to serve as "statistical" units for present purposes.

Of the Mediterranean population, about 40% is concentrated on the coast and it is expected to double by the year 2025. The urban development resulting from this concentration exerts great pressure on natural resources and areas, land (required for building) and water (section 2.2.8) and energy supply (section 2.2.11). The stress is also reflected in the increased demand for food (sections 2.2.5 and 2.2.6), transportation (section 2.2.3) and recreation facilities (section 2.2.4), and, beyond that, in health and quality of life, including employment, especially in the service sector, in which a high level of skills is usually required; those having such skills are generally more exigent as to living conditions.

It is hard to quantify the quality of the urban environment. The measurement of air pollution (section 3.2), for example, or the amount of domestic wastes produced (section 3.1.2), or even the percentage area given to green spaces in the urban environment, are only indicators of the overall quality.

3.1.2 Disposal of industrial and domestic wastes

The amount of waste generated by human society is generally a direct function of its population size and industrial development, although the nature of a society and its industry may determine the nature and quantity of the waste produced.

The discharge of sewage occurs in the vicinity of all the major cities of the basin, and has drastically modified the ecosystem in this vicinity. The "dumping" of heat (cooling water) from coastal industrial and power-generating plants in the Mediterranean may also have contributed to such modification. Moreover, pollution-combatting techniques are not being developed as fast as industry is expanding (Ramade *et al.*, 1990).

The dumping of industrial and urban wastes is an important use of the sea in the basin, the main routes being direct discharge, normally through coastal outfalls, indirect discharge via rivers, themselves discharging to the sea, and via the atmosphere from which wastes, especially particulates, are deposited dry on the sea surface or washed out by rain (see section 3.2). For some metals, organochlorines and some petroleum hydrocarbons, atmospheric deposition is a major pathway from source to sea.

Direct industrial discharges to the sea are generally dispersed relatively quickly, mainly by the sedimentation of solid wastes and the dilution of liquid wastes, usually within only a few tens of kilometres of the point of discharge. Nevertheless, the flora and fauna are usually severely affected within this area (i.e., the so-called river or discharge plume). Dispersal and dilution are much slower if discharge is direct into rivers, and the flora and fauna correspondingly under much greater and more prolonged stress. Estuaries and deltas often serve as spawning and nursery areas for many species of invertebrates and fishes, so the early-life stages can be severely prejudiced.

Table IV. Coastal areas and resources for Mediterranean countries

Country	Length of coastline * (kilometers)	Population * (thousands)		Average annual volume of goods loaded and loaded 1988-1990 (thousand metric tons)			Offshore oil and gas resources					
							Annual Production				Proven Reserves	
				Petroleum		Dry Cargo	Oil (thousand metric tons)		Gas (million cubic metres)		Oil (million metric tons)	Gas (billion cubic metres)
		Total	Mediterranean	Crude	Products		1982	1992	1982	1992	1992	1992
Albania	418	3 256	1 325	X	71	1 673	0	0	0	0	67	0
Algeria	1 200	23 039	10 105	29 110	24 409	15 266	0	0	0	0	0	0
Bosnia and Herzegovina *	20	4 470	300	X	X	X	0	0	0	0	0	0
Croatia *	5 790	4 900	1 520	X	X	X	0	0	0	0	0	0
Cyprus	782	503	503	545[b]	502	4 586	0	0	0	0	0	0
Egypt	950	58 978	24 004	146 855	4 204	25 351	28 386	0	755	0	367	142
France	1 703	56 556	5 839	68 135	40 443	110 786	0	0	0	0	0	0
Greece	15 000	10 264	9 209	15 407	4 590	26 680	0	299	0	0	4	11
Israel	160	5 472	3 041	6 463[b]	1 412	15 593	0	0	0	0	0	0
Italy	7 953	57 104	32 621	88 893	46 074	100 510	498	3 685	10 523	3 618	8	227
Lebanon	225	3 000	2 700	23[b]	205[b]	1 058	0	0	0	0	0	0
Libya	1 770	4 900	3 920	48 241[a]	4 545	7 242	0	6 972	0	0	109	3
Malta	180	362	362	X	564	1 546	0	0	0	0	0	0
Monaco *	4	30	30	X	X	X	0	0	0	0	0	0
Morocco	512	26 074	3 670	4 910	140	28 990	0	0	0	0	0	0
Slovenia *	32	2 020	250	X	X	X	0	0	0	0	0	0
Spain	2 580	39 434	15 926	47 932	22 958	89 71	1 413	697	0	920	1	7
Syria	183	14 186	1 362	16 233	3 287	6 070	0	0	0	0	0	0
Tunisia	1 300	8 785	6 164	4 330[a]	937	13 762	1 520	1 245	0	0	34	0
Turkey	5 191	56 473	11 336	87 729	57 969	64 083	0	0	0	0	0	0

a. Goods loaded; b. Goods unloaded; 0 = zero or less than half the unit of measure; X = not available.

(Adapted from WRI, 1994), *Data provided by Blue Plan

Gaseous wastes are mainly the gases of combustion (water vapour, carbon dioxide and monoxide, nitrogen and sulphur dioxides), methane, chlorofluorocarbons, volatile organic compounds, including solvents, heavy metals (generally released with volatile organics). There are quantitative and qualitative differences between those emitted by urban agglomerations and those by industry, but there is also appreciable overlap, qualitatively.

WHO and UNEP/MAP have carried out a questionnaire exercise on land-based sources of pollutants, in the Mediterranean coastal area and, on that basis, have reviewed the related industrial and domestic waste management (UNEP/WHO, 1996). Responses to the questionnaire were received from Albania, Algeria, Croatia, Cyprus, Egypt, France, Greece, Monaco, Slovenia, Spain, Syria and Turkey. It should be said, however, that responses to some questions were lacking or incomplete. Nevertheless, a number of useful basic tabulations were prepared and the main results are mentioned in the following sub-sections. Although the responses were broken down by major conurbation and even by specific discharge point, only the general situation at the national and regional levels are considered here.

Wastewaters

Urban liquid wastes comprise mainly dirty water (from domestic or industrial washing), detergents (usually with the dirty water) and lubricating oils; some solvents may also be part of such waste, but they normally evaporate at an early stage in the disposal chain. The amount of urban wastes, solid as well as liquid, is growing very fast, and especially in countries with intermediate average incomes (between $6,000 and $10,000 per year).

Industrial liquid wastes comprise wastewater, oils, detergents, solvents, organic chemicals and heated cooling water.

The survey mentioned above showed that over 90% of the population (understood here as that of the Mediterranean-basin parts of the responding countries) which is served by a waste-water collection system, is so served by municipal sewer systems. Although the ratio of permanent residents to summer visitors (tourists etc.) is generally very high, France and Spain of the responding countries, have ratios of 50-60% (i.e., roughly a doubling of the coastal population in the summer); by inference, Italy must also have a low ratio, and probably Greece and Turkey have fairly low ratios, as well.

Some 33% of the population (as specified in the preceding paragraph) have the disadvantage of no municipal sewage treatment, and about 41% have the benefit of secondary treatment (preliminary and primary treatment occupying the remainder, ~26%; Table V).

About 5% of the waste-water is re-used, of which 95% in irrigation and 5% in recreational areas. When discharged, about 85% of it goes, directly or indirectly, to the sea; only about 15% is discharged onto the land or used further (UNEP/WHO, 1996). Table VI gives the disposal of municipal wastewater for each of the responding countries.

Solid wastes

Urban solid wastes comprise, basically, organic matter (e.g., food debris), paper, glass, wood, textiles, plastics and metals. A practical guide for the management of urban solid waste in coastal Mediterranean countries has been prepared by UNEP (1991a). The solid wastes (mainly garbage) of human habitation and socio-economic activity are either used for land fill or, sometimes, dumped into the sea, although there is a growing recycling industry producing paper and packaging materials, composite insulation materials (shredded paper in a resinous matrix), glass for bottle-making, and scrap metal; such recycling only slows down the eventual discharge to land or sea environments, however.

Industrial solid wastes comprise slag (from coal mining, coal processing and steel making), sludge (from the processing of, for example, bauxite and ilmenite, the main titanium ore), dust and combustion ashes, and mine tailings.

Regarding municipal sludge, the disposal of over 50% of it was not specified in the above-mentioned questionnaire responses; recognized discharge covers about 33% and about 10% goes to agricultural purposes.

Table V. Estimated annual amount of municipal waste water and treatment level (UNEP/WHO, 1996)

No.	Country	Total ww 10^6 m^3/yr	Untreated ww 10^6 m^3/yr	%	Treated waste water					
					Prelim.	%	Prim.	%	Sec.	%
1.	Albania	8.52	8.52	100	0	0	0	0	0	0
2.	Croatia	71.44	61.78	86	9.51	13	0	0	0.15	0.2
3.	Cyprus	16.66	14.75	88	0	0	0	0	2.05	12
4.	France	361.00	47.70	13	0	0	0	0	313.20	87
5.	Greece	520.26	226.36	43.46	0	0	220.74	42.43	72.39	13.92
6.	Monaco	7.50	0	0	0	0	0	0	7.5	100
7.	Slovenia	6.13	1.09	18	0	0	5.04	82	0	0
8.	Spain	589.29	180.62	31	45.22	8	17.30	3	346.15	59
9.	Syria	24.80	24.51	99	0	0	0	0	0.29	1
10.	Turkey	404.87	103.23	25.5	216.26	53.42	-	-	85.37	21.09
TOTAL		2 010.47	668.56	33.25	270.99	13.50	243.08	12.10	827.10	41.15

Table VI. Municipal waste disposal (UNEP/WHO, 1996)

No.	Country	Total urban waste water (million m^3/year)	Estimated annual discharge (million m^3/year)							Estimated annual amount of waste water re-used (million m^3/yr)					
			Into the sea or rivers												
			Through municip. sewer system	Through other sewer system	Sub-total	Onto land	Into sub-soil	Other	Sub-total	In irrig-ation ponds	In fish ponds	In Industry	In recreation areas	In recharges	Sub-total
1.	Albania	8.52	7.92	-	7.92	-	0.60		0.60		-	-	-	-	-
2.	Croatia	71.44	50.23	9.58	59.81	-	-	11.60	11.60		-	-	-	-	-
3.	Cyprus	16.66	-	-	-	0.36	14.38	0.84	15.58		-	-	1.11		1.11
4.	France	361.00	359.52	-	359.52	-	1.50	-	1.50		-	-	-	-	-
5.	Greece	520.26	373.76	0	373.76	0.29	136.33	1.53	136.63	1.53	0	0	0	0	1.53
6.	Monaco	7.50	7.50	0	7.50	0	0	0	0	0	0	0	0	0	0
7.	Slovenia	6.13	5.08	-	5.08	-	0.94	0.11	1.05	0	0	0	0	0	0-
8.	Spain	589.29	489.08	5.68	494.76	0.33	-	-	0.33	91.24	-	0.05	3.69	-	94.98
9.	Syria	24.80	24.45	0.35	24.80	-	-	-	-	-	-	-	-	-	--
10.	Turkey	404.87	358.48	0.30	358.78	42.20	0	0	42.00	4.08	0	0	0.12	0	4.18
TOTAL		2 010.47	1 676.02	15.91	1 691.93	42.91	153.75	12.40	209.29	96.85	0	0.05	4.92	0	101

The above figures refer to land-based sources of pollution in the Mediterranean coastal area.

Table VII shows the amount of municipal sludge disposed of and its uses.

Over two million tons of solid wastes are disposed of by composting (~21%) or incineration (~7%), but over 70% of it is disposed of by unspecified means, again according to the afore-mentioned survey. Table VIII shows the amounts of municipal solid wastes produced and their treatment or disposition.

It is interesting to note that, in the five Mediterranean countries (France, Greece, Italy, Spain and Turkey) that are members of the OECD, there is an increasing trend in the generation of municipal and household waste (OECD, 1995). Municipal waste, defined as waste collected by or at the order of municipalities, includes waste originating from households, commercial activities, office buildings, institutions such as schools and government buildings and small businesses that dispose of waste at the same facilities used for municipal collected waste. The municipal waste generation in kg/capita increased during 1980-1992 respectively from 260 to 310 for Greece, from 250 to 350 for Italy, from 270 to 360 for Spain, and from 270 to 390 for Turkey, while in France it increased from 460 in 1990 to 470 in 1992 respectively. Also, in France, the amount of household waste defined as waste generated by domestic activity of households, which include garbage and waste collected separately, has risen from 310 kg/capita in 1980 to 360 kg/capita in 1992.

Hazardous wastes

Whereas, in general, industry is a principal source of hazardous or toxic wastes, urban development is a principal source of microbiologically risky wastes (see section 3.1.2), as well as of detergents and lubricating oils (together with industry).

However, the draft Protocol (to be submitted to the Contracting Parties to the Barcelona Convention) on the Prevention of Pollution of the Mediterranean Sea Resulting from the Transboundary Movements of Hazardous Wastes and their Disposal provides a list, in draft Annex I, of twenty-one categories of substances or materials that are considered to be hazardous, and twenty-seven kinds of substances, elements or compounds which, if present in wastes, are considered to render such wastes hazardous. The list covers all the elements, compounds and substances that are considered as pollutants in the present report, as well as some that are not specifically so considered. Also covered by the draft protocol are any substances or materials that have one or more of fourteen characteristics that could render them physically hazardous.

The draft protocol also specifies fifteen operations that do not lead to the possibility of resource recovery, recycling, reclamation, direct use or alternative uses, and thirteen that do. They are all based on actual or past applications. Hazardous wastes must, in any case, be managed in an environmentally sound manner, under this draft Protocol.

No attempt is made here to provide amounts of hazardous wastes handled by individual countries or transported between them. Although such quantities may provide an indication of the level of hazard, the nature of a given material or substance, the methods of disposal, and the quality of their application, will have a significant bearing on the risk involved under a given set of circumstances. The relevant regulations and controls, and whether or not they are properly enforced, are important factors in risk assessment. The nature of the risks in, for example, maritime transport in the Mediterranean have been briefly mentioned in section 2.2.3, above, for what amounts to a random selection of transported substances (mostly crude oil, in fact).

3.1.3 Soil degradation, desertification and forest fires

These three topics are closely related. Soil is degraded quantitatively by erosion and qualitatively by prolonged use for agriculture without adequate addition of fertilizer, by overgrazing, and by repeated heavy rainfall leading to leaching of essential chemicals and loss of fine-grained sediment, thus denying the soil a suitable structure for plant root systems (a coarse-grained soil has poorer water retention capacity). In some areas, subject to long periods of insolation, soil may become crusted, thus

Table VII. Municipal sludge disposal (UNEP/WHO, 1996)

No.	Country	Total 10^3 m^3/yr	Discharged 10^3 m^3/yr	Agriculture 10^3 m^3/yr	Discharged and Agriculture combined 10^3 m^3/yr	Other or not indicated 10^3 m^3/yr
1.	Albania	0	0	0	0	0
2.	Croatia	1.75	1.75	0	0	0
3.	Cyprus	5.30	5.30	0	0	0
4.	France	1 207.37	251.26	155.05	24.62	776.44
5.	Monaco	91.50	0	0	0	91.50
6.	Slovenia	0	0	0	0	0
7.	Spain	3 980.85	1 460.95	381.05	194.99	1 943.87
8.	Syria	0	0	0	0	0
9.	Turkey	67.94	0	0	27.94	40
TOTAL		5 345.71	1 719.26	536.10	247.55	2 851.81

Table VI. Municipal solid wastes (UNEP/WHO, 1996)

No.	Country	Total 10^3 tons/yr	Incineration 10^3 tons/yr	Composting 10^3 tons/yr	Other 10^3 tons/yr	Remarks
1.	Albania	70.70	-	-	70.70	Landfill
2.	Croatia	189.75	-	-	189.75	Landfill
3.	Cyprus	368.80	8.30	-	360.50	S. Landfill
4.	Monaco	13.00	13.00	-	-	-
5.	Slovenia	29.39	-	-	29.39	S. Landfill
6.	Spain	1 771.28	154.44	431.58	1 184.67	
7.	Syria	144.88	-	44.00	100.88	Landfill
8.	Turkey	2 121.30	0	187.50	1 933.80	Landfill
TOTAL		4 709.10	175.74	663.08	3 869.69	

The above figures refer to land-based sources of pollution in the Mediterranean coastal area.

preventing rapid or deep penetration by water when rainfall comes.

Forest fires, by destroying the forest, deprive the soil of a major water-retention and anti-erosion system.

Soil erosion due to the removal of plant cover (e.g., deforestation) in watersheds increases sediment loading of rivers and changes the seasonal cycle and amount of fresh water run-off to coastal seas, as well as the levels of siltation (GESAMP, 1993). High riverine sediment loads adversely affect anadromous species such as salmon and sturgeon, and estuarine organisms such as oysters. It also has a serious negative impact on aquatic vegetation which is often of key importance as fish and bird habitat.

The end product of this system of degradation, aided by high temperatures and low rainfall, is desert. The main processes briefly outlined above are described in more detail by Mensching (1986). In view of the growing deficit in food products for most of the region, the Blue Plan has identified soil degradation and soil loss as one of the major problems facing the Mediterranean in medium term, and, in cooperation with FAO and using the CORINE land-cover system, is currently analyzing the evolution of this process (Grenon and Batisse, 1989).

The use of satellite remote sensing of the Mediterranean, as a means of assessing the spread of desertification and lesser forms of soil degeneration, as well as changes in vegetation cover, is indeed a useful tool and has also been undertaken under the DAPHNE Project of the Regional Activity Centre for Environment Remote Sensing (UNEP, 1995a).

Forest fires have increased considerably in frequency in recent decades (Marchand *et al.*, 1990; Ramade *et al.* 1990; Table IX), accidentally, owing mainly to increased tourism and grazing and to psychologically motivated pyromania, and intentionally, owing to criminal pyromania, often inspired by an ambition to make land available for real-estate development (hotels, apartment buildings and secondary residences) or for grazing areas. These causes have been aided by poor forest management.

Not only does Table IX show the growth in the frequency of forest fires, but also the improved coverage of the data.

Table IX. Growth in the number of forest fires in the Mediterranean basin, for 1970-1985 (adapted from Ramade *et al.*, 1990)

Country	1970-1975	1975-1980	1980-1985
Algeria	-	-	904
France	3 559	5 550	5 350
Greece	-	1 620	1 184
Israel	-	-	899
Italy	4 924	4 074	11 854
Morocco	-	-	185
Spain	3 175	5 612	8 314
Tunisia	-	-	101
Turkey	-	1 108	1 204
ex-Yugoslavia	-	752	908
Total	11 658	18 716	30 903

The increasing frequency of fires reduces a forest's ability to recover. Holm oaks, cork oaks and Aleppo pines recover the most rapidly. Nevertheless, the recovery time for an Aleppo pine forest is ~75 years, and for a holm-oak forest, ~200 years.

3.2 Airborne Pollution

There are three aspects to the air-pollution problem: one is the pollution of the air itself, with its impacts on human health and possibly on weather and climate; another is the atmosphere's role in the transfer of pollutants; and a third is the contribution of the sea itself to atmospheric pollution.

GESAMP (1989) has reviewed the atmospheric input of trace chemical species to the world ocean and has summarized the data relevant to the Mediterranean Sea.

UNEP/WMO (1994) have undertaken a comprehensive review of airborne pollution of the Mediterranean Sea by sulphur and nitrogen compounds and heavy metals.

Two important regional projects have addressed pollutant-transfer aspects of air pollution in the Mediterranean basin: DYFAMED (Dynamique et Flux Atmosphériques en Méditerranée Occidentale - France) addresses the problem specifically; under EROS-2000 (European River-Ocean System), a project of the Commission of the European Union, it is one of six sub-projects.

The main objective of the WMO Global Atmospheric Watch (GAW), established in 1989, is to provide data and other information on the chemical composition and related physical characteristics of the atmosphere and its interactions with the oceans and the biosphere (Soudine, 1992).

One of the six sub-projects of EROS-2000 has attempted to compare riverine and atmospheric fluxes to the north-western Mediterranean. Saharan dust and some heavy metals are predominantly airborne. These and other relevant substances (e.g., nitrogen) play a major role in the key biogeochemical cycles, of which little is known in the Mediterranean region.

One of the main objectives of DYFAMED is the study of the dynamics of the atmospheric fluxes and their evolution in the water column. DYFAMED results so far have revealed considerable seasonal fluctuation in the atmospheric inputs of pollutants to the sea, and there is also rapid downward transport in the marine water column.

The MED POL component of the WMO Global Atmospheric Watch comprises 15 monitoring stations; the suite of observations (not yet fully attained) is: <u>in precipitation</u> - pH, conductivity, sulphate, ammonia, nitrate, sodium, potassium, magnesium, calcium, chlorine, cadmium, lead, copper and zinc; <u>in the air</u> - cadmium, lead, total particulate matter, surface ozone. To these may be added, in due course, ^{137}Cs, transuranics, PCBs, DDTs, HCHs, PAHs and particulate hydrocarbons, the nutrients N and P, and carbon black, as a good inert tracer for validating model calculations (Soudine, 1993).

Mention has already been made of the predominance of the atmosphere in the transfer of some trace metals (as mercury, lead, zinc), most organochlorines (notably PCBs, DDT/DDE/DDD) and PAHs.

The fate of atmospherically transported trace metals deposited at the sea surface is critically determined by the degree of solubilization in sea water, since this controls the manner in which they take part in the biogeochemical processes in the mixed layer. Particulate/dissolved phase relationships of atmospherically transported particulate trace metals are determined by the solid-state speciation of the metals in ærosols. Gravitational deposition will deliver ærosols to the sea surface in a "dry" state; they will react directly with sea water. Particulate/dissolved phase changes can be initiated in rain water, prior to deposition on the sea surface. This can be very important because the Ph of rain water can be considerably lower (more acidic) than that of sea water, leading to enhanced leaching of trace metals from ærosols (Liss and Slinn, 1983).

Martin *et al*. (1989) have compared, for the north-western Mediterranean (data for the eastern Mediterranean are still very scarce), the relative contributions of the atmosphere and the rivers to the input, to the sea, of several contaminants. Thus, the contribution (in ascending order) of ^{238}plutonium, total phosphorus, ^{241}americium, total nitrogen, and ^{137}cæsium is predominantly (mean percentage >50%) via riverine discharge; that of water is almost half and half atmospheric (rainfall) and river/land run-off; and (also in ascending order) the contribution of dissolved cadmium, $^{239+240}$plutonium, dissolved copper, particles, particulate copper, particulate cadmium, particulate lead and dissolved lead are all predominantly (also >50%) via the atmosphere. The contribution of lead in both forms (particulate and dissolved) is >90% atmospheric.

The available data (and model computations) from the GAW show (Soudine, 1992) that a significant proportion of the pollutants entering the Mediterranean Sea is transported via the atmosphere from coastal and remote land-based sources. By comparing specific cadmium sources and receptor points, using 36-hour atmospheric (wind) trajectories, the role of the atmosphere has been confirmed, and it may be concluded that pollutants emitted to the atmosphere on the European hinterland may reach the Mediterranean in 24-48 hours; it should be noted that the main trajectories are determined by the principal topographical features and the corresponding winds discussed in section 1.3, above. For cadmium, in particular, it has been shown that the Gulf of Lions, the Gulf of Genoa, the northern Adriatic and the Aegean Sea are the marine areas most affected by the long-range transport of cadmium from the major sources in Europe.

The principal available data for various atmospheric inputs to the Mediterranean Sea summarized by GESAMP (1989) refer almost entirely to the western basin or even just the north-western part. The main inputs are of the silicon, aluminium and iron minerals, which have total depositions of 1535, 435 and $360x10^6$kg/year, respectively. Of the trace elements, contaminant or not, the corresponding annual depositions of the predominant species are: zinc ($17x10^6$kg); phosphorus ($16x10^6$kg); lead ($14.5x10^6$kg); vanadium ($12.5x10^6$kg); manganese ($11x10^6$kg); well ahead of copper ($2.1x10^6$kg), cadmium ($0.5x10^6$kg) and arsenic ($0.5x10^6$kg). GESAMP also gives some percentages of European emissions from human activities entering the NW Mediterranean Sea via the atmosphere: zinc (21%), cadmium (19%), lead (12%) and copper (11%). For zinc and copper, at least, the ratio of wet to dry deposition is about 4:1. Also, atmospheric deposition fluxes are increased by rainfall, which scavenges the atmosphere of ærosols.

No data on atmospheric mercury deposition are presented, either by GESAMP or by UNEP/WMO (1994). Goldberg (1976) points out the fact that mercury has not only a relatively high vapour pressure, but is also degassed from the Earth's crust, giving global degassing rates of $2.5x10^{10}$ to $1.5x10^{11}$g/year and comparing them to estimated global riverine discharge of $<3.8x10^9$g/year; global production of mercury amounts to about $10x10^9$g/year. The situation in the Mediterranean is not known, but Man's influence appears to be negligible except, no doubt, for localized "hot spots".

Some difficulties arise in the analysis of many synthetic organic compounds in the atmosphere, because, for example, the partitioning of these compounds between the gaseous and the particulate phases is highly influenced by carbon soot and dust, the effects of which are in turn highly dependent on particle size, which may greatly affect deposition rate (input to the sea).

Regarding synthetic organic chemicals in natural waters, the net flux has hitherto been from the air to the sea, but, recently, decreased production and emission of many hydrophobic organic chemicals (HOC), such as PCBs and PAHs, have resulted in lower levels of these compounds in the environment, so that HOC fluxes across the interface may have reversed and the sea may now be a source of organic contaminants to the atmosphere.

Very few data on atmospheric deposition of synthetic organic compounds are available for the Mediterranean. In GESAMP (1989) the following values were given for total deposition over the north-western Mediterranean: alpha-HCH (4.3x10^{6}g/year), gamma-HCH (5.6x10^{6}g/year), ÓHCH (9.9x10^{6}g/year), ÓDDT (0.3x10^{6}g/year), ÓPCB (1.7x10^{6}g/year) and HCB (0.2x10^{6}g/year). A corresponding value of 3.8x10^{6}g/year for the riverine input of ÓPCB is also given. In general, the Mediterranean values are lower than those over the North Sea and the Baltic Sea but higher than over the open ocean. Moreover, on a global basis, the atmospheric inputs of these synthetic organic compounds represent 85-99% of their total inputs (atmospheric + riverine).

The principal effects of sulphur oxides, lead, nitrogen oxides, carbon dioxide and monoxide, volatile organics, molecular mercury, methane etc. on the atmosphere are those associated with the so-called "greenhouse" effect and those producing smog: in certain places under certain atmospheric conditions, particularly those prevailing over some big cities, the volatile organic compounds and nitrogen oxides are modified photochemically by solar radiation to produce so-called photochemical oxidants that, in association with dust particles (as condensation nuclei) and water vapour, produce the oppressive smoke-fog ("smog"). Added to the aforementioned forms of pollution, in some places, is that due to the burning of kerosene, coal or firewood for domestic heating, the products of which are mainly carbon dioxide and monoxide, volatile organic substances and sulphur oxides; their effects are similar to those described above.

There are a few other substances that play a role in atmospheric pollution, but not much is yet known about them in this sense. They are: dimethyl sulphide, carbonyl sulphide and methane, which have significant fluxes from the sea to the atmosphere, and nitrous oxide. They are discussed in a little more detail in the section 3.6, on climatic change.

Loye-Pilot *et al.* (1990) and Martin *et al.* (1989) present a body of data on the input of nitrogen to the sea via the atmosphere, and the results are summarized in GESAMP (1989). Some 350x10^{6}kg N/year are so input to the ocean, compared to a value of 227x10^{6}kg N/year via riverine discharge. This nitrogen contributes some 10% "new" primary production (i.e., relative to the average for the western basin) and perhaps as much as 50% under oligotrophic conditions (i.e., such as is more commonly found in the eastern basin). However, in the eastern Mediterranean, "new" production is dominated by the internal flux (deep winter mixing); therefore, atmospheric input may contribute only about 10% of the "new" production, as suggested for the western basin.

Carbon soot arises from combustion of all kinds of organic compounds. Particle size is very small (micrometre range), thus providing a very large surface for the adsorption of other chemical elements and compounds, including pollutants, and making the atmosphere an effective vehicle. Owing to its low chemical activity and low sedimentation rate in sea water, soot serves as a tracer of atmospheric fine-particle inputs to marine surface waters and of particle packaging and transport in sea water. Other particulate matter may play similar roles and be almost certainly important in the dispersion of pollutants in sea water.

Ramade *et al.* (1990), among others, have drawn attention to the often serious negative effects of polluted air (as manifested in, for example, acid rain) on buildings, hence on the region's architectural/archæological heritage, the notable examples being Athens, Istanbul and Rome. Moreover, acid rain, and photo-oxidants generally, seriously affect the ærial parts of the vegetation.

3.3 Marine Environment

The monitoring of the sources, levels and effects of pollutants in the Mediterranean Sea, and the related research, have been one of the cornerstones of the Mediterranean Action Plan. The Coordinated Mediterranean Pollution Monitoring and Research Programme (MED POL) is the environmental assessment component of the Action Plan. It was mainly designed to help the Contracting Parties to the Barcelona Convention to participate in a full-scale marine pollution research and monitoring programme, as well as to provide continuous information on the pollution of the Mediterranean; it is described in UNEP (1984).

The monitoring of pollutants affecting the Mediterranean marine environment reflects primarily the immediate and long-term requirements of the Barcelona Convention and its Protocols, but also takes into account those factors directly relevant to understanding the relationship between the socio-economic development of the region and the pollution thereof. The monitoring under MED POL started in 1983 through the implementation of National Monitoring Programmes and, at present, 18 Mediterranean countries have ongoing activities and are submitting data. They are: Albania, Algeria, Croatia, Cyprus, Egypt, France, Greece, Israel, Lebanon, Libya, Malta, Monaco, Morocco, Slovenia, Spain, Syria, Tunisia and Turkey. Through this programme, pollution is being regularly monitored at hundreds of sampling stations (Fig. 2).

Now, as result of concerted international efforts, current knowledge of the state of contamination of the Mediterranean Sea is much greater than it was two decades ago. Through MED POL, the Mediterranean Action Plan has, since 1976, coordinated these efforts with the support of the governments of 20 Mediterranean coastal States, the European Union and the relevant bodies of the United Nations (ECE, UNIDO, FAO, UNESCO, WHO, WMO, IMO, IAEA, IOC). The study has permitted the identification of the priority pollutants and the preparation of assessments thereof which, in some cases, have lead to proposals for control and abatement measures. It has also permitted the formulation and implementation of a long-term pollution monitoring and research programme - MED POL Phase II (1981-1996) - which has been helping the Mediterranean countries to evaluate their own pollution problems, assess the effectiveness of control and abatement measures and allow long-term trend studies to be conducted.

The data generated through MED POL are used as the basis for the analysis of the present "state of health" of the Mediterranean Sea and the trends in pollution levels (Jeftic, 1991).

Perhaps the most important task of MED POL Phase II is closely connected with the implementation of the Land-Based Sources Protocol which foresees the formulation and adoption, by the Contracting Parties, of common measures (guidelines, standards, criteria) for substances listed in Annex I (Black List) and Annex II (Grey List) of the Protocol.

Most of the factual information in this section has been obtained from MAP/MED POL assessments and other technical documents.

3.3.1 Levels of marine pollution

The concentration of marine pollutants varies considerably, from one environmental medium to another, from one ecological province to another, from one faunal group to another, and even from one species to another, as well as from place to place. The confirmation of a trend is therefore not easy. Any trend in concentration of a major pollutant tends to be most easily related to human activities, since variations due to natural processes have tended to an equilibrium.

For any given environmental medium, ecological province, species of marine organism, and place, the concentrations of the key pollutants are unlikely to fall outside the ranges given by Jeftic *et al.* (1990) and UNEP (1993b). The sources, inputs, environmental and sea-food levels of the main marine contaminants are also summarized in WHO (1995).

Not only does human settlement bring with it the problems of contamination referred to elsewhere here, but it also threatens the habitat of many species of marine life: fish, turtles, birds, mammals and other organisms that habitually live in the coastal zone, in the sea or on the land nearby.

Trace metals (see box on page 41)

The main trace metals, in the context of the Mediterranean Sea, are: cadmium, mercury, lead, tin, copper and zinc, the latter two being considered as biologically necessary to organisms. Arsenic, which is a metalloid (i.e., can form "metallic" compounds such as arsenic sulphide and "non-metallic" ones such as sodium arsenate) has some environmental impact and can be conveniently dealt with in this sub-section.

There are undoubted problems in the

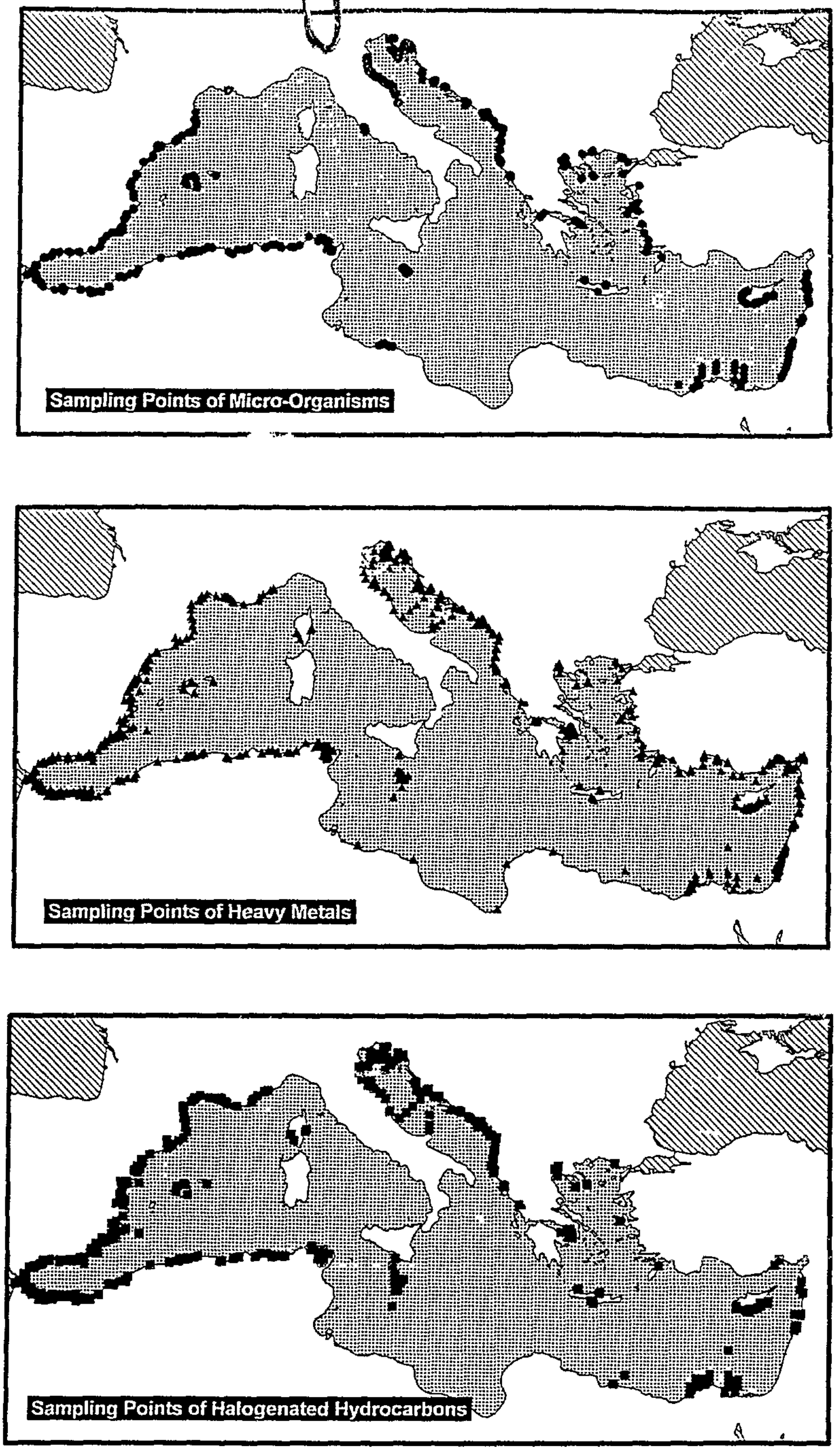

Fig. 2 Locations of sampling stations for the monitoring of marine pollution in the framework of the MED POL Programme (1983-1993)

HEAVY METALS

In contrast to most organic pollutants, heavy metals are natural constituents of the Earth's crust which are released through geological weathering and erosion and are mainly transported to the marine environment by rivers, surface run-off and atmospheric deposition. Also, many metals are essential to life and only become toxic when exposures to biota become excessive (i.e., exceed some threshold for the introduction of adverse effects). However, human activities have drastically altered the biochemical and geochemical cycles and mass-balances of some heavy metals. Heavy metals are stable and persistent environmental contaminants since they cannot be degraded or destroyed. Therefore, they tend to accumulate in the soils and sediments.

Metals and their compounds, both inorganic and organic, are released to the environment as a result of a variety of human activities. The main anthropogenic sources of heavy metals are various industrial point sources, including present and former mining activities, foundries and smelters, and diffuse sources such as piping, constituents of products, combustion by-products, traffic etc. Relatively volatile heavy metals and those that become attached to air-borne particles can be widely dispersed on very large scales. Heavy metals conveyed in aqueous and sedimentary transport media (e.g., river run-off) enter the normal coastal biogeochemical cycle and are largely retained in near-shore and shelf regions.

A wide range of metals and metallic compounds found in the marine environment pose risks to human health through the consumption of seafood in which contaminant content and exposure are significant. While certain non-essential metals do not have explicit exposure thresholds for the introduction of effects, the biological responses to metals are a direct consequence of exposure and are defined through dose-effect relationships. These differ from the dose-response relationship associated with many synthetic organic contaminants and radionuclides, for which the risk of adverse effects is assumed to be proportional to exposure. Consequently, the predominant challenge, in the case of heavy metals, is to limit exposure to levels that do not cause adverse effects.

The main heavy metals in the context of the Mediterranean Sea are: cadmium, mercury, lead, chromium, copper and zinc. So far, in the framework of the Mediterranean Action plan, assessment documents were prepared for mercury, cadmium, zinc and copper, on the basis of which control measures have been approved by the Contracting Parties to the Barcelona Convention. A summary of heavy-metal levels in the marine environment appear on pages 39-46 of this document, while their effects on marine life appear on page 58.

The high mercury levels reported for the Mediterranean in the 1970's created justifiable concern for human health, but an in-depth study indicated that the Mediterranean population in general was not at risk. In 1985, the Contracting Parties agreed to consider the FAO/WHO Provisional Tolerable Weekly Intake (PTWI) of 0.3 mg of mercury when setting national standards for maximum residue levels (MRLs) in seafoods while in 1987 they adopted a limit value for all effluent discharges of 50 µg/l.

It is estimated that 65 percent of the world's mercury resources are located in the Mediterranean basin which occupies only 1% of the earth's surface. Mining and chlor-alkali plants contribute substantially to the marine environmental loads. Early studies estimated that the inputs from domestic and industrial effluents, as well as from rivers, were about 130 tons per year. An appreciable amount of mercury, similar to that from land-based sources, must enter the Mediterranean through the atmosphere, but no reliable estimates are yet available.

Cadmium is one of the rarer metals in the earth's crust, with an average concentration of about 0.1mg/kg. Its yearly world production is about 18,000 tons. Mediterranean countries account for about 10% of this. Almost all cadmium is obtained as a by-product of zinc, copper and lead ore processing and refining. In 1989, the Contracting Parties agreed on a set of control measures, effective 1.1.91, to limit cadmium discharges into the marine environment. The limit value adopted is 0.2mg of cadmium per litre of industrial effluents discharged.

Recent studies, which also take into account atmospheric and marine inputs through the straits, estimate that a total of 92,400 tons of zinc enter the Mediterranean Sea per year. The respective inputs of copper amount to 29,000 tons per year. In 1996, the Contracting Parties adopted a quality objective in coastal waters for zinc and copper of 10µg/l and 5µg/l, respectively, as well as limit values in all effluent discharges of 1.0 and 0.5mg/l, respectively, on a monthly basis.

The objective/proposed target of the Washington Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA) is to reduce and/or eliminate anthropogenic emissions and discharges in order to prevent, reduce and/or eliminate pollution caused by heavy metals.

An indispensable action of every country is to develop, compile and maintain inventories on significant sources, including natural sources, of priority heavy metals and their compounds. Using these inventories, inputs can be assessed and areas of concern can be determined for action. The GPA proposes, *inter alia*, the following regional actions:

- encouraging existing regional agreements and action plans dealing with the prevention and elimination of pollution of the marine and coastal environment from land-based activities, to develop or continue to develop and implement programmes and measures to reduce and/or eliminate emissions and discharges of heavy metals;
- development and implementation of monitoring programmes and regular assessments of levels, inputs and effects, based on regionally agreed quality control and quality assurance procedures and harmonised assessment criteria;
- encouraging states to join regional seas arrangements regarding the protection of the marine and coastal environment from land-based activities; and
- promotion of cooperation in the development of cleaner production technology and processes.

measurement of trace metals in the marine environment and in drawing valid conclusions from the data, in terms of environmental quality and human health and safety. At the same time, there is always a need, in the context of the Mediterranean Action Plan, to show that a serious effort is being made to measure trace elements in the main environmental compartments. Jeftic *et al.* (1990) have given adequate proof of such effort.

The main difficulties to be kept in mind, for purposes of environmental management, are as follows.

It is important, but also difficult, to ensure that measurements made at one time and place are of the same accuracy (closeness to the "truth") and precision (consistency between repeated measurements of the same sample) as those made at another time and place, if differences between areas (e.g., eastern and western basin, inshore and offshore) are to be regarded as real. Moreover, such accuracy and precision must also survive in time within each analytical laboratory. Intercalibrations at regular intervals are necessary, even if the results are sometimes disconcerting. This requires carefully prepared reference standards for each trace element of interest and for each environmental medium. Such standards are not always available for all metals and media. The problems of data quality and the value of intercalibration are described in detail in UNEP/IAEA (1994).

Some of the so-called trace metals in the marine environment are subject not only to movement by Man in the course of his industrial and mining activities, but also to movement by Nature in the course of weathering of rocks, transport and discharge (into the sea) by rivers and release in the course of volcanic and tectonic activity; there is the well established case of high natural mercury levels in tuna (relative to most other fish) and of bioaccumulation in general in certain marine organisms (notably shellfish). The quantities mobilized by human activities are often small compared to those mobilized in the normal biogeochemical cycle (mercury being an example).

Another problem is the so-called chemical speciation of polyvalent metals (and arsenic), due to the fact that they have the capacity to enter into chemical combination in more than one way. The particular valency assumed depends mainly on the particular geochemical "history" of the metallic ions and the nature of the medium in which they might find themselves; the particular environmental pathway followed depends a lot on this process. It is still difficult to determine the partitioning of a particular trace metal, hence the likelihood of it ending up more or less directly in a sink (e.g., the sediments) or in biota in the food chain leading to Man. In some cases the analytical method itself "reduces" the metal present in an environmental sample to one valency state, and methods appropriate to the measurement of the principal valency states have, in some cases, yet to be developed.

Depending on local circumstances (e.g., proximity to a point source) as well as the aforementioned factors, the observed ranges of most of the key trace metals are considerable in space; comparable observations in time (i.e., regular sampling at the same sites at regular intervals, with other parameters being kept as constant as possible) are less frequent. As UNEP (1986), UNEP/FAO/WHO (1987), UNEP/IOC (1988), UNEP/FAO/WHO (1989), Gabrielides *et al.* (1990), Jeftic *et al.* (1990), Alzieu *et al.* (1991), Michel (1992) and UNEP (1995b) show, there are considerable differences between the results reported by different reliable authors for a given element and environmental medium.

Although it is necessary to pursue serious routine monitoring, refining sampling and analytical methods continually, the predominant practical issue is to control the risk of human intake of toxic trace elements directly in food or indirectly via fish and shellfish cultivated in water so contaminated (see section 3.3.2, below).

The sources, main environmental pathways and levels of trace metals in Mediterranean sea water, sediments and biota, as far as these are known, are summarized below. In general, there is a tendency for sea-water values to decline with distance from the coast, but this may also be partly due to the fact that, except in the NW

Mediterranean, the sampling depth was near the sea surface offshore. Also, some trace metals enter easily into strong stoichiometric associations with certain organic molecules, known as chelates, or adsorb strongly onto suspended particles, such that the fate of the metal is tied to that of the organic molecule or the particle; such molecules and particles are much more abundant in inshore waters.

The levels in the marine sediments are usually very much higher than those in the sea water and may be assumed to be in a long-term sink if at depths (in the sediment) greater than, say, 50cm; above this depth, recirculation to the sea water by organisms - bioturbation - or by physico-chemical activity in the pore waters may occur. Relatively little is known about these processes (except from very localized studies of them).

The levels of trace metals in marine organisms also vary over a wide range generally exceeding the levels in the sea water and, in some cases, such as zinc, the levels in the sediments. In organisms, however, as noted, bioaccumulation may play an important role.

The differences between the main MED POL sub-regions of the Mediterranean are exposed by Jeftic *et al.* (1990); in some cases, data for specific localities within sub-regions are given. "Within-subregion" ranges sometimes approach "between-subregion" ranges, but it should be stressed that there are often important differences between analysts for ostensibly comparable samples (as to medium and place).

The main sources (primary and secondary) of the principal trace metals are: rocks (mainly as sulphide ores); mining; ore processing; smelting (of copper, lead, nickel and zinc); agricultural, domestic and industrial wastes; combustion of fossil fuels.

The main environmental pathways are: rocks (following weathering by wind and water) and soil erosion 6 rivers 6 sea; or 6 run-off 6 rivers 6 sea; or (following combustion, metal processing, volcanic activity) 6 air 6 sea; or (from agricultural run-off, domestic, industrial effluents, via outfalls) 6 sea or 6 rivers 6 sea.

In considering the levels, presented here only in terms of range between the lowest and the highest values observed, the fact that the values come from a wide range of sampling sites and times must be kept in mind.

Cadmium comes from: copper refining (as a by-product); lead processing; electroplating; solders; batteries; production of alloys, pigments and PCBs; sewage sludges.

The levels in sea water cover a wide range of values (UNEP, 1986; UNEP/FAO/WHO, 1989; Jeftic *et al.*, 1990): open sea 0.004 - 0.06 µg/l (recent and probably more reliable data); coastal sea <0.002 - 0.90µg/l, with a tendency for high values to be related to sources (estuaries, coastal mining).

The levels in sediments cover a much wider range: 0.02 - 64µg/g dry weight.

The levels in biota likewise cover wide ranges (depending on the groups of organisms considered; UNEP, 1986; UNEP/FAO/WHO, 1989): plankton 0.4 - 4.6µg/g d.w.; crustaceans 90 - 490µg/kg wet (or fresh) weight (w.w.); Mediterranean mussels 5 - 1060µg/kg w.w.; red mullet 1 - 590µg/kg w.w.

Mercury comes from rocks (mainly as sulphide ores), degassing (of elemental mercury) from the Earth's crust and oceans, volcanoes, chlor-alkali plants, petrochemical industry and sewage outfalls.

Jeftic *et al.* (1990) gave special attention to mercury because it is already the object of legislation in several Mediterranean countries, in respect of sea food. The FAO/WHO Provisional Tolerable Weekly Intake is 0.3mg of mercury, of which no more than 0.2mg may be in the form of methylmercury. MED POL has produced a document on the assessment of mercury pollution (UNEP/FAO/WHO, 1987), and the PAP/RAC prepared a specific case study of mercury pollution in Kastela Bay, Croatia (UNEP, 1990a). In general, human emissions are substantially less than natural ones; ratios of 1:4 up to 1:30 have been derived, admittedly from very rough raw data. Goldberg (1976) indicates a ratio of two orders of magnitude between the mercury content of the world oceans and the amount mined (i.e., potentially mobilized) by Man.

The levels of total mercury (Hg-T) in the Mediterranean marine environment seem to be decreasing in many areas, mainly owing to the fact that analytical procedures have improved and more attention has been paid to the problem of sample contamination. Earlier results indicated high values, with concentrations in sea water in the so-called "open" sea areas reaching 140ng/l, and in coastal areas, 520ng/l (UNEP/FAO/WHO, 1987; Jeftic *et al.*, 1990). However, more recent data indicate that open-sea concentrations are only a few nanograms per litre, and those in coastal areas affected by pollution sources do not exceed 50ng/l (e.g., Kastela Bay; Horvat *et al.*, 1986). That is, in general, mercury levels in sea water are no higher, on average, than those elsewhere.

The levels (also of Hg-T) in sediments vary, depending on the distance of the sampling location from the sources, as well as on the fraction of the sediment analyzed. The failure to normalize the data and apply and intercalibrate standard sampling and extraction techniques (including the use of different grain-size fractions) is an impediment to proper comparison and interpretation of the results. However, in general, 0.05-0.10mg/kg d.w. can be considered as background concentrations (UNEP/FAO/WHO, 1987). "Open-sea" sediments may have concentrations up to 1mg/kg d.w., and concentrations in very polluted areas may exceed 5mg/kg d.w. (Jeftic *et al.*, 1990; Gabrielides, 1994)

The mercury levels in biota reported earlier created justifiable concern from the human-health standpoint, since red mullet (*Mullus barbatus*) from the Tyrrhenian Sea were reported to have concentrations in their flesh as high as 7mg/kg w.w. An in-depth study showed, however, that the Mediterranean population in general was not at risk (Gabrielides, 1994). Recent data indicate that the mercury levels in biota exceed 1mg/kg w.w. only in large animals or carnivorous species, such as swordfish and tuna. In fact, the inter-quartile range (that between the lower 25% and the upper 75% limits of concentration levels) calculated from the MED POL data bank is 0.12 - 0.86mg/kg w.w. for all fish, 0.24 - 0.88mg/kg w.w. for all crustaceans, and 0.03 - 0.23mg/kg w.w. for benthic fauna (bivalves and gastropods).

A significant proportion of the mercury in organisms may be in the form of methylmercury; the percentage depends on a variety of factors, such as species, individual age and the tissue sampled. There is some association between amount of mercury in sediments and in the local benthic organisms.

<u>Lead</u> comes from: mining; smelting; steel-making; production of alloys; batteries; pigments; combustion of leaded (by lead tetraethyl) petrol. A ratio of 7:1 for industrial:domestic discharge has been calculated.

The levels in sea water cover a wide range of values (UNEP, 1986; Jeftic *et al.*, 1990): open sea 0.018 - 0.14µg/l (recent and probably more reliable data); coastal sea 0.016 - 20.5µg/l, with a tendency for high values to be related to sources (lead tetraethyl production and estuaries).

The levels in sediments cover a much wider range: 3 - 3300µg/g d.w.

The levels in biota cover wide ranges (depending on the groups of organisms considered; UNEP, 1986); Mediterranean mussels 50 - 16100µg/kg w.w.; red mullet 23 - 610µg/kg w.w.

<u>Tin</u> comes from: antifouling additive in marine paints; fungicides; acaricides; molluscicides; wood and stone preservatives; disinfectants (the tin used in these applications is mainly in the form of tributyltin/TBT and triphenyltin); antihelminthics; stabilizers in PVC; catalysts in the production of silicones, polyurethanes etc. (dibutyltin/DBT and monobutyltin/MBT). Tin may also be present as methyltin (TMT/DMT/MMT) and as inorganic tin (Sn-I).

The main pathway to the marine environment is by leaching from treated cooling pipes and vessel (especially yacht) hulls into the ambient water.

The levels in sea water cover a wide range of values (UNEP/FAO/WHO/IAEA, 1989; Gabrielides *et al.*, 1990; Jeftic *et al.*, 1990), depending significantly on the level in the source and the dilution of the river, estuarine or sea water (marinas, ports etc.): mostly 100 - 1000ng/l; maximum ranges are: <2 - 12,150ng/l (TBT); <1 - 484ng/l (DBT); <0.5 - 2774ng/l (MBT), though values are generally much higher in the water surface microlayer. Alzieu *et al.* (1991) provided further data on TBT, DBT and TPT (triphenyltin) but these data fell within the ranges already cited.

The levels in sediments are only available, so far, for Alexandria harbour: 35 - 975ng/g d.w. (TBT); 10 - 305ng/g d.w. (DBT); 0 - 330ng/g d.w. (MBT); 310 - 4720ng/g d.w. (Sn-I).

There are no data available for levels in biota in the Mediterranean region (Gabrielides *et al.*, 1990).

<u>Copper</u> comes from: mining; alloys; metal plating; electricals; catalysts; jewellery; algicides; wood preservatives.

The levels in sea water cover a wide range of values (UNEP, 1986; Jeftic *et al.*, 1990; UNEP, 1995b): open sea 0.04 - 0.70µg/l (recent and probably more reliable data); coastal sea <0.01 - 50µg/l, with a tendency for high values to be related to sources (Nile discharge, coastal mining).

The levels in sediments cover a much wider range: 0.6 - 1890µg/g d.w.

The levels in biota, likewise cover wide ranges (depending on the groups of organisms considered; UNEP, 1986; Jeftic *et al.*, 1990; UNEP, 1995b): microplankton 5.9 - 172µg/g d.w.; non-gelatinous macroplankton 12.6 - 71.1µg/g d.w.; gelatinous macroplankton 2 - 22.4µg/g d.w.; Mediterranean mussels 2.4 - 154µg/g d.w.; red mullet 0.0025 - 2.7µg/g w.w.; seaweed (*Ulva lactuca*) 2.4 - 154µg/g d.w.

<u>Zinc</u> comes from: smelting; alloys; steel-making; metal-plating and galvanizing; paints and dyes; batteries; organic chemical production; oil refining; fertilizers; paper pulp; viscose rayon production. A ratio of 2.5:1 for industrial:domestic discharge has been calculated.

The levels in sea water cover a wide range of values (UNEP, 1986; Jeftic *et al.*, 1990; UNEP, 1995b): open sea 0.24 - 0.56µg/l; coastal sea 0.20 - 210.0µg/l. UNEP (1995b) give a range of 0.016 - 48µg/l for a wide variety of Mediterranean waters.

The levels in sediments cover a much wider range: 1.7 - 6200µg/g d.w.

The levels in biota likewise cover wide ranges (depending on the groups of organisms considered; UNEP, 1986; UNEP, 1995b): microplankton 52 - 2500µg/g d.w.; non-gelatinous macroplankton 37 - 228µg/g d.w.; gelatinous macroplankton 17 - 312µg/g d.w.; Mediterranean mussels 12 - 644µg/g d.w.; red mullet 0.1 - 7.1µg/g w.w.; seaweed (*Ulva lactuca*) 33 - 1549µg/g d.w.

<u>Arsenic</u> is a by-product or waste of non-ferrous metal processing (copper, zinc, lead, gold and cobalt), of fossil-fuel burning and the processing of phosphate rock and bauxite (for aluminium).

The levels of total dissolved arsenic in sea water, in the western Mediterranean below the photic zone (since arsenic is metabolized by phytoplankton), are 1.3 - 1.4µg/l (Michel, 1992). In estuaries and rivers the values are much more variable: 1.5 - 3.75µg/l in the Rhone delta.

The levels in sediments cover a much wider range: values of 40µg/g d.w. and of ~1400µg/g have been measured in the port of Athens and the Gulf of Saronikos, respectively. In deep-sea sediments, however, values tend to authigenic levels and the arsenic there is probably of oceanic origin. Particulate arsenic in suspension tends to decrease with increasing salinity.

The levels in biota likewise cover wide ranges (not only interspecifically but also intraspecifically) and are often related to proximity to a point source (Michel, 1992): seaweeds 3 - >200µg/g d.w.; 6 - 19µg/g d.w.in sea lettuce (*Ulva*); 34 - 40µg/g d.w. in *Porphyra umbilicalis*; 9 - 59µg/g d.w. in Mediterranean mussels; 14 - 27µg/g d.w. in oyster (*Crassostrea gigas*); 3 - 26µg/g d.w. in scallops (*Pecten maximus*); 7 - 14µg/g d.w. in shrimps (*Crangon crangon*). The values in fishes are very variable, depending on species, individual size and dietary habits.

Organochlorines (see box on page 47)

The principal organohalogen contaminants in the Mediterranean marine and coastal environment are PCBs, DDT and its metabolites (DDE and DDD), hexachlorohexane (HCH), hexachlorobenzene (HCB), heptachlor, and the pesticides aldrin, dieldrin (the epoxide of aldrin) and endrin (a stereo-isomer of dieldrin) (UNEP/FAO/WHO/IAEA, 1991a). The majority of organohalogens are released from their sources into the atmosphere, and in particular from soils by two possible processes, known as "wick - evaporation" and "absorption displacement" (Goldberg, 1976). Such mechanisms are necessary to explain their wide distribution in the atmosphere and in a variety of environmental media far from the main sources. Also, there is certainly some return from the sea to the atmosphere by molecular evaporation from the sea surface and purging by bubbles bursting at the sea surface or by "upward scavenging" by sea spray. Nevertheless, those (the majority) used in agriculture are also washed off the land into rivers, thence to the sea, or directly into the sea via outfalls or run-off.

Over 80% of the total input into the sea is via the atmosphere, and less than 20% via rivers. The agricultural pesticides transported by the atmosphere from inland sources may reach the sea, but over a wide area (regional, if not global) so that the effect on the coastal sea is not easily quantifiable and is probably moderate (Goldberg, 1976). The majority of organohalogens appear not to persist in sea water or sediments, but do appear to have quite complex biogeochemical pathways (UNEP/FAO/WHO/IAEA, 1991a and UNEP/IAEA/FAO, 1992).

The appreciable analytical uncertainty of the measurements of organochlorines in marine samples and, in the Mediterranean context, the extremely uneven coverage as to environmental compartments (as air, water, sediments and biota) and sampling sites, makes the evaluation of the data and results highly problematical.

There is a wide range of levels in sea water, depending on the type of water sample (e.g., surface microlayer, surface water, sea-water-dissolved phase, subsurface water) and sampling site; only PCBs have been satisfactorily analyzed in Mediterranean open-sea water samples.

Polychlorinated biphenyls (PCBs) are industrial hydrocarbons used as dielectric fluids in transformers and capacitors, as coolants in refrigerants, and as plasticizers in some paints. They are ubiquitous in the atmosphere and are transferred to the sea by scavenging by rain and by dry deposition. In the sea, they are particle-reactive compounds, partitioning between lipid and natural organic phases.

The levels in sea water are (UNEP/FAO/WHO/IAEA, 1991a and UNEP/IAEA/FAO, 1992): up to 548ng/l in sea water itself and up to 597ng/l in the surface film.

The levels in sediments cover a much wider range: up to 16,000µg/kg d.w., although most minima observed are <0.1µg/kg d.w.

The levels in biota, likewise, cover wide ranges (UNEP/FAO/WHO/IAEA, 1991a and UNEP/IAEA/FAO, 1992) and are very variable within most species, with some relation to proximity to a specific source, however: values up to 453µg/kg w.w., although most minima observed are <0.1µg/kg d.w.; PCBs are most abundant in mussels and fish.

DDT is a well known, potent insecticide used on a global scale especially to control the spread of malaria by mosquitoes. It has, however, also been implicated in the demise of bird populations through egg-shell thinning and in the premature calving of seals. Although banned from use in western Europe, it is used in some countries bordering the Mediterranean Sea. DDT is metabolized to DDE which is very persistent in the environment and is thought to be a metabolic dead-end with a considerable toxicity.

PERSISTENT ORGANIC POLLUTANTS (POPs)

Persistent Organic Pollutants (POPs) are, by definition, organic compounds that are highly resistant to degradation by biological, photolytic or chemical means. Substances in this category of pollutants also possess a number of other characteristics. They are: (i) liable to bioaccumulate; (ii) toxic; (iii) prone to long-range transport and deposition; and (iv) probably hazardous to human health or the environment. POPs are typically characterised as having low water solubility and high-fat solubility. Only a few compounds possess all characteristics required for inclusion in this category.

The primary transport routes into the marine and coastal environment include atmospheric deposition and surface run-off, the former being by far the greatest. Because many POPs are relatively volatile, their remobilization and long-distance redistribution through atmospheric pathways often complicates the identification of specific sources. POPs, even those no longer in use, are almost always found when environmental samples are analysed.

POPs have been associated with significant environmental impact in a wide range of species and at virtually all trophic levels. Many POPs have been implicated in a broad range of adverse human health and environmental effects, including impaired reproduction and endocrine dysfunction, immunosuppression and cancer. In addition, exposure to POPs has been correlated with population declines in a number of marine mammals. However, as with many environmental pollutants, it is difficult to establish causality of illness or disease that is directly attributable to exposure to a specific POP.

The UNEP Governing Council, at its meeting in May 1995, identified 12 specific POPs which require urgent attention. These are PCBs, dioxins and furans, aldrin, dieldrin, DDT, endrin, chlordane, hexachlorobenzene, mirex, toxaphene and heptachlor. All these POPs are synthetic organochlorines, nine of which are pesticides used on agricultural crops and/or in public health vector control. Hexachlorobenzene is a fungicide but is also a byproduct of the manufacture of industrial chemicals. It is a known impurity in several pesticide formulations.

The use and/or sale of organochlorine pesticides has been banned or restricted in most Mediterranean countries since the mid-1970's. However, DDT is still used to control mosquito vectors of malaria in numerous countries of the world.

Polychlorinated biphenyls (PCBs) which are mixtures of chlorinated hydrocarbons (209 possible compounds) are produced for industrial uses especially as dielectrics in transformers and large capacitors and as heat exchange fluids. Their use is now mostly restricted in closed systems.

Polychlorinated dibenzo-para-dioxins (dioxins) and polychlorinated dibenzofurans (furans) are two groups of planar tricyclic compounds that have very similar chemical structures and properties. There are 75 possible positional isomers for dioxins and 135 for furans. Neither dioxins nor furans are produced commercially, and they have no known use. They are impurities resulting from the production of other chemicals. Dioxins may be released into the environment through the production of pesticides and other chlorinated substances. Furans are a major contaminant of PCBs. Both are related to a variety of incineration reactions, and the synthesis and use of a variety of chemical products. Dioxins and furans have been detected in emissions from the incineration of hospital waste, municipal waste, hazardous waste, car emissions, and the incineration of coal, peat and wood.

Most POPs are monitored systematically in the Mediterranean region. Characteristic levels are indicated on pages 46-48 of this document. Following the preparation of relevant assessment documents, the Contracting Parties to the Barcelona Convention adopted, in 1989, common measures for the control of pollution by organohalogen compounds. These measures basically include an environmental quality objective for total DDT in coastal waters of 25ng/l effective 1.1.91. In 1989, the Contracting Parties also agreed to promote measures to reduce inputs into the marine environment and to facilitate the progressive elimination of organophosphorus compounds hazardous to human health and the environment by the year 2005. They also adopted restrictions on the use of TBT-containing antifouling paints. In 1993, they recommended the reduction and phasing out, by the year 2005, of inputs to the marine environment of toxic, persistent and bioaccumulative substances listed in the LBS protocol, in particular organohalogen compounds having those characteristics. This decision is also included in the 1995 Barcelona Resolution.

Twelve POPs are mentioned specifically in the LBS protocol after its amendment in March 1996. According to Article 5 and Annex I, the Parties undertake to eliminate pollution deriving from land-based sources and activities, in particular to phase out inputs of the substances that are toxic, persistent and liable to bioaccumulate, giving priority to organohalogens and specifically to the 12 POPs.

POPs are also included in the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (Washington, 1995). For POPs the objective/proposed target is:

- to reduce and/or eliminate emissions and discharges of POPs that threaten to accumulate to dangerous levels in the marine and coastal environment;
- to give immediate attention to finding and introducing preferable substitutes for chemicals that pose unreasonable and otherwise unmanageable risks to human health and the environment;
- to use cleaner production processes, including best available techniques, to reduce and/or eliminate hazardous by-products associated with production, incineration and combustion (e.g. dioxins, furans, hexachlorobenzene, PAHs); and
- to promote best environmental practice for pest control in agriculture and aquaculture.

DDT deposition in northern Europe today is some 5 to 10 times greater than that at similar latitudes in North America.

Like PCBs, DDT is most abundant in mussels.

Hexachlorohexanes (HCHs) are a mixture of isomers of which one (gamma-HCH, lindane) is an insecticide. The atmosphere is the main pathway (99% of total input) in the global distribution of HCHs, but they are highly soluble in water so they may be washed out of the atmosphere by rain and accumulate in aquatic biota.

Hexachlorobenzene (HCB) is predominantly an industrial product, although its sources (as a marine contaminant) are still not precisely known. It is mainly used as a fumigant and a fungicide in grain storage. It may be enriched in aquatic environments in a similar manner to that of PCBs.

Heptachlor is an insecticide and is found in technical chlordane. It is degraded or metabolized in the environment and is often detected as its epoxide.

Agricultural pesticides

The commonest are aldrin, dieldrin and endrin, but others in common use in the Mediterranean basin are: chlordane; endosulfan or thiodan; toxaphene or campheclor; mirex; captan; dicofol or kelthane, 2,4-D, and dichlorophen. UNEP/IAEA/FAO (1992) stress, however, that they form only a small proportion of the total agricultural pesticides used.

Polar agricultural herbicides

The commonest herbicides found in the Mediterranean Sea are atrazine, simazine, alachlor, metolachlor and molinate, all widely used in agriculture and horticulture (Readman *et al.*, 1993a), as well as the triazines used as biocide additives to marine paints (Readman *et al.*, 1993b).

The principal pathway for the former group is wash-out from agricultural land to rivers, hence to estuaries and the sea. In contrast to hydrophobic pesticides and organochlorines, such as DDT and PCB, these compounds bind poorly to soil, sediments, organic matter and organisms, and are transported primarily in the dissolved phase. The Mediterranean region, being the drainage basin of large agricultural areas, as those of the river plains of the Ebro, the Rhone, the Po and the Nile, probably has important concentrations of these polar compounds, but few specific studies have been made of them.

The levels in nine rivers, two Greek gulfs and the northern Adriatic Sea are given by Readman *et al.* (1993a). They are <1.5µg/l and usually <<1.5µg/l. They are moderately persistent in sediments; measurements in the sediments of the two aforementioned gulfs and the deltas of the Ebro and the Nile are <5µg/g d.w.and usually <<5µg/g d.w. (Readman *et al.*, 1993a). In general, the concentrations decrease seawards.

The levels of triazine in the inshore waters of the Côte d'Azur relate closely to sources (marinas, ports) and range from <5 to 280ng/l; values in commercial ports tend to be less than those in marinas (Readman *et al.*, 1993b).

Organophosphorus compounds

These are synthetic organic compounds; some 58 OPs are used as pesticides and another 13 have non-pesticide uses (UNEP/FAO/WHO/IAEA, 1991b); in the last two decades, OP pesticides have tended to replace the persistent organochlorine pesticides. The main uses are as insecticides, acaricides, nematicides, antihelminthic agents, fungicides and herbicides, and, industrially, as flame retardants, plasticizers, solvent, antifoaming agents, hydraulic fluids, lubricants, dispersants and detergents.

In general, OPs are unstable in water, but some of them have a very high toxicity. Information on their levels in the Mediterranean marine environment is very scarce. The bulk of the research on OPs relates to their toxicity (UNEP/FAO/WHO/IAEA, 1991b).

Petroleum hydrocarbons

Petroleum hydrocarbons and crude oil. The information available on inputs to the Mediterranean Sea is still limited, as it is for some key processes, such as biodegradation processes, in the biogeochemical cycle. Nevertheless, information on levels in water (dispersed/dissolved, particulate) and on beaches (tar) has increased considerably in recent years, whereas that on levels in sediments and organisms remains rather poor (UNEP/IOC, 1988).

The physicochemical complexity of oil has made intercomparison of samples (sites, environmental compartments etc.) very problematical.

The levels of dissolved/dispersed oil in sea water range from 0µg/l to 5µg/l, with a few values exceeding 10µg/l. Tar, which floats in the sea until it is deposited on the sea shore, ranges (in sea water) from 0.6g/m^2 to 130g/m^2 and (on beaches) from 0.2 to 4388g/m (linear metre of whole beach along water edge). There is some suggestion of a reduction in these tar levels in recent years, notably in the eastern Mediterranean.

There is some indication, also, that petroleum hydrocarbons tend to accumulate in the sediments. A wide range of levels is given in UNEP/IOC (1988), and an attempt is made to construct a mass-balance statement. In terms of annual amounts (x1000 tonnes), the partition proposed is:

- surface microlayer: 0.018
- dissolved/dispersed: 30 (surface water) and 72 (subsurface water)
- tar: 8.8 (floating) and 100 (beached)
- sediments: 230 (superficial flocculent) and 120 (consolidated)
- organisms: 0.220
- atmosphere: 155

Lubricating oils, although derived from oil, are highly processed products with a wide range of industrial and domestic uses; besides the obvious use - as lubricants in engines and machinery - they are also used as cooling fluids (oil and oil-water emulsion) in most kinds of metalworking, in electrical transformers, rubber processing, spinning and natural-gas transmission (UNEP, 1989). During the processing of lubricating oils, several other compounds are added depending on the intended purpose of the oil; examples of additives are barium, zinc, sodium and phosphorus compounds, oxidation and rust inhibitors. Furthermore, some compounds, notably PAHs, are solvent-extracted during the processing.

Although it may be assumed that lubricating oils behave much as oils, no direct measurements have been made of this source of marine contamination, recourse being had to estimates based on such quantities as the number of cars in circulation, the amounts treated in municipal waste disposal systems etc. (UNEP, 1989). The major difficulties confronting such a study are the discrimination of lubricating oils and petroleum oils in the marine environment and the dispersion of the sources of the lubricating oils relative to those of petroleum oils.

Polycyclic aromatic hydrocarbons

PAHs are a group of substances mainly formed by the incomplete combustion of organic materials (e.g., petrol, coal, oil). They are highly hydrophobic and are mainly transported to the sea by ærosols. Some are carcinogenic, and those that are carcinogenic are generally also mutagenic (UNEP/WHO, 1995 and WHO/UNEP, 1990).

Few data are available on the levels of PAHs in the marine environment. The range in mussels of the Ligurian coast for eight PAHs is from "nil" (for three PAHs) to 80.24ng/g (for fluoranthene). It is apparently based on wet weight, since other data given in UNEP/WHO (1995) for the Ligurian Sea for *Mytilus* sp. range from 14 to 571ng/g d.w. The range for the Ebro delta and the Barcelona coast is much smaller, corresponding mainly to C_1-phenanthrenes.

The level in sediments for the Ebro delta range from 0.2 to 36.5ng/g d.w., and for the Barcelona coast, from 0 to 797ng/g d.w.

Radioactivity

There are at least 60 natural radionuclides, of which 14 are produced by radioactivation in the Earth's atmosphere by nuclear reactions or bombardment by cosmic-ray particles. The remainder are considered to have been present in the raw material of the Earth. Life has evolved in the presence of these nuclides, so the environmental problems refer mainly to those created or mobilized in the course of human activities (nuclear power plants, nuclear fuel reprocessing, nuclear weapon testing, medicine, nuclear physical research etc.). There are presently 29 nuclear power stations, with 4 more under construction, and 2 reprocessing plants in the Mediterranean basin, mostly sited along the Ebro, Rhone and Po rivers (UNEP/IAEA, 1992).

The environmental pathways and chemical behaviour of radionuclides is considered, *a priori*, to be the same as those of their stable (non-radioactive) counterparts, although, in certain cases (^{106}ruthenium, ^{144}cerium), the chemical form or species of the released radionuclide differs from that of its stable counterpart. The radioactivity itself, although often presenting a significant environmental risk, does not basically affect biogeochemical processes.

The radioactive contamination of the Mediterranean Sea, before and after the Chernobyl "injection" through fall-out, is given in UNEP/IAEA (1992).

Thus, the inventory of ^{137}cæsium is now some 36% greater than it was in the western Mediterranean before the Chernobyl accident; the added quantities are derived from fallout debris.

There remain higher-than-background concentrations of ^{137}cæsium in the Levantine Intermediate Water Mass. In contrast, the transuranic element ^{239}plutonium associated with this water mass remains stable. The ^{137}cæsium spike may be used as a tracer of the Levantine Intermediate Water mass in the western Mediterranean.

The present rate of removal of ^{239}plutonium from the upper 1000m of the western Mediterranean to greater depths is estimated to be 2 - 4.5% of the annual standing inventory. Therefore, the vertical distribution of ^{239}plutonium may be a valuable tracer of vertical transport of particles to deep waters.

Marine pathogenic organisms: water quality for bathing and shellfish waters

The health risks from pollution by pathogenic organisms in the Mediterranean marine environment have been summarized in UNEP/WHO (1991a,b) and in WHO (1995). The principal organisms are: bacteria (mostly of the genera *Salmonella, Shigella, Vibrio, Staphylococcus, Pseudomonas, Clostridium, Campylobacter, Escherichia* and *Aeromonas*); viruses (mainly 5 types of enterovirus, including hepatitis A virus, and adenovirus and rotavirus); fungi (mainly of the genera *Candida, Penicillium, Aspergillus, Cladosporium, Mucor, Fusarium* and *Rhizopus*); microparasites (mainly of the genera *Entamoeba, Giardia, Balantidium* and *Nægleria*); and toxic algæ (mainly of the dinoflagellate genera *Gonyaulax, Gymnodinium, Dinophysis* and *Alexandrium*).

Most of these organisms are considered to enter the marine environment through municipal waste-water discharges, although the atmosphere may be a significant route and the contribution of sea bathers themselves cannot be discounted. The principal discharges of concern in the present context are the direct discharges into the coastal marine environment; discharges into rivers, although not to be neglected, are likely to arrive at the sea in a much altered state (of abundance, toxicity etc.).

Little is known of the fate, in the sea, of the non-marine micro-organisms mentioned above, especially of the viruses, fungi and microparasites. The salinity, temperature and solar irradiation of the sea water, as well as natural predators and the dissolved marine contaminants in the sea water, are, however, known to affect the survival of pathogenic organisms encountered. Flocculation of microbial cells and subsequent sedimentation may be important also, and may explain their enrichment in the superficial marine sediments. Fæcal streptococci survive longer than the fæcal coliforms.

The classical method for determining water quality from the microbiological or sanitary standpoint is by measurement of the coliform bacteria, fæcal and non-fæcal, and the fæcal streptococci, which almost certainly explains why so little is known of non-bacterial pathogenic organisms (WHO, 1994).

There has been a significant improvement in the quality of coastal bathing water in the Mediterranean basin in recent years, judging from EEC data for Spain, France, Italy and Greece (CEC, 1993a), the 1992 levels of acceptable bathing water quality at established seaside resorts being 74%, 87%, 92% and 97%, respectively (WHO, 1995). However, a number of other Mediterranean countries, including Albania, Algeria, Croatia, Cyprus, Egypt, Israel, Malta, Morocco, Syria, Tunisia and Turkey, have also been monitoring the quality of bathing waters for the last few years, within the framework of the MED POL Programme Phase II; nevertheless, good comparable data are not yet available. These improvements have no doubt occurred in response to an increasing demand for such water quality from the tourist, as well as the resident, populations (see box on page 52). More attention is now being paid to beach sand as well, since it may be contaminated by certain pathogenic organisms and ingested by swimmers and sunbathers (especially children).

The effects on human beings and key marine organisms are outlined in the next section, but indirect effects arise through the consumption of marine organisms themselves "infected" or "polluted" with the above-mentioned microbial organisms; this is particularly the case for shellfish cultured for human consumption, because of the concentration of the species under mariculture and their frequent proximity to their main market (the coastal urbanized populations, hence to the main sources of contamination - sewage outfalls). Thus, the quality of the shellfish themselves and of the water in which they are grown has been the main consideration (UNEP, 1987c; UNEP, 1991b).

The results of a MED POL study (1976-1981) indicate that, while a majority of the sites sampled (47% - 86%, all data together) had satisfactory water quality, few (0% - 21%, all data together) had satisfactory shellfish quality (according to the criteria used in the project and without depuration of the shellfish in clean sea water). It may be expected that, with the increased demand for quality in food, from tourist and resident populations, the quality of shellfish flesh and shellfish-growing waters is improving.

Anionic detergents

The most important sources of anionic detergents in the Mediterranean Sea are land-based sources. Information on the amount of anionic detergents reaching the Mediterranean Sea is sparse (UNEP, 1994e). A pilot monitoring survey carried out in 1992 provided some information on levels of anionic detergents. Levels in sea water range from 0.01 to 4.2g/l; in effluents, from 0.11 to 34.07g/l; and in rivers, from 0.06 to 26.86g/l. This study, however, had to be restricted to a few coastal areas and the results cannot be interpreted as providing any indication of the situation prevailing in the Mediterranean as a whole.

Anionic detergents are often considered to be an environmental nuisance; although they are rapidly metabolized in human beings, they may have some negative effects on ecosystems.

Man-made litter

It is no easy matter to quantify so heterogeneous a pollutant in the marine environment; the principal interest attaches to the persistent non-natural substances, the synthetic and plastic materials. The sources, inputs and distribution of garbage are summarized in UNEP/IOC/FAO (1991). A survey of thirteen Mediterranean beaches is reported by Gabrielides *et al.* (1991).

The main components of coastal litter are, in approximate descending order of abundance:

MICROBIOLOGICAL POLLUTION OF BATHING WATERS

The Mediterranean basin can be taken as a typical example of the problems of coastal pollution insofar as they affect recreational areas, and of the difficulties in achieving adequate safety measures and in obtaining cohesion and harmonization among 19 countries which, though varying to a degree in their state of socio-economic development, do have practically the same ecological conditions, overall if not in detail.

Tourism, domestic and foreign, is heavily concentrated during the summer months, and the sea constitutes the major recreational amenity for resident and visiting populations. As a result, during this period, most beaches, particularly those located in the vicinity of cities and tourist resorts, are heavily overcrowded. The prevailing warm climatic conditions, including a fairly high water temperature, result in a comparatively long time spent on the beach, especially in the sea itself. The bather is therefore subjected to a longer exposure period to sea water than is the case in more temperate regions. Apart from pollution of the water itself, there is also the heterogeneous nature of beach populations to consider.

Potentially, all human diseases spread by the faecal-oral route, the causative pathogens of which are shed in the faeces of affected individuals or carriers, could be contracted by swimming or bathing in sewage-polluted waters. Such diseases have been reported to include bacterial diseases such as salmonellosis (typhoid and paratyphoid fever), shigellosis (bacillary dysentery), cholera, viral diseases such as infectious hepatitis, illnesses caused by a number of enteroviruses, gastroenteritis (caused by a variety of bacteria and viruses), and diseases caused by a variety of animal parasites, such as amoebic dysentery. In addition, a number of diseases and disorders affecting the eye, ear, skin and upper respiratory tract have also been associated with bathing.

From the viewpoint of human health hazards related to bathing, this situation was largely a result of the fact that over 90% of municipal sewage was discharged in a raw, untreated state from outfalls onto the immediate shoreline, in many cases in the immediate vicinity of heavily frequented bathing beaches. Although the situation has improved considerably since that time, problems still exist in a number of areas.

The countries of the Mediterranean basin, as a consequence of the Protocol against Pollution from Land-based Sources, have, since 1985, adopted common measures including criteria and standards for the protection of bathing waters against microbiological pollution. Furthermore, the four Mediterranean countries that are Member States of the European Union are also bound by the relevant EC Directives.

In line with global practice, recreational water quality standards in the Mediterranean are based on acceptable concentrations of bacterial indicator organisms (mainly faecal coliforms, supplemented by faecal streptococci) and, in some instances, pathogens such as *Salmonella* and enteroviruses.

According to the data submitted to the MED POL Programme, the quality of bathing waters in the areas covered by the countries of the Mediterranean basin has shown a positive trend during recent years. The number of stations monitored has increased year by year, from approximately 400 stations monitored in 1985 (not including EU countries) to more than 10,000 stations in 1994 (including EU countries). Compliance of non-EU countries with the monitoring frequency requirement varied between 30% in 1985 and 76.1% in 1990 with an average overall frequency of 61.1% over the 1983-1992 period, while the percentage of stations complying with coliform standards varied between 94.1% in 1983 and 69.1% in 1992 with an average overall compliance of 85.7%. While compliance might appear to be reasonably high on microbiological grounds alone, the percentages in question are affected by the fact that a large proportion of the stations were not monitored at the minimum frequency. The identified bathing areas of EU countries showed that the stations conforming to mandatory coliform standards varied between 89.1% and 89.9%, the average being 89.5%.

The increasing use of the sea as a recreational amenity, coupled with the spread of international tourism, has led to major concern among health authorities over actual and potential hazards to bathers in those areas affected by sewage pollution. The main response to the problem has been twofold: reduction of pollution at source wherever feasible through the establishment of sewage treatment plants and/or construction of submarine outfalls that discharge the effluent out to sea; and the development and enforcement of recreational water quality criteria and standards aimed at ensuring, as far as possible, that recreational marine areas present no health hazard due to sewage pollution. Both approaches are necessarily intimately interlinked, and the design and location of treatment plants and outfall structures depend on the specific characteristics of the areas concerned. In turn, water-quality criteria and standards must be based on firm epidemiological evidence if the aim is to protect the health of exposed population groups.

The MED POL programme, through its cooperation with the WHO Regional Office for Europe, contains an even stronger health-related component than was the case in the past. Emphasis is given to the development and enhancement of national programmes for regular monitoring of pollution sources and recreational waters. Research topics, in support of such monitoring, include studies on microbiological methodology with particular emphasis on seawater analysis, and the development of a common methodology, survival and adaptation of pathogens in the marine environment, pathogen indicator relationships, epidemiological studies correlating recreational water quality with health effects on exposed population groups, and carcinogenic and mutagenic marine pollutants. The progressive implementation of the recently amended land-based pollution Protocol includes the development and implementation of national and regional action plans and programmes, the strengthening of existing systems of inspection by the competent authorities so as to assess compliance with authorizations and regulations, and the application of the best available techniques and best environmental practice, including clean technologies, with the aim of minimizing pollution at source.

plastics (fragments, sheets, bags, containers), wood (driftwood, crates), metal (especially drink and food cans, spray cans), glass (bottles), styrofoam (a special form of urethane plastic characterized by high buoyancy in water), fishing gear (currently rare, except in Turkey), construction materials (also currently rare, except in Sicily), rubber (but not rubber foam), and the rest (clothes, paper, cardboard, foodstuffs).

Litter that floats depends not only on density (e.g., wood, styrofoams) but also on form (e.g., empty bottles, cans).

The sea-bed litter includes mainly metal, waterlogged wood, glass, fishing gear, some plastics (sheets, bags, containers).

The main sources are domestic and industrial activities and the main pathway is direct dumping into the sea or into coastal garbage dumps; users of beaches also leave substantial amounts on the beach; vessels, especially large (long-distance) fishing vessels, may also dump their garbage directly into the sea. It is obviously very difficult to specify sources in situations where the main sources are active at the same time. Inferential studies usually have to be employed. Several such studies are reported in UNEP/IOC/FAO (1991). With substantial variation, from place to place and time to time, in the composition of marine litter, and the relative usefulness of the counting or the weighing of objects, intra-regional comparisons are of doubtful value, but the Mediterranean basin, as a semi-enclosed sea, appears to have a higher level of marine litter than most open-sea regions.

Dust load

Dust, although not a contaminant itself, is an important factor in the binding of pollutants; many of these attach preferentially to the dust particles in the atmosphere which are deposited dry on the sea surface or are washed out of the atmosphere by rain. Thus, Saharan dust, which is not itself significantly loaded with pollutants, helps to channel European pollutants into the Mediterranean Sea or its coastal zone. Calcium ions can be used to trace Saharan dust input, and the Ph of marine precipitation can be used to differentiate between the dust of Saharan and industrial origins. Satellite remote sensing is a useful tool for assessing the Saharan dust over the Mediterranean (Moulin *et al.*, 1994).

Other possible contaminants/pollutants

Organosilicons may also be an environmental nuisance (UNEP, 1987d). There are two groups of organosilicons: silicon derivatives of organic compounds, which are potentially an open-ended group in which silicon can replace either carbon or hydrogen; and siloxanes. In the first group, the silicon does not change the basic characteristics of the parent organic compound, and siloxanes are rather inert. Organosilicons are used increasingly as polymers, especially in medical applications; the best known is silicone, whose physiological inertness is well known. In general, organosilicons, because of their stability, present little risk; no major adverse effects have been detected at present environmental levels. Nevertheless, chlorinated organosilicons may produce hydrochloric acid on breaking down (on moist membranes, for example), causing irritation in human beings.

Although fluorides are not, in themselves and at normal levels, major environmental pollutants, their production during the processing of bauxite to make aluminium is sufficiently high that they have a disastrous effect on the vegetation in the vicinity of the processing plant; perhaps fortunately, in this respect, such plants are not abundant in the region.

There are significant leather industries in Spain, Israel, Turkey, Greece and Egypt; two of their main waste products are chrome salts and odours. They therefore represent some danger to the living resources in their vicinity, but also reduce considerably the amenity value of the areas in which they are found; they are generally incompatible with tourism and recreation.

Nutrients

Although nutrients (notably, nitrogen and phosphorus) are not pollutants, they can, in exceptionally high concentrations in sea water, have considerable effects (discussed in section

3.3.2, below, under the heading **Nutrients and eutrophication**); few regional data are available on their levels in the Mediterranean marine environment.

Of particular concern in this context is the nutrient transfer from terrestrial to fresh water and marine systems and, most particularly, the largely one-way flux of phosphorus from the terrestrial to the aquatic compartments of the environment. In its various forms, phosphorus is a key element in potentially limited supply for intensive agriculture, an important component of domestic and industrial wastes, and for which, unlike nitrogenous compounds, environmental transfer is largely aquatic. Human activities are estimated to have caused an approximately five-fold increase in river inputs of nitrogen to the oceans and a four-fold increase of phosphorus; it may only be assumed at present that these relative increases also hold true for the Mediterranean. The annual global input of phosphorus to the oceans is about 0.6Tmol (1 teramole of phosphorus represents about 31 million tons), compared to the global production of about 0.4Tmol of phosphorus (as phosphate fertilizer) and about 0.03Tmol (as phosphate detergent).

Polat and Tugrul (1995) report that the Aegean Sea receives annually 11,000 tons of phosphorus (total-P) and 180,000 tons of nitrogen (total-N) from the Black Sea; these inputs are comparable with the totals of land-based inputs to the northeastern Mediterranean (Yilmaz *et al.*, 1995).

3.3.2 Effects of marine pollution

General comments

The effects of marine pollution on marine organisms have traditionally been related to contaminant concentrations in biotic material, and the objective was principally to measure these levels. This approach has now widened to include the measurement of a wide range of genetic, biochemical, physiological and ecological parameters of biological change. Such biological changes, biomarkers, can provide information on exposure to contaminants and sometimes on effects. If no changes are found in biomarkers, organisms or community structure, there is a sound basis for not pursuing investigation of potential pollution (UNEP, 1993b).

There is not always a straightforward relation between a concentration of a contaminant in an organism and the effect produced in that organism, however. The effect is registered as a departure from the normal condition of the organism, particularly in terms of such parameters as physiological or biochemical responses, at the cellular level, or as growth rate, natural mortality, reduced behavioural responses etc., at the individual level, or species abundance and community composition, at the population level. Since many animals, particularly filter-feeders, accumulate chemicals from their environment (sea water, sediments, food), they can provide early warning of potential pollution problems. Some organisms that respond rapidly to contaminants, can be used for toxicity testing and thus help to develop water-quality standards. These methods are discussed in some detail in Gray *et al.* (1992).

Some general comments may now be made on the effects of pollutants in the marine environment, after which, specific examples will be given under the same sub-headings as those used to discuss pollutant levels (section 3.3.1).

As already noted, a significant proportion of the discharges to the Mediterranean Sea comes from agriculture, especially as a result of excessive application of fertilizers and of intensive livestock rearing; in the latter case, a fraction of the nitrogen and phosphorus that finds its way into aquatic systems has its origin in marine sources in the form of fishmeal used in livestock feeds, thus providing a minor feed-back loop in the nutrient cycle. Some of the problems of the effects of agricultural fertilizers, with particular reference to nitrogen, have been discussed by Clarholm *et al.* (1988).

The discharge of nutrient-rich wastes, such as excess agricultural fertilizers and sewage, to otherwise nutrient-poor seas, such as the Mediterranean, if in moderation and if contamination by toxic wastes can be excluded, can even somewhat enhance biological production in some fishery resources. If uncontrolled, however, nutrient enrichment inshore and imbalance of nutritive elements also lead to unusual and dense phytoplanktonic blooms which, on decomposition, produce unæsthetic conditions close to the points of discharge, thus adversely affecting coastal activities such as tourism; the Adriatic Sea is a good example (UNEP, 1994f). There is an ecosystem adaptation up to the biological limits posed by the modified environment, but the components of this new ecosystem adapted to eutrophic conditions are rarely those of interest for human exploitation.

Experience in the Mediterranean, which is basically an oligotrophic sea (characterized by low biomass, low availability of nutrients, trace metals and/or growth factors) suggests that moderate levels of enrichment of originally nutrient-limited marine systems may favour production and even suspension culture of some bivalve species, and higher production of small pelagic fish of low economic value, but they do so at the expense of more valuable bottom-dwelling fish and crustacea. Increased nutrient loads in the fresh water run-off to semi-enclosed seas may also accelerate phytoplankton growth to the point that it adversely affects aquatic vegetation by reducing light penetration, especially if accompanied by a high load of suspended sediments.

Blooms of toxic phytoplankton species arising from the disposal of nutrients and other compounds into the sea can lead to diarrhoeic shellfish poisoning and other serious negative effects on health (ICES, 1992b; UNEP, 1995c), necessitating the temporary prohibition of the sale of affected fish products. Untreated sewage can lead to the risk of viral contamination of shellfish and consequent human illness. It should be noted that, even after primary or secondary treatment, the nutrient impact of sewage outflows remains unchanged. Consequent over-fertilization can cause fouling and clogging of nets and cages used in aquaculture. A recent European Union directive requires of its member countries tertiary treatment (e.g., denitrification and phosphorus reduction) for discharges into sensitive areas.

The Mediterranean, with a flushing time of some 80 to perhaps 300 years, allows nutrients and toxic materials to accumulate rapidly, which is most likely to lead to a decline in ecosystem diversity and to progressive dominance of the production system by short-lived, especially pelagic, species.

Recruitment, mortality and growth of a fish stock are affected by the impacts of other users of the aquatic habitat and its catchment area; such impacts arise potentially from all up-stream economic activities, such as industry and agriculture, as well as from fishing.

The adverse effects of marine pollutants can be viewed from more than one standpoint: (i) the changes (such as turbidity, oxygen depletion, chemical contamination) caused in the water that alter its value as a medium for living animals and for human recreation and other uses; (ii) the changes (such as flocculation, oxygen depletion, chemical contamination) caused in the sediments on the sea bed that alter its value as a habitat for marine organisms, especially those of economic interest; (iii) the changes (such as tainting, poisoning/toxicity, growth/development inhibition) caused in marine organisms that are of economic or ecological value to Man; and (iv) changes in Man due to the consumption of altered marine organisms, to bathing in altered waters, and to breathing contaminated marine air.

There may also be some beneficial effects of contamination, but they are rarely the object of environmental research.

Some of the parameters of environmental effect cannot yet be measured adequately or have not yet been measured *in situ*, and, in some cases, recourse must be had to toxicity testing, in the laboratory, to establish levels at which discernible effects occur; it is not normally feasible to conduct such tests directly on human beings, so that most public health standards are based on effects observed on other, physiologically similar animals in the laboratory, leading to an assessment of risk to human health.

The very wide variety of effects observed can only be summarized very superficially here; most of the documents cited in section 3.3.1, above, have specified the best-known effects of marine contaminants, insofar as such effects have been clearly established, but this is not to say that they actually occur in the Mediterranean: only specific case studies can determine such effects in specific circumstances.

In very general terms, the majority of the socio-economic consequences of marine pollution are manifested as immediate or long-term effects on human health. In this context, the two main types of human exposure to pollutants in the marine environment are through direct contact with polluted seawater and/or beach sand, including ingestion of the former while swimming or bathing, and consumption of contaminated seafood (UNEP/WHO, 1991a, 1991b).

A number of diseases have been tentatively associated with bathing in polluted waters. Such diseases have been reported to include bacterial diseases. In addition, a number of diseases and disorders affecting the ear, eye, skin and upper respiratory tract have been associated with bathing (WHO, 1995).

With the exception of those associated with pathogens having a relatively low infective dose, diseases affecting the gastrointestinal tract are much more easily contracted by humans through the consumption of raw or partially cooked food, particularly shellfish. The number of epidemics and outbreaks of various diseases attributed to the consumption of contaminated shellfish is likely to be very high.

Pollution of the sea by persistent chemicals, such as mercury and other metals, DDT, PCBs and a number of other organic substances, creates a completely different hazard. Following entry into the marine environment, these chemicals accumulate in plants and animals as they pass through the marine food chain, reaching their highest levels in filter-feeders, such as bivalve molluscs, and in large predatory fish, such as tuna and swordfish. Effects on humans through the consumption of chemically contaminated seafood are essentially long-term, depending on the chemicals themselves, and the rate and amount of intake. In general, the principal risk is restricted to those individuals consuming seafood more than two to three times a week, although the risk varies with the type of seafood, the concentration of pollutant and the circumstances of the consumer.

Not only do coastal industries degrade the local marine environment where they discharge, but they also occupy the terrestrial environment in their vicinity at the expense of other biologically important critical habitats for marine and coastal species. To the extent that habitat loss and contamination depress the quality and abundance of the marine fauna, local fisheries are adversely affected by coastal industry; and, in the long term, the sum of all coastal industrial discharges not fully absorbed by the sea has the potential to affect adversely coastal marine fisheries in general. However, it is not always certain that fishes (of economic, fishery interest) are adversely affected by some forms of chemical pollution. Nevertheless, on the whole, coastal industry (even including industrial-scale fish farming) has the potential to be prejudicial to coastal fishery interests.

Sea-bed mining, if it becomes widespread, and especially if some of the industrial processing is done at sea, may become important because of the discharge of waste rock dust into the sea to create significantly increased turbidity or increased concentrations of elements that are normally rare in sea water but become toxic at higher concentrations, for example.

Such extraction adversely affects benthic organisms by destroying habitats and damaging spawning grounds of demersal and other fishes; it also interferes with trawling and other bottom-fishing methods; however, the duration of the effects, once sea-bed mining has ceased, is relatively short.

The practical measures to control the effects of run-off relate largely to actions on land: to improve land use strategies; to encourage local control of run-off into waterways; and to improve effluent treatment and discharge practices.

Concern has been expressed over the possible reduction of marine biomass due to the effects of toxic waste discharge into the sea. This biomass acts as a "sink" for carbon, and hence reduces the free carbon dioxide and methane in the atmosphere, thus limiting the so-called "sierra" or "greenhouse" effect. An alternative effect might follow from nutrient enrichment if a large proportion of organic material produced as a result of eutrophication enters carbon "sinks" such as bottom sediments underlying anoxic water masses. There is growing evidence that coastal sediments on clean bottoms of rock, gravel and sand in areas affected by nutrient enrichment are being converted by eutrophication into organic mud or muddy sand. Beside the effect the storage of carbon-containing material in bottom sediments might have on the benthic and demersal resources of an area, it may also be a significant factor in the context of global warming.

Sulphur and nitrogen oxides, which are emitted by thermal power plants, by a majority of industrial plants and by urban heating systems, are the main cause of so-called acid rain which degrades building stonework, forests and water bodies.

The main effects of oil on water bodies, fresh or marine, are due to: direct discharge, intentionally or accidentally, leading to such now familiar problems as the tarring of marine animals, notably seabirds and marine mammals, and of fishing gear, degradation of beach quality, if the oil comes ashore, and the tainting of seafood. The "mining" of oil and geothermal energy often leads to the production of dirty water which, at best, degrades the quality of natural bodies of fresh water, and the effluents of thermal power plants may contain toxic substances that contaminate the waters, fresh or marine, depending on the site, receiving these effluents. Drainage water from coal mines may have comparable effects on subterranean water bodies.

Solid wastes from coal- or uranium-processing plants, for example, may be toxic or otherwise dangerous, and even non-toxic wastes, such as cinders from thermal power stations, may be so abundant as to constitute a serious environmental problem of disposal and of protection of subterranean water, if these cinders are left to be washed out by rain, for example.

Another form of waste related particularly to the production and transformation of energy is the heat due to the cooling of turbines and condensation towers; this heat is dumped with the cooling water back into the water body from which it came, creating a local environmental nuisance, modifying the pre-existing aquatic ecosystem, usually, but not always, for the worse.

Intensive aquaculture or mariculture may itself be a source of over-fertilization of semi-enclosed seas that have a limited exchange of water with the ocean, even though their sheltered conditions and ease of access make them initially attractive for aquaculture. Setting criteria for biological loadings of bays and lagoons as a result of cage culture of fish is already feasible, but defining a "favourable" level of aquatic enrichment, from the standpoint of the wild fishery resource, is still very difficult.

Discharge into the environment, and subsequent concentration in the food web, of such contaminants as heavy metals, PCBs and dioxins, has begun to have a significant impact on fish-product quality.

In areas of oil exploitation, once the exploratory drilling phase is over, and the production platforms are in place, fishing is only likely to be seriously affected if these platforms are closely spaced, so that a substantial area of sea bed is closed to fishing; however, such "platform parks" may provide a haven for the fish, and thus eventually increase recruitment to the fished stock. Platform accidents, leading to discharge of substantial quantities of oil into the sea, are more likely to have adverse effects on human activities such as tourism and fishing.

Chemical pollution may influence fish production in numerous ways: reduction of stocks by mass mortalities; gradual decline, or changes in composition, of populations or entire ecosystems; increased occurrence of diseases; deterioration of fish-food quality; lowered growth rates. The seas, and land-locked water bodies, also receive a significant proportion of pollutant chemicals via the atmosphere, so that effects distant from the source cannot be discounted. Despite this, although such effects need much more rigorous control, there is pressure for some use of the marine environment for waste disposal, as a consequence of expected population growth and of the failure, in general, to provide sufficient landside facilities to handle and dispose of wastes in an environmentally sound way. It would be more practical to attempt to define the levels of pollution that cause no appreciable risk and the areas where such risk is most serious for living resources.

The unrestrained use of rivers and estuaries for the discharge of nutrients and toxic compounds leads to significantly adverse impacts on critical marine habitats, but water extraction and, more generally, the regulation of rivers for navigation and flood prevention have adverse effects on diadromous species (e.g., salmon, eels, shad). The effect of inappropriate land management within the watershed on siltation of coastal and estuarine areas, with its adverse effects on coastal habitats, is another environmental factor due to human activities in the coastal zone.

GESAMP (1986) has defined the ability of a component of the marine environment to accommodate a particular level or intensity of human activity as its environmental capacity. Intrinsic to this concept is the recognition that: (i) a certain level of contaminant will not produce an unacceptable impact on the living marine resources; (ii) the environment has a finite capacity to accommodate wastes without becoming significantly altered by them; (iii) such a capacity can be quantified.

Trace metals

In discussing effects, it should be borne in mind that an effect may depend on many factors: (i) the ease with which a trace metal is taken up by a marine organism, or by a human being, or released by the body before it can do any harm; (ii) the form (e.g., ionic or chelated or otherwise bound to an organic molecule or in a particular valency state) in which the element is "available" for uptake; and (iii) the species and/or life-history stage and/or tissue concerned.

Cadmium enters the human body mainly via the food (notably crustaceans and molluscs), but only about 5% is absorbed into the bloodstream, the rest being rejected in the fæces; its main (adverse) effect is on the physiology of the kidney and, to a lesser extent, the liver. Although UNEP/FAO/WHO (1989) provided data on cadmium uptake, few data appear to be available on its actual effects on marine organisms; the principal effect of long-term cadmium contamination is growth inhibition/delayed development.

Mercury shows bioaccumulation with increasing age of an organism, but with strong variation between species. The value of most of the analytical data for mercury in organisms is greatly lowered by the lack of accompanying age data. Mercury is absorbed in the intestine and widely distributed in the tissues; it is also discharged in the fæces. There is some demethylation of methylmercury in the body. The organs most affected are the brain and nervous system

Lead is taken in mainly with food and water, but some absorption from the air via the lungs certainly occurs. At effective concentrations in the tissues it causes anæmia and degrades brain and nervous system function. Children are the most susceptible; the gastrointestinal tract and the liver are also affected, and there may be some hormonal dysfunction. Little is known of the effects of lead on marine organisms, but they are generally thought to be similar, particularly in vertebrates, to those observed in human beings.

Tin in the form of triethyltin and trimethyltin is a neurotoxin in human beings, with some potential for carcinogenic, mutagenic or teratogenic effects, but the necessary clinical observations are still inadequate. These alkyltins can also cause shell-thickening in oysters and induce imposex in gastropods.

Copper appears to present no hazard to human beings or marine organisms, at least at the levels likely to be found in sea water or seafood.

Zinc can cause coughing, dyspnea, muscle and joint pain, gastric irritation and peptic ulcers in human beings, but it is not carcinogenic, mutagenic or teratogenic. Little is known of the effects of zinc on marine organisms.

Arsenic bioaccumulates only slowly and, in marine organisms, mainly in the form of arseno-organic compounds, normally presents little risk to human consumers of sea food containing arsenic, which is all or nearly all excreted within 48 hours. Arsenic does present some toxicity to phytoplankton, reducing the growth in some species and the productivity, leading to modification of the phytoplankton composition which may have a "knock-on" effect on the zooplankton community.

Organochlorines

These compounds generally accumulate in fatty tissues in human beings and marine organisms. Organochlorines in seafood present a measurable risk of carcinogenesis.

PCB inhibits plant growth. Marine invertebrates and fishes are affected more at the juvenile stage than the adult. Birds are affected by PCBs, as well as DDT, egg-shell thinning and other pathological conditions being induced. Reproductive anomalies in marine mammals have also been observed.

DDT is thought not to affect phytoplankton photosynthesis, but may alter the species dominance in a phytoplankton community. It may have a marked effect on crustacea. In fish, it can pass from the female to her eggs and alters the natural mortality rate adversely. It may also induce premature pupping in seals. It appears to have no effect on human beings at the levels normally encountered in the food or in the atmosphere, tending generally to occupy the fatty tissues benignly.

HCH and the "drins" have little effect at the normal concentrations encountered in the marine environment.

Herbicides

At the observed concentrations, they are not likely to affect marine organisms, although they may modify the structure of phytoplankton communities.

Triazines

They have some adverse effect on phytoplankton photosynthesis.

Organophosphorus compounds

There is no information on the effects of OPs on marine organisms or ecosystems.

Petroleum hydrocarbons

They have little effect on phytoplankton communities, but may have significant effects on littoral communities (notably at times of oil spills), but much depends upon the water mixing at a given time and place which would ensure dispersion of the PHCs in the marine environment; in some cases, several years are needed to restore the littoral floral and faunal communities, although a few weeks usually suffice. The larval and juvenile forms of marine organisms tend to be more affected than the adult stages.

Radioactivity

As already indicated in section 3.1.1, radioactive elements, as far as physiological functions are concerned, behave essentially as their stable counterparts (if these exist, which is not the case for the artificially produced "transuranic" elements). Since these elements and their counterparts are at very low concentrations in the marine environment, they have no major effects on organisms or human beings, except in unusual circumstances. There is, however, a tendency to bioaccumulate in marine organisms and there is notable accumulation in marine sediments.

As far as their radioactivity is concerned, their effects depend on the nature of the decay sequence that each normally pursues (emission of alpha or beta particles or of gamma radiation). In the body, such emissions may have a mutagenic or carcinogenic effect, but there is only a very general association between exposure and actual effect.

Marine pathogenic organisms

Pathogenic organisms produce different diseases or adverse health effects in human beings and certain marine organisms. The main effects are:

Salmonella: they are the agents of typhoid and paratyphoid fevers, food poisoning and gastroenteritis, but they have only a short life in sea water; in contrast, they are accumulated in food and, if at a sufficient density, can cause disease.

Shigella: they are the agents of bacillary dysentery, but they have only a short life in sea water.
Vibrio: *V. choleræ* is the agent of cholera, but others are the agents of gastroenteritis, and still others are agents of otitis, sore throat and wound infections.
Staphylococcus: they may cause infections in the skin, skin glands and mucus membranes, meningitis, furunculosis, pyæmia, osteomyelitis, and food poisoning (*S. aureus*). These genera have a relatively long life in sea water.
Pseudomonas: they may cause infections of the ear and eye, of wounds, burns and the urinary tract, and enteritis.
Aeromonas: they may cause diarrhoea, pneumonia, abscesses and wound infections.
Enteroviruses: they may cause paralysis, meningitis, respiratory disease, rash, diarrhoea, fever, herpangina, myocarditis, pleurodynia, encephalitis, hæmorrhagic conjunctivitis.

Man-made litter

The direct effects of litter are mainly æsthetic, although, on beaches, they also present a danger (accidental wounding) to swimmers and sunbathers. Some marine organisms, especially seals, turtles and birds may become entrapped by certain components, such as rubber and plastic bands or rings, and fish netting, which pass over their head and become stuck, often eventually throttling them. Pieces of plastic in the sea are also mistaken for prey fish and are eaten; since they are indigestible, they block the alimentary canal and finally the digestion of food.

Nutrients and eutrophication

The principal marine nutrients, notably nitrogen and phosphorus, although not themselves contaminants, may have an important effect on the marine environment: eutrophication. Certain coastal zones become eutrophic due to high levels of nutrient discharge arising from human activities, although this may occur, to a lesser degree, naturally and more slowly in upwelling areas. Eutrophication is described in detail in UNESCO (1988) (UNEP/UNESCO/FAO, 1988, is the same document published in the MAP Technical Report Series) and in UNEP (1995c).

The question of phosphorus and nitrogen input into the Mediterranean Sea was briefly touched upon in the previous section (3.3.1). However, not all phosphorus in suspension in the water is available to marine food webs; like silt, metals and many toxic compounds, much of the phosphorus is precipitated out to estuarine and marine sediments. Unlike nitrogen, phosphorus compounds are not broken down to the gaseous inactive element, and a large proportion of phosphorus in run-off, although partially inactivated if stored in oxygenated sediments, may be more easily recycled from deoxygenated bottom sediments back into the pelagic food web, and contribute once again to eutrophication. From the standpoint of agriculture, this loss from terrestrial systems is surely not beneficial, and contributes to unnecessarily high fertilizer budgets (i.e., the over-application of phosphate fertilizer to make up the "loss").

Much scientific debate has focused on whether primary production in aquatic systems is limited by phosphorus or by other nutrients or trace elements. The general consensus seems to be that nitrogen is usually limiting in coastal waters in northern temperate latitudes, although the precedent for considering available phosphorus as a measure of biological production throughout the food web appears to have been established (Andersen and Ursin, 1977); nevertheless, other elements than phosphorus and nitrogen, such as silicon and iron, should be given closer attention.

Eutrophication is normally manifested as a marked increase in the abundance of the phytoplankton, hence a very high primary production, as a result of the high nutrient levels, with substantial detrital "rain" promoting heterotrophic bacteria and flagellates, sometimes leading to seasonal or permanent anoxic zones in bottom water and sediments, with corresponding adverse impact on the benthos and on demersal food webs, but often sustaining a high standing crop of small pelagic fishes and zooplanktivores supported by high densities of planktonic herbivores feeding on the phytoplankton, if suitable conditions are present in the affected area (Jeftic *et al.*, 1990; Caddy, 1993).

The over-abundant plankton may lead to: (i) fish kills, by asphyxiation due to the clogging of fish gills and to the increasing consumption of the oxygen dissolved in the sea water in the oxidization (i.e., decomposition) of dead organic matter in the water; (ii) by reducing, consequently, the success of fertilization of fish eggs or the survival of fish larvæ, or by inducing the displacement of older fish away from the usual fishing areas; and (iii) the fouling of fishing nets and the clogging of engine cooling systems. It may be that these various forms of clogging are due to polymers secreted into the water by the phytoplankters (especially dinoflagellates) involved; these polymers may also be responsible for the formation of slime and of surface foam (which dampens wave action and may even be a mechanism by which phytoplankton creates turbulence-free niches useful for its own survival). All the above phenomena are especially visible in enclosed basins such as the Adriatic (see box on page 62)

Some algal blooms are due to certain species of dinoflagellates (such as *Noctiluca*, *Pyrodinium*) that produce what are known as "red tides" which are, in the Mediterranean, widespread, seasonal and often site-specific. Several species of dinoflagellates produce toxins that may severely affect fish ingesting them and, once accumulated in fish or shellfish, may severely affect human beings eating infected sea food, causing such disorders as diarrhoeic or paralytic shellfish poisoning. Human beings may also be affected by the respiration of certain toxic dinoflagellates in ærosols.

The excess of nutrients close to the source, and possibly causing observable eutrophication, may become dispersed farther away and have beneficial effects on the pelagic food chain; thus, in the Adriatic, an increased abundance of small pelagic species, especially sardines, has been observed and persists even as fishing effort on such species tends to increase (Jeftic *et al.* 1990; Caddy, 1993). Jeftic *et al.* (1990) also report increased standing crops of mussels and oysters on the Istrian peninsula. There is also some indication that Kastela Bay (Croatia) and the Gulf of Saronikos (Greece) may follow the same evolution, provided that the discharge of toxic substances with the nutrients is controlled.

There is some reason to suppose that the conditions that favour eutrophication, if followed by dispersion and dilution of the excess nutrients, may also lead to an increase in productivity which, by increasing the amount of food available, may cause "plagues" of medusæ, especially of the common species *Pelagia noctiluca* (UNEP, 1991c). However, other causes may be natural fluctuations in population abundance of the species, changes in the abundance of its predators, significant changes in water currents causing the sudden appearance and accumulation of jellyfish in a particular area at a particular time, or major hydroclimatic changes affecting factors that normally control jellyfish abundance (see box on page 63).

There may also be some relation to the incoming Atlantic water inasmuch as this water is nutrient-poor but relatively well oxygenated; to the extent that early mixing can take place with eutrophied Mediterranean coastal waters, relatively productive water may result, and this may sometimes be the case in the Sea of Alboran.

3.4 Natural Resources, Protected Areas and Species

3.4.1 Natural resources

The major part of the living resources (marine invertebrates and fishes, and forests) of the Mediterranean, and their present state, have been described succinctly in section 2.2.5, above. The effects of fishery are now fairly well, but far from perfectly, known; the effects of the degradation and pollution of the marine environment on the fish/shellfish resources are only just beginning to be known and understood. The state of the forests is now reasonably well known.

Although there is no urgent concern about most of the birds of the Mediterranean marine and coastal areas, the region lies on several migration routes of migratory birds, some of which are endangered (see sections 3.4.2, 3.4.3

EUTROPHICATION: THE CASE OF THE NORTHERN ADRIATIC SEA

Starting in the 1970s, eutrophication phenomena such as algal blooms and the production of mucilage have, particularly in the northern Adriatic, given rise to great concern because of their new considerable frequency, intensity and geographical extension.

The physico-geographical characteristics of the Adriatic, in addition to specific climatic conditions and the prevailing surface water circulation, make this basin (already a theatre of natural eutrophication phenomena) an especially vulnerable area in view of the extensive land and river inputs of pollutants deriving from human activities. However, the situation differs considerably from the southern part to the northern part of the Adriatic. According to the 1996 assessment by UNEP/MAP, based on the work of many researchers during the last twenty years, the trophic conditions of the Adriatic sea can be summed up as follows:

- coastal areas in the north-western Adriatic and at some sites on the coasts of Croatia and Montenegro that have high nutrient levels and are affected by recurrent microalgal blooms are classified as eutrophic;
- the open sea waters of the north-western basin are mesotrophic-oligotrophic; and
- the majority of the central-southern basin is oligotrophic.

The serious deterioration that has occurred in the northern area of the Adriatic for over twenty years is attributable to the nutrient input in amounts that exceed the basin's natural assimilation capacity. The Po, carrying some 100,000 tons/year of inorganic nitrogen and some 6,000 tons/year of inorganic phosphorus, contributes most of the total nutrient load of the northern Adriatic basin. The next largest of the rivers flowing into the northern Adriatic, the Adige, contributes about 14,000 tons/year of total nitrogen and 1,200 tons/year of total phosphorus, although its mean nutrient concentrations are lower than those of the Po. The total nitrogen and total phosphorus discharged into the northern Adriatic from Italy alone amounts to some 270,000 and 24,000 tons/year, respectively. To these must be added the inputs from Istria, estimated at 12,600 and 600 tons/year of total nitrogen and total phosphorus, respectively.

The other areas of the northern Adriatic, between the Po delta and Trieste, generally have lower levels than the adjacent area. The hydrodynamics of this basin are such that Po waters tend to be carried mainly southwards by the currents. Further, the area north of the Po delta receives a lower input of eutrophying substances, and residence times of water from local tributaries are shorter because of the absence of clear low-salinity fronts.

Eutrophication phenomena, with a distribution and persistence much greater than in any other part of the Mediterranean, have occurred and continue to occur in the coastal waters of Emilia-Romagna to the south of the Po delta. The first cases reported date back to 1969. These were followed by a relatively long period in which the phenomenon was not observed until it returned in 1975, when an immense bloom of flagellates caused widespread anoxia in the bottom waters, accompanied by bottom fauna kills and the beaching of large quantities of bottom fish (7,000 tons in the Municipality of Cesenatico alone). Subsequently, events succeeded one after another in the summer of almost all the following years. The blooms in this area are normally caused by diatoms and dinoflagellates. The former, although they may cause blooms at any time of the year, tend to dominate during winter and spring, whereas flagellate blooms occur especially in the summer and autumn.

The recurrent anoxia in the bottom waters caused profound modifications in the benthic ecosystem; there were considerable reductions in the original populations of the least mobile bottom organisms (molluscs, crustaceans and polychaetes) most sensitive to oxygen deficiency. Repetition of these dystrophies has led to the disappearance of about fifteen species of mollusc and three species of crustacean.

Further, the recurrent phenomena of eutrophication and the general deterioration of water quality in the north-western Adriatic have had serious negative repercussions on the economy of the region, especially tourism and fisheries. With regard to fishing, and mollusc farming in particular, considerable damage has been done by the dinoflagellate of the genus *Dinophysis*, which produces (D.S.P.) toxins. The occurrence of these flagellates, which have become more plentiful during the last decade, has led to temporary and prolonged bans on the harvesting and sale of mussels (*Mytilus galloprovincialis*) farmed in the coastal and lagoon areas of Emilia-Romagna. Further, *Alexandrium tamarensis*, a dinoflagellate capable of producing (P.S.P.) toxins, has been observed in the waters of the northern Adriatic, although no pathologies in the resident populations attributable to PSP intoxication have ever been encountered.

Considering that the eutrophication phenomena are no longer occasional events, but are provoked by structural deficiencies on land, there is a need to eliminate such deficiencies, which are mostly linked to tourism, agriculture, animal husbandry and municipal sewerage. During the eighties, important laws, decrees and norms were approved at the European Community and the national levels mostly addressing the reduction of phosphorus in the detergents produced, bringing the limit down to 1 percent. As a result, it has been possible to quantify a decrease of 10,000 t/year in the input of phosphorus to the sea. In contrast, no important reduction of nitrogen in the sea has been monitored, in spite of a 1991 Community norm in that direction. This is mostly due to the difficulty of applying the norm (e.g., lack of economic incentives) and the lack of controls.

There is ample scientific evidence of the increased spread and intensity of eutrophication in several areas of the Mediterranean endangering the natural equilibria of the basin. The status of the Adriatic is in fact only a mirror of a situation more and more worrying for the entire Mediterranean. Methods already exist for the abatement of the intensity and extension of the eutrophication phenomena through appropriate analysis and management of the activity sectors concerned and the implementation of legal, technical and other measures. The fight against the causes of eutrophication should be a priority for all the Mediterranean Coastal States.

JELLYFISH BLOOMS IN THE MEDITERRANEAN

The occurrence of massive blooms of the schyphomedusa *Pelagia noctiluca* in various areas of the Mediterranean is a case of the common and still not fully understood gelatinous zooplankton blooms. Large *Pelagia* blooms were first reported in the Adriatic in 1977; during their peak (1981-1983) they involved extensive areas of coastal waters throughout the northwestern, central and northeastern Mediterranean and had a significant impact mostly on tourism and fishing; they also created considerable concern for human health. The following are the findings of the MED POL Jellyfish Programme coordinated by UNEP/MAP and carried out from 1984 to 1986.

P. noctiluca (Semaeostomeae, Pelagiidae) was first described by Forskal in 1775 as *Medusa noctiluca*. Unlike meroplanktonic jellyfishes (Anthomedusae and Leptomedusae) which are usually restricted to shallow waters because of their dependence on a hard substrate on which their benthic life stages may settle, holoplanktonic jellyfishes, as *P. noctiluca*, may complete their life cycle in open waters because of the absence of a benthic stage.

The periodicity of occurrence of the bloom period appears to differ greatly between different parts of the Mediterranean. In the western Mediterranean, or at least in the Ligurian Sea, there appears to be a rough periodicity of 12 years. Bloom periods appear to be much less frequent in the Adriatic during the present century where they were reported during 1907-1914 and then not again until 1977. On the other hand, only a few aggregations of *Pelagia* were reported along the Lebanese and Turkish shores.

During the bloom period of the eighties, enormous numbers of *Pelagia* individuals (in some cases up to 100 individuals per cubic metre) were reported in coastal waters and on the shores of the Ligurian Sea, the central Mediterranean, the Adriatic and parts of the Aegean Sea. Between the bloom periods, *Pelagia* appears to be absent from the Adriatic and rare in the western Mediterranean offshore waters.

Observations in the Mediterranean suggest that the bloom period may be divided into three phases: the initial phase, the peak phase and the phase of decline. The initial phase is recorded at different times in the different regions. During the blooms of the eighties, the first reports of *Pelagia* aggregations in coastal waters came from the northern Adriatic and only later in Maltese waters and in the Ligurian Sea. The occurrence of the peak phase and the declining phase appear instead to be more synchronized over the whole geographical region. Pronounced seasonal fluctuations in the populations of *Pelagia* have been shown to occur during the initial and the declining phases of the bloom period, with coastal aggregations being more evident during the March-June period. On the other hand, during the peak phase, *Pelagia* adults could be detected throughout the whole year. For example, during 1981-1983 (peak phase) the presence of *Pelagia* in the coastal waters off Villefranche did not change significantly although the seasonal fluctuations in seawater temperatures ranged from 13E to 26EC.

Reports from the northern Adriatic indicate that some aggregations are formed by actively swimming individuals generally at subsurface levels. Reports from the same region, as well as from the central Mediterranean, indicate that other surface aggregations could also be passively maintained by surface currents.

The distribution of *Pelagia* in the Mediterranean during the bloom period appears to have been determined by the hydrological and, possibly, the natural trophic characteristics of the particular area. For example, in the Ligurian Sea, this was found to be correlated with natural eutrophic conditions, so that relatively large numbers were found to be concentrated on both sides of the Liguro-Provincial Front. The occurrence of *Pelagia* aggregations was never found to be directly correlated with localized land-based pollution. However, any enrichment in nutrients, whether by natural means or as a result of man's activities, may lead to localized increased productivity and this in turn may be expected to lead to increased numbers of *Pelagia*. It has been suggested that temperature may have a predominant influence on the stability and persistence of an aggregation. Aggregations in the Gulf of Trieste were normally formed when the seawater temperature ranged from 16E to 20EC, whereas in Greek waters they were more often associated with seawater temperatures ranging from 20E to 25EC, and were rarely seen at temperatures above 25EC.

The phenomenon of blooms of *P. noctiluca* in the Mediterranean may be taken to be a highly visible biological expression of the epipelagic community's response to long-term hydroclimatic changes in the physical environment. Although human activities, such as overfishing of the natural jellyfish predators and the discharge of land-based pollution, may help to sustain its blooms for longer periods of time, their occurrence is a natural phenomenon which has been recorded in the region long before man's impact on the marine environment could have reached significant proportions.

Various hypothesis to explain the triggering and controlling mechanisms of the *Pelagia* blooms have been suggested. For the northwestern Mediterranean, it was suggested that the occurrence of *Pelagia* bloom periods over the last hundred years may be correlated with pluri-annual climatic and hydrological cycles. The years prior to the bloom periods are in fact characterized by a deficit in rainfall and by anomalous high temperatures and atmospheric pressures, especially in May and June. Such climatic factors may possibly enhance the reproductive potential and, as a result, the increased investment in growth (hormesis) may constitute the biological response of this species to natural stressors as its populations are introduced into new areas by anomalous water currents. Another hypothesis suggests that blooms in *Pelagia* or other planktonic species may result when their internal circannual clocks anticipate the regular and seasonal fluctuations in the environment so that they would be able to exploit the favourable season with greater success than their natural competitors, thus leading to a population explosion. It has still to be established whether any such factors trigger the blooming phenomenon simultaneously in the various Mediterranean regions affected, or in some restricted primary centres from which it later spreads by means of water movements.

and 4.3, below). The hunting of migratory birds has increased in recent years; all together, about 20 million birds are killed annually by hunting (Ramade *et al.*, 1990). Moreover, the drying of wetlands for agricultural or building purposes denies resting places for migratory birds and habitation for wading and swimming birds, leading to further reduction in their number. The increasing use of pesticides has also drastically reduced the numbers of prey birds, by interfering with their normal physiology, hence also the numbers of predator birds (Ramade *et al.*, 1990).

The situation with respect to marine mammals and turtles is dealt with in sections 3.4.3 and 4.3, below.

Besides the living resources taken in isolation, there is abundant natural landscape in the region which is affronted by many stress factors. There is a decline in natural beauty and loss of amenity due to the construction of overground electricity grid systems. Roads, though having as an objective an increase in amenity, also reduce natural beauty, by their very existence, and, some would argue, by the greater affluence of human beings to natural beauty spots that they facilitate. Human litter, if not promptly and continually removed, is a direct consequence of the facilitated access, together with vehicle exhaust gases. It is this consideration, perhaps most of all, that has lead to the steady growth of hiking or rambling, in which part of the pleasure is getting to natural beauty spots with the least possible interference. Agriculture (directly by encroaching on land or indirectly by the adverse effects of pesticides and fertilizers), water use (notably dam construction, pipelines and storage tanks), industry and mining (also by occupying land and discharging wastes thereto) are also inevitable "enemies" of the natural landscape; so, evidently, is unchecked urban spread. The creation of protected areas (see section 3.4.4, below) is a first, but still inadequate, step towards the protection of sites of natural beauty or ecological interest.

3.4.2 Biodiversity

Biological diversity means the variety and variability among living organisms and the ecological complexes which occur. It is often divided into three levels which are genetic (diversity within species), species (diversity among species) and ecosystem (diversity among ecosystems). Biological diversity is indeed of value because we cannot be sure of the impact of removal of any component (e.g., variety, species or group of species) from a given ecosystem or from the Earth itself, owing to our weak understanding of how ecosystems function. Nevertheless, it should be realized that life itself is the greatest destroyer of biodiversity, especially at the gene and species level; but life is unreasoning, whereas Man is not, so Man's responsibility is unique and great.

Human activities result in the destruction of natural habitats, pollution of the environment and exploitation of natural living resources, thus diminishing the number of wild organisms and the number of species; that is, eroding the biodiversity of the planet. Moreover, the breeding of specialized strains and, now underway, their creation by genetic engineering for use in agriculture, stock-raising, aquaculture, pharmaceuticals and specialty chemicals, represent an emerging threat to the genetic variety of cultivated species. Efforts to establish and maintain special depositories for plant and animal genetic material (rice, wheat, maize, microbiological banks, for example) are not, at present, keeping up with the rate of loss of potentially or actually valuable genetic combinations, which are likely to be needed to deal with environmental changes, and increasing resistance of infective organisms to pesticides, in areas where cultivated species now live, or to provide varieties for cultivation in new areas, in response to the demands of human populations. Although genetic engineering, by speeding up the creation of new and better adapted varieties, may appear to be a possible means of raising biodiversity, it too depends on having available to it a high level of genetic diversity.

The introduction of new organisms, in the form of exotic species or highly cultivated strains of endemic species, nearly always poses a risk to the environment/ecosystem involved in the introduction, and therefore requires the greatest possible circumspection.

The conservation of biodiversity of aquatic organisms is an attempt to counteract loss of species and local races due to harmful practices such as overfishing, habitat destruction and pollution. Although relatively few species extinctions have resulted from overfishing, this is not true for some populations and races, and other impacts of human activities have been critical through their effects on species habitats.

The number of species foreign to a particular marine environment that have either been deliberately or accidentally introduced by Man (*Caulerpa taxifolia*, mentioned in section 1.3, is an example in the Mediterranean, UNEP, 1995d) has increased considerably, and it is clear that changes in the environment due to human activities may facilitate this process. The establishment of exotic species has resulted in far-reaching changes to the faunal composition of many of the world's enclosed and semi-enclosed seas, estuaries and coastal marine waters. The effects of such introductions include: immediate ecological impacts at the community level through changes in inter-specific competition and predation; changes in the nature of the environment itself through the influence of certain organisms and possible genetic degradation of indigenous stocks. The co-introduction of pathogenic organisms has often adversely affected native and introduced species alike, particularly cultured shellfish. Many such species came through the Suez canal and are known, after the canal's builder, as Lessepsian species. Spanier and Galil (1991) discuss Lessepsian migration with particular reference to the Indian Ocean jellyfish, *Rhopilema nomadica*, which was first recorded in the south-eastern Mediterranean in 1977 and now forms enormous swarms in summer, from time to time. This may reflect the ecological success that sometimes falls to invaders initially, rather than eutrophic or other aberrations of the marine environment; an equilibrium with native species often becomes established in due course.

Some 500 Indo-Pacific species into the eastern Mediterranean since the construction of the Suez canal is a specific example of such effects (Por, 1968). This, and their subsequent spread westwards and northwards, was facilitated by the more saline conditions created by construction of the Aswan Dam and consequent removal of the low-salinity barrier created by the Nile discharge into the eastern Mediterranean Sea.

The conservation of biodiversity of aquatic organisms poses problems at two main levels: firstly, for wild fish stocks, the loss of species and, more especially, local races, through environmental change, overfishing or competition through species introduction, is a real and persistent danger. The trend towards developing new, uniform strains adapted to rearing in captivity is increasing the dangers these inbred traits pose to wild populations as a result of the escape of cage-cultured strains, and consequent cross-breeding between cultured and wild strains. Such genetic "accidents" could reduce the variability of stocks needed to ensure resilience and adaptability in a changing environment.

One possible effect of intensive fishing on biodiversity is gear selection for specific fish sizes depending on the fishing method. Such pressures may also lead to selection for early-maturing or slow-growing individuals, with effects that are expected to be measurable over a limited number of generations. This type of effect may be reduced or reversed by alternative fishing strategies.

One special biodiversity problem relates to the influence of man-made canals linking faunistically different regions, and the influence of shipping in facilitating inadvertent transport of exotic species.

In general, the conclusion emerges that, as for terrestrial ecosystems, Man's intensive exploitation of all habitats and ecosystems reduces their complexity and favours simple ecosystems and pioneering species of generalists, specialized for rapid growth and reproduction, often with substantial fluctuations in stock density.

Cash crops of rice, fish and other products almost inevitably replace the less intensive benefits which may arise in the future from maintaining the genetic diversity of complex habitats (despite, for example, the latter's potential for production of new pharmaceuticals), and the less tangible and less enforceable common-property benefits of preserving coastal vegetation for flood control, as ecological reserves and as nursery areas for coastal and shelf stocks of fish and shrimp.

Not much attention has yet been paid directly to biodiversity problems in the Mediterranean. The Convention on Biological Diversity, drawn up in Rio de Janeiro at the UN Conference on Environment and Development, in June 1992, entered into force at the end of 1993. It will require signatories to regulate access to genetic resources, control the origin, transfer (in trade or for research purposes) and destination of genetic material.

Species inventories (taxonomy, distribution, abundance) are still very far from complete for most parts of the world; moreover, the changes taking place as a result of human activity require regular updating even of relatively complete inventories. In the light of this widespread ignorance, it is clearly necessary to apply the so-called "precautionary principle", which requires protection and conservation measures to be taken in advance of sufficient scientific knowledge and understanding and therefore forbids the needless destruction of flora and fauna. In other words, a high standard of living-resource management, whether in exploitative or conservative situations, will be essential.

3.4.3 Endangered and threatened species

The issue of the erosion of the Mediterranean biodiversity has been addressed with special emphasis in terms of risk of total or regional extinction of species. Species that are in immediate danger of extinction throughout all or (a significant) part of their range are normally referred to as "endangered species". Species are designated as "threatened" when they are likely to become extinct within the foreseeable future throughout all or part of their range, if the factors causing numerical decline or habitat degradation continue to operate. The general issue of endangered and threatened species in the Mediterranean region has been discussed in the last years by some authors (Ramade *et al.* 1990; Boudouresque 1993,1995); it has also been the theme of two main meetings, namely the international conference "Marine species to be protected in the Mediterranean", Carry-le-Rouet, 18-19 Nov. 1989 (Boudouresque *et al.*, 1989) and the Expert Meting on endangered species in the Mediterranean, Montpelier, 22-25 Nov. 1995, this latter having agreed on a list of endangered or threatened species in the Mediterranean (UNEP, 1995). In the following, the status of the most significant *taxa* will be briefly discussed.

Marine plants

The Red Book "Gérard Vuignier" of marine plants, populations and landscapes threatened in the Mediterranean (UNEP/IUCN/GIS Posidonie, 1990) lists and reports on the status of 48 species of marine plants referable to as threatened.

The species whose status at present raises more concern is probably the Mediterranean endemic *Posidonia oceanica*. *P. oceanica* cannot be considered threatened to extinction as a species, as it still covers important seabed surfaces throughout the Mediterranean basin. However, the meadows it forms are regressing in most of the known stations, under the negative impact of (i) pollution (in particularly increased water turbidity, related to either direct or to the effects of eutrophication, which reduces light penetration at depth and is in the origin of regression of the lower limit of the meadows), (ii) coastal and river works (ports, artificial beaches, dams, etc.), covering the areas occupied by the meadows or inducing modifications in sediment income at the level of the meadow, which in turn result in the burial or the inverse uprooting of the plants, (iii) trawling, dredging and anchoring, all activities damaging the meadows by uprooting the plants. *Posidonia* meadows are one of the most diverse marine communities, and carry out important functions related to biomass and oxygen production, sediment retention and protection of the shores from erosion, (iv) being a nursery area for many species of commercial value (see box on page 67).

Several species of the genus *Cystoseira* are recorded in the Mediterranean, which form typical and important habitats normally referred to as "forests". Similarly to *Posidonia* meadows, *Cystoseira* forests are regressing at numerous stations, mainly, as it seems, under the negative impact of pollution. Some of these species are to

THE POSIDONIA SEA-GRASS MEADOWS

Posidonia oceanica is a marine flowering plant endemic to the Mediterranean which builds thick meadows from the surface of the water down to a depth of 25-40m (depending on water transparency). The Posidonia meadows shelter an extremely rich flora, and especially, fauna, and so constitute a key focus of biodiversity in the Mediterranean. Moreover, the primary production of this sea grass and the epiphyte algae on its leaves is quite considerable. The leaves, when they fall, are consumed by detritivores, whereas the leaf epiphytes are consumed by herbivores. However, a large percentage of the leaves (30-40%) is not consumed on the spot, but exported to other ecosystems, especially deep ones, where Posidonia meadows act as spawning grounds and nurseries for many species of fish and invertebrates, especially fish of commercial interest. Furthermore, *P. oceanica* meadows play a role in controlling sediment flow. Finally, they decrease the strength of hydrodynamic phenomena (swell, waves) and contribute thus to the protection of beaches against erosion.

Sediment trapping by Posidonia leaves, along with the vertical growth of rhizomes, results in raising the seabed (0.1m to 1m per century). In certain protected bays, *P. oceanica* may nearly reach the surface of the water and build a barrier reef which is separated from the coast by a lagoon. In the surface waters of the warmest areas (Turkey, Sicily and especially Tunisia), *P. oceanica* grows in narrow, parallel strips; this very special type of meadow is called "tiger prairie".

The Posidonia meadows cover approximately 300km^2 along the continental coast of France, 750km^2 in Corsica, and 50km^2 in Liguria (Italy). The total area in the Mediterranean covered by Posidonia sea-grass prairies is not known, but could exceed 25,000km^2. It is thought that the most extensive meadows are in Libya, Tunisia, Sicily, Sardinia, Corsica and in the Hyères bay, France.

In a large part of the Mediterranean, especially around large industrial harbours (Athens, Naples, Genoa, Marseille, Barcelona, Algiers, etc.), the Posidonia meadows have receded considerably since the 1960s. The Gabès Gulf (Tunisia) causes perhaps the greatest concern. Given the slow growth of its rhizomes and the rarity of its fructification, the destruction of a prairie must, on the human scale, be considered as irreversible.

The causes of this regression are: (1) pollution (especially nutrients and detergents), to which the species is very sensitive; (2) decrease in water transparency (turbidity, plankton growth) which raises the lower depth limit; (3) land-reclamation schemes (shoreline projects which affect the seabed: seawalls, harbours, artificial beaches); (4) trawling activities to which the meadows are very sensitive, through rhizome denudation due to loss of sediment; (5) explosives (e.g., dynamite) used by some fishermen; (6) changes in sediment flow caused by development projects, which result in excess or deficiency of sediment; and (7) anchoring of boats, when it occurs frequently (as in certain open anchoring sites of NW Mediterranean). In the Alpes-Maritimes region of France, the spread of *Caulerpa taxifolia*, an exotic algal species introduced into the Mediterranean, is an additional threat to *P. oceanica*.

In the bays where important development projects have been carried out, most of the Posidonia barrier-reefs have disappeared.

Posidonia oceanica is protected by law in France (Decree dated 19 July 1988) and Cataluña (Spanish Order dated 31 July 1991). In the Communidad Valenciana (Spain), the 23 January 1992 Order bans the destruction of marine phanerogam prairies and thus favors the protection of *P. oceanica*. Finally, the *Posidonia oceanica* meadows are included in Annex I of the Habitat Directive of the European Union, dated 21 May 1992 (natural habitats of Community interest, the preservation of which makes necessary the setting up of special conservation areas).

In several coastal Mediterranean States (especially Spain, France, Italy and Tunisia), trawling activities are banned within three miles of the coast or in areas where the depth is less than 50m. Theoretically, this should mean that most Posidonia meadows are protected from trawling damage, but the relevant regulations are not respected anywhere.

P. oceanica meadows should be legally protected by all Mediterranean coastal States, within the framework of the Barcelona Convention and the relevant national legislation.

The ban on trawling on Posidonia meadows should be adhered to fully. To achieve that goal, the system of setting up anti-trawling reefs has proven effective in Spain (Alicante) and France (Côte Bleue, near Marseille).

The monitoring of *P. oceanica* meadows on the model of RSP (Réseau de Surveillance des Posidonies of the PACA region in France) should be extended to all Mediterranean States. Moreover, the sensitivity of *P. oceanica* to pollution makes such monitoring a biological indicator of the global quality of coastal waters.

Schemes to replant *Posidonia oceanica* could be envisaged on condition that the following guidelines are respected: (1) that *P. oceanica* was recently present on the exact site of the replanting; (2) that the causes for the disappearance of *P. oceanica* have ceased to exist; (3) that the regression of *P. oceanica* is of such scope that, for the medium term, natural regrowth cannot be expected; and (4) that replanting is not carried out to compensate the destruction of *P. oceanica* caused by coastal development. Experimental replanting has been carried out in Italy and France.

be considered threatened due to their currently limited geographical distribution.

Marine mammals

The Mediterranean monk seal (*Monachus monachus*) has been considered endangered since the sixties, and is, today, one of the species most threatened by extinction. The total population of the species is estimated at 300 to 500 specimens, including the Atlantic groups. Its overall decline has continued to the present alarming levels in spite of a considerable effort towards its conservation. The monk seal issue is discussed in greater detail in another part of this document. The current status of the monk seal in the Mediterranean is summarized on a country basis in UNEP (1994g) (see box on page 69).

Among cetaceans, dolphin species (*Delphinus delphis*, *Tursiops truncatus* and *Stenella coeruleoalba*) and sperm whales (*Physeter macrocephalus*) are heavily impacted by their interactions with fisheries, which can be classified as: (i) incidental catches, mainly in drift-nets, but also in other fishing gear; (ii) deliberate capture and killing by fishermen; (iii) depletion of the stocks of prey species due to overfishing. Concern has also risen by the possible impact of marine pollution, as analysis on tissue samples has shown that dolphins in the Mediterranean are among the animals most highly contaminated by toxic substances like PCBs, DDT and heavy metals such as mercury. Even if the effects of such contaminants on marine mammals need to be better elucidated, evidence exists, at present, on their linkage with reproductive disorders and immuno-suppression. Additional threats are represented by the ingestion of plastic floating debris and the noise arising from human activities at sea (such as shipping, exploration for and extraction of minerals, military operations, etc.), whose levels are capable of interfering with signals produced by cetaceans and may even cause damage to their sound receptors. The current status of cetaceans in the Mediterranean is summarized in UNEP/IUCN (1994).

Sea birds

Birds are probably the taxonomic group for which the best information concerning the status and distribution of the different species in the Mediterranean is available. Extensive work has been carried out, in particular for the European countries (Grimmett & Jones, 1989; Langeveld & Grimmet, 1990; Langeveld, 1992; Tucker *et al.*, 1994). A directory of important seabird sites in the Mediterranean is available (Sultana, 1993). Drawing on the current available information, the already mentioned Montpelier meeting of experts (1995) has listed 15 species of birds as endangered or threatened, all having a direct relation with the marine medium.

Marine reptiles

The main species under threat in the Mediterranean are the green turtle (*Chelonia mydas*), the Nile soft-shelled turtle (*Trionyx triunguis*) and the loggerhead turtle (*Caretta caretta*), which nest in the Mediterranean. They are so endangered because they require undisturbed beaches on which to lay their eggs, then to allow them to incubate. The green turtle nests, at present, mainly on beaches in southern Turkey and Cyprus and to a limited extent in Israel; the loggerhead turtle currently nests on Greek, Turkish, Cypriot, Syrian Israeli, Egyptian, Libyan and Tunisian beaches.

These two species, as well as the hawksbill turtle (*Eretmochelys imbricata*, which occurs only incidentally in the Mediterranean, however), are highly vulnerable to commercial fishing, often being taken accidentally or being the object of fishery themselves for their flesh and their carapace (tortoise shell). Whatever their nesting habits, these species are known to migrate extensively within the Mediterranean Sea (this migration may also include at least the eastern Atlantic). Groombridge (1990) and UNEP/IUCN (1990) have summarized the distribution and population state of the five main species of marine turtle (those mentioned above plus the leatherback turtle, *Dermochelys coriacea*, and Kemp's ridley turtle,

CONSERVATION OF THE MEDITERRANEAN MONK SEAL

For many years, there has been great concern among conservation biologists that the Mediterranean monk seal (*Monachus monachus*) might be rapidly approaching extinction. It has been classified as "Endangered" since 1966 and is today on the IUCN world list of the twelve animal species that are in greatest danger of extinction.

The former range of the species extended from the coasts of the Black Sea throughout the whole Mediterranean to the Atlantic Ocean around Madeira, the Canary Islands, and the north-west coast of Africa as far south as Cap Blanc. Since the beginning of this century, the monk seal has disappeared from most of the Mediterranean and Black Sea coasts. The monk seal population was estimated at 600 to 1000 specimens worldwide, in 1980. Today, the total population is estimated at 300 to 500 specimens dispersed in a few scattered groups mainly located along the coasts of Greece, Turkey and, to a lesser extent, North Africa in the Mediterranean, and in the Madeira archipelago and Cap Blanc in the Atlantic. Today, the main threats to the remaining monk seal populations are:

(i) deliberate killing by fishermen, who consider the seals competitors and blame them for damaging their nets;
(ii) accidental killing/capture in fishing gear;
(iii) disturbance and destruction of their habitat, mainly by industrial and tourism development;
(iv) overfishing, which reduces the fish stocks on which it feeds;
(v) pollution.

In addition, the present status of monk seal makes it very vulnerable to risks such as diseases, other catastrophes, and inbreeding.

Concern over the risk of monk seal extinction has led to numerous initiatives by most Mediterranean countries, several intergovernmental bodies and non-governmental organizations. With a view to providing a rational framework for these activities, as well as a mechanism for cooperation and coordination among the different groups working on monk seal conservation, an Action Plan for the Management of the Mediterranean Monk Seal has been formulated and adopted within the Mediterranean Action Plan and is coordinated by the MAP Secretariat through the Regional Activity Centre for Specially Protected Areas (SPA/RAC) in Tunis. The Action Plan outlines immediate and long-term actions, along the following main lines:

(i) reduction in adult mortality;
(ii) establishment of a network of marine reserves;
(iii) development of research, data collection and rehabilitation;
(iv) development of awareness, information and training programmes.

A number of activities have been undertaken by different actors since its adoption. In the framework of MAP programmes, action has been mainly focused on the preparation, publication and distribution of public-awareness and scientific documents, the establishment of a training programme, the conduct of field studies aimed at assessing monk seal populations and the state of their habitat. In 1994, a meeting of experts aimed at evaluating the implementation of the Action Plan was held in Rabat (Morocco), and was called upon to evaluate monk seal status and conservation initiatives and to make recommendations for future action.

The numerous initiatives undertaken, either before or after the adoption of the Action Plan, undoubtedly resulted in a number of achievements. Now, the monk seal is granted legal protection in most countries over its past and present range. Protected areas aimed at protecting the resident seal populations and their habitat have been established at several Mediterranean and Atlantic sites: in particular, Foça (Turkey), Montecristo (Italy), La Galite (Tunisia), Northern Sporades (Greece), Desertas islands (Madeira, Portugal), Cap Blanc (Mauritania). A rescue centre for injured or orphaned seals has been set up in Alonissos, Northern Sporades, Greece. Thanks to the research and monitoring programmes undertaken so far and ongoing, a lot of data and information have been obtained on critical issues such as the distribution pattern of the monk seal, interaction with fisheries, habitat requirements, etc. The numerous information and educational campaigns have raised considerably awareness of the critical situation of the species, triggering the adoption of protection measures and conservation initiatives.

Despite of these positive results, however, the efforts made so far do not seem to have succeeded in reversing the decline of the species. Actually, all the causes of decline are still active. Protection measures are, in most cases, poorly enforced and protected areas, which have been shown to be the most effective instrument for the protection of the monk seal and its habitat, are still very few. Cooperation and coordination among the different actors working on the protection of the monk seal are far from being satisfactory. The conservation of the monk seal remains a challenge for conservationists and governments of the Mediterranean region.

Drawing upon the outputs of the meeting of experts held in Rabat, the following main recommendations can be made for future action:

- ensuring the effective implementation of adopted protection and conservation measures, strengthening in particular the control on deliberate killing of animals and on potentially dangerous tourist activities;
- establishing new protected areas at sites of present and recent occurrence of monk seal. The Ionian islands (Mediterranean) and the Seal coast (Atlantic) are identified as priority sites;
- reducing interactions between seals and fishermen, in particular by (i) including appropriate measures in fishery regulations for all areas where monk seal still occurs and (ii) developing research on techniques and measures aimed at minimizing interaction with fishing gear;
- continuing and intensifying the efforts to monitor seal populations and, in particular, their dispersal pattern;
- carrying out studies on habitat requirements;
- developing public awareness programmes, intended in particular for fishering communities;
- establishing an effective coordination mechanism among the different actors.

Lepidochelys kempi) and the protection they are currently afforded. The resident and the reproductive populations are all seriously reduced in number.

3.5 Historic Sites and Landscape

The Regional Activity Centre for the Priority Actions Programme has produced detailed guidelines for the rehabilitation of Mediterranean historic settlements (UNEP, 1994i, volume I), backed up by five case-studies (UNEP, 1994j, volume II).

Some of the world`s most significant periods of artistic and cultural development have been centred on the Mediterranean region. There, also, human architecture, on a small, individualistic scale, as well as on the grand scale of public buildings, has reached major peaks. Through the UNESCO International Convention on the Protection of the World Cultural and Natural Heritage, of 1972, the most important Mediterranean historical monuments and sites have been identified and listed; they constitute a majority of the whole number so listed. A hundred Mediterranean sites (Fig. 3), many of which are on the UNESCO World Heritage list, have been selected for especial attention under the Mediterranean Action Plan in collaboration with the Atelier du Patrimoine in Marseilles (UNEP/Marseille, 1995).

Besides the 100 sites formally adopted, there are many other significant historical settlements of interest and concern from the environmental standpoint, as: (i) old towns or settlements of significant historical interest, or such areas within them, that reflect a particular form or style of urban or rural life or culture; (ii) sites of archæological interest representing ancient civilizations, whether such sites have been explored or not; (iii) buildings or groups of buildings of historical interest, such as: those dedicated to religious observance (temples, churches, mosques, synagogues, monasteries etc.); those serving military purposes (fortresses, ramparts, barracks etc.); those having civic functions (town halls and other public administration buildings, hospitals, museums, theatres and cultural centres, fountains etc.); monuments of architectural or sculptural interest and memorials to the famous; houses; shops; commercial buildings; civil infrastructure (bridges, roads, canals, waterworks, harbours etc.); and (iv) sites of a complex nature, usually combining natural and architectural interest, such as: historical and memorial parks; sites significant for their natural and historical/artistic features; gardens (if they comprise elements of historical/artistic interest).

Buildings are subject to decay or destruction due to natural phenomena or to human activities; this may occur over a long time (normal ageing) or catastrophic ally (by fire, floods, landslides, avalanches, earthquakes, volcanism).

Natural ageing depends on such factors as geographic location and orientation, hence on local climate (especially temperature variations and exposure to solar radiation, rainfall and humidity, wind strength and persistence), hence on the establishment of harmful organisms (e.g., moulds, algæ, higher plants on walls, ceilings or floors, or insects, birds, rodents etc. within a building's structure).

Natural catastrophes are, for the most part, inevitable and unpredictable, either as to timing or extent, but not altogether unforeseeable. Damage limitation from such causes has been practised since Antiquity. Now, however, much effort is devoted to improving prediction of such events from selected environmental variables and their evolution. Even so, the necessary opposition of the rarity of occurrence, in a given place and period, and the generally considerable but localized damage that is done (notably to human structures) limits the resources devoted to achieving useful predictability.

Human causes are a result, generally, of ill-considered socio-political decisions or bad management. They may depend on local, regional or even global political forces, changes in economic systems or even in architectural fashion, and may reflect political or ideological intolerance. The economic changes may be in the system of production or of trade, leading to a decline or a major change in such activities as agriculture, crafts, industry, fishing, mining etc. The disappearance of socio-economic activities leads, almost always, to physical decay of the buildings in which they were carried out, and even, in some cases, to the abandonment of

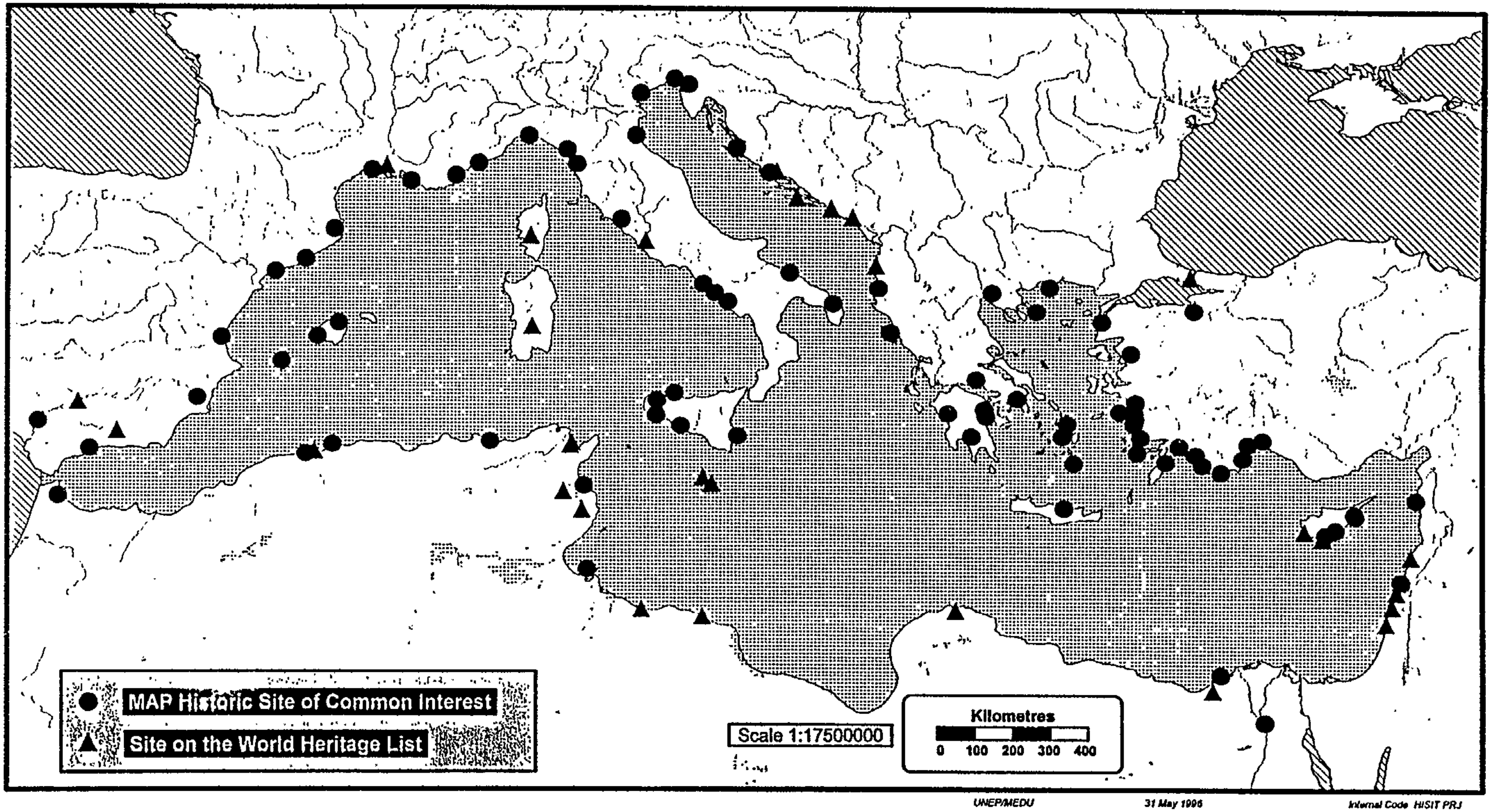

Fig. 3 Locations of Mediterranean Historic Sites

entire towns and villages. In some cases, also, it may be only tourism that can save such buildings, villages or towns, as they are restored in the interest of tourism itself.

Economic change can also overload historic city centres with commercial, administrative and other functions for which they were never intended and not designed. Modern transport systems, heavy through-traffic and parking lots for residents' and tourists' vehicles are not easily accommodated, but somehow, accommodated they are, usually at the expense of important historic structures. The associated negative consequences for buildings, in the form of vehicle exhaust gases and other pollutants (not least in the form of acid rain), were mentioned earlier in the present document. Vibration (which includes noise) due to traffic (ground and air) is an additional decay factor for buildings.

The solution is proper management (including maintenance) of existing buildings, and sound planning of new buildings as to their structure, location and "cohabitability" with respect to historic buildings. Such management must incorporate disaster preparedness, and limitation of damage due to inevitable accidents and catastrophes. It cannot, however, comprise war, yet an aggressor nation may include in its war objectives the destruction of another nation's cultural heritage, and notably the buildings that are the main physical manifestation of such a heritage.

The document (UNEP, 1994i (volume I) and UNEP, 1994j (volume II)) goes on to provide a set of fairly detailed instructions on such matters as, *inter alia*, rehabilitation of buildings, architectural surveys and analysis of the current state of a site of interest.

Volume II provides five case studies in which the methodology proposed in the guidelines has been applied. They are: the Plaka district of Athens, the oldest Athenian neighbourhood, at the foot of the Acropolis; (ii) Genoa's historic centre (now not so central, socially speaking, as it once was); (iii) Marseilles, which has a long experience in the application of an effective methodology to the documentation and research on sites of archæological/historical interest; (iv) Split, of which the historic centre encompasses Diocletian's palace (built nearly 2,300 years ago), as well as pre-Romanesque, Romanesque, Gothic, Renaissance and Baroque buildings; and (v) the Hafsia district of Tunis, which covers the lower part of the Medina (fort), is disadvantaged by its topography and was, historically, reserved for foreign minorities; the PAP/RAC methodology has been followed in the attempt to rehabilitate this district.

The work in Marseilles has been carried out under the ægis of the Atelier du Patrimoine de la Ville de Marseille (the Marseilles Heritage Workshop), but comprises a wider range of activities. Of particular interest is the protection of the submarine archæological heritage in the Mediterranean (UNEP/Marseille, 1995). This heritage has only been fully recognized since the introduction of the aqualung some forty years ago. The document cited reviews the state of such archæology in Albania, France, Israel, Italy, Malta, Spain, Tunisia and Turkey. The vast majority of the sites are shipwrecks dating from 3,600 years ago up to recent historic times; the remaining submarine sites comprise ancient ports and harbours (notably in Israel and Tunisia), human settlements (notably in Albania, Malta and Tunisia), ramparts (Malta) and quarries (Albania). However, in France alone, over 600 submarine sites of historical, artistic or achæological interest have been identified, though not all in the Mediterranean.

The main problems confronting these submarine sites are siltation (whether gradual or as a result of submarine slides), destruction of once-exposed wood by xylophagous worms (teredos), encrustation by corals, serpulid worms (calcareous tubes), etc., damage by trawl gear, and plundering by "amateur" scuba divers.

3.6 Implications of Climate Change

The implications of climate change for the Mediterranean basin have been described in detail by Jeftic (1992a) and Jeftic *et al.* (1992, 1995).

In the long term, it is essential to assess the impacts on climate change of the various air-sea exchanges discussed in section 3.2 (on air pollution), particularly as a result of serious modification of the air-sea exchanges and the "greenhouse" effect due to biogases in the atmosphere.

Climate change due principally to the "greenhouse" effect can be expected to have a significant impact on, *inter alia*, the marine environment and the adjacent coastal zone in the coming decades. Some of the known and suspected biogases were discussed in section 3.2, above.

The primary "greenhouse" effect is to raise the Earth's mean temperature, particularly that of its atmosphere. The main general consequences are most likely to be changes in: (i) atmospheric transport patterns (wind field, particularly at the land-sea interface); (ii) air-sea interaction (evaporation, precipitation, gas and salt exchange); (iii) the sea's volume (hence mean sea level); and (iv) its density distribution (hence circulation patterns). From these changes will flow changes in relative humidity, rainfall and wind regimes, for example, leading to ecosystem changes (in vegetation patterns, soil state, animal distribution etc.).

This impact has been assessed by a regional UNEP Task Team on the Implications of Climate Change for the Mediterranean region (Jeftic *et al.,* 1992). The Task Team was asked to examine the following possible effects: (i) of sea-level changes on coastal ecosystems (e.g., deltas, estuaries, wetlands, coastal plains, lagoons); (ii) of temperature increases on terrestrial and aquatic ecosystems, particularly with respect to economically important species; and (iii) of climatic, physiographic and ecological changes in socio-economic structures and activities. It was also asked to determine areas or systems that appear to be the most vulnerable to such changes.

The Mediterranean Task Team initially identified eight topics for which regional assessments were undertaken: (i) climate change; (ii) sea-level change; (iii) oceanography; (iv) hydrology; (v) coastal lowlands; (vi) land degradation; (vii) vegetation; and (viii) socio-economic activities. It also carried out six site-specific case studies on: (i) the delta of the Ebro; (ii) of the Rhone; (iii) of the Po; (iv) of the Nile; (v) Thermaikos Gulf; and (vi) the Bizerta/Ichkeul Lakes. The results have been published in a book, in two volumes, titled Climatic Change and the Mediterranean, by Jeftic *et al.*, 1992 (volume I) and Jeftic *et al.*, 1995 (volume II).

Subsequently, five new site-specific studies have been undertaken on: (i) the Island of Rhodes; (ii) Kastela Bay; (iii) the Syrian coast; (iv) Malta; and (v) the islands of Cres/Losinj. These five case studies identified and assessed possible implications of expected climate change on the terrestrial, aquatic and marine ecosystems, populations, land use and sea use practices and other human activities at these sites; they also determined areas or systems that appear to be most vulnerable to the expected climate change, and identified options for the planning and design of major infrastructure and other systems.

The results were reviewed at a Meeting on Implications of Climate Change on Mediterranean Coastal Areas (Valletta, 1992). They indicated a number of shortcomings in the assessments: (i) an oversimplification of the processes (e.g., beach dynamics, ecosystem adaptability) that would mediate or even mitigate a given expected impact; (ii) insufficient data or insufficient exploitation of available data to allow a reliable assessment; and (iii) inadequate attention to extreme events (e.g., storm surges, wave action) through which an impact might be heightened.

Three new case studies on the implications of climate change were carried out from 1993 to 1995 on the Albanian coast (UNEP, 1996a), the Sfax region (UNEP, 1996b) and the Fuka-Matruh region (UNEP, 1996c) (see box on page 74).

Some of the variations in the conditions under which marine ecosystems exist and operate are, now and in the future, likely to be due to global climate change. Such changes will add to the natural variations all ecosystems have always been subject to. Their effects on fisheries and aquaculture are, at best, difficult to forecast.

The UNEP/WMO Intergovernmental Panel on Climate Change (IPCC) has assembled the views of the international scientific community

IMPLICATIONS OF CLIMATE CHANGE IN THE MEDITERRANEAN
A case study in Fuka-Matrouh (Egypt)

According to a broad scientific consensus, increasing atmospheric concentrations of greenhouse gases resulting from human activities are leading to changes in climate. Rises in global temperature and mean sealevel are expected to be among the major consequences of future climate change. In order to assess the likely impacts of climate change on marine and coastal systems, UNEP in 1987 initiated studies in Regional Seas Programme. The objectives of these studies were to analyse the potential implications of predicted climate change and to assist the governments in designing policies and measures that may avoid or mitigate the expected negative effects of these changes, or to adapt to them.

During the work on the Mediterranean regional study, it was felt that considerable differences in the impact of climate change could be expected at different sites, and that, consequently, different responses options would be required. One of these studies was made on Fuka-Matrouh region of Egypt. The study programme for this area was planned to cover the climate, the geology, the hydrology, the ecosystem and the socio-economic aspects. Accordingly, a task team of experts was formed which match these disciplines in order to establish a framework for sound environmental management policy based on sustainable resource development and efficient land-use for the Fuka-Matrouh region.

The terrestrial part of Fuka-Matrouh study area extends for about 72 km along the Egyptian Mediterranean coast with an average width of about 70 km. The area is considered to be a virgin area with almost no major industrial activity in the time-being. The climatic condition of the study area ranges between a semi-Mediterranean in the North along the coastal plain, to arid in the southern part. The summer season is warm and dry. The average annual rainfall is around 140 mm in the North and decreases rapidly southward. Grazing and cultivation are the main income source of the natives. The cultivated land is distributed between figs, olive, barley and wheat and agriculture depends mainly on winter rainfall. The present total population of the study area amounts to about 49,000 mainly concentrated in the coastal zone with average population density of about 12 person/km^2. The average annual growth rate is about 3.2 percent of which 10 percent is due to migration.

Scenario of future climate change in the region of Fuka-Matrouh was prepared by the Climate Research Unit of the University of East Anglia, UK and predicted that the annual change in the temperature will be (for each degree of global temperature change) from 0.7 to 0.8EC by the year 2030 and from 2.0 to 2.3EC by the year 2100. The annual change in the precipitation is predicted to be from 0 to -4% (2030) and from 0 to -10% (2100) for each degree of the global temperature change. Scenarios for each season were also prepared, in addition to annual scenarios. The rise of the mean sealevel was predicted to be +16 cm by 2030 and +48 cm by 2100.

Main conclusions of the study were:

- the most important climate change would be the northward shift of winter cyclonic patterns affecting the western Mediterranean coast in winter. The increase in the length of the summer and the decrease of winter precipitation may lead to extension of summer aridity;
- due to rising sealevel, the eastern part of the project area would be subjected to some coastal erosion and flooding of backshore areas and depressions;
- the instability and breakup of barrier islands could become frequent in the coming decades. Beaches in front of these barriers could be subjected to accelerated erosion. Low sandy coasts at the east would adapt to sealevel rise as they have the capacity to reform themselves with the rising sealevel by gradual migrating landwards;
- a consequence of rising sealevel would also be an increase in the occurrence of extreme events, like severe storms, waves, currents and high tides;
- increase of air temperature will change the soil thermal regime. Higher temperature will reduce soil moisture and thus increase soil/wind erosion, and soil salinity, while soil fertility would be decreased and it would accelerate land desertification;
- the amount of potable water may become not sufficient for people and animals;
- due to the rise in annual temperature and decrease in precipitation, the nature flora of the inland may shift northwards. The flora of the present inter-dunal depressions may expand at the expense of the original endemic flora; and
- rainfall decrease and temperature increase will affect the pattern of cultivated crops. Change in rainfall and increase in evapotranspiration may lead to a reduction in the cultivated areas and agriculture is likely to change towards more intensive farms.

The following measures were proposed to limit greenhouse gas emissions and to avoid, mitigate and/or adapt to the predicted implications of climate change:

- improving energy efficiency to reduce its demand and using cleaner energy sources to reduce CO_2 emissions;
- preparing designs of coastal protection measures for critical sites. Regarding the coastal dunes, suitable stabilisation methods (by using plants, wood fences, and stabilization by spraying) should be undertaken to protect the foredunes and coastal dunes which act as natural barriers against sea attack;
- controlling the undergraound water exploitation to avoid salt water intrusion in coastal areas;
- gradual landward transfer of the tourism projects which are already located at critical sites. The existing Environment Protection Law has to be strictly implemented which stipulates leaving a distance of 200 m between the shore line and any construction;
- carry out extensive programs to upgrade awareness of water users with the scarcity of fresh water resources and to introduce cultural practices for water conservation;
- adopting well defined concept for land use based on expected changes in natural resources;
- select suitable draught tolerant crops, shrubs and forage plants to maximize the yield and to minimize adverse impacts; and
- adoption of new safety elevations for drainage and sewerage systems.

on the magnitudes of expected global change related to the climate (IPCC, 1992), and the International Council of Scientific Unions (ICSU) has initiated an International Geosphere-Biosphere Programme (IGBP) to assess the pace of all the major observable terrestrial changes (Williamson, 1992). Regarding the oceans, the IOC has initiated a Global Ocean Observing System (GOOS) (Kullenberg, *et al.*, 1993).

The preparatory studies to these ends suggest that carbon dioxide (a "greenhouse" gas) in the atmosphere is likely to double by 2025-2050 on a "business as usual" basis, leading to a probable increase in the global mean temperature of 1.5E - 4.5EC (IPCC, 1992). This rise is expected to cause a rise in mean sea level of about 20 cm by 2030, and of about 65 cm by 2100, and to an increase in sea-surface temperature between 0.2EC and 2.5EC. Bakun (1992) projects some likely effects of such changes on coastal and shelf-sea ecosystems, referring particularly to the likely increase in the temperature differences between the land and the sea in the coastal zone, which is predicted to amplify upwelling by changing the air-pressure/wind regime (see also Bartzokas and Metaxas, 1991).

Methane (CH_4) is a "greenhouse" gas that may be produced naturally on land (agriculture, forestry), in certain industrial processes (e.g., oil extraction and refinery), in fresh water bodies and estuaries and in the sea, by methane-forming bacteria or under reducing conditions or by algal metabolism. Eutrophication can be expected to play a role in this flux of methane between the sea and the atmosphere. Some of this methane, which is relatively stable in the marine environment, is released into the marine atmosphere (Liss, 1989).

Although little is known of the biological production of methane in the sea and of its contribution to the atmospheric methane levels, results from other areas (e.g., the Arabian Sea) suggest that it is more important than hitherto suspected, at least in specific areas of the Mediterranean, including the basin depths where reducing conditions may prevail.

Besides carbon dioxide, several other gases are known or thought to be "greenhouse" gases or to be likely to play a role in climate change. Dimethyl sulphide (DMS) is present everywhere in marine surface waters. Its main biological precursor, dimethylsulphonium propionate (DMSP), is produced by many marine algæ (Holligan and Kirst, 1989) as well as some sea grasses and salt-marsh grasses (Andreae, 1989). DMS is also formed by the methylation of sulphur by certain species of phytoplankton. Although production is variable according to region and season of sampling, eutrophication, by favouring algal growth, may favour production of DMS, which may be lost to the atmosphere where it is oxidized to such products as methane sulphonate, sulphur dioxide and sulphate. The sulphate is in the form of submicronic ærosol particles (hence not originating from sea salt) which act as condensation nuclei for atmospheric water vapour, thus affecting the atmospheric radiation balance, in the short term, and possibly the climate, in the long term.

Carbonyl sulphide (COS) is produced by the photochemical degradation of dissolved organic sulphur compounds and is transferred from the sea to the atmosphere where it is oxidized to sulphate, with similar effects to those of DMS (above).

Nitrous oxide (N_20) is potentially a "greenhouse" gas originating from bacterial metabolism of nitrates and from industrial combustion; it can also affect the ozone layer. The marine contribution to the atmosphere is not known at present.

The global climate change mentioned above is not expected to change overall fish production in a major way, although particular stocks may be adversely affected, and changes in rainfall and river run-off will affect life in coastal fishery and fish-nursery areas. Coastal aquaculture will also be affected. Tropical upwelling zones, which produce large amounts of fish resources, may shift polewards and increase in intensity. The year-to-year variability of the resources they support may increase; however, increased plankton productivity may

4. *The Policy and Legislative Context*

4.1 Environmental Policy

4.1.1 The Mediterranean countries

The environmental policy of the Mediterranean countries is becoming progressively aligned with the requirements of the Barcelona Convention, its Protocols and the diverse agreed measures arising therefrom, since twenty Mediterranean countries are signatories to the Barcelona Convention. This international, though regional, policy is also applicable to UNEP's Mediterranean Action Plan (see section 4.2, below).

The Barcelona Convention has been in force since 1978; its four protocols currently in force are: (i) Protocol for the Prevention of Pollution of the Mediterranean Sea by Dumping from Ships and Aircraft (1978); (ii) Protocol Concerning Cooperation in Combatting Pollution of the Mediterranean Sea by Oil and Other Harmful Substances in Cases of Emergency (1978); (iii) Protocol for the Protection of the Mediterranean Sea against Pollution from Land-based Sources (1983); and (iv) Protocol for Specially Protected Areas (1986). The Protocol for the Protection of the Mediterranean Sea against Pollution from Offshore Exploration and Exploitation of the Continental Shelf and the Seabed and its Subsoil was adopted in 1994, but has not yet entered into force. A Protocol Concerning Specially Protected Areas and Biological Diversity in the Mediterranean was adopted at the Conference of Plenipotentiaries in June 1995 (UNEP, 1995e) and is, likewise, not yet in force, but when it does come into force it will replace Protocol (iv), above; its two Annexes have still to be adopted, however. The so-called Dumping and LBS Protocols (i and iii above) were amended by the respective Conferences of Plenipotentiaries (UNEP, 1995e and 1996d).

The main purpose of the amendments to the Convention was to bring it into line with the outcome of the UN Conference on Environment and Development, encompassing the concept of sustainable development, the relevant tenets of the Convention on the Law of the Sea and of other regional declarations (Declaration of Genoa, 1985; Charter of Nicosia, 1990; Declaration of Cairo, 1992; Recommendations of the Conference of Casablanca, 1993; and the Declaration of Tunis, 1994). The title of the Convention was also changed to *Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean*.

The main amendments to the LBS Protocol were the extension of the protocol area to the hydrologic basin of the Mediterranean; development of regional and national programmes of action for the implementation of the LBS Protocol; for the preparation of such plans, priorities were given to substances that are toxic, persistent and liable to bioaccumulate as well as to wastewater treatment and management; and the introduction of the precautionary principle, the polluter pays principle, undertaking of environmental impact assessment, application of best available techniques and best environmental practice.

The amendments to the Dumping Protocol include deliberate disposal or storage and burial of wastes on or in the sea bed, and deliberate combustion of wastes at sea.

The Contracting Parties have also adopted thirteen common measures in respect of the Land-based Sources Protocol: Interim Environmental Quality Criteria for Bathing Waters (1985); Interim Environmental Quality Criteria for Mercury (1985); Measures to Prevent Mercury Pollution (1987); Environmental Quality Criteria for Shellfish Waters (1987); Measures for the Control of Pollution by Used Lubricating Oils (1989); Measures for the Control of Pollution by Cadmium and Cadmium Compounds (1989); Measures for the Control of Pollution by Organotin Compounds (1989); Measures for the Control of Pollution by Organohalogen Compounds (1989); Measures for the Control of Pollution by Organophosphorus Compounds (1991); Measures for the Control of Pollution by Persistent Synthetic Materials (1991); Measures for the Control of Pollution by Radioactive Substances (1991); Measures for the Control of Pollution by Pathogenic Micro-organisms (1991); Measures for Control of Pollution by Carcinogenic, Teratogenic and Mutagenic Substances (1993). Other Common Measures are being elaborated for zinc, copper and anionic detergents.

Insofar as the Contracting Parties to the Barcelona Convention have ratified the UN Convention on the Law of the Sea (United Nations, 1983), which came into force in November 1994, the 1973/1978 Convention on the Prevention of Marine Pollution from Ships (MARPOL), and the 1972 Convention on the Prevention of Marine Pollution by the Dumping of Wastes and Other Matter, their respective national legislation should also not run counter to these conventions.

Implementation is slow, however, because, for example, MARPOL calls for the establishment of costly reception facilities, and the LBS Protocol itself, since it calls for substantial action on the control and abatement of pollution from land-based sources, also calls for far-reaching decisions on such matters as urban policy, waste-treatment plants and improved agricultural practices (Chircop, 1992). Moreover, as noted in section 4.4, below, in respect of protected areas, national policy, as expressed in national legislation, is essentially sovereign in the coastal zone and territorial waters of each country and the harmonization of national with the relevant international legislation is relatively slow, even after ratification of the relevant international conventions.

National environmental policy is also expressed in national environmental plans and programmes. Documents describing such plans and programmes, as well as providing information on the state of the environment, have been received from 16 of the Mediterranean countries, which is a great increase over previous years. It is not possible in the present document to go into details. For some countries, their responses to a questionnaire issued by the Regional Activity Centre for the Priority Actions Programme have also been used.

The mechanisms for implementing such policy are generally complex, since responsibilities are spread amongst a relatively large number of national authorities and agencies and, in some cases, national non-governmental organizations. There is also, therefore, a general need to improve the coordination and cooperation between the various entities concerned, in most countries. It should be noted too that, nearly always, the relevant laws were enacted without taking adequately into account the environmental protection aspects. Thus, many laws are in need of amendment in this sense. The institutional mechanisms and the main environmental issues in the individual Mediterranean countries, insofar as the information is available, are briefly described in section 4.1.3, below.

The Executive Council of the UN Environment Programme, at its 18th session, in May 1995, in a decision on The State of the Environment in the Palestinian Territories and Other Arab Occupied Territories, drew attention to the degradation of the environment in these territories and decided to provide specific assistance to the Palestinian authorities in the environmentally sound development of the territories under their control.

4.1.2 The Mediterranean Action Plan

Mediterranean countries and the EEC adopted in 1975 the Mediterranean Action Plan (MAP) and in 1976 the Convention for the Protection of the Mediterranean Sea against Pollution (Barcelona Convention). The main objectives of MAP were to assist the Mediterranean Governments to assess and control marine pollution, to formulate their national environment policies, to improve the ability of governments to better identify options for alternative patterns of development and to make better rational choices for allocation of resources (Jeftic, 1993a).

Although the initial focus of the MAP was on marine pollution control, the experience soon confirmed that socio-economic trends, combined with poor management and planning of development, are at the roots of most environmental problems, and that meaningful and lasting environmental protection is inseparably linked to social and economic development. Therefore, the focus of MAP gradually shifted from a sectorial approach to pollution control to integrated coastal zone planning and management as the key tool through which solutions are being sought.

Although it is difficult to assess progress achieved, there is direct and indirect evidence that a large number of concrete actions were taken by many countries in conformity with the requirements and provisions of MAP, thus influencing the environmental policies and practices of the Mediterranean countries. MAP has been a significant instrument for change and progress in environmental matters in the Mediterranean. Among the achievements of particular importance are the creation of awareness of the significance of a healthy environment for the present and future of the Mediterranean and its people; marked change in the attitude of policy-makers towards the protection of the environment; and the creation of a sense of solidarity and the need to act collectively towards a better future for the Mediterranean.

The environmental policy of MAP is laid down by the Contracting Parties to the Barcelona Convention and its protocols, as described in section 4.1.1, above. The Conference of Plenipotentiaries in June 1995, mentioned above, adopted Phase II of the Action Plan, as Appendix I to the Barcelona Resolution mentioned in the Introduction to the present report. The main objectives of MAP Phase II are: to ensure sustainable management of natural marine and land resources and to integrate the environment in social and economic development and land use policies; to protect the marine environment and coastal zones through prevention of pollution, and by reduction and, as far as possible, elimination of pollutant inputs, whether chronic or accidental; to protect nature, and protect and enhance sites and landscapes of ecological or cultural value; to strengthen solidarity among Mediterranean coastal States in managing their common heritage and resources for the benefit of present and future generations; and to contribute to improvement of the quality of life.

Environmental policy under MAP is also kept consistent with the UN Convention on the Law of the Sea, the 1973/1978 Convention on the Prevention of Marine Pollution from Ships (MARPOL), and the 1972 Convention on the Prevention of Marine Pollution by the Dumping of Wastes and Other Matter.

4.1.3 Institutional aspects

The Coordinating Unit of MAP

To coordinate activities in the framework of MAP, the Coordinating Unit for MAP was established and has been, since 1982, located in Athens, Greece. This unit performs such secretariat functions in the name of UNEP as provided for in the Convention. It prepares meetings with their necessary documentation, transmits notifications, considers inquiries, performs functions assigned to it by the protocols and coordinates all activities of MAP.

Regional Activity Centres

The Unit deals directly with the MED POL component (see sections 3.2 and 3.3) and coordinates and supervises the work of the following Regional Activity Centres of MAP:

- Blue Plan Regional Activity Centre (BP/RAC), Sophia Antipolis, France;
- Priority Actions Programme Regional Activity Centre (PAP/RAC), Split, Croatia;
- Regional Marine Pollution Emergency Response Centre for the Mediterranean (REMPEC), Manoel Island, Malta;
- Specially Protected Areas Regional Activity Centre (SPA/RAC), Tunis, Tunisia;
- Environment Remote Sensing Regional Activity Centre (ERS/RAC), Palermo, Italy;
- Cleaner Production Regional Activity Centre (CP/RAC), Barcelona, Spain; and
- Secretariat for the Protection of Coastal Historic Sites, Marseille, France.

The Regional Activity Centres are responsible for the implementation of respective components of the Mediterranean Action Plan. RACs (except REMPEC) are considered to be national centres carrying out regional functions on behalf of the Mediterranean community. This regional function is financed through the Mediterranean Trust Fund. They perform tasks under the guidance and supervision of the Coordinating Unit and in accordance with the decisions of the meetings of the Contracting Parties.

The Blue Plan Regional Activity Centre (BP/RAC) has studied and clarified the past, present and future environment and development interactions in the Mediterranean basin on the basis of several probable hypotheses as to growth in such parameters as human population, urbanization, industry, agriculture, trade, energy, tourism and transport, including the related impacts on soil, forests, fresh water resources, the coastal fringe and the sea itself. The Blue Plan is progressively updating its prospective scenarios through more in-depth thematic studies. Concentrating on the coastal regions and the hydrological basin, BP/RAC is constantly improving its analysis and evaluation through MAP - Mediterranean Environment and Development Observatory, supported by the European Commission, with a view to providing relevant information and pertinent indicators for decision-making towards sustainable development, in cooperation with corresponding international, regional and national institutions (UNEP, 1994k). Considering the objectives, extent and context of sustainable development, the systemic and prospective approach assisted by the environment and development observatory function, including elaboration of indicators, constitutes a major tool for decision-making process (see box on page 81).

The Priority Actions Programme Regional Activity Centre (PAP/RAC) attempts to address immediate problems, of a developmental nature, and effects of stress on coastal environments and resources, at specific sites, with a view to inducing sound environmental management practices required for sustainable socio-economic development. A major tool used is integrated coastal and marine area management. Projects are being carried out in selected coastal areas, such as Albania, Fuka-Matruh (Egypt), Izmir (Turkey), Rhodes Island (Greece), Syria etc. Other fields of activity include aquaculture, rehabilitation and reconstruction of historic sites, water resource management for islands and isolated coastal areas, solid- and liquid-waste management, and land use planning in earthquake zones.

The Regional Marine Pollution Emergency Response Centre for the Mediterranean (REMPEC) (previously called ROCC) has played, since the adoption of the Emergency Protocol, a fundamental coordinating role in the implementation of that Protocol by the Mediterranean countries. In addition, the Centre's role was expanded from its initial task to deal with accidental oil pollution, to deal with accidental pollution by hazardous substances. REMPEC is working on the development of a Regional Information System, of National Systems for Preparedness and Response to accidental marine pollution, and on the preparation and launching of sub-regional contingency plans (see box on page 82). REMPEC has also assisted developing countries of the Mediterranean extensively by organizing important programmes of regional and national training on the scientific and managerial aspects of accidental marine pollution.

The Specially Protected Areas Regional Activity Centre (SPA/RAC) has played an essential role in the implementation of the Protocol concerning Specially Protected Areas in the Mediterranean. The Centre has assisted several countries by giving the necessary

SYSTEMIC AND PROSPECTIVE APPROACH : BP SCENARIOS

Considering the complexity of the Mediterranean region, it was decided to give proper attention to the past, present and future interactions between development and environment for the whole Mediterranean basin and its coastal areas, in particular, so as to enlighten decision-making in the pursuit of sustainable development.

The work has developed in three successive phases which can be summed up as "understand, explore and suggest". By exploring the evolving relationships between populations, natural resources and the environment, based on a consistent set of realistic hypotheses on population trends, economic growth, environment and land-management policies, and the level of intra-mediterranean co-operation, images of possible futures, trends and alternative scenarios were designed.

Although depending upon the choice and range of hypotheses, hence upon the uncertainties inherent in any prospective exercise, this work does provide significant results concerning major development issues and risks facing the environment and the populations themselves, and consequently the sustainable development of the Mediterranean.

The results of the Blue Plan's prospective approach and its various scenarios, allow the following expectations:

- Populations dynamics is the dominant factor in the economic, social and environmental evolution of the Mediterranean basin. The total population of all the Mediterranean countries together, which was 356 million in 1985 and 382 million in 1990 would rise to between 520 and 570 million in 2025, most of the increase coming from southern and eastern countries. At the same time, the population of the coastal area, which was 133 million in 1985, would rise to 217 million in 2025.

- Tourism plays a considerable role in the Mediterranean, accounting for a third of the world's tourists, with a major concentration in the coastal area which received some 100 million tourists per year in 1985 and would have to support between 170 and 340 million tourists in 2025, national and international (the alternative favouring a strong increase in national tourism in the southern countries).

- Soil degradation due to erosion, desertification, buildings, salination and general loss of biological productivity is in danger of accelerating. The incapacity to stop this process is one of the most worrying threats to the basin.

- Good quality water resources and their sustainable management are both the key conditions and the limiting factors in Mediterranean development. The exploitation index already exceeds 100% for some countries. About half of the Mediterranean countries will come close to this index or exceed it by year 2025.

Several other results can be found in BP's major output on "Futures for the Mediterranean Basin".

The prospective approach is also being applied to the coastal regions through the Coastal Areas Management Programme (CAMP), for which a series of scenarios have been elaborated together with local and national decision-makers.

The general approach to the Mediterranean is being pursued through specific thematic studies (forests, islands, water, energy, tourism, etc..) known as Blue Plan "fascicles". A major overall updating, based on the consequences of a sustainable development "model" and using the capacities and results of the Mediterranean Environment and Development Observatory, is foreseen for the year 2000 and would cover the period 2000-2025 and 2050.

training and advice on the creation and management of protected areas and has successfully worked for the formulation and implementation of specific action plans for the protection of endangered species such as the monk seal, the marine turtle *Caretta caretta* and the Mediterranean cetaceans. The Centre is expected to play an important coordinating role in the activities related to the preservation of biodiversity in the Mediterranean.

The Environment Remote Sensing Regional Activity Centre (ERS/RAC) has introduced the application of remote sensing techniques into the Mediterranean Action Plan. Such techniques successfully supplement the field data gathered by the various activities with satellite data which can provide information on the dynamics of the changes in the coastal regions of the Mediterranean. The Centre has been especially active in a number of Coastal Area Management Programmes (CAMPs) by carrying out studies and projects focused on the coastline changes, the dynamics of the coastal sea, the assessment of land resources as well as in projects on a regional scale for the monitoring and classification of the vegetation in the whole Mediterranean area. These activities represent an important advanced support to the management of the coastal areas especially in relation to the

THE DEVELOPMENT OF BILATERAL OR MULTILATERAL OPERATIONAL AGREEMENTS (SUBREGIONAL CONTINGENCY PLANS)

Pooling of resources and expertise provides a cost-effective and efficient way of combating a major spill which cannot immediately be dealt with by the existing resources of a single country. It is widely accepted that cooperation in cases of major oil spills would involve mainly those States close enough to be able to render assistance. Organizing such cooperation requires detailed planning by these neighbouring States, and this can be achieved through operational arrangements adopted within the framework of a Regional Agreement such as the Emergency Protocol. The development of contingency plans at the subregional level, then permits a more detailed consideration of specific local factors.

In the framework of a Regional Agreement (Emergency Protocol), operational arrangements between neighbouring coastal States undoubtedly represent the best method of pre-determining the conditions of cooperation and establishing the responsibilities at the appropriate level. These arrangements are intended to facilitate the development of response operations, and to coordinate the use of the available means in a defined geographical area. They also outline in advance the financial conditions and administrative clauses of the actions, thus permitting rapid intervention in case of emergency, whilst removing the need for lengthy negotiations during the course of the event.

A project for the development of a subregional system for combating major marine pollution incidents concerning **Cyprus, Egypt** and **Israel**, financed by the EU financing mechanism LIFE, started on 1 January 1993 and ended with the last activity planned under the project, the Fifth Meeting of the Steering Committee, held in Brussels from **7 to 8 December 1995**.

The project produced the following **outputs**:

(i) 3 national reports containing *inter alia* recommendations for improving the national systems for preparedness and response to accidental marine pollution;

(ii) 3 estimates for additional equipment required for an effective response by individual countries to oil spills of 4000 tons (Cyprus and Israel) or 6000 tons (Egypt), and jointly to oil spills of up to 15000 tons;

(iii) a training programme comprising proposals for national training courses, a subregional training course and a joint exercise; and

(iv) a Subregional Contingency Plan, signed in June 1995.

The **results** of the project are:

(i) the progressive improvement of the existing national systems for preparedness and response;

(ii) the development of close cooperation between the three countries; and

(iii) the adoption of a Subregional Contingency Plan leading to the establishment of a system for cooperating in case of a major incident.

As part of the whole process of building the Subregional System for combating major marine pollution incidents, the joint exercise organized with the deployment of equipment (vessels, helicopter, response equipment, response teams) from the three countries permitted a start to testing the System.

problem of desertification, soil erosion, urbanization, management of protected areas, etc. (see box on page 83).

The Cleaner Production Centre has been recently introduced and will attempt to spread the idea of clean production, its techniques and practices and its advantages in the improvement of the manufacturing sector. Among other objectives, the most important include the encouragement and cooperation in initiatives and programmes for the minimization of industrial wastes in general and hazardous wastes in particular, and the reduction of environmental pollution.

The Secretariat for the Protection of Coastal Historic Sites (100 Coastal Historic Sites) attempts to protect the coastal historic sites of common Mediterranean interest already identified by the Contracting Parties on the basis of approved selection criteria. The programme concentrates its work on the identification and assessment activities for the protection and conservation of sites on the list of 100 Historic Sites in various Mediterranean coastal States. Training programmes and workshops are used as tools and methods for historic-site management. The main priority fields are stone degradation of historic sites and underwater archæological sites including shipwrecks.

REMOTE-SENSING TECHNIQUES AND THEIR USE IN THE MEDITERRANEAN REGION

The demand for continuous, reliable and updated information on the state of and changes in the environment, as well as the need for an efficient organization of the data from various sources, have driven planners, decision-makers and scientists to adopt advanced techniques and methods.

An effective contribution to meet these perceived requirements can be made by remote-sensing, the application of which has helped spawn a revolution in the observation and understanding of the environment, pursuing the working out of new and more effective methods based on multidisciplinary approaches.

The Mediterranean area is widely recognized for its considerable experience and potential in the field of earth observation through remote-sensing, as well as for the availability of a huge choice of advanced tools.

AVHRR data from NOAA satellites are largely used in current operational applications (e.g. for sea-surface temperature observations for meteorological forecasting, for mapping of suspended sediments, for analysis of the Normalized Difference Vegetation Index), owing to the coverage repeat cycle and continuity/reliability of these satellites.

The SPOT and Landsat satellites are widely used as well, mainly in land applications (land use/cover, vegetation cover, geomorphological features, suspended sediments in marine coastal areas, etc); other instruments on board satellites are also being used operationally, such as the ERS-1/2 satellites' scatterometers (for wind-field simulation in weather forecast models), the ERS-1/2 synthetic-aperture radar (for shallow water bathymetry and for operational wave forecasting), the ERS-1/2 radar altimeter (for significant wave height determination for off-shore operations).

The use of satellite remote-sensing makes it possible to observe and monitor the state of several environmental features in a synoptic, repetitive and updated way, thus acquiring an objective knowledge of these features, which provides a necessary basis for planning and decision-making.

The awareness that many areas of the Mediterranean region are affected by serious degradation, as erosion and desertification, and the consideration that only an updated and objective knowledge of the vegetation type and status will make it possible to identify their evolution, has led to the implementation of projects for the observation, study and classification - based on NOAA satellite data - of vegetated areas in all the Mediterranean coastal countries, to help them to set up proper policies and programmes for the sustainable management of plant resources.

The information derived from remotely sensed data also responds to the demand for homogeneity, since it is made directly comparable and reliable - whether acquired from the same satellite or from different ones - through proper data processing. Besides, from a methodological point of view, the integration of satellite data with conventional data - through geographical information systems - proves particularly useful and effective in several applications. A good example is provided by the use of time-series of high-resolution satellite data processed together with data derived from multi-temporal topographic maps, for the monitoring and analysis - on a periodical basis - of the most recent evolution of coastal strips.

Remote-sensing is also regarded as a necessary tool to improve the efficacy of ground-based surveys, and in this context, the support provided, for instance, by Landsat satellite images for land-resources analysis and classification may be mentioned. The interpretation of these images allows the identification of homogeneous land areas on the basis of which a proper number of selected check points may be surveyed *in situ*.

Satellite remote-sensing data will be also profitably assimilated into the development - at an operational level - of models (e.g. sediment transport, erosion, pollution, primary production, currents, sea state, etc.), the application of which strongly benefits from the long-term availability of satellite data and from their quasi-synoptic nature. For instance, as for the assessment of the dispersion of pollution from land, in marine coastal areas, the combined use of numerical models - integrated with sea-surface temperature maps from satellites - proves to be useful for the characterization of the coastal sea circulation, and models for the evaluation of pollutant-dispersion mechanisms.

In conclusion, it may be stressed that remote-sensing applications - when properly carried out - prove to be cost-effective and able to provide huge benefits, especially when they include the maintenance and up-dating of monitoring systems.

The expectation is that, in the future, the diffusion of space-borne remote-sensing applications will be significantly increased.

To this end, the scientific community, also in compliance with the process started by the European Union in the framework of the "Centre for Earth Observation" programme, has been focusing its efforts on the promotion of the use of remote-sensing and the demonstration of its contribution to the fulfilment of the requirements of all the Mediterranean countries.

Mediterranean countries

The institutional arrangements that have been made in the countries of the Mediterranean region and the main environmental issues they must address may be summarized, based on the information available, as follows.

In Albania, the principal government entity is the Committee of Environmental Protection, of the Ministry of Health and Environmental Protection (Albania, 1993 and 1995).

The Committee defines government strategy, coordinates the relevant monitoring functions of ministries, other central institutions and local authorities. It organizes the monitoring of pollution at the national level and proposes specific steps for the protection of air, water and soil purity and the national biodiversity. It determines the basic policies and defines priorities for investment in environmental protection. It also sets the admissible limits for gaseous, liquid, solid and radioactive pollutant substances in water, air and soil, and the levels of harmful and toxic substances. It is assisted scientifically and technically in these fields by the Institutes of the Academy of Sciences and by other institutes of different ministries. Steps are being taken to set up a national environment and development observatory.

The main environmental issues in Albania are: deforestation; soil erosion; contamination of surface waters by uncontrolled discharges of industrial and domestic wastewaters; sewage treatment, which is entirely lacking; air pollution is present in some industrial areas and is increasing in the main cities because of the increasing traffic.

In Algeria, the national environmental policy is established and managed by the Secretariat of State for the environment (Secrétariat d'Etat à l'Environnement) as part of the Ministry of the Interior (Ministère de l'Intérieur). The Secretariat of State includes a Head Office for the Environment (Direction Générale de l'Environnement), a General Inspectorate for the Environment (Inspection Générale de l'Environnement), and local Inspectorates for combatting and preventing all forms of pollution, deterioration of natural resources, protection of biodiversity and for setting rules and regulations for the protection of the environment.

The structure concerned with the development and combatting the degradation of forests is the Head Office for Forests (Direction Générale des Forêts), as part of the Ministry of Agriculture (Ministère de l'Agriculture). The Ministry also includes a National Institute for Forest Research (Institut National de Recherche Forestière) and a National Institute for Agronomic Research (Institut National de Recherche Agronomique) as supporting research institutes.

The departments for water resources, physical planning and public works are part of the Ministry of Equipment and Physical Planning (Ministère de l'Equipement et de l'Aménagement du Territoire). These departments set the regulations in their fields; they discharge these responsibilities through the National Water Resources Agency (Agence Nationale des Ressources Hydrauliques), the National Agency for Physical Planning (Agence Nationale de l'Aménagement du Territoire) and the Committees for Public Works and Physical Planning (Délégations aux Grands Travaux et l'Aménagement du Territoire). The Department concerned with Tourism is part of the Ministry of Tourism and Traditional Crafts (Ministère du Tourisme et de l'Artisanat) which has the responsibility of development of touristic areas.

The National Coast-Guard Service (Service National des Gardes Côtes) is part of the Ministry of National Defence (Ministère de la Défense Nationale). Its responsibilities are the monitoring, the control and the intervention in case of events at sea.

The main coastal environment issues in Algeria concern the protection of resources of maritime and coastal waters and combatting coastal pollution.

In Croatia, although some ten ministries have specific environmental concerns and responsibilities, the key governmental body is the recently established State Directorate for Environment. Besides the aforementioned ministries, some 20 governmental quasi-governmental or non-governmental institutions are occupied with one or another aspect of the environment.

The main environmental issues in Croatia are: harmful algal blooms in the northern Adriatic, though less of a problem than on the western side; severe pollution problems in several coastal bays (Bakar, Sibenik and Kastela) and ports with large local populations (Pula, Rijeka, Zadar, Sibenik, Split and Dubrovnik), mainly due to the discharge of unprocessed urban and industrial wastewaters (Croatia, 1993a,b).

In Cyprus, the main environmental issues relate to land use conflicts, to the significant pressures exercised by economic development on the coastal area, the limited water resources, fragile wildlife habitats, and the vulnerability of the marine environment. They also relate to noise in urban areas and the production of waste.

Cyprus has put together a number of measures (legal, administrative and institutional, and technical) for the protection of the environment.

The Council of Ministers has the overall responsibility for the formulation of environmental policy.

Environmental policy has recently been readjusted through the preparation of an Action Plan for the Protection of the Environment, approved by the Council of Ministers in March 1996. The Plan deals with horizontal integration issues such as fiscal instruments, information, research and participation and with issues in the fields of general environmental policy, water protection and management, waste management, radiation, atmosphere, noise, chemicals, industrial accidents and biotechnology and protection of nature and wildlife.

The Minister of Agriculture, Natural Resources and Environment, is the Minister responsible for the administration of the overall control and the coordination of the environmental protection and preservation (excluding town and country planning issues).

The Council for the Protection of the Environment is the higher advisory body on environment and development, its members being representatives from governmental and quasi-governmental agencies, the business and technical sectors and local government. The Council, which is chaired by the Minister of Agriculture, Natural Resources and Environment, advises on environmental issues and makes recommendations on environmental policy and legislation.

The Environment Committee is chaired by the Permanent Secretary of the Ministry of Agriculture, Natural Resources and Environment, and its members are the Permanent Secretaries or their representatives, from various Ministries and Agencies. The Committee reviews environmental programmes, advises on the formulation and determination of environmental policy objectives and further redefines environmental policies.

The Environment Service at the Permanent Secretary's Office is the coordinating service for Government programmes for the protection of the environment. It heads the technical committee on environmental impact assessment, advises on environmental policy, is mandated to ensure the implementation of environmental policy, and administers parts of the Law on the Control of Water Pollution. It also coordinates the process for the adoption of the European Union's environmental policy and legislation, promotes environmental awareness, training and information and is the National Focal Point for the Commission on Sustainable Development, the Basel Convention, CITES, the Montreal Protocol and the Biological Diversity Convention.

Implementation and enforcement of specific sectoral aspects of the environment is carried out in accordance with specific laws and regulations by a number of Ministries, Departments and Services in the related subject areas, all participating in the Environment Committee and the Environment Council.

Under the responsibility of the Minister of the Interior, the Planning Council, the

Department of Town Planning and Housing and local councils, the environmental and physical planning networks, interlinked, operate in parallel.

A number of specific laws regulate the protection of the environment, the most important being forestry, fisheries, water pollution control, pesticides, dangerous substances, antiquities, town and country planning, atmospheric pollution control, and coastal protection laws.

The draft of a comprehensive environmental framework law is now being finalized, aimed at addressing the institutional and administrative framework for environmental planning. It introduces the principles under which sectorial legislation could be implemented in an integrated way. It covers land pollution, hazardous waste management, environmental and fiscal instruments, environmental impact studies, the protection and management of nature, including wildlife habitats and species, and the establishment and management of protected areas. It also introduces the principles of civil liability, environmental compensation schemes, compensation for damage to wildlife, implementation of the polluter-pays principle, and delegates emergency powers for immediate action or request for an injunction to halt activities detrimental to the environment.

An integrated System for Environmental Impact Assessment has been implemented since 1991 in line with the relevant European Union Directives.

In Egypt, the Egyptian Environmental Affairs Agency, under the Ministry of Enterprise and the Minister of State for Administrative Development and Environment Affairs, is responsible for drawing up national policy on the welfare of the environment and the natural resources; it endorses executive plans and programmes, promulgates and follows up relevant legislation. It operates through environment enhancement departments in each governorate.

The Academy of Scientific Research and Technology draws up the national programme of environmental research on the relationship between the population and its environment. Several non-governmental and voluntary environmental societies are concerned with public orientation and information, legislation and enhancement of the output of environmental systems.

The main environmental issues are: urban encroachment on valuable agricultural land, in spite of the rapidly rising demand for agricultural products; disregard of environmental considerations in the siting of some industrial installations which, with related urban growth, has exposed the Nile river to pollution from industrial liquid, solid and gaseous wastes; failure to use, treat and re-use agricultural wastewaters; critical pollution levels in Lake Mariut and in the air over large cities; growth in the use of agricultural chemicals; pollution of irrigation and drainage networks, as well as of the Nile itself; oil pollution of the sea water and the nearby shoreline due to the dense maritime traffic (Suez canal); growing shortage of traditional energy sources; accumulation of large volumes of solid and liquid wastes combined with inadequate handling and management, re-use and re-cycling; the need to protect several rare Egyptian species; pollution and environmental degradation of numerous pharaonic, christian and islamic archæological sites and some tourist sites; the need to increase public awareness through education and the media (Egypt, 1992).

In France, as a relatively large, well developed country, the governmental structure is also relatively complex and not least in the environmental field (IFEN, 1994).

At the central government level, the Ministry of Environment (Ministère de l'Environnement) now has four major departments: Water Department (Direction de l'Eau), Department of Pollution and Hazard Prevention (Direction de la Prévention des Pollutions et des Risques); Head Department for Administration and Development (Direction Générale de l'Administration et du Développement); and Department of Nature and Landscapes (Direction de la Nature et des Paysages). Eleven public bodies depend on the technical authority (sometimes non-exclusive) of the Ministry of Environment:

- seven basin agencies in charge of water resource management for each hydrographical basin;
- seven national parks (national park management);
- the Conservatoire de l'espace littoral et des rivages lacustres (coastline protection through land ownership and land use policies);
- the Institut français de l'environnement, which is the statistical and information arm of the Ministry of Environment;
- the Agence de l'environnement et de la maîtrise de l'energie (waste, air and soil pollution, noise, clean technologies);
- the Institut national de l'environnement industriel et des risques (technical assistance to industry for preventing industrial hazards);
- the Agence nationale pour la gestion des déchets radioactifs (management of radioactive waste);
- the Office national des forêts (management of public forests);
- the Conseil supérier de la pêche (fisheries);
- the Office national de la chasse (hunting);
- the Museum national d'histoire naturelle (scientific advice).

At the regional level, dependent on the authority of the Ministry of the Environment, there are the Regional Offices for the Environment (Directions Régionales de l'Environnement); the Regions are specific French socio-political entities.

The main environmental issues in France, at the national level, at least, are: waste management; the rehabilitation of polluted areas; the restoration of water courses and protection against flooding; the management and protection of nature and landscape; the fight against noise; the construction of waste-water treatment plants. At the local level and in the Mediterranean basin, the main issues are: excessive and sometimes uncontrolled coastal development for tourism, recreation and secondary residences; coastal pollution; coastal erosion (in some areas); marine and coastal protected areas.

In Greece, the National Council for Physical Planning and the Environment is responsible for environmental policy and the approval and supervision of all urban/regional plans and programmes for environmental protection (Greece, 1995). The Ministry of the Environment, Physical Planning and Public Works is responsible for the development of policies for physical planning and the environment and for the coordination and supervision of their implementation; it is supported by regional and prefectural services. The Ministry of National Economy draws up general guidelines for economic planning and development policies, but the various ministries elaborate and implement sectorial policies within their respective fields of competence; the main ministries involved, in respect of environmental matters, besides the aforementioned Ministries of the National Economy and Environment, are: Agriculture, Health, Merchant Marine and Interior. Several other national entities are also involved with specific aspects of the environmental question: the Greek National Tourist Organization, the Public Power Corporation, the General Secretariat for Research and Technology, and other National Research Centres.

The main environmental and coastal management issues in Greece are: water resource management (made difficult by the broken terrain and uneven population distribution); air pollution over and around the large Greek cities (Athens-Piræus, Thessaloniki, Patras and Volos) and the marine pollution in the gulfs associated with these cities (Saronikos, Thermaikos, Patraikos and Pagassitikos, respectively); soil erosion (in which deforestation/fires and overgrazing are the main factors); agricultural pesticide and fertilizer residues in run-off and river water; impact of extensive open-cast mining (notably for lignite, bauxite, magnesite, limestone/marble) on agricultural and forest land.

In Israel, responsibility is invested in the Ministry of the Environment which replaced and absorbed the pre-existing Environmental Protection Service and has since taken over certain environmental functions from the Ministries of Defence, Industry, Commerce, Interior, Agriculture and Health; these ministries, however, retain responsibility for the handling of hazardous substances specific to their respective fields of action (Gabbay, 1994). The goals of the

Ministry are to formulate a comprehensive national environmental policy and to develop the tools for implementing this policy, based on the principle of incorporating environmental considerations fully into planning and decision-making. It aims also at: implementing pollution control, monitoring and research programmes; developing and updating environmental legislation and standards; ensuring effective enforcement and supervision; promoting environmental education and public awareness; and advancing regional and global cooperation in this field.

The main environmental issues in Israel are: water resource management, particularly with respect to irrigation and the water quality of the coastal aquifer; waste-water treatment and recycling; air pollution, mainly over the large cities but also due to an unfavourable meteorological situation; disposal of solid waste, given the small land area and the relatively high level of industrial, commercial and urban activity; the occupation and use of the coastal area and the competing claims of industry, tourism/recreation and agriculture (on the country's most fertile land).

In Italy, the Ministry of the Environment has a coordinating function in coastal affairs and sets relevant standards; in collaboration with the Ministry of the Merchant Marine, it defines and creates natural reserves, defines minimum acceptable values for water microbiological parameters, and authorizes industrial waste dumping. The recently created National Agency for Environment Protection, under the authority of the Ministry of the Environment, is in charge of environmental protection, data collection and dissemination, and cooperation with the European Environment Agency. Coastal area management is organized at four levels: ministerial, regional, provincial and municipal (Italy, 1993). The Ministry of Defence manages all coastal areas under military jurisdiction and runs the Maritime Hydrographic Service, which is charged with marine bathymetry and safety at sea. The Ministry of the Merchant Marine manages State property, including use permits, regulates navigation in territorial waters, fishery, and a permanent coastal water monitoring network. Through its Harbour Offices, it collaborates with the Ministry of Defence in all matters concerning State property, port activity, fishing, maritime traffic, pleasure boating, port tariffs, sea rescue and coast guard, and cooperates in the elaboration of marine maps; it collaborates with regional authorities in matters of tourism. The Ministry of Public Works is responsible for the construction and maintenance of major harbours, and the construction of coastal protection works. Its executive arm is the Water Authority which is responsible for internal water management, including coastal lagoons. The Ministry of Health, through the Higher Institute of Health, monitors industrial discharges and bathing water quality. Its Local Health Authorities undertake routine and emergency water sampling and control urban discharge. The Ministry of Cultural Wealth is the competent authority in respect of coastal area landscape and issues permits for underwater archæological activities. The Ministry of Industry, among other things, issues permits for oil exploration and exploitation.

The regions are responsible for planning and development and, in coastal areas, they are delegated to manage state property used for tourism and recreation; they are responsible for small harbours, the coordination of environmental protection and monitoring of wastewaters, and drawing up regional water resource rehabilitation plans.

The provinces carry out waste-water surveys, whereas the municipalities are responsible for the maintenance of coastal protection structures, controlling wastewaters, managing aqueducts, sewers, depuration plants, issuing permits for building construction and waste-water discharge, and collecting environmental taxes and charges.

The most important coastal environmental issues in Italy are: the impact of tourism and recreation facilities (including unregulated construction of secondary homes); maritime transport of hazardous substances (oil and chemicals); development of commercial, industrial and leisure port facilities, increasing erosion, pollution and landscape degradation; technical and political difficulties in controlling urban and industrial waste (strict law, low compliance) and the correct siting of heavy industrial plants; impact of military uses (loss of fishery and tourist space, effects of explosives); marine parks and reserves (population often still hostile), eutrophication and the production of mucilage by algæ (notably northern Adriatic, adversely affecting tourism and fishery); and coastal erosion, mostly due to human activities (dams, inland irrigation systems, inshore structures modifying wave action).

Regarding Lebanon, Fawaz *et al.* (1992), in a report for UNDP, Beirut, indicate that the governmental structure dealing with environmental problems is beginning to emerge in the period of post-war reconstruction that started in 1991 following the prolonged strife from 1975 to 1990; responsibility is still, however, dispersed among several ministries (as in many other countries of the region). Paradoxically, the same reconstruction is in many ways a solution to a catastrophic environmental situation due to the long period of strife in the country. The lead in the development of an environmental policy falls to the State Ministry for the Environment. Fawaz *et al.* (1992) have proposed a work programme for 1993-1998 and a framework programme to enable Lebanon to respond to Agenda 21 of UNCED.

In Libya, the principal governmental entity is the Technical Centre for Environment Protection of the Secretariat of Public Utility and Housing. The centre defines government strategy, coordinates the relevant monitoring functions of other secretariats and other national institutions.

The centre organizes and conducts the relevant monitoring of pollution at national level and proposes specific steps for the protection of air, water and soil purity and national biodiversity. It is assisted scientifically and technically in this field by the Marine Biology Research Centre, Industrial Research Centre and the Petroleum Research Centre.

The main environmental issues in Libya are: contamination of surface waters by uncontrolled discharges of industrial and domestic wastewaters, sewage treatment, desertification and soil erosion, and management and protection of nature.

In Malta, as a small island with a comparatively simple government structure, most environmental concerns are dealt with by governmental Departments (Malta, 1995). The Drainage Department is responsible for sewage and is aiming at total tertiary treatment by the year 2000, with total recycling for re-use in irrigation and zero marine discharge in summer. The Public Health Department and the Environment Protection Department are jointly responsible for health monitoring of bathing beaches. The Planning Authority is responsible for the urban environment, especially near the coast (nearly all the coastline is owned by the government which strictly controls development there). The University of Malta undertakes the required environmental research in support of the government Departments concerned.

The main environmental issues in Malta are: soil erosion; water resource management (including desalination);and the impact of tourism and the related coastal development (including secondary summer residences).

In some respects, Monaco is similar to Malta in having a simple governmental structure (Monaco, 1992). The Environment Service (Service de l'Environnement) is charged with: the elaboration, supervision and implementation of the environmental regulations; the promotion of environmental protection and public information; and monitoring of environmental quality and pollution sources. It is under the Department of Public Works and Social Affairs (Département des Travaux Publiques et des Affaires Sociales).

The main environmental issues in Monaco are: water resources; impact of tourism; and marine pollution.

In Morocco, the Ministry of Environment became autonomous in 1995, inheriting and enhancing the responsibilities of the former Under-secretariat for the environment. The new Ministry is responsible for inter-ministerial coordination, policy-making, and promotion of scientific research and information on environmental issues. Several other sectoral ministries are in charge of resource management and environmental protection:

- Ministry of Agriculture (irrigation, forest protection, and national parks management,

soil conservation);
- Ministry of Public Works (water management, air pollution monitoring);
- Ministry of Interior (land use planning, assistance to municipalities in water supply and sewerage); and
- Ministries of Public Health, Trade and Industry, Energy and Mines, Fisheries, etc.

The National Environment Observatory of Morocco (ONEM) was set up as a permanent instrument of environmental monitoring. Its main objectives are to foster a better knowledge of the Moroccan environmental system, to study the interactions between environment and development and to reinforce the prospective analysis as a tool for decision-making towards sustainable development. The Observatory also manages (that is, collects, processes and disseminates) environmental data. This can take several forms, such as publication of reports and studies on the environment, the Report on the State of the Environment in Morocco (REEM), the National Strategy for Environmental Protection and Sustainable Development, or reports on regional/local environmental monographs.

A National Council for the Environment has been created to promote interministerial coordination of environmentally related actions.

The main environmental concerns in Morocco are: human settlements; the management of water resources, soil and desertification; management of toxic wastes; health protection, etc.

In Slovenia, the Nature Protection Administration of the Ministry of Environment and Regional Planning is the principal governmental entity responsible for environmental matters (Slovenia, 1995).

The main environmental issues in Slovenia are: harmful algal blooms in the northern Adriatic, causing the production of massive amounts of mucilage in the sea water and benthic fish kills due to very low oxygen levels in the bottom water; forest fires; water resources; impact of tourism; and, sometimes, air pollution over the main cities.

Regarding Spain, the national report on the environment (Spain, 1992) stresses that all the public administration entities have a greater or lesser competence in environmental matters, which renders their integration into a coherent framework very difficult. Responsibility is set at three main levels: the State, the Autonomous Communities, and the Local (Local Corporations and Municipalities). At the State level, after three decades of evolution after 1960, the central body is the office of the Secretary of State for Water Policy and the Environment (with responsibility for: environmental standards; coordination with relevant ministerial departments, with the Autonomous Communities, with the European Union and other international organizations in this field; environmental impact assessments at the national level; conduct of water resources policy; protection and management of State property in the maritime-terrestrial public domain; climatology; and cartography). At the Autonomous Community level, certain Communities have the right to undertake environmental legislation in conformity with their respective Statutes of Autonomy, though always in conformity with basic State criteria, and certain executive powers; for other Communities only the power to execute State laws is granted. At the local level the Local Corporations have specific standard-setting powers, and the Municipalities have significant competences regarding disturbing, unhealthy, harmful and dangerous activities. Spanish environmental policy is strongly influenced by the environmental directives issued by the European Union.

The main environmental issues in Spain are: erosion and desertification (efforts at reforestation, rehabilitation of degraded floral biotopes and hydraulic works notwithstanding); water resource management; industrial wastewaters and sludges, as well as atmospheric emissions; urban waste disposal.

In Syria, several ministries and departments are concerned with one or another aspect of coastal resource management and environmental protection (Syria, 1995).

The Ministry of Transport's General Directorate of Ports is responsible for the protection of the marine environment and public property in the coastal strip, overseeing commercial maritime navigation and coastal ports and territorial waters. The Ministry of Agriculture is concerned with forests as well as agriculture (including agricultural settlement zones). The Ministry of Culture and its General Directorate of Antiquities and Museums are responsible for archæological sites and historic monuments. The Ministry of Local Administration is mainly responsible for town and country planning, land survey and public utilities. The Ministry of Environment is responsible for environmental cleanliness and combatting all sources of pollution; to this effect, a new laboratory was recently created in Damascus to deal with chemical pollution. The Ministry cooperates with other bodies, especially in Tartus and Lattakia, concerned with the coastal area.

The University of Tishrine, in Lattakia, operates the marine research centre.

The most important issues in the coastal area are: management of land use, particularly for agriculture, housing, tourism/recreation, ports, warehouses, roads, railways, silos, industrial plants and construction in general; urban population increase (although no overall population policy has yet been developed); sand extraction from dunes; illegal fishing methods (e.g., use of dynamite); contamination of sea water by oil spills, sewage discharge and industrial and agricultural liquid and solid wastes; location of heavy industry (oil refinery, cement manufacture, hydroelectric power generation); environmental protection of forests and smaller wooded areas, river estuaries and some special ecosystems; strengthening the role of the Ministry of Environment in the supervision and enforcement of regulations, international standards and conventions.

In Tunisia, with respect of environmental protection, nature conservation and physical planning, the Ministry for the Environment and Physical Planning is responsible for:

- drawing up and implementing national policy;
- coordinating the various actors;
- promoting relevant legislation; and
- monitoring pollution control.

Four public bodies under the aegis of the Ministry for the Environment and Physical Planning are active in the field of environmental protection.

- The National Agency for Environmental Protection (ANPE) with a double role, on the one hand to analyse and monitor the role of the environment in the country and on the other, to combat all forms of pollution, especially industrial pollution. The ANPE is also responsible for solid waste management and projects to improve the quality of life in cities and towns.

- The National Office for Public Health infrastructure (Office National d'Assainissement - ONAS) responsible for managing all public health projects in residential, industrial and tourist areas.

- The Agency for the Protection and Development of Coastal Areas (APAC) which manages physical planning projects in the coastal areas and monitors implementation and compliance with relevant legislation and regulations in force.

- The Tunis International Centre of Environmental Technologies (CITE) which trains environmental managers and technicians in the various techniques/methods of environmental protection; it also adapts environmental technologies to the specific conditions of developing countries with a view to their transfer; further, to promote applied research for the development of new technologies to deal with the specific environmental problems of the region, within the framework of a partnership among the private sectors, research institutes and administrations.

The Ministry and its services continued to be strengthened in terms of environmental protection in 1994, through the setting up of six regional Directorates (three of which are responsible for the Northern, the Central and the Southern parts of the coast respectively); they were designed on the basis of a division of the national territory in respect of the natural environmental specifications of the regions.

Other electronic media and economic instruments:

- The Tunisian Observatory for the Environment and Development (OTED) collects environmental data and draws up annually a report on the state of the environment.

- The Fund to Clean Up Pollution (Fonds de depollution - FODEP) stipulated by the Financial Act of 1993 encouraged actions to protect the environment from industrial pollution.

In Turkey, the principal government entity is the Ministry of Environment (Turkey, 1991) which has 33 provincial directorates throughout the country. Several other bodies are attached to this Ministry, but their functions are not yet fully defined: the Supreme Environmental Board and the Local Environmental Boards. The Authority for the Protection of Special Areas has been affiliated with the Ministry of Environment. From its establishment, one of the major responsibilities of this Authority is to contribute to the national implementation of the SPA Protocol. The Ministry itself is designed to set up and implement policies for the protection and conservation of the environment and for the sustainable development and management of natural resources. The Ministry of Energy and Natural Resources has a General Directorate of State Hydraulic Works which is charged with developing water resources for irrigation and hydro-electric power generation and with preventing damage to surface and ground waters as well as ensuring their quality. It is also responsible for drinking and industrial water supply in cities of more than 100,000 population, monitoring water quality and undertaking environmental impact assessment on special projects. The Bank of Provinces, attached to the Ministry of Public Works and Settlement, is responsible for planning sewerage and waste-water treatment plants in small cities (<100,000 inhabitants). The Ministry of Energy and Natural Resources is responsible for the production, use and control of these "commodities". The Ministry of Industry and Trade is responsible for industrial policy development, in the light of potential environmental impacts. The General Directorate of Protection and Control, of the Ministry of Agriculture and Rural Works, and the General Directorate of Rural Services, of the Prime Ministry, also conduct environmental management projects on sewerage and irrigation systems. The Ministry of Forestry is responsible for: protection and management of forests; national parks; natural parks; natural monuments; nature reserves; wildlife protection areas; protection of endangered fauna; erosion control and afforestation; development of forest villages. The Ministry of Health is responsible for health networks and the monitoring of air and bathing water quality. The Ministry of Interior-Coast Guard is responsible for the control of marine pollution caused by marine vessels in areas outside the boundaries of the Greater City Municipalities. The Undersecretariat of Maritime Affairs, attached to the Prime Ministry, among others, is responsible for ensuring that maritime system and services are developed and carried out in accordance with the needs and interests of the country. It is also responsible for research activities in marine areas and for prevention, control and response to pollution caused by marine vessels.

The main environmental issues in Turkey are: degradation of forests by illegal settlements, tourism, agriculture, fire and pests; the drying up of wetlands for other purposes (Turkey is an important route for migratory waterfowl); protection of marine turtle nesting beaches and of monk seal habitats; the degradation of valuable archæological and architectural sites from air pollution, urban encroachment, smuggling of antique artifacts etc.; water pollution; solid-waste disposal in the coastal area (in particular); air pollution due to the burning of lignite and high-sulphur coal; and soil erosion.

UN cooperating agencies

Several UN agencies competent in the marine environmental field have cooperated closely with the MAP Coordinating Unit in the implementation of MAP, each according to its specific mandate and competence.

Food and Agriculture Organization of the United Nations (FAO)

FAO has four major departments focused on resources and environment: Agriculture; Forestry, Fisheries and Sustainable Development.

In the Fisheries Department, the focus being on the rational use of fishery resources, increased consideration is given to the relationship of a resource with its environment, its response to fishing, the demand for fish and fish products, the socio-economic role of the fishery and the legal and administrative constraints on fishing, fish processing and marketing.

To bring the Department's experience, knowledge and information to bear on regional fishery problems, FAO has created several regional subsidiary bodies; for the Mediterranean, the relevant body is the General Fisheries Council for the Mediterranean (created in 1952).

The Fisheries Department has, therefore, cooperated principally in the MED POL programme on the effects of pollution on marine organisms. FAO has also been involved in related questions of human food quality.

FAO was the lead agency for a number of pollutant assessments; notably, on the state of pollution of the Mediterranean Sea by mercury; cadmium; copper and zinc; organohalogens; organotins; organophosphorus compounds; and eutrophication.

FAO has also collaborated with the UN Environment Programme in the development of a Marine Mammal Action Plan, though not in the framework of MAP.

United Nations Educational, Scientific and Cultural Organization

UNESCO promotes marine science in general (notably, but not exclusively, through IOC). The UNESCO Man and the Biosphere (MAB) programme, among other activities of much wider scope, seeks to reveal whole ecosystem linkages and to promote the creation of marine as well as terrestrial biosphere reserves.

UNESCO has cooperated with MAP particularly in the organization of a major Scientific Workshop on Eutrophication in the Mediterranean: Receiving Capacity and Monitoring Long-term Effects, held in Bologna in 1987, which FAO also cosponsored.

World Health Organization (WHO)

WHO works closely with UNEP on the overall planning, implementation and evaluation of health-related aspects of the Mediterranean Action Plan. Through MAP, it participates in the establishment and/or progressive development of health-related aspects of national marine pollution monitoring programmes (pollution sources, coastal recreational and shellfish areas) including identification of requirements, development of standardized sampling and analytical methods, organization of individual and group training, quality control of microbiological data, evaluation of country data and analysis of trends.

WHO coordinates research projects implemented by Mediterranean institutions within the MED POL Phase II programme, including technical assessment of proposals, identification of requirements, formulation of intercountry projects and development of networks, progress in monitoring and evaluation of results in the broad field of environmental pollution-related health risks.

WHO also participates in the organization of the preparation of guidelines on various aspects of waste treatment and disposal in terms of the Protocol for the Protection of the Mediterranean Sea against Pollution from Land-Based Sources, and has participated as well in the preparation of health-related aspects of overall regional assessments of the state of pollution of the Mediterranean Sea by specific substances, including proposed prevention and control measures for adoption by Governments.

World Meteorological Organization (WMO)

The relation of WMO to marine environmental pollution monitoring and research is mainly through its Global Atmosphere Watch. The routine monitoring programme includes measurements of key parameters and chemical species in precipitation and in the air itself.

WMO has collaborated with MAP, coordinating the programme on monitoring, modelling and assessment of pollution of the Mediterranean Sea through the atmosphere.

WMO, through the WMO/ICSU/IOC World Climate Research Programme (WCRP), is concerned directly with global climate change and this provides a basis for evaluating possible long-term changes in the marine and coastal environment. UNEP also participates directly in the WCRP.

International Maritime Organization (IMO)

The IMO is concerned mainly with shipping: safety of navigation; safety (of seamen and others) at sea; protection of the marine environment from discharges of wastes, pollutants and hazardous substances from ships (including garbage-dumping vessels).

IMO is the depository and secretariat of the global London Convention which regulates the dumping of wastes into the sea and of the International Convention for the Prevention of Pollution from Ships (MARPOL 73/78).

IMO has, through the work of the Marine Environment Protection Committee, also focused on the definition of Sensitive Sea Areas.

It has collaborated closely with MAP, mainly through its support and supervision of the Regional Marine Pollution Emergency Response Centre, in Malta.

International Atomic Energy Agency (IAEA)

IAEA is particularly concerned with, *inter alia*, the contamination of the marine environment and organisms by radioactive substances in the sea, but in the last decade, through its Marine Environment Laboratory in Monaco, has engaged in the analysis of specific non-radioactive compounds in the marine environment. It has been particularly active in preparing and providing standard reference samples (of sediments and marine organism tissues) for the analysis of key contaminants, and in the conduct of intercalibration exercises, many specifically within the MAP context.

IAEA(MEL) has collaborated in several MAP assessments on: radioactive substances; organotins; organohalogens; and organo-phosphorus compounds.

Besides the examples of inter-agency cooperation already given in the foregoing sections, there is a mechanism for more general inter-agency cooperation which provides useful scientific and technical input to MAP. It is the IMO/FAO/UNESCO-IOC/WMO/WHO/IAEA/UN/UNEP Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP), which produces, *inter alia*, overview reports on the state of the marine environment.

Intergovernmental Oceanographic Commission (IOC)

The Intergovernmental Oceanographic Commission (of UNESCO) is playing a key role in defining the physical, chemical and biological factors underlying marine resource use, and in promoting international cooperative investigation and data collection on marine resources and environment. It also provides a context for improving understanding of the links between the oceans and climate, and between the oceanic environment and the biological components supporting food chains leading to fisheries. IOC's Global Investigation of Pollution in the Marine Environment (GIPME), in which UNEP, IMO, and IAEA also participate, has as major elements chemical pollution, effects of pollution on marine organisms and ecosystems, while specialized groups of experts prepare manuals and guidelines on marine pollution monitoring. IOC coordinates research projects dealing with transport and distribution of contaminants, modelling, biogeochemical cycles and remote sensing applications.

The IOC/UNEP/WMO Global Ocean Observing System (GOOS) through its component for the Mediterranean, MED-GOOS, currently under development, will systematically collect, analyze and disseminate data which are of direct relevance to environmental degradation, climate change and coastal zone management.

The IOC has also participated in a number of pollution assessments conducted under MAP, notably on: applicability of remote sensing for the survey of water quality parameters; petroleum hydrocarbons; persistent synthetic materials; and organohalogen compounds.

World Bank for Reconstruction and Development

The World Bank-European Investment Bank Programme for the Mediterranean was initiated in 1988 to address the environmental policy, institutional and investment needs of the region (WB/EIB, 1990). The aim is to influence the formulation of economic policies and investment projects. Phase II, following a diagnostic Phase I, was initiated in 1990 and comprises the Mediterranean Technical Assistance Programme (METAP) specifically to identify projects, assist in their preparation, strengthen national environmental management institutions and advise on policy and legislation (Kudat *et al.*, 1994). The main priority fields are: water resource management; management of solid and hazardous wastes; prevention and control of marine pollution from oil and chemicals; and coastal zone management. Phase II will consist of implementation proper. Cooperation with MAP has been formalized, as well.

Non-governmental organizations

Non-governmental organizations (NGOs) have played a key role in developing environmental awareness with respect to marine resources and environmental issues. They are too numerous to deal with individually. However, they should be recognised as partners in promoting the concept of sustainable development and in the implementation of Agenda MED 21 through their expertise, experience and capacity in their particular fields.

4.1.4 Legislation and its enforcement

For the most part, international legislation does not apply to coastal terrestrial development and the question of implementation and compliance does not arise. This also holds essentially true for territorial seas. Exceptions arise where activities in these national domains have effects outside them in the international domain.

The status of signature and ratification of the Barcelona Convention and its Protocols is given in Table X. The main international instruments governing the marine and coastal environment in the Mediterranean region are summarized below.

Since environmental policy under MAP takes into account the UN Convention on the Law of the Sea, the 1973/1978 Convention on the Prevention of Marine Pollution from Ships (MARPOL), and the 1972 Convention for the Prevention of Pollution by Dumping of Wastes and Other Matter, it is worth noting that the following Mediterranean countries have not yet ratified these conventions: Albania, Bosnia-Herzegovina, Croatia, Israel, Lebanon, Libya, Malta, Morocco, Slovenia, Spain, Syria and the European Union (MARPOL); Albania, Algeria, Bosnia-Herzegovina, Israel, Lebanon, Syria, Turkey and the European Union (Dumping); and Albania, Croatia, France, Greece, Israel, Italy, Lebanon, Libya, Monaco, Morocco, Slovenia, Spain, Syria, Turkey and the European Union (Law of the Sea).

The two main areas in which international legislation is widely applicable in the Mediterranean are sea-bed mining and fisheries.

<u>Sea-bed mining</u>: In the Mediterranean, this covers mainly the extraction of oil and gas, and of sand and gravel. Most of this activity is conducted in territorial seas and, in itself, is governed only by national legislation. The relevant international legislation is: the Protocol for the Protection of the Mediterranean Sea against Pollution Resulting from Exploration and Exploitation of the Continental Shelf and the Sea-bed and its Sub-soil, adopted in 1994, as is; and, in certain cases (ships engaged in mining operations), the Barcelona Convention (1976) and the Dumping Protocol (1976).

<u>Fisheries</u>: The UN Convention on the Law of the Sea, by stipulating the rights and

Table X: Status of Signature and Ratification of the Barcelona Convention and its Protocols (UNEP, 1995c)

	Convention for the Protection of the Mediterranean Sea against pollution	Protocol for the prevention of pollution of the Mediterranean Sea by Dumping from Ships and Aircraft	Protocol concerning cooperation in combating pollution of the Mediterranean Sea by Oil and Other Harmful Substances in Cases of Emergency	Protocol for the Protection of the Mediterranean Sea against pollution from Land-Based Sources	Protocol concerning Mediterranean Specially Protected Areas	Protocol for the Protection of the Mediterranean Sea against pollution resulting from Exploration and Exploitation of the Continental Shelf and the Sea-bed and its Sub-soil
Place/Date Adoption	Barcelona 16. 2.1976	Barcelona 16. 2.1976	Barcelona 16. 2.1976	Athens 17. 5.1980	Geneva 3. 4.1982	Madrid 14.10.1994
Entry into force	12.02.1978	12. 2.1978	12. 2.1978	17. 6.1983	23. 3.1986	
Albania	30.05.1990(AC)	30. 5.1990(AC)	30. 5.1990(AC)	30. 5.1990(AC)	30. 5.1990(AC)	
Algeria	16.02.1981(AC)	16. 3.1981(AC)	16. 3.1981(AC)	2. 5.1983(AC)	16. 5.1985(AC)	
Bosnia-Herzegovina	22.10.1994(AC)*	22.10.1994(AC)*	22.10.1994(AC)*	22.10.1994(AC)*	22.10.1994(AC)*	
Croatia	12.10.1993(AC)*	12.10.1993(AC)*	12.10.1993(AC)*	12.10.1993(AC)*	12.10.1993(AC)*	14.10.1994 (S)
Cyprus	19.11.1979 (R)	19.11.1979 (R)	19.11.1979 (R)	28. 6.1988(AC)	28. 6.1988(AC)	14.10.1994 (S)
European Community	16. 3.1978(AP)	16. 3.1978(AP)	12. 8.1981(AP)	7.10.1983(AP)	30. 6.1984(AP)	
Egypt	24. 8.1978(AP)	24. 8.1978(AP)	24. 8.1978(AP)	18. 5.1983(AC)	8. 7.1983 (R)	
France	11. 3.1978(AP)	11. 3.1978(AP)	11. 3.1978(AP)	13. 7.1982(AP)	2. 9.1986(AP)	
Greece	3. 1.1979 (R)	3. 1.1979 (R)	3. 1.1979 (R)	26. 1.1987 (R)	26. 1.1987 (R)	14.10.1994 (S)
Israel	3. 3.1978 (R)	1. 3.1984 (R)	3. 3.1978 (R)	21. 2.1991 (R)	28.10.1987 (R)	14.10.1994 (S)
Italy	3. 2.1979 (R)	3. 2.1979 (R)	3. 2.1979 (R)	4. 7.1985 (R)	4. 7.1985 (R)	14.10.1994 (S)
Lebanon	8.11.1977(AC)	8.11.1977(AC)	8.11.1977(AC)	1994 (AC)*	1994 (AC)*	
Libya	31. 1.1979 (R)	31. 1.1979 (R)	31. 1.1979 (R)	6. 6.1989(AP)	6. 6.1989(AP)	
Malta	30.12.1977 (R)	30.12.1977 (R)	30.12.1977 (R)	2. 3.1989 (R)	11. 1.1988 (R)	14.10.1994 (S)
Monaco	20. 9.1977 (R)	20. 9.1977 (R)	20. 9.1977 (R)	12. 1.1983 (R)	29. 5.1989 (R)	14.10.1994 (S)
Morocco	15. 1.1980 (R)	15. 1.1980 (R)	15. 1.1980 (R)	9. 2.1987 (R)	22. 6.1990 (R)	
Slovenia	15.3.1994 (AC)	15.3.1994 (AC)	15.3.1994 (AC)	15.3.1994 (AC)	15.3.1994 (AC)	
Spain	17.12.1976 (R)	17.12.1976 (R)	17.12.1976 (R)	6. 6.1984 (R)	22.12.1987 (R)	14.10.1994 (S)
Syria	26.12.1978(AC)	26.12.1978(AC)	26.12.1978(AC)	1.12.1993 (AC)	11.9.1992 (AC)	
Tunisia	30. 7.1977 (R)	30. 7.1977 (R)	30. 7.1977 (R)	29.10.1981 (R)	26. 5.1983 (R)	14.10.1994 (S)
Turkey	6. 4.1981 (R)	6. 4.1981 (R)	6. 4.1981 (R)	21. 2.1983(AC)	6.11.1986(AC)	

S = Signature R = Ratification AC = Accession AP = Approval * pending confirmation from the Depositary State (Spain) obligations of coastal States in extending their jurisdiction over fisheries, removed the free and open access which the distant-water fleets formerly operated under within 200 miles of the coast. Subsequently, many coastal States internalized the problem of effort control, allowing an increase in fishing effort under the free and open-access conditions prevailing within national maritime jurisdictions (e.g., EEZs). This occurred because no specific rights were assigned to national harvesters and, in many cases, through excessive use of inappropriate subsidy schemes, this led to excessive fishing effort and further deterioration of the national resource base. One possible solution is that specific geographical rights to specified fishery areas, referred to as TURFs (Territorial User Rights of Fishermen), be granted in a Mediterranean regional framework.

In the Mediterranean Sea itself, no State has established an Exclusive Economic Zone, although Malta has established a small exclusive fishing zone, so, in effect, almost all fishing activity, except that within territorial seas, is conducted under an open-access regime. Since most fish stocks, and not least the highly migratory resources, lie across national maritime boundaries or between territorial seas and international waters, the prospects for joint management of the stock are particularly problematical, given that a unit stock must be managed in a coordinated fashion based on information on catches throughout its range.

Under the UN Convention on the Law of the Sea, jurisdiction over shelf resources lies with the coastal States, except for limited areas of shelf beyond 200 miles, and States are charged with cooperating to ensure sustainable management of shared marine resources, to use an existing fishery commission, or to set up such a body for this purpose.

The Convention's definition of a semi-enclosed sea, such as the Mediterranean, incorporates several key ideas: (i) the potential effect of land on the marine system; (ii) the direct involvement of two or more States; (iii) a connection with another sea or ocean through a strait; and (iv) the division of the sea area into territorial seas and/or Exclusive Economic Zones, in theory at least, since, as noted above, no formal EEZ claims have yet been made in the Mediterranean.

The Convention definition excludes seas that are wholly national, such as the Sea of Marmara, even though, as for archipelagic seas and straits in general, the unhindered passage of marine resources from one jurisdiction to another through such wholly national waters is internationally recognized and accepted. This imposes a special obligation on the concerned States for conservation of international migratory resources while they are traversing straits and national seas.

4.1.5 Public awareness and participation

In spite of the fact that the general public, and notably the tourist population in the Mediterranean region, is becoming more and more aware of the marine and coastal environment, not the least evidence being the increasing demand for so-called eco-tourism and eco-recreation (see section 3.2.7), it appears that MAP is still lacking a popular constituency in the resident and tourist populations. This is partly because it has always been addressed to national and international decision-makers. Tourists may be willing to pay an "environmental protection" tax, especially as the aforementioned eco-tourism expands and æsthetic insults such as tarred and littered beaches, for example, as well as transport difficulties (i.e., coastal road traffic jams), become more frequent and possibly influence tourist quality. However, tourists would need to be much better informed of what MAP is and what it is doing to improve the environment in the way that tourists and resident populations seek.

An "environmental protection" tax implies a need to cost resource utilization more realistically than at present (Chircop, 1992). The possibility that such a tax could be paid into the Mediterranean Trust Fund for MAP should not be excluded.

4.2 Prevention and Control of Marine Pollution

Various definitions of marine pollution need to be taken into consideration in assessing the effects of human activities on marine resources.

The basic definition was provided by GESAMP: "the introduction by man, directly or indirectly, of substances or energy into the marine environment (including estuaries) resulting in such deleterious effects as harm to living resources, hazards to human health, hindrance to marine activities including fishing, impairment of quality for use of sea water, and reduction of amenities".

The UN Convention on the Law of the Sea, in 1982, in Article 1, paragraph 1(4), largely followed the GESAMP definition, by describing marine pollution as "...the introduction by man, directly or indirectly, of substances or energy into the marine environment, including estuaries, *which results or is likely to result* in such deleterious effects as hazards to human health, hindrance to marine activities, including fishing and other legitimate uses of the sea, impairment of quality for use of sea water and reduction of amenities;".

Under Article 1 of the London Dumping Convention, contracting parties pledge to "take all practicable steps to prevent the pollution of the sea by the dumping of waste and other matter that is liable to create hazards to human health, to harm living resources and marine life, to damage amenities or to interfere with other legitimate uses of the sea".

The slight modification of the GESAMP definition, as it appears in the UN Convention on the Law of the Sea, is very significant, since it introduces the precautionary principle. For this reason, this modified definition was adopted in the amended Barcelona Convention. It should be noted that the introduction of the same substances into the marine environment that do not cause the above-mentioned negative effects would not be considered pollution.

The prevention and control of marine pollution is the primary responsibility of the Contracting Parties; these act principally through the Mediterranean Coordinating Unit in the framework of the Mediterranean Pollution Monitoring and Research Programme (MED POL). The policy guidance springs, primarily, from the Protocols (i)-(iii) mentioned above in section 4.1.1 and from the Common Measures adopted under the Land-based Sources Protocol. A detailed evaluation of MED POL was carried out by a group of experts and is reported in UNEP (1993c). With the benefit of hindsight, it draws attention to a number of policy and implementation weaknesses in Phases I (1976-1980) and II (1982-1995) of MED POL which should be progressively corrected in Phase III (1996-2005).

Scientific research on marine pollution problems is seen as a means of reducing present uncertainties facing management decisions and of establishing links between inputs, concentrations and effects of contaminants and other stresses. That is, scientifically based hazard assessment of contaminants is essential to correct management decisions (Jeftic, 1992b).

4.3 Protected Areas and Endangered Species

There are 123 Specially Protected Areas (SPAs) designated under the SPA Protocol. 47 of these cover marine spaces, either exclusively (15) or as part of a mixed (land and sea) space (32). The remainder are terrestrial and/or include coastal wetlands.

The national legislation of the Contracting Parties in respect of protected areas has been compiled by RAC/SPA (MAP/UNEP) (1993) and reviewed and summarized by UNEP/IUCN (1994); their conclusions are, succinctly, as follows.

For the most part, there is a widespread separation of regulatory powers between governmental entities responsible for the land and those responsible for the sea, which make it very difficult to establish protected areas in the coastal zone (i.e., land + sea regimes). In some countries there is also potential legal opposition between national and regional governments, the former generally having responsibility for national parks, the territorial seas and other entities of national stature, the latter generally having responsibility for the actual territory occupied by a protected area and for the management of such areas.

There is, moreover, very little legislation allowing or governing the creation of marine protected areas, *de novo*; most marine protected areas established have so been by extending the domain of coastal/terrestrial protected areas.

These two major difficulties have been overcome, to some extent, by using laws designed for quite other purposes (e.g., restriction on hunting of wildlife or on fishing). There are some examples in which laws in more than one legal domain (e.g., fishery law + navigation law + wildlife protection law) have been applied to achieve, *de facto*, a protected area. Of all the Contracting Parties, only Italy at present has a specific law governing the creation of marine protected areas.

A major problem is that protected areas established under non-specific laws cannot also have their regulation fixed under such laws; hence they only afford limited protection of such areas, usually against only certain specific activities but not others. Also, as a rule, the legislation governing national parks and reserves is often the only legislation applicable, but often ill-adapted, to special coastal areas such as wetlands and salt marshes.

Regarding specific activities in protected areas, the following constraints generally apply:

(i) fishing may be totally prohibited or only allowed under special, and restricted, license;
(ii) cropping of sea-food species is generally governed likewise;
(iii) hunting is widely banned, with occasional derogations under specific circumstances;
(iv) navigation is subject to a wide variety of restrictions as to vessel track, speed and mooring, but total prohibition is rare;
(v) swimming and diving is generally restricted and regulated, especially to exclude hunting (use of harpoons etc.);
(vi) removal of rocks and minerals is also generally restricted and regulated, especially to prevent disturbance of the substrate (sea bed);
(vii) introduction of exotic species is generally restricted or banned, but regulation sometimes applies only to flora; and
(viii) discharge of pollutants is generally restricted or banned, but sometimes is limited to specific sites and/or types of pollutant.

The general prohibition of any action likely to disturb or modify the flora, fauna, water or substrate is widespread in the legislation at the national level. A zonation of protected areas is often adopted to allow accommodation of locally long-established rights of exploitation in, or in the immediate vicinity of, a protected area.

The management of marine protected areas is not usually based on the law under which they were created. Regulations are often established by a local entity under specific statutes, or are not established at all. *Ad hoc* management committees are sometimes set up; they may or may not be effective in the management of the protected area. Sometimes *ad hoc* arrangements are made between interested parties and may prove workable.

Declassification criteria (for the disestablishment of a protected area) are rarely more severe than those for establishment, so that the duration of a protected area is only weakly assured.

UNEP, through its Specially Protected Areas Regional Activity Centre, and with the collaboration of the World Conservation Union (IUCN), has prepared a directory of marine and coastal protected areas of the Mediterranean region (UNEP, 1994h), which lists, in Part 1, 233 sites of biological and ecological value, all under some degree of protection. IUCN has also compiled a directory of the world's protected areas (IUCN, 1990), of a much wider scope than that prepared by UNEP (1994h) and not limited to the coastal zone.

Protected areas, including SPAs, are all established, so far, in areas under national jurisdiction, and there are, therefore, few international legal instruments governing their establishment, regulation and management; the SPA Protocol to the Barcelona Convention is the principal one in the Mediterranean.

A number of international conventions are applicable in the Mediterranean region, insofar as the coastal States are signatories to, or have ratified, them. These have been summarized by de Klemm (1993). They are, with place and date of signature in parenthesis (UNEP, 1995f):

- The African Convention for the Conservation of Nature and Natural Resources (Algiers, 1968). The species in Class A (in Annex) must be fully protected by the contracting States against hunting, slaughtering, capture or collection. The marine species of main concern in this priority Class, as well as in the Mediterranean context (see section 3.3.1), are the monk seal, all marine turtles, storks, cranes, flamingoes and pelicans. In the Mediterranean, Algeria, Egypt, Morocco and Tunisia are signatories.
- The Convention on the Conservation of Migratory Species of Wild Animals (Bonn, 1979). The species in Annex I (total protection) of actual or possible concern in the Mediterranean are the blue whale (*Balænoptera musculus*), the monk seal (also in Annex II, which requires signatories to make every effort to establish agreements amongst themselves to protect and manage the resources of the animals listed), all marine turtles (in both Annexes), the white pelican, Audouin's sea gull, and two other bird species: white-tailed eagle (*Haliaëtus albicilla*) and slender-billed curlew (*Numenius tenuirostris*). The coastal States signatories to this Convention in the basin are Spain, France, Monaco, Italy, Israel, Egypt, Tunisia and Morocco, as well as the European Union.
- The Convention on the Conservation of European Wildlife and the Natural Habitats (Bern, 1979). The species in Annex II (total protection) of actual or possible concern in the Mediterranean are the blue whale (*Balænoptera musculus*), the killer whale (*Orcinus orca*), the false killer whale (*Pseudorca crassidens*), Risso's dolphin (*Grampus griseus*), the pilot whale (*Globicephalus melæna*), the common dolphin (*Delphinus delphis*), the bottlenosed dolphin (*Tursiops truncatus*), the rough-toothed dolphin (*Steno bredanensis*), the striped dolphin (*Stenella coeruleoalbia*), the harbour porpoise (*Phocoena phocoena*), the dense-beaked whale (*Mesoplodon densirostris*), Cuvier's beaked whale (*Ziphius cavirostris*), the bottle-nosed whale (*Hyperoodon rostratus*) (all other cetaceans are included in Annex III - protection and management), the monk seal, the green turtle, the loggerhead turtle, the hawksbill turtle, Kemp's ridley turtle (*Lepidochelys kempi*), the leatherback turtle (*Dermochelys c. coriacea*), and the vast majority of birds. The coastal States signatories to this Convention in the basin are Spain, France, Monaco, Italy, Malta, Greece, Cyprus and Turkey, as well as the European Union.
- The International Convention for the Regulation of Whale Hunting (Washington, DC, 1946). The species of whales that are the object of this Convention and are likely to be found in the Mediterranean are the blue whale, the fin whale (*Balænoptera physalus*), the sei whale (*B. borealis*), the minke whale (*B. acutorostrata*) and the sperm whale (*Physeter macrocephalus*). All are protected species or are the subject of a whaling moratorium. The coastal States signatories to this Convention in the basin are Spain, France and Monaco.
- The Convention on International Trade in Endangered Species of Wild Fauna and Flora (Washington, DC, 1973). This Convention is relevant to the protection of species mainly in the sense that it prohibits or controls the loop between supply (of native species) and demand (for non-native species), but it thereby favours the creation of protected areas. The coastal States signatories to this Convention in the basin are Spain, France, Monaco, Israel, Italy, Malta, Greece, Cyprus, Egypt, Tunisia, Algeria and Morocco.

The Council of the European Union has also adopted two directives which apply only to EU Member States and, in the Mediterranean, to Spain, France, Italy and Greece, at present, which have the protection of endangered species as their principal objective: 79/409 on the conservation of wild birds; 92/43 on the conservation of natural habitats and wild fauna and flora.

PNUE/UICN (1994) also reviews the national legislation relating to the protection of marine and coastal species.

The UNEP/MAP and the Specially Protected Areas Regional Activity Centre organized an expert meeting on environmental legislation related to specially protected areas and endangered species in the Mediterranean (UNEP, 1993d). It reviewed the state of development of national legislation in this field and, in particular, submitted a proposal to the Contracting Parties to modify the title of the SPA Protocol, essentially to add the notion of "wildlife", and the related revision of the text that might be necessary.

The Contracting Parties, through the Genoa Declaration (1985), also adopted ten objectives to be attained by 1995. Among these objectives were the protection of endangered marine species, such as the monk seal and marine turtles, and the creation of a Mediterranean network of some fifty protected areas.

Ten Mediterranean coastal States have established 38 biosphere reserves as part of the World network set up under UNESCO's Man and the Biosphere Programme. These reserves are designed to conserve genetic resources (see section 3.4.2, above) and representative ecosystems, while allowing the sustainable development of the neighbouring human populations. These reserves are unconventional and are adapted to local ecological and socio-economic circumstances; they comprise a central zone of strict protection, surrounded by a buffer zone with strict limitations on human activities, in turn surrounded by a transition zone where human activities are allowed under certain restrictions.

The protection of specific natural areas, insofar as it is effective, also protects endangered species, although it is not always necessary to set up such areas to ensure protection of many species.

The Contracting Parties have adopted Action Plans for the Management of the Mediterranean Monk Seal (1987), the Conservation of Mediterranean Marine Turtles (1989), and the Conservation of Mediterranean Cetaceans (1991). It may also be noted that UNEP adopted a Global Action Plan for the Conservation of Marine Mammals (1984).

A Meeting of Experts on the Evaluation of the Action Plan for the Management of the Mediterranean Monk Seal (Rabat, October 1994) reviewed progress in this field since 1987, making a number of recommendations aimed at generalizing the application of the Action Plan by the Contracting Parties (UNEP, 1994l).

The newly adopted Protocol (to the Barcelona Convention) Concerning Specially Protected Areas and Biological Diversity in the Mediterranean notably calls for the establishment of a list of Specially Protected Areas of Mediterranean Importance (SPAMI): to conserve biodiversity; to contain specific Mediterranean ecosystems. Related measures include: protection and conservation of species; regulation of the introduction of non-indigenous or genetically modified species; environmental impact assessments of any projects or activities likely to affect protected areas and taking into account traditional human activities, without prejudice to achieving the objectives of the Protocol; improvement in publicity and scientific, technical and management research relevant to SPAs.

4.4 Protection and Development of the Coastal Zone

Ever since MAP was established it has been aware of the need to apply the integrated management of coastal areas, and integrated planning, to the protection of the Mediterranean environment. During the first decade of MAP, activity concentrated on monitoring the state of the Sea and on intervention to improve the state of the natural system. In doing so, it became increasingly clear that 80% of the marine pollution problem had a source on the land, and that it was necessary to harmonize development, globally and regionally, with the receiving capacity of the environment. This requires a continuing process of integrated planning and rational management of the region's limited resources, with particular emphasis on the interface between the land, as the main source, and the sea as the main recipient - the coastal zone (UNEP, 1993e) (see box on page 102).

The policies for environmental and resource management and for coastal area development, as a major contributor to the land-based sources of pollution, must therefore be based on complementary objectives and be applied using

COSTS AND BENEFITS OF MEASURES TO REDUCE DEGRADATION OF THE ENVIRONMENT BY LAND-BASED SOURCES OF POLLUTION

Placing monetary values on environmental resources is one of the main contributions of environmental economics to environmental policy and pollution control programmes. Methodological and data problems continue to stimulate case studies to improve locally relevant valuation and measurement techniques. The fact that estimation methods may sometimes give only approximate money value to environmental costs and benefits does not mean that environmental costs and benefits do not exist or that their importance to planning and policy-making is marginal.

The study of the benefits of measures to reduce the environmental impacts of land-based sources of pollution on the coastal environment on the Island of Rhodes, in Greece, demonstrates the uses of the results of a cost/benefit approach to environmental policy.

The Island of Rhodes has experienced rapid growth in tourism leading to emerging pressures on the coastal environment. Over one million tourists visit the island every year bringing pressure to bear on the northern part of the coastal zone which concentrates over 85% of the island's tourist accommodation capacity of about 70,000 beds. Prospects for future environmental impacts have stimulated policy and investment responses by the local and national authorities. The cost/benefit case study is central to the effort to strengthen programme development and justify the priority assigned to investment allocations to environmental management expenditure.

On the cost side, the Rhodes case study identified and estimated environmental costs in terms of four indicators:

(i) loss of tourist revenue;
(ii) degradation of the beach;
(iii) health hazards; and
(iv) reduction of residential amenity.

Costs were expressed in monetary values through estimates of market and market-related variables including:

(i) changes in production (to overcome loss of tourist revenue);
(ii) cost of rehabilitation (to restore beach quality);
(iii) direct household expenditure (for health treatment); and
(iv) changes in urban land productivity (to change property values).

The monetary costs were estimated at about $15.2 million a year, within a range of approximately 25%, representing roughly 3% of the Island's Gross Domestic Product. Loss of tourist revenue amounted to 8.1 million a year; reduction of urban residential land values, 3.5 million a year; beach degradation, 2.7 million a year; and health costs, only 0.9 million a year. Costs in terms of lost tourist revenues, estimated on the basis of the decline in hotel occupation rate, was the largest category. Costs in terms of health hazards were found to be negligible accounting to information on the number of visits to the doctor for problems relating to the quality of bathing waters. Costs of urban residential amenity, expressed in reduced land development rents, were far less than foregone tourist opportunities but still quite important. Environmental factors were found to be responsible for depressed property values in particular locations subject to relative environmental degradation, mainly near the ports and in parts of the bay of Ixia.

On the benefit side, the Rhodes case study examined environmental investment in the central sewerage system over the period 1988-91 and planned investment up to 1999 and focused on the direct and indirect benefits expected from the investment. The direct benefits comprised two main categories:

(i) the expected increase in tourist revenues from improved coastal zone management; and
(ii) cost savings associated with the pre-investment system of sewage removal and disposal by carryer vehicles.

The indirect benefits concerned general improvements in the island's environment and particularly in the level of residential amenities by reduction in obnoxious odours, car traffic and noise which are expected to have positive effects on property values. The main areas to accrue benefits are the island's "hot spots" to be served by the central sewerage system, such as the bay of Ixia, the coast of Faliraki and the area of the ports.

The case study showed that, excluding significant qualitative benefits which are harder to measure, the monetary value of the measurable benefits mentioned above far exceeds the investment cost. From a total investment of US$94 million in the sewerage system of the cities of Rhodes, Ialyssos, Koskinou and Lindos, annual benefits of US$21.2 million were estimated, equal to a present value of US$200 million, reflecting a benefit/cost ratio of well over 2. It was also shown that 45% of the benefits will accrue from expected property value increases, 35% from cost savings and 20% from future tourist revenues.

The case study also highlights another set of results. That "benefits" of rapid country-specific cost/benefit appraisal on environmental policy do not only hinge on numerical accuracy but primarily on placing a policy tool in the hands of decision-makers for use in the competitive process of investment allocation for the environment.

instruments that are compatible and efficient; that is, cost-effective. As noted in the Introduction to the present report, the priority fields of activities for the environment and development in the Mediterranean Basin - 1996-2005 were adopted as Appendix II to the Barcelona Resolution.

The objectives of an integrated coastal area management scheme in a given place, time and socio-economic context are multiple and often conflicting; therefore, these objectives must also be socio-economic objectives of the responsible government and local authorities in such a way as to maximize the common good. The public perception of this good may not be constant, but it must also be related to the time scale on which human societal development proceeds: that is, decadal. This common good must, in the current climate of social thinking, have sustainable development as its main objective.

The reduction of user conflict would generally demand the assignation of a value (expressed as some form of rent for use) to the coastal zone which would require a restriction on access, either through the economic cost of the rent or through socially established limits, and necessitate zoning whereby different uses are, as far as possible and, indeed, convenient, kept physically separate, so as to avoid adverse impacts on other users and uses and, perhaps above all, on the environment and the natural resources.

It is not normally possible for all these uses to co-exist in the same coastal area. Coastal habitation, tourism and recreation, on the one hand, and industry and marine mining, on the other, tend to be mutually exclusive, if the coastal area under consideration is relatively small; and all these uses tend to prejudice the pursuit of fishing (perhaps even sport fishing) and marine aquaculture. The choice of an integrated coastal area management scheme is therefore important mainly because ecological criteria of choice in terms of space and objectives are unlikely to correspond to political criteria, in terms of jurisdiction and economics. Controlling coastal development and protecting habitats will require improved planning procedures, and will often involve painful social and political choices. It is important that the general public be involved in making these choices.

With these considerations in mind, MAP has worked to identify appropriate institutional, technical or policy mechanisms to make environmental and coastal zone development policies mutually supporting and reinforcing, to evaluate the effectiveness of such mechanisms and to assist in their establishment.

In the majority of Mediterranean countries the concept of integrated coastal area planning has not yet been fully applied and modern tools for such planning have not yet been introduced. Even those plans that have been drawn up do not take into account the atmosphere, nor the nearshore and offshore areas relevant to the plans, nor the role of natural processes and human activities in the hinterland.

The major form of assistance provided to the Contracting Parties by MAP in this field are the Coastal Area Management Programmes (CAMPs). They represent a new form of cooperation between MAP and the relevant national institutions and experts. The sum of MAPs knowledge and experience is now being applied to the development and execution of CAMPs. The details of this action are given by UNEP (1995g) and summarized by Jeftic (1993b).

The main objectives of CAMPs are to introduce or develop the process of integrated planning and management of Mediterranean coastal zones and to contribute to a sustainable development and environmental protection.

Each CAMP contains the following components:

- implementation of legal instruments (LBS Protocol, monitoring, survey of pollution, common control measures, Emergency Protocol, Dumping Protocol, MARPOL Convention);
- resource evaluation, protection and management (water, soil, forests, coastline, marine ecosystems, protected areas);
- activities (evaluation and trends);
- natural hazards and phenomena (seismic risk, implications of climatic changes);

- planning and management tools (database, geographical information system (GIS),Environmental Impact Assessment (EIA), carrying capacity);
- development-environment scenarios; and
- integrated planning and management (integrated planning studies, resource protection and management plans).

CAMPs are aimed at creating suitable conditions for the Integrated Management of Coastal and Marine Areas. That is, an area-specific activity carried out in comparatively small selected areas of the region and based on the integration of knowledge and experience obtained by all MAP components (Jeftic, 1993b).

To assist such activities, the "Guidelines for Integrated Management of Coastal and Marine Areas" (UNEP, 1995g) were prepared.

So far, CAMPs were completed for the Bay of Izmir (1993), the Syrian coast (1994), the Kastela Bay (1994), the Albanian coast (1996), and the Island of Rhodes (1996), will be completed in 1996 for Fuka-Matruh and in 1997 for the Sfax region, and are being developed for Israel, Lebanon, Malta and Morocco (Figure 4). Using prospective scenarios the Blue Plan has also made an integrated coastal study of Iskenderun Bay in Turkey (UNEP, 1994m).

4.5 Sustainable Development

4.5.1 Objectives

The concept of sustainable development was at the core of the debate at the UN Conference on Environment and Development, held in Rio de Janeiro in June 1992. The need for sustaining improvements in human well-being, while pursuing policies compatible with the capacity of the global environment to sustain such improvements over the long term, has led in recent years to the ideal of sustainable development. This concept embodies the idea of "progress", the motive force for technologically driven changes since the middle of the last century, and the idea of "stability", the ability of mankind to extract a constant level of benefits from an ecosystem over an indefinite period. The more limited notion of "development" therefore embodies the notion of exploitation or harvesting of natural resources, but such exploitation must be constrained by the capacity of the exploited resource and its natural environment to resist the impact of exploitation, if such development is to be sustainable. The pursuit of "progress" without restrictions has had negative effects on marine, as well as terrestrial, environments (WB/EIB, 1989).

The definition of sustainable development adopted by the World Commission on Environment and Development in 1987 (the Brundtland Report) is perhaps the simplest:

"Development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

This definition recognizes that the value systems of society are continuously changing, as will the relative value currently assigned to a particular living resource. A more explicit definition for aquatic and terrestrial systems was adopted by the FAO Council in 1988:

"Sustainable development is the management and conservation of the natural resource base, and the orientation of technological and institutional change in such a manner as to ensure the attainment and continued satisfaction of human needs for present and future generations. Such development conserves land, water, plant and genetic resources, is environmentally non-degrading, technologically appropriate, economically viable and socially acceptable."

The main objectives for the achievement of sustainable development in the Mediterranean context are outlined in the Action Plan for MAP Phase II (UNEP, 1995e) and in CEC (1993b) for all the major areas of socio-economic activity. They may be summarized as follows. Regarding economic activities, the main areas of concern are agriculture, industry, energy production and consumption, tourism, transport and fisheries.

Agricultural production is expected to increase, particularly in the countries on the southern and eastern borders of the

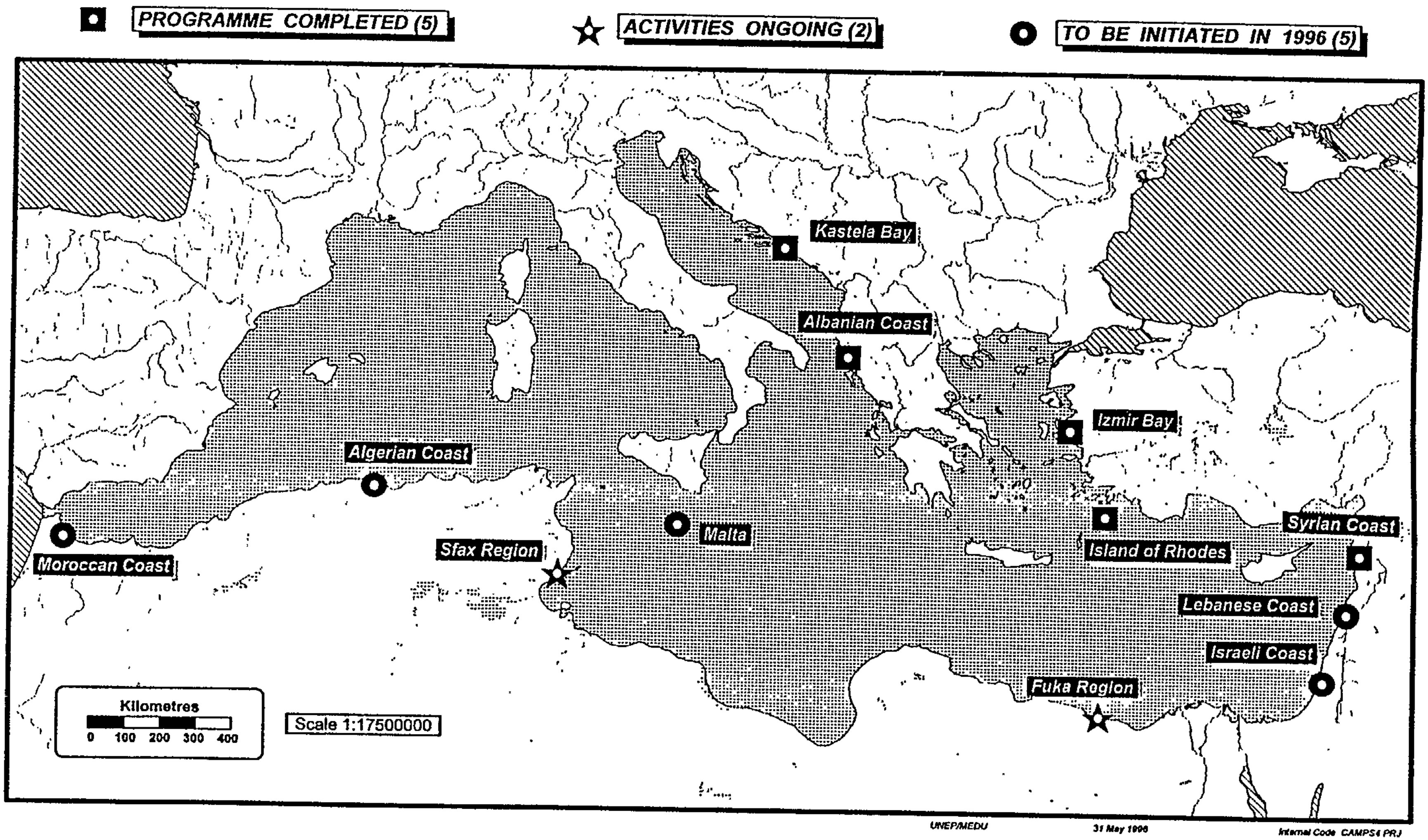

Fig. 4 Coastal Areas Management Programme of MAP

Mediterranean Sea. The continued or increased use of inefficient irrigation systems will increase the negative impact on soil, through changes in its composition, nutrient content and texture, and on water quality, since the volume of discharged water will be reduced and have to carry a higher load of excess chemicals (including salt), fertilizers and pesticides. This reduced free-water volume will also facilitate soil erosion which is a factor in desertification.

The main objectives in the sustainable development of agriculture should include:

- adoption of farming practices that are well adapted to the physical and ecological conditions, especially with respect to soil and water resource conservation;
- adoption of environmentally friendly techniques to increase agricultural productivity and production and to conserve biodiversity;
- adoption of much more efficient systems of irrigation and water drainage;
- greater control and more limited use of chemicals that pollute soil and water; and
- increased use of natural fertilizers.

Regarding industry, a principal problem is the persistence of old-established industries in which the industrial processes used were designed when there was not much concern with the environmental impact of the wastes they produced; nor was there enough demand to force a much greater exploitation of those wastes, by recycling or the manufacture of secondary products based on them. The main objectives, among others, of sustainable development of industry should include:

- the promotion of the use of "clean" industrial procedures and techniques, and the transfer, adaptation and control of this technology between Mediterranean countries;

- the reduction of industrial wastes and their improved management and control, so as to minimize the environmental impact of these wastes, or, as far as possible, the incorporation of processes to exploit them.

Regarding energy production and consumption, the growth of the demand and the supply, mainly of fossil fuels, is a main factor in environmental pollution and other forms of environmental degradation. The objectives of sustainable development should include:

- increased use of new (i.e., currently non-conventional) and renewable energy sources that are more environmentally friendly than the burning of fossil fuels, in domestic, industrial, private and public uses;
- development and application of techniques, especially insulation and ventilation, for better controlling and saving energy;
- modernization of existing power stations in the Mediterranean basin and the environmentally friendly design of any new power stations to be installed there.

Tourism, though having a generally positive impact on the economies of "tourist-importing" countries, has a generally adverse effect on the environment in which it takes place, through pressure on land (for accommodation and other facilities), on food resources, on transport facilities, on coastal seas, on historical and natural sites, and, culturally, on the resident population.

The main objectives of the sustainable development of tourism include:

- improved assessment of the tourist carrying capacity of each tourist area;
- increased cooperation between the "tourist-exporting" and the "tourist-importing" countries, so as to improve public awareness of the environmental factor and the cost, *sensu lato*, of minimizing environmental impact;
- regular monitoring of the natural, cultural and human tourist resources and the regular assessment of the response of each tourist site to the tourist impact;
- promotion of tourism based on the natural, unspoiled environment and, as far as possible, at off-season periods of the year.

Transport is an infrastructural economic activity. Air and land transport will continue to grow and to have an increasing impact on resources, notably land and fuel, through the increased number and size of roads (hence vehicles) and airports (hence aircraft).

The main objectives for the achievement of sustainable development in this respect, are:

- to develop new forms of transport that, while providing all necessary comfort for individuals and efficiency for goods, decrease the amount of fuel and space used for each individual or unit product transported;
- improve the systems of transport for persons and goods, by facilitating the use of mixed modes of transport for different purposes;
- harmonize, at least on a regional basis, the systems of transport that are best suited to the Mediterranean basin.

Fisheries have probably reached a plateau in terms of what can be taken from the sea without driving the stocks to economic distinction, which normally precedes biological extinction unless the public willingness to pay the cost of capture remains directly proportional to the availability of the catch. In some cases, this is regrettably the case (e.g., bluefin tuna), and sustainable development is severely compromised.

The main objectives for the achievement of such development are:

- control of fleet size, technical advances in gear, vessels and navigational and fish-finding equipment, so as to adjust fishing effort rapidly to changes in stocksize and biological yield;
- development of a much improved information base to allow accurate assessment of the state of the stocks and the optimum biological yield therefrom;
- rational and equitable allocation of fishing areas and resources, so as to place responsibility for stock maintenance in the hands of those to whom the resources have been so allocated;
- the special protection of estuaries and associated nearshore areas from use prejudicial to the fishery resources, because of the biological importance of these land-water interfaces which are nursery areas for many valuable species, areas where coastal marine systems are fertilized from the land, and on which marine resources harvested farther offshore depend;
- the rehabilitation of coastal ecosystems in which fishery resources once prospered;
- the development of legal, management and conservation mechanisms required for the management of the fresh water-seawater interface and the related resources;
- the implementation of the FAO Code of Conduct for Responsible Fishing, the Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas, and in due course, the relevant decisions expected to emerge from the UN Conference on Straddling Fish Stocks and Highly Migratory Species.

Marine aquaculture and habitat enhancement measures such as the construction of artificial reefs, are centered on coastal waters, estuaries and lagoons. The allocation of exclusive rights to users over the area of operation, the promotion of environmentally friendly aquaculture, and the protection of aquacultural standing crops against the harmful effects of other users of the environment are essential to the sustained development of marine aquaculture.

There are several socio-economic activities that need to be developed so as to contribute effectively to the achievement of sustainable development in the Mediterranean basin. They are: urban management, the management of natural resources, whether exploited or not, the conservation of natural landscape and natural sites of special ecological, social or cultural interest.

In terms of the particularly complex coastal area, the aforementioned activities may be dealt with under the concept of integrated coastal area management.

Urban management - increased analysis of the urban environment and the application of the results thereof to urban planning or redevelopment, taking environmental issues into account; the creation and development, where necessary, of a policy for urban management and an institutional and financial framework for such management; the development of the required professional and institutional capabilities; increased regional cooperation, possibly through a "twin-cities scheme", to promote exchange of experience in urban management throughout the

Mediterranean basin.

Management of natural resources - this covers four main areas: water resources; soil; forests and other natural vegetation; living marine resources.

The actions directly relevant to the sustainable development of water resources are: improved monitoring of water demand and of the supply to meet such demand; the preparation of national water resource plans (see box on page 109), on a drainage-basin basis, and the application of respective management programmes derived from such plans, with particular attention to the special problems of the coastal area and of small islands; increased and improved re-use of wastewaters; increased regional and international cooperation to ensure adequate exchange of experience between countries in this field.

The actions directly relevant to the soil and its sustainable development are: increased and improved monitoring of soil state and mapping of soil types, preferably on a drainage-basin basis; development and application of policies and programmes to combat and, if possible, prevent soil degradation (down to desertification) and loss; the application, as appropriate, of the Convention to Combat Desertification.

The actions directly relevant to the sustainable development of forests and other natural vegetation may be derived conveniently from the FAO Mediterranean Forest Action Programme which requires: an assessment of the state of the forests in each country and the identification of problems to be given priority attention; the preparation and eventual application of Forest Directory Plans for each country for the protection, sustainable development of forests and their multi-purpose use; and increased cooperation between countries of the region in the exchange of information and experience.

The actions directly relevant to the sustainable development of the living marine resources, other than those discussed above under fisheries, are: improvement of the information base (e.g., biological data, biogeographical data and human consumption data) required to determine the state of stocks of living marine resources, whether the object of fishery or not, because of the importance of inter-specific relations (predation, competition for ecological niches, food supply etc.), and to determine the effects of environmental degradation and fishery pressure on the natural stocks (even of species not directly subject to fishery); the development of regional resource management policies and mechanisms inspired by the "precautionary principle".

Conservation of natural landscape and natural sites of special ecological, social or cultural interest - this conservation is an essential part of sustainable development because of the very heavy pressure exerted on these resources by uncontrolled urban, industrial and touristic development and the wastes they produce and discharge into the natural environment. Not only is land space increasingly denied to other uses, and historical sites destroyed, at worst, or seriously marred, at best, but typical ecosystems and unique species assemblages are also degraded or permanently modified, if not destroyed. The UN Conference on Environment and Development established a basis for the promotion of sustainable development known as Agenda 21 (UNCED, 1992), and for the conservation of the Earth's

biodiversity by the adoption of the Convention on Biodiversity. The main actions called for are: periodic assessment of the state of the natural resources; the development and application of legal measures to protect them; improved management of natural resources; promotion of improved public awareness thereof; and the international exchange of experience in the conservation of natural resources and their biodiversity.

The very first principle of the Rio Declaration, however, states that "Human beings are at the centre of concern for sustainable development. They are entitled to a healthy and productive life in harmony with nature". As a "cross-cutting" issue, health is well represented throughout Agenda 21 in the chapter on "promotion and protection of human health", where one of the five priority areas consists of

MANAGEMENT OF WATER RESOURCES:
A case study of the Island of Rhodes (Greece)

The island of Rhodes lies in the Aegean archipelago. It is the largest and most densely populated of the Aegean islands, with a population of about 100,000.

The island is one of the most important tourist destinations of Greece. With approximately 1% of the national surface area, the island accounts for about 15% of the total hotel capacity, 25% of tourist arrivals, and nearly 30% of overnight stays in Greece.

The economic base of Rhodes is predominantly tourism; its development just after 1971 marked the most important turning point in the socio-economic structure of the island, stimulating the population growth, as well as creating an evident land-use differentiation between the urbanized northern part and the rural southern part. Employment in hotels and restaurants accounts for about half of the total employment, while, indirectly, tourism supports a much larger employment share, thus dominating the island's employment profile. The small size of the island and its elongated shape offered few physical constraints on the sprawl of tourist-related building development to many parts of the coast of Rhodes, rendering the whole island subject to development pressure related to tourism, despite evident sub-regional differences. The hinterland, which has been untouched by tourism, is undergoing depopulation, socio-economic decline and relative decay due to the strong pull of resources towards the coast.

Because of all this, water resources management, and particularly a reliable and safe supply, is essential to the economy of the island, and, given its present state, a limiting factor in future development.

The island has 38 watersheds, the largest being that of Gadouras (annual mean flow 28 million m^3), followed by Makaris (10 million m^3), and Loutanis (7.5 million m^3). The flow is characterized by high seasonal fluctuation. Most of the water sources are located in the northern part of the island. At present, the only surface water used is taken at the Appolakia dam (8 million m^3 capacity) for irrigation purposes. The remaining demand is met from ground-water resources through more than 350 boreholes and wells, the total annual extraction amounting to 27 million m^3.

Owing to such a situation, the present level of water-resource management and the ever increasing demand for water have resulted in pollution, overpumping of aquifers and lowering of the water level, reducing the yield and deteriorating the water quality. In addition, previous studies indicated the lack of a consistent long data time-series and the mass of relevant hydrological and hydrogeological studies, including the establishment of a water-resource balance.

With regard to the above facts, the MAP CAMP/METAP "The Island of Rhodes", implemented in 1994-96 and supported by the European Investment Bank, paid a great attention to water-resource management. A general Water Resources Master Plan was prepared, presented to national, regional and local authorities and experts, and adopted. PAP/RAC was entrusted with the implementation of the activity, which enjoyed the participation of IGME (Institute of Geology and Mineral Exploration, Athens), and a number of Greek national and local experts, as well as a group of international consultants engaged by PAP.

This activity produced reports on: hydro-climatological factors; regime and quality of the surface waters; hydrology, regime and quality of the ground water; natural water balance; water demand and utilization including the analysis of the natural and socio-economic factors. Finally, a general long-term plan for the development, exploitation and protection of the water resources was prepared, including chapters on water storage, protection of water against adverse natural phenomena, analysis of the sewerage system, water exploitation and water supply solutions.

The results of the general water-resource master plan indicate that the water balance is very favourable, so, the present and future demands can be met reliably; nevertheless, they confirmed the need to build additional water reservoirs, the largest and most important being the one at Gadouras. The drinking-water needs will be met from the reservoirs through a comprehensive water-supply system, while those for irrigation will be secured from the ground water. In addition, recommendations were made on the relevant institutional arrangements, as well as on the follow-up activities: a feasibility study of the proposed water-supply system; and the establishment of an appropriate database to integrate the hydrometeorological and hydrological data.

The Water-Resource Management Plan should be placed within the context of integrated management of the natural resources of the island of Rhodes, and particularly harmonized with the integrated management plan of the island, currently in preparation. Such coordinated action could prevent uncontrolled building, especially in the non-urbanized parts of the island, and direct the construction of tourist facilities to the areas allocated for those purposes by the plan.

reducing health risks from environmental pollution and hazards. Other chapters, most notably those on toxic chemicals, hazardous and solid wastes, fresh water and human settlements are very much human-health oriented.

4.5.2 Planned and ongoing activities

The achievement of sustainable development (CEC, 1993b) is an ideal, though an essential one for human success and perhaps even survival, and only a very small beginning has been made. Many of the underlying concepts and possible mechanisms for such development were crystallized, but not "invented" at UNCED. Nevertheless, a number of activities have been carried out or are planned for the coming decade or more that, if pursued diligently, will help to promote the achievement of sustainable development.

In the Mediterranean region, MED POL and the Regional Activity Centres have, for many years, been identifying and analysing many of the impediments to such an achievement and applying new as well as old and reliable methods to this end. FAO and its GFCM have, likewise, always made sustainable development the keystone of fishery management without so naming it.

The removal, and especially the prevention, of disease in human beings, which has been the basis of WHO's work for many decades, is also essential to sustainable development. Similar remarks could be made of all the collaborating UN agencies (see section 4.1.3, above) and of many NGOs. The latter play an important role, sometimes supporting, sometimes stimulating. MAP cooperation with NGOs is outlined in UNEP (1995h).

5. *Assessment of the State of the Marine and Coastal Environment and Conclusions*

It is not difficult for a member of the general public, even in European countries outside the Mediterranean region, to recall at least one example of a **marine or coastal pollution** problem in this region: plagues of jellyfish; mucilage in the northern Adriatic; "red tides"; dead dolphins and whales on beaches; garbage on the beaches and in the sea water; holidays spoiled by ear-ache, sore throat, skin rash, hepatitis, or "diarrhoea"; the increasing rarity of monk seals and marine turtles.

Less well known are the **"indicators" that imply serious pollution**; for example: a 100 million or more tourists a year, mostly in summer, over and above the resident coastal population of about 130 million; about 1.7x 10^9 cubic metres of municipal waste water discharged directly into the sea, mostly (about three-quarters) without treatment; about 66x 10^9 cubic metres of industrial waste water likewise discharged; some 120,000 tons of mineral oils; 60,000 tons of detergents; heavy metals, phosphates, nitrates in excess of admissible or desirable levels; and so on.

Much less widely known, but still important as "indicators" of a changing or changed ecosystem are the many **non-Mediterranean species** that have become established in the region, often dramatically at first, but usually more moderately later on when the ecosystem has adjusted (i.e., changed). The aquatic alga, *Caulerpa taxifolia*, is the current example in most people's minds, but there are over 300 known "alien" species, most of which have entered the Mediterranean by way of the Suez Canal, especially since about 1970.

The overall picture is discouraging, but the Mediterranean region is not made to provide such a simple picture.

It is not possible to capture the **immense variety of the Mediterranean basin** in a general document. The amount of data and information accumulated by and through the Mediterranean Action Plan alone fills over two hundred reports and technical papers; the relevant data and information to be found outside the ambit of MAP is several times greater, although it should be stressed that most of the MAP reports exploit these outside research data sources.

Regarding the basin as a whole, there are many **marked differences**, ecologically, environmentally, meteorologically and oceanographically speaking, between the western and the eastern basin, which, among other important reasons, help to explain the uneven results between the two basins and the sometimes disparate results of scientific research and monitoring regardless of basin. The environmental characteristics of the surface water in the western basin do not strongly influence those of the surface water in the eastern basin, and vice-versa; in other words, the marine pollution problems in the two basins are to a large extent independent.

The same is true for the Adriatic Sea vis-à-vis the central Mediterranean, and even for the Aegean vis-à-vis the Levantine Sea, even if only in the sense that the Aegean Sea is influenced by the discharge of the Black Sea via the Sea of Marmara and the Dardanelles (Canakkale Bogazi).

The **discharges of** the Ebro and Rhone **rivers** into the western basin are certainly very important factors determining the state of the marine environment in the western basin but appear to have no identifiable effect on the rest of the Mediterranean. The discharge of the river Po has a considerable effect on the northern Adriatic but not very much on the southern Adriatic and practically none at all on the rest of the eastern basin; the effect of the Nile discharge, reduced in amount but not in concentration of many agricultural chemicals, for example, is also relatively limited.

The **situation with the deep water** is probably very different, but very few data on environmental and pollution parameters of interest are available for these waters; the residence time of these waters in the deep basins is certainly much longer than that of the upper waters, so they can be more deeply marked by specific Mediterranean "characteristics". The relative "obscurity" of the deep water largely explains the paucity of interest and of observations, but if the trends in pollutant discharge into the Mediterranean Sea continue, there is a real risk that it will follow the same path as that of the Black Sea, which has no dissolved oxygen in its waters below 150-200m depth; this greatly reduces the living space available to marine organisms, thus leading to greater competition for vital ecological space and, as experience shows almost everywhere, the loss of slow-growing, demersal fishes, which are the backbone of the marine component of the human diet. Aquaculture can only guarantee the supply of a very small number of such species now and probably for a long time to come.

To the extent that the state of the marine and coastal environment is measured by the **levels of the key pollutants in the water, organisms and sediments**, the most recent values given in the literature used for the present document do not fall outside the ranges observed up to the time of the previous statement on this state, but it should be stressed that the conditions under which new data are obtained are sometimes, perhaps even always, somewhat different from those prevailing a few years ago. Analytical methods and procedures have improved; those laboratories that participated in intercalibration exercises for certain pollutants in certain media may not have done so for other pollutants and media; sometimes, sampling sites will have changed, which is important inasmuch as proximity to a point source plays a big role in the level of certain pollutants in certain organisms (or specific tissues thereof).

So, although there is no obvious deterioration in the **environmental situation of the basin** between the present and the previous evaluation, all the major factors continue to operate and rarely at a lower level. These factors can only be described in relatively general terms, because each factor may be viewed differently, or may operate differently, from country to country. Thus, for example, soil erosion is a well recognized process, yet it varies in its specific nature from sub-region to sub-region, and even from place to place within a sub-region.

With this reservation for each of the general factors considered, the **environmental issues highlighted by each country**, either explicitly or implicitly, in its report on the state of its environment, show that the main problems or concerns arise from (in approximate order of importance, that is, concerns stressed by 6-9 Mediterranean coastal countries): tourist pressure; waste disposal/sewage treatment; water supply (quantitatively and qualitatively); air pollution (especially over large cities); soil erosion; coastal marine pollution; urban development in the coastal zone; and industrial development in the coastal zone. Lesser but still important issues evoked nationally (stressed by 1-5 Mediterranean coastal countries) are: deforestation (including forest fires); water resource contamination; agricultural residues (mainly pesticides and fertilizers); pollution due to ports or in ports; contamination of specially protected areas; contamination or degradation of sites of historical, architectural or archæological interest; rehabilitation of degraded areas; algal blooms/jellyfish plagues and other possible effects of eutrophication; degradation of fisheries; river/lake pollution; rehabilitation of degraded water courses; urban/industrial noise.

These issues were generally evoked in the context of the administrative/political infrastructure, in place or planned, required to deal with them. Moreover, there is appreciable **inter-relationship**

between factors; thus, urban and industrial coastal development both imply increased infrastructure (roads, vehicles, energy and water requirements, wastes etc.), but each country has its own approach. The nub of the problem is usually the lack of planning and weak control of the development.

Urbanization, if planned at all, is rarely planned on a larger scale than that of a city block, and the construction of secondary residences on the sea front or near to it is rarely planned on a scale larger than a builder's "development" level; infrastructure (access roads, sewage systems, telephone services etc.) may lag well behind in time. Since many large cities have substantial rural immigrant populations living, sometimes physically and economically, on their peripheries, there is often no strong sense of identification with the city, hence no public will to accept and abide by development plans. The system of "twin cities" now prevalent throughout Europe has proved a powerful factor in enhancing this sense of identification and the adoption of appropriate development plans. This approach may be helpful in Mediterranean urban development.

Industrial development, especially the establishment of a new plant in the coastal area, is rarely preceded by a proper environmental impact assessment and, in some cases in which such development is subject to a national or local development plan, the requirements of such a plan may not be adequately met. Sometimes, serious environmental problems ensue from failure to foresee the environmentally sound disposal of industrial wastes or the imperative need to recycle or otherwise use them.

The **growth in transport**, requiring more roads, more motor vehicles, more aircraft, more or bigger airports, more ships and bigger, more efficient ports, and, in some cases, more and faster trains, with modern stations, is probably creating as many, and as big, problems as it is intended to solve. Even if, for example, air pollution could be reduced by technologically superior motors and environmentally superior fuels, the construction of motorways and, even more so, their upkeep in natural environmental conditions of high temperature, presents major problems of financing and equipment. Some of these improvements would also reduce environmental noise. They might also constrain the demand for fuels and lubricating oils, hence constrain the environmental problems due to these sources.

Tourism and recreation may, in effect, be assimilated mainly into urbanization, since the creation of facilities and accommodation is inevitably followed by what may be called "infrastructural urbanization". The greatest problem remains the handling of wastes (mainly sewage and litter, which, over a twelve-month period, may cover a quantitative range from one to ten, in some cases), and their disposal in such a way that no new environmental problems are created. Sometimes, the waste is disposed of by removal to a place that is in effect "hidden" from the tourist population and even the associated residential population, but not from a more remote and less vocal part of the local population. This "lateral transfer" of the pollution problem is often presented as an "improvement" in a particular situation.

Agriculture, which is usually seen from the outside as being a much more important factor than was expressed in national reports, is shrinking in terms of area covered (loss to urban and industrial development) but increasing in terms of intensity, hence as a source of pesticides, herbicides and fertilizers, which are seen more in terms of a danger to the water supply for irrigation and other forms of consumption than as a source of contamination or (for fertilizers) a risk of eutrophication in coastal seas.

For the most part, **fisheries and mariculture** are not seen as presenting serious environmental problems, partly because they too are relatively "hidden"; fisheries, although often the main cause of the decline in fish stocks, are also viewed as the main victims, but, in practice, what is remarked is the absence of preferred species from the market place or the uncomfortably high prices charged for them in the market and the restaurant. Mariculture may only receive consideration if there is an outbreak of shellfish poisoning (not common, overall) or localized intense eutrophication due to, for example, flushing of mariculture installations. The possible effects of release of specially bred varieties to the wild are likely to be spread out over a number of years, hence not be perceived as an environmental problem of urgence.

Forests become the centre of attention mostly when on fire, but destruction by massive logging, over-use for grazing herds, as well as other environmental attacks, as by acid rain, fluorides and other chemicals, has a long-term effect on the environment in general, particularly in the form of soil erosion. The problems are usually faced when it is too late. Reforestation is expensive and is often limited to quick-growing trees, which are not appropriate for many important wood applications; the replacement of long-lived hardwood stands is a good but unenvied choice, since it is always costly and time-consuming (twenty to fifty years before useful yield). Also, it is hoped that some form of plastic will do as well as wood. The environmental burden of plastics is thus allowed to grow, as is soil erosion due to deforestation.

Water resources, besides being scarce, are seen as a victim of environmental pollution and degradation, but can be a significant contributor to environmental degradation, to the extent that they are not controlled and carefully managed (even where they are abundant). Uncontrolled rivers and seasonal water courses are major factors in soil erosion or at least in the transport of sediments (and pollutants) to the estuary and the sea. They are also an important factor in flooding and flood control. Covering substantial amounts of the land surface by concrete (i.e., by roads, buildings etc.) prevents the dissipation of the free water into the soil and deprives the subterranean aquifers of the means of remaining full, hence of resisting the infiltration of saline water in the coastal area.

Petroleum and natural gas, insofar as they are controlled (i.e., not discharged into the sea, illegally, with tanker bilge water, or as a result of shipping accidents) are comparatively clean environmentally. Nevertheless, when petroleum is subject to refining and excess natural gas is burned off (as a safety measure), the environment is subject to a significant input of odours, noxious by-product gases and carbon particles. The use of refined petroleum products in the manufacture of plastics, for example, adds to the environmental load that can be ascribed to petroleum. The problems, here as elsewhere, are removed in time or space from the root cause, so that they are not always properly weighed in the environmental balance that is sought by environmental managers in the Mediterranean region.

Mining is different: where it takes place it is obvious, and the damage it does is usually highly visible, especially if it is open-cast mining. The loss of useful land surface is striking, not only for the mining itself, but also for the mining wastes (tailings, slurries etc.) which are usually dumped in the vicinity. "Fortunately", mining normally takes place away from urban and tourist centres, and so constitutes another "hidden" problem. Moreover, the value of the mined ore tends to "pay for" the environmental insult; hence mining, as such, was not evoked by the coastal countries as an important environmental problem.

Something similar could be said for **energy generation and consumption**. From outside, the transformation and consumption of energy are considered to be important sources of environmental damage, but such is the demand for energy, few countries are prepared to place any but the most essential environmental constraints on energy production and use.

The foregoing are general considerations, and it must be stressed that there are many local situations in which pollution is a serious problem, but each has its own characteristics, even if there are similarities or comparable causes. The situation in Izmir Bay, in Turkey, and Kastela Bay, in Croatia, for example, have been subjected to detailed study through the Priority Actions Programme, through the implementation of the **Coastal Area Management Programme** in the form of special projects, with a view to recommending an integrated approach to the management and development of these sites. In the other CAMP projects, the objectives were different, though adapted to specific environmental and developmental circumstances, so that the recommendations for rational environmental management are not the same in each case.

A key element of the underlying philosophy of **MED POL** has been to make it possible to compare reliably the state of marine pollution in all the main regions of the Mediterranean (ten were chosen for operational purposes), with a long view to enabling the countries to establish regional standards of environmental safety (in all its main senses: food safety, bathing water quality, amenity quality, air quality, even fishery water quality), based on the soundest possible scientific advice. This is only possible if all the national institutions involved in the actual sampling and measurement of environmental samples measure the same element, compound or substance in the same medium (e.g., water, organisms, especially those used for human food) in a generally similar way and with adequate regularity, and if they participate in calibration exercises on a regular and continuing basis, to ensure the quality and comparability of the data obtained. This is not easy, partly because of differences between laboratories as to analytical capabilities, partly because, as mentioned above, the problems are not always perceived in the same way in the different sub-regions, partly because key organisms in marine pollution monitoring (such as the Mediterranean mussel) are not equally abundant or accessible in all sub-regions.

Since the values of the concentrations of the key pollutants are bound to reflect the corresponding analytical accuracy and precision, the confirmation of a real trend requires the continuation of all forms of monitoring (even if frequency or spacing of samples can be relaxed in the light of experience) and of the accompanying **data quality-assurance** programmes. This confirmation also requires at least twenty years for each pollution parameter data time-series, with adequate "temporal intercalibration" of the data via the application, if necessary, of scientifically based correction factors where, for example, a new or improved analytical method is introduced into the monitoring system. As for several environmental issues mentioned above, the sampling, analysis, intercalibration and data-quality control are "hidden" from public view - on board vessels at sea, in laboratories and sometimes in relatively remote sampling sites - so that the monitoring, which is designed to solve or help solve several key environmental problems, is given much less consideration by governments than it should properly have.

Under the increasing **pressure of public awareness** of the need to resist environmental degradation, industries are increasing their efforts to control or to modify their waste discharges, but assessments of this and other land-based sources of pollutants and of their atmospheric transport have not yet covered a sufficient number of years, pollutants or areas to confirm such a trend definitely.

The situation of specific pollutants or forms of environmental degradation is relatively stable; that is, no definite trends are evident in the available data on most of them.

Given the rapid dissemination of pollutants in the atmosphere (a matter of days), **air pollution** has a more uniform character than has the sea water and, even more so, the organisms therein. The main source of air pollution, for the large cities, is the exhaust of motor vehicles, that of domestic heating systems, garbage incinerators and factory chimneys. The general solutions are similar in all cases (improved car engine maintenance, use of exhaust catalyst systems, improved fuel, alternative-energy vehicles and domestic heating systems, retention, cleaner industrial processes, recycling or re-use of industrial waste gases and smoke). Similar or the same arguments apply to the discharge of most of the major pollutants into the atmosphere (trace metals, organic chemicals, gases).

Discharges of solid or semi-solid industrial wastes present the biggest problem, if it is accepted that domestic wastes are mainly in the form of sewage and garbage, which are perhaps more a serious nuisance than a serious environmental danger in the coastal area context. The disposal of solid or semi-solid industrial wastes as landfill may seem to be an adequate short-term solution or even a long-term solution, unless certain of the pollutants they contain have the possibility to contaminate natural water bodies (rivers, lakes, aquifers etc.) or agricultural land. For their disposal in sea water, a system of rapid and complete dispersion, such as energetic tidal flushing of a coastal bay, is required; this is not widely available in the Mediterranean. The dumping of solid wastes in the deep marine basins is costly and potentially environmentally objectionable, at least until detailed studies have been made of the capacity of specific sites to store for a very long time or forever the dumped materials. The growth of such wastes will probably oblige such studies.

The **"dumping" of garbage** (litter) on beaches and other tourist sites which is perceived as a major pollution or amenity problem by the users themselves can be solved by continuous efforts to educate these users, as the main agents of this form of pollution, and to ensure facilities for controlling and removing beach litter; the problem of what to do with the litter remains, however, and environmentally controlled landfill seems to be the best means, but only after all reasonable recovery and recycling of suitable components of the litter has been carried out.

The **effects of pollutants** and other environmental nuisances are only a way of measuring a pollution problem and, to some extent, of dictating the priority to be given to solving it. Thus, effects on human beings are seen as being much more important than those on ecosystems, especially the marine ones. Again, there is a tendency to assume a linear relationship between the levels of pollutants and the "seriousness" of their effects; this and the "visibility", figuratively and physically, of the environmental problems plays a key role in socio-political decisions taken to solve them and to pursue environmental management; such a short-term strategy is the main enemy of the institution of sustainable development. Yet the often subtle but real effects on terrestrial and marine ecosystems are probably as important as simply ensuring a high level of human health. At the present time, such questions, and biodiversity, are still given a relatively low priority in national concerns. Even for endangered species, action is stimulated mainly by specific national, regional or international interest groups, rather than by governmental entities which are more concerned with immediate national socio-economic necessities.

The same is to some extent also true for **protected areas**, whether biological or historical, except that some such areas are also of touristic advantage; yet many of them are resented rather than welcomed by the local population, and many are created only to suffer environmental insult originating outside their boundaries. For example, the protected area may become deprived of the natural water supply, due to "upstream" water works or to contamination as a result of ill-considered siting of industrial plants; or the area may become degraded as a result of uncontrolled movement of private and commercial vehicles.

Given the prevalent "short-termism" in the Mediterranean, as elsewhere, the potential **impacts of climatic change** on the region still have a low priority, not only for some of the reasons mentioned above, but also because such changes are thought to be slow and to allow adaptation to them; moreover, the Mediterranean region has seen some of them before in historical times, including, for example, mean sea-level changes greater than those predicted for the next fifty or a hundred years. The real issue is, however, whether human activities may or may not greatly accelerate such changes. The continued and expanded study of such changes is the only way to determine this possibility and to foresee the adaptation it might require.

While it is clear that **public awareness** of the problems is growing and that national governments are developing the administrative and technical structures to deal with a wide range of environmental problems, environmental security can only be achieved if this awareness is manifested in environmentally sound actions (as, for example, "pre-separation" of domestic wastes by individual households to facilitate re-use) and in effective implementation of environmental policies and enforcement of the relevant laws by the aforementioned national entities. Still too often do governments react to the demands of active environmental groups rather than take the lead.

The **legislative framework** - the Barcelona Convention, its Protocols and the related Common Measures - is largely in place; the support of concerned international intergovernmental and non-governmental organizations is largely assured; and the necessary international (i.e., MAP) programmes have been drawn up, including MAP Phase II, up to the year 2005. A basis for sustainable development exists, but government action, in particular, and national, non-governmental action, in general, must follow and be sustained, for real results to be achieved. So must compliance with environmental laws be pursued much more vigorously than hitherto.

The **actions to be taken** are numerous and most of them have been indicated in this section. There are some, however, that are often forgotten, yet are essential to measure the success of applied environmental policies. It is essential to make inventories of flora and fauna, and of the ecosystems into which they are organized, and to keep them well up to date in all areas known to be under environmental stress, not only to measure this stress but also the effect of particular rehabilitation policies. The return of certain fish species to once polluted rivers is a common example; likewise, inventories of sites of historical, archæological or architectural interest, to allow assessment of their degradation or of measures taken to restore them.

Some **actions** are **necessary to reduce and control serious pollution situations**, and may require costly installations for which, possibly, international financing may be necessary if early action is to be taken. An example is the need to increase hazardous-waste reception facilities in commercial ports, and, if facilities of this type are not feasible, facilities for assistance in cases of environmental emergency must be set up or strengthened, perhaps on a regional or sub-regional basis. Possible examples are surveillance and emergency assistance services for: forest fires, and even urban fires and volcanic disasters; shipping accidents and oil spills, even if this places environmental protection above simple national sovereignty from time to time. The Barcelona Convention, together with its Protocols and the related Common Measures, does this.

The **sub-regional diversity** referred to above militates against a basin-wide statement of environmental health but, at the same time, the regional sharing of information and experience, and of approaches to similar problems, even if the circumstances of each coastal country differ, leads more easily to specific and to general solutions than would otherwise be the case.

The **Mediterranean continues to be a polluted semi-enclosed sea**, quite badly so in certain places at certain times, but perhaps quite moderately so in general. This is no basis for complacency. The coastal regions of the Mediterranean States constitute one of their most precious assets for the present and for the future. Every effort should be made to ensure their sustainable and environmentally sound management. There is no time to loose.

References

Albania (1993). Report on the Environmental Situation in Albania and National Environmental Action Plan. Ministry of Health and Environmental Protection. Tirana, Albania. 71pp.

Albania (1995). Environmental Status Report 1993-1994. Ministry of Health and Environmental Protection. Tirana, Albania. 30pp.

Alzieu, C., Tolosa, I., Bacci, E., Mee, L.D. and Readman, J. W. (1991). Organotin compounds in the Mediterranean: a continuing cause for concern. **Marine Environmental Research**, 32:261-270.

Andersen, K.P. and Ursin, E. (1977). A multispecies extension to the Beverton and Holt theory of fishing, with accounts of phosphorus circulation and primary production. **Meddr Danm. Fisk. - og Havunders**., N.S. 7:319-435.

Andreae, M.O. (1989). Flux of volatile sulphur species across the air/sea interface. pp.70-76 in: The Ocean as a Source and Sink for Atmospheric Constituents. Final Report of SCOR Working Group 72. **UNESCO Technical Papers in Marine Science** 56. UNESCO, Paris, France.

Bakun, A. (1992). Mechanisms of physical-biological interaction in coastal marine ecosystems in relation to projected trends of global change. Paper submitted to the Bremen Marine Training Centre's International Workshop on Marine Environmental Protection and Coastal Living Resources Monitoring: Training and Implementation. 29 September - 3 October 1992, Bremerhaven, Germany. 10pp.

Bartzokas, A. and Metaxas, D.A. (1991). Climatic fluctuation of temperature and air circulation in the Mediterranean. pp.279-293 in: Duplessy, J.C., Pons, A. and Fantechi, R. (eds.) Climate and Global Change. Report EUR 13149 EN. Commission of the European Communities. Brussels.

Boudouresque, C.F. (1993). Etat actuel de la biodiversité marine en Méditerranée. pp.75-90 in: Pollution of the Mediterranean Sea: pollution research and environmental monitoring. Analyses, recommendations and assessment of the scientific and technological options. Briant, F. (Ed). European Parliament, Directorate General for Research, Scientific and Technological Options Assessment, CIESM, Monaco.

Boudouresque, C.F. (1995). Selection criteria and draft list of endangered or threatened species. Document UNEP(OCA)/MED WG. 100/3. UNEP Specially Protected Areas, Regional Activity Centre, Tunis. 33 pp.

Brigand, L. (1991). Les îles en Méditerranée: enjeux et prospective. **Les Fascicules du Plan Bleu**, 5. Economica, Paris, France. 98pp.

Caddy, J.F. (1993). Towards a comparative evaluation of human impacts on fishery ecosystems of enclosed and semi-enclosed seas. **Reviews in Fisheries Science** 1(1):57-95.

Caddy, J.F. and Griffiths, R.C. (1995). Living Marine Resources and Their Sustainable Development: Some Environmental and Institutional Perspectives. **FAO Fisheries Technical Paper,** 353. FAO, Rome, Italy. 167pp.

Campbell, J.A. (1993). Guidelines for Assessing Marine Aggregate Extraction. Ministry of Agriculture, Fisheries and Food, Directorate of Fisheries Research, Lowestoft Laboratory, **Laboratory Leaflet** 73. MAFF, Lowestoft, United Kingdom. 12pp.

CEC (1993a). Quality of Bathing Water 1992. Document EUR 15031. Commission of the European Communities (Directorate-General Environment, Nuclear Safety and Civil Protection). Brussels. 63pp. + 11 National Charts.

CEC (1993b). Towards Sustainability: A European Programme of Policy and Action in Relation to the Environment and Sustainable Development. Commission of the European Communities (Directorate-General XI: Environment, Nuclear Safety and Civil Protection). Brussels, Belgium. 162pp.

CEC (1994). The Common Fisheries Policy. Fact Sheets of the Commission of the European Communities (Directorate-General for Fisheries). Brussels, Belgium.

Charbonnier, D. *et al.* (1990). Pêche et Aquaculture en Méditerrannée: État Actuel et Perspectives. Programme des Nations Unies pour l'Environnement, Plan d'Action pour la Méditerranée. **Les Fascicules du Plan Bleu,** 1. Economica, Paris, France. 94pp.

Chircop, A.E. (1992). The Mediterranean Sea and the quest for sustainable development. **Ocean Development and International Law,** 23:17-30.

CIHEAM (1995). Aquaculture Production Economics. Proceedings of the seminar of the CIHEAM Network on Socio-economic and Legal Aspects of Aquaculture in the Mediterranean (SELAM), Montpelier (France), 17-19 May 1995. **Cahiers Options Méditerranéennes,** Vol. 14. Institut Agronomique Méditerranéen de Zaragoza, Zaragoza, Spain. 276pp.

Clarholm, M. *et al.* (1988). Does agriculture kill fish? Possible ways to decrease nitrogen reaching from land to water. **Ecological Bulletin,** 39:139-140.

Croatia (1993a). National Report on Environment and Development. Ministry of Environmental Protection, Physical Planning and Housing. 52pp.

Croatia (1993b). National Report on the Implementation of the Barcelona Convention -for the Period from the Middle of 1991 to the Middle of 1993. Ministry of Civil Engineering and Environmental Protection. 16pp. + 2 Annexes.

ECE (1991). European Red List of Globally Threatened Animals and Plants (and recommendations on its application as adopted by the Economic Commission for Europe at its forty-sixth session (1991) by Decision 46). United Nations, New York.

Egypt (1992). National Report on Environment and Development in Egypt. Egyptian Environmental Affairs Agency, Cairo, Egypt. 225pp.

FAO (1993). FAO Yearbook: Fishery Statistics - Catches and Landings. **FAO Fisheries Series**, 43. FAO, Rome, Italy. 677pp.

Fawas, M., Mallat, H. and Khawlie, M. (1992). Environment and Development in Lebanon: National Report on Environmental Status of Lebanon in View of UNCED - Agenda 21: Concept of Sustainability. United Nations Development Programme. Beirut, Lebanon. 81pp.

Fischer, W., Bauchot, M.-L. and Schneider, M. (eds.) (1987). Fiches FAO d'Identification des Espèces pour les Besoins de la Pêche. (Révision 1). Méditerrannée et Mer Noire. Zone de Pêche 37. Volume I. Invertébrés. pp.1-760. Volume II (Fischer, W., Schneider, M. and Bauchot, M.-L., eds.). Vertébrés. pp.761-1530. Publication préparée par la FAO, résultat d'un accord entre la FAO et la Commission des Communautés Européennes (Projet GCP/INT/422/EEC) financée conjointement par ces deux organisations. FAO, Rome, Italy. (Also available in English)

Gabbay, S. (1994). The Environment in Israel. Ministry of the Environment. Jerusalem, Israel. 255pp.

Gabrielides, G.P. (1994). Pollution of the Mediterranean Sea. pp.7- 16 in: Proceedings of the International Symposium on the Pollution of the Mediterranean Sea. Nicosia, Cyprus, 2-4 November 1994. Organized by the Water Treatment Scientists Association (Cyprus), sponsored by the International Association on Water Quality. 710pp.

Gabrielides, G.P., Alzieu, C., Readman, J.W., Bucci, E., Aboul Dahab, C. and Salihoglu, I. (1990). MED POL survey of organotins in the Mediterranean. **Marine Pollution Bulletin,** 21(5):233-237.

Gabrielides, G.P., Golik, A., Loizides, L., Marino, M.G., Bingel, F. and Torregrossa, M.V. (1991). Man-made garbage pollution on the Mediterranean coastline. **Marine Pollution Bulletin,** 23:437-441.

GESAMP (1986). Environmental Capacity: An Approach to Marine Pollution Prevention. IMO/FAO/UNESCO/WMO/WHO/IAEA/UN/UNEP Joint Group of Experts on Scientific Aspects of Marine Pollution(GESAMP), **Reports and Studies,** 30. FAO, Rome, Italy. 49pp.

GESAMP (1989). The Atmospheric Input of Trace Species to the World Ocean. IMO/FAO/UNESCO/WMO/WHO/IAEA/UN/UNEP Joint Group of Experts on the Scientific Aspects of Marine Pollution(GESAMP), **Reports and Studies,** 38. World Meteorological Organization, Geneva, Switzerland. 111pp.

GESAMP (1991). Reducing Environmental Impacts of Coastal Aquaculture. IMO/FAO/UNESCO/WMO/WHO/IAEA/UN/UNEP Joint Group of Experts on Scientific Aspects of Marine Pollution(GESAMP), **Reports and Studies,** 47. FAO, Rome, Italy. 35pp.

GESAMP (1993). Anthropogenic Influences on Sediment Discharge to the Coastal Zone and Environmental Consequences. IMO/FAO/UNESCO-IOC/WMO/WHO/IAEA/UN/UNEP Joint Group of Experts on Scientific Aspects of Marine Environmental Protection(GESAMP), **Reports and Studies,** 52. UNESCO, Paris, France. 67pp.

Giri, J. *et al.* (1991). Industrie et Environnement en Méditerranée. **Les Fascicules du Plan Bleu**, 4. Economica, Paris, France. 115pp.

Goldberg, E. (1976). The Health of the Oceans. UNESCO, Paris, France. 172pp.

Gray, J.S., McIntyre, A.D. and Stirn, J. (1992). Manual of Methods in Aquatic Environment Research. Part II - Biological Assessment of Marine Pollution - with Particular Reference to Benthos. **FAO Fisheries Technical Paper,** 324. Prepared in co-operation with the UNEP Mediterranean Action Plan. 49pp.

Greece (1995). Report of Greece on the State of the Marine and Coastal Environment in the Mediterranean Region. Ministry of Environment, Physical Planning and Public Works, Athens, Greece. 54pp.

Grenon, M. and Batisse, M. (eds.) (1989). Futures for the Mediterranean Basin: The Blue Plan. **Oxford University Press,** Oxford, United Kingdom. 279pp.

Grenon, M. *et al.* (1993). Energie et Environnement en Méditerranée. **Les Fascicules du Plan Bleu**, 7. Economica, Paris, France. 168pp.

Groombridge, B. (1990). Les tortues marines en Méditerranée: distribution, populations, protection. Council of Europe, **Collection Sauvegarde de la Nature,** 48:8-9; 11-17; 81-89.

Holligan, P.M. and Kirst G.-O. (1989). Marine algæ as a source of dimethylsulphide emissions to the atmosphere. pp.64-69 in: The Ocean as a Source and Sink for Atmospheric Constituents. Final Report of SCOR Working Group 72. **UNESCO Technical Papers in Marine Science,** 56. UNESCO, Paris, France.

Horvat, M., Zvonaric, T. and Stegnar, P. (1986). Determination of mercury in seawater by cold-vapour atomic absorption spectrophotometry. **Rapp. Proc.-verb. Reun. CIESM**, 30(2):116

ICES (1992a). Effects of Extraction of Marine Sediments on Fisheries. International Council for the Exploration of the Sea, **Co-operative Research Report,** 182. ICES, Copenhagen, Denmark. 78pp.

ICES (1992b). Effects of Harmful Algal Blooms on Mariculture and Marine Fisheries. International Council for the Exploration of the Sea, **Co-operative Research Report,** 181. ICES, Copenhagen, Denmark. 38pp.

IFEN (1994). L'Environnement en France. Edition 1994-1995. Institut Français de l'Environnement. Paris, France; DUNOD, Paris, France. 399pp.

IPCC (1992). Scientific Assessment of Climate Change. WMO/UNEP Intergovernmental Panel on Climate Change(IPCC), Supplement. WMO, Geneva, Switzerland. 24pp.

Italy (1993). Report on the State of the Environment in Italy. Ministry of the Environment. Rome, Italy. 487pp.

IUCN (1990). Protected Areas of the World: a Review of National Systems. Volume 2, Palæarctic. The World Conservation Union (IUCN), Gland, Switzerland.

IUCN (1993). Biological Diversity Workshop in North Africa. Tunis, 1-3 November 1993. Annexes 5 (Country Reports for Algeria, Egypt, Libya, Morocco and Tunisia) and 6 (Critical Issues in the Implementation of the Convention on Biological Diversity: Background Document for the Biological Diversity Workshop in North Africa). The World Conservation Union (IUCN), Gland, Switzerland.

Jeftic, L. (1991). Long-term Programme for Pollution Monitoring and Research in the Mediterranean (MED POL). Second International Symposium on Integrated Global Ocean Monitoring (IGOM-II). Leningrad, 14-21 April 1991. 18pp.

Jeftic, L. (1992a). Implications of expected climate change in the Mediterranean region. pp.539-560 in: Proceedings of the International Workshop on Global Climate Change and the Rising Challenge of the Sea. Isla Margarita, Venezuela, 9-13 March 1992. US National Oceanic and Atmospheric Administration, Washington DC, in collaboration with UNEP, WMO and the US Environmental Protection Agency; hosted by the Venezuelan Ministerio del Ambiente y de los Recursos Renovables.

Jeftic, L. (1992b). The role of science in marine environmental protection of regional seas and their coastal areas: the experience of the Mediterranean Action Plan. **Marine Pollution Bulletin,** 25(1-4):66-69.

Jeftic, L. (1993a). The Mediterranean Action Plan of the United Nations Environment Programme. UNEP Mediterranean Action Plan, Athens, Greece. 14pp.

Jeftic, L. (1993b). Integrated Coastal Zone Management in the Mediterranean Action Plan of UNEP. pp.465-482 in: Proceedings of the First International Conference on the Mediterranean Coastal Environment, MEDCOAST '93, 2-5 November 1993, Antalya, Turkey.

Jeftic, L. (1994). Experience of the Mediterranean Action Plan on the Control of Land-Based Sources of Pollution. Document UNEP(OCA)/CAR WG.14/Inf.9, 15 March 1994. Second Meeting of Experts on Land-Based Sources of Pollution in the Wider Caribbean Region, San Juan, Puerto Rico, 21-24 March 1994. UNEP, Athens, Greece. 64pp.

Jeftic, L., Bernhard, M., Demetropoulos, A., Femex, F., Gabrielides, G.P., Gasparovic, F., Halim, Y., Orhon, D. and Saliba, L. (1990). State of the Marine Environment in the Mediterranean Region. **UNEP Regional Seas Reports and Studies,** 132. UNEP, 1990; and **MAP Technical Reports Series,** 28. UNEP, Athens, Greece. 225pp.

Jeftic, L., Milliman, J.D. and Sestini, G. (1992). Climatic Change and the Mediterranean. Vol. 1. Arnold Publishers, London. 672pp.

Jeftic, L., Keckes, S. and Pernetta, J. (1995). Implications of future climatic changes on the Mediterranean coastal region. pp.1-26 in: Jeftic, L., Keckes, S. and Pernetta, J. (eds.) Climate Change and the Mediterranean. Volume 2. Arnold Publishers, London.

Klemm, C. de (1993). La Protection des Cétacés, du Phoque Moine, des Tortues Marines, des Plantes Marines et des Oiseaux. Document UNEP(OCA)/MED/WG.73/5. UNEP Regional Activity Centre for Specially Protected Areas. Tunis. 25pp.

Kudat, A., Peabody, S. and Ozmen, N. (1994). METAP Capacity Building: a Renewed Commitment to Participation. 28pp. (Mediterranean Technical Assistance Programme, co-sponsored by CEC, EIB, UNDP and WB)

Kullenberg, G. K., Andersen, N. and Cole, M. (1993). Global ocean observing system. pp.2986-3000 in: Coastal Zone '93. Proceedings, 8th Symposium on Coastal and Ocean Management. New Orleans, Louisiana, USA, July 1993.

Lanquar, R. (1995). Tourisme et environnement en Méditerranée: enjeux et prospective. **Les Fascicules du Plan Bleu**, 8. Economica, Paris, France. 174pp.

Liss, P.S. (1989). Methane and light non-methane hydrocarbons. pp.77-80 in: The Ocean as a Source and Sink for Atmospheric Constituents. Final Report of SCOR Working Group 72. **UNESCO Technical Papers in Marine Science,** 56. UNESCO, Paris, France.

Liss, P.S. and Slinn, W.G.N. (eds.) (1983). Air-Sea Exchange of Gases and Particles. D. Reidel, Dordrecht. 561pp.

Loye-Pilot, M. D., Martin, J.-M. and Morelli, J. (1990). Atmospheric input of inorganic nitrogen to the western Mediterranean. **Biogeochemistry**, 9:117-134.

Malta (1995). State of the Marine and Coastal Environment in the Mediterranean Region.

Marchand, H. *et al.* (1990). Les Forêts Méditerranéennes. **Les Fascicules du Plan Bleu**, 2. Economica, Paris, France. 108pp.

Margat, J. (1992). L'Eau dans le Bassin Méditerranéen. **Les Fascicules du Plan Bleu**, 6. Economica, Paris, France. 96pp.

Martin, J.-M., Elbaz-Poulichet, F., Guieu, C., Löye-Pilot, M.D. and Han, G. (1989). River versus atmospheric input of material to the Mediterranean Sea: an overview. **Marine Chemistry**, 28:159-182.

Mascle, J. and Renault, J.-P. (1991). Le destin de la Méditerrannée. **La Recherche,** 22:188-196.

Mensching, H.G. (1986). Desertification in Europe? pp.3-8 in: Desertification in Europe. Proceedings of the Information Symposium in the EEC Programme on Climatology, Mytilene, Greece, 15-18 April 1984. Fantechi, R. and Margaris, N.S. (eds.). D. Reidel Publishing Company, Dordrecht, Netherlands.

Michel, P. (1992). L'Arsénic en Milieu Marin: Biogéochimie et Ecotoxicologie. Institut Français de Recherche pour l'Exploitation de la Mer, Nantes, France. 59pp.

Monaco (1992). Rapport National pour la Conférence des Nations Unies sur l'Environnement et le Devéloppement. Principauté de Monaco.

Morocco (1994). Rapport national. Conseil national de l'environnement, Commission nationale du développement durable.

Moulin, C., Dulac, F., Andre, J. M., Guillard, F. and Guelle, W. (1994). Remote sensing of airborne desert dust mass over oceans using Meteosat and CZCS imagery. **Mémoires de l'Institut océanographique, Monaco,** 18:35-43.

OECD (1995). OECD Environmental Data - Compendium 1995. Organisation for Economic Cooperation and Development, Paris, France. 305pp.

PNUE/UICN (1994). Les Aires Protégées en Méditerranée: Essai d'Etudes Analytique de la Législation Pertinente. **MAP Technical Report Series**, 83. UNEP, Athens, Greece. 42pp.

Polat, C. and Tugrul, S. (1995). Chemical exchange between the Mediterranean and the Black Sea via the Turkish straits. **Bull. l'Institut océanographique, Monaco**, ICSEM Volume on the Dynamics of the Mediterranean Straits (to be published).

Por, D. F. (1968). Lessepsian Migration. **Ecological Studies,** 23. Springer-Verlag. 228pp.

Ramade, F. *et al.* (1990). Conservation des Ecosystèmes Méditerranéens. **Les Fascicules du Plan Bleu**, 3. Economica, Paris, France. 144pp.

Readman, J.W., Albanis, T.A., Barcelo, D., Galassis, S., Tronczynski, J. and Gabrielides, G.P. (1993a). Herbicide contamination of Mediterranean estuarine waters: results from a MED POL pilot survey. **Marine Pollution Bulletin**, 26(11):613-619.

Readman, J.W., Laval, L. W. K., Grondin, D., Bartocci, J., Villeneuve, J.-P. and Mee, L. D. (1993b). Coastal water contamination from a triazine herbicide used in antifouling paints. **Environmental Science and Technology**, 27:1940-1942.

REMPEC (1992a). Report on Major Accidents in the Mediterranean. Document REMPEC/WG.5/Inf.21. Meeting of Focal Points of the Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea (REMPEC), Malta, 22-26 September 1992. 2pp.

REMPEC (1992b). Review of the Implementation of the Regional System Regarding International Assistance in Cases of Emergency. Document REMPEC/WG.5/Inf.22. Meeting of Focal Points of the Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea (REMPEC), Malta, 22-26 September 1992. 5pp.

REMPEC (1994a). An Overview of Maritime Transport in the Mediterranean. Document REMPEC/WG.10/Inf.25. Meeting of Focal Points of the Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea (REMPEC), Malta, 4-8 October 1994. 21pp.

REMPEC (1994b). Accidents in the Mediterranean Region and Implementation of the Regional System in Case of Emergency. Document REMPEC/WG.10/7/1/1. Meeting of Focal Points of the Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea (REMPEC), Malta, 4-8 October 1994. 2pp.

REMPEC (1994c). Review of the Implementation of the Regional System Regarding International Assistance in Cases of Emergency. Document REMPEC/WG.10/Inf.10. Meeting of Focal Points of the Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea (REMPEC), Malta, 4-8 October 1994. 9pp.

Reynaud, C. (1996). Transports et environnement en Méditerranée: enjeux et prospective. **Les Fascicules du Plan Bleu**, 9. Economica, Paris, France. (sous presse).

Slovenia (1995). The Conditions of the Marine and Coastal Areas of the Mediterranean : the Territory of Slovenia. Slovenian Ministry of Environment and Regional Planning. 32pp.

Soudine, A. (1992). The WMO Global Atmosphere Watch System and the airborne pollution of the Mediterranean Sea. **Bollettino Geofisico**, Anno XV 5:1-15. Università degli Studi di Roma "La Sapienza", Rome, Italy.

Soudine, A. (1993). MED POL Airborne Pollution Monitoring Programme. pp.197-200 in: Extended Extracts of Papers Presented at the WMO Region VI Conference on the Measurement and Modelling of Atmospheric Composition Changes Including Pollution Transport. Sofia, Bulgaria, 4-8 October 1993. WMO, Geneva, Switzerland.

Spain (1992). Medio Ambiente en España '91. Ministerio de Obras Públicas y Transportes. Madrid, Spain. 311pp.

Spanier, E. and Galil, B.S. (1991). Lessepsian migration: a continuous biogeographical process. **Endeavour,** New Series, 15(3):102-106.

Stamatopoulos, C. (1993). Trends in Catches and Landings - Mediterranean and Black Sea Fisheries: 1972-1991. **FAO Fisheries Circular,** 855.4. FAO, Rome, Italy. 177pp.

Sultana, J. (1993). Important seabird sites in the Mediterranean. Malta Ornithological Society, Valletta, Malta. 64 pp.

Syria (1995). Environmental Policies for the General Committee on Environmental Affairs of Syria. 10pp.

Tunisia (1992). Rapport National sur l`Etat de l`Environnement 1993. Ministere de l`Environnement et de l`Amenagement du Territoire. Tunis, Tunisia. 138pp.

Turkey (1991). Turkey and the Mediterranean Action Plan. Ministry of the Environment. Ankara, Turkey. 145pp.

UNCED (1992). Agenda 21 Chapter 17: Protection of the Oceans, All Kinds of Seas, Including Enclosed and Semi-enclosed Seas, and Coastal Areas and the Protection, Rational Use and Development of their Living Resources. (Rio Conference, 1992). United Nations Conference on Environment and Development, Conches, Switzerland. 44pp. (mimeo)

UNEP (1984). Coordinated Mediterranean Pollution Monitoring and Research Programme (MED POL-Phase I): Programme Description. **UNEP Regional Seas Reports and Studies**, 23. UNEP, Geneva, Switzerland. 94pp.

UNEP (1986). Assessment of the Present State of Pollution by Cadmium, Copper, Zinc and Lead in the Mediterranean Sea. Document UNEP/WG.144/11. Fourth Meeting of the Working Group for Scientific and Technical Co-operation for MED POL, Athens, 16-20 June 1986. UNEP, Athens, Greece, in co-operation with FAO. 41pp.

UNEP (1987a). Promotion of Soil Protection as an Essential Component of Environmental Protection in Mediterranean Coastal Zones/Promotion de la Protection des Sols Comme Elément Essentiel de la Protection de l'Environnement dans les Zones Côtières Méditerranéennes. **MAP Technical Reports Series,** 16. UNEP Priority Actions Programme, Regional Activity Centre, Split, Croatia. 424pp.

UNEP (1987b). Environmental Aspects of Aquaculture Development in the Mediterranean Region/Aspects Environnementaux du Développement de l'Aquaculture dans la Région Méditerrannéenne. Documents Produced in the Period 1985-1987/Documents Établis pendant la Période 1985-1987. **MAP Technical Reports Series,** 15. UNEP Priority Actions Programme, Regional Activity Centre, Split, Croatia. 101pp.

UNEP (1987c). Assessment of the State of Microbial Pollution of Shellfish Water in the Mediterranean Sea and Proposed Measures. Document UNEP/WG.160/10. Fifth Meeting of the Working Group for Scientific and Technical Co-operation for MED POL, Athens, 6-10 April 1987. UNEP, Athens, Greece, in co-operation with WHO, Geneva. 31pp.

UNEP (1987d). An Assessment of Organosilicons as Marine Pollutants, with Particular Reference to Their Status in the Mediterranean Dumping and Land-based Sources Protocols. Document UNEP/WG.160/12. Fifth Meeting of the Working Group for Scientific and Technical Co-operation for MED POL, Athens, 6-10 April 1987. UNEP, Athens, Greece. 23pp.

UNEP (1989). Assessment of the Situation Regarding Used Lubricating Oils in the Mediterranean Basin and Suggested Progressive Measures for Their Elimination as Marine Pollutants. Document UNEP(OCA)/MED WG.3/Inf.4. Joint Meeting of the Scientific and Technical Committee and Socio-economic Committee, Athens, 26-30 June 1989. UNEP, Athens, Greece, in co-operation with UNIDO and WHO. 41pp.

UNEP (1990a). An Analysis of Mercury Levels in the Kastela Bay: Case Study. Document CPP/1988-1989/YU/Doc.3C. UNEP Priority Actions Programme, Regional Activity Centre, Split, Croatia. 46pp.

UNEP (1991a). A Practical Guide for the Management of Urban Solid Waste in Coastal Mediterranean Countries. Document PAP-7/COP.1. UNEP Priority Actions Programme, Regional Activity Centre, Split, Croatia. 66pp.

UNEP (1991b). Assessment of the State of Pollution of the Mediterranean Sea by Pathogenic Micro-organisms. Document UNEP(OCA)MED WG.25/Inf.7. Joint Meeting of the Scientific and Technical Committee and the Socio-Economic Committee, Athens, 6-10 May 1991. UNEP, Athens, Greece, in co-operation with WHO. 34pp.

UNEP (1991c). Jellyfish Blooms in the Mediterranean. Proceedings of the II Workshop on Jellyfish in the Mediterranean. **MAP Technical Reports Series**, 47. UNEP, Athens, Greece. 320pp.

UNEP (1993a). Carrying Capacity Assessment for Tourism of the Central-Eastern Part of the Island of Rhodes. Document CAMP/1991-1992/GR/CC.1. Regional Activity Centre for the Priority Actions Programme, Split, Croatia. 44p.

UNEP (1993b). United Nations Environment Programme Environmental Data Report, 1993-94. Blackwell Publishers, Oxford, UK. 408pp.

UNEP (1993c). Evaluation Report of the MED POL Programme. Document UNEP(OCA)MED IG.3/Inf.6. Eighth Ordinary Meeting of the Contracting Parties to the Convention for the Protection of the Mediterranean Sea against Pollution and Its Related Protocols, Antalya, Turkey, 12-15 October 1993. UNEP, Athens, Greece. 62pp.

UNEP (1993d). Report of the Expert Meeting on Environmental Legislations Related to Specially Protected Areas and Endangered Species in the Mediterranean. Document UNEP(OCA)/MED/WG.73/6. UNEP Specially Protected Areas, Regional Activity Centre, Tunis. 15pp.

UNEP (1993e). Costs and benefits of measures for the reduction of degradation of the environment from land-based sources of pollution in coastal areas. A case-study of the Bay of Izmir. Case study of the Island of Rhodes. **MAP Technical Reports Series,** 72. UNEP, Athens, Greece. 52pp.

UNEP (1993f). Directory of environmental legislations concerning protected areas in the Mediterranean riparian countries. UNEP Specially Protected Areas, Regional Activity Centre, Tunis. Document prepared by the Environmental Law Centre, Bonn - IUCN.

UNEP (1994a). Analysis of the Application of Economic Instruments in Coastal Management in the Mediterranean Region. Document PAP-4/1994/W.1/1. UNEP Priority Actions Programme, Regional Activity Centre, Split, Croatia. 30pp.

UNEP (1994b). Report of the Workshop on the Application of Economic Instruments in Coastal Zone Management in the Mediterranean Region, Split, Croatia, 12-14 December 1994. Document PAP-4/1994/W.1/4. UNEP Priority Actions Programme, Regional Activity Centre, Split, Croatia. 9pp. + four Annexes.

UNEP (1994c). Workshop on Application of Integrated Approach to Development, Management and Use of Water Resources. Marseilles, 24-26 November 1994. Workshop Report. Document PAP-3/1994/W.1/1. UNEP Priority Actions Programme, Regional Activity Centre, Split, Croatia, in collaboration with the Mediterranean Water Institute. 12pp. + Annex IV.

UNEP (1994d). Report of the Workshop on Environmental Aspects of Shellfish Culture in the Mediterranean with Special Reference to Monitoring. Dubrovnik, Croatia, 19-22 July 1994. Document PAP-10/EAM/W.1/1. UNEP Priority Actions Programme, Regional Activity Centre, Split, Croatia, in collaboration with the Institut Français de Recherches pour l'Exploitation de la Mer (IFREMER). 13pp. + four Annexes.

UNEP (1994e). Assessment of the State of Pollution of the Mediterranean Sea by Anionic Detergents. Document UNEP(OCA)/MED WG.89/Inf.4. Joint Meeting of the Scientific and Technical Committee and the Socio-Economic Committee, Athens, 3-8 April. UNEP, Athens, Greece, in co-operation with WHO. 127pp.

UNEP (1994f). Monitoring Programme of the Eastern Adriatic Coastal Area: Report for 1983-1991. **MAP Technical Reports Series,** 86. UNEP, Athens, Greece. 311pp.

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UNEP (1994h). Directory of Marine and Coastal Protected Areas of the Mediterranean Region. Part I, Sites of Biological and Ecological Value. UNEP Specially Protected Areas, Regional Activity Centre, Tunis. 271pp.

UNEP (1994i). Guidelines for the Rehabilitation of Mediterranean Historic Settlements. Document PAP-5/1994/G vol. I (draft). UNEP Priority Actions Programme, Regional Activity Centre, Split, Croatia. 58pp.

UNEP (1994j). Guidelines for the Rehabilitation of Mediterranean Historic Settlements. Document PAP-5/1994/G vol. II. UNEP Priority Actions Programme, Regional Activity Centre, Split, Croatia. 69pp.

UNEP (1994k). L'Observatoire Méditerranéen pour l'Environnement et le Développement (OMED) du Centre d'Activités Régionales du Plan Bleu. Centre d'Activités Régionales du Plan Bleu, Sophia Antipolis, Valbonne, France. 69pp.

UNEP (1994l). Report of the Meeting of Experts on the Evaluation of the Implementation of the Action Plan for the Management of the Mediterranean Monk Seal. Document UNEP(OCA)/MED/WG.87/4. UNEP Specially Protected Areas, Regional Activity Centre, Tunis. 57pp.

UNEP (1994m). Iskenderun Bay Project, Volume II, Systemic and Prospective Analysis. **MAP Technical Reports Series,** 90. Blue Plan Regional Activity Centre, Sofia Antipolis, Valbonne, France. 128pp.

UNEP (1995a). Remote Sensing for the Mediterranean Environment: Objectives and Activities of the Regional Activity Centre for Environment Remote Sensing. UNEP Regional Activity Centre for Environment Remote Sensing, Palermo, Sicily. 38pp.

UNEP (1995b). Assessment of the State of Pollution of the Mediterranean Sea by Zinc, Copper and Their Compounds. Document UNEP/(OCA)/MED WG.89/Inf.3. Joint Meeting of the Scientific and Technical and the Socio-Economic Committees, Athens, 3-8 April 1995. UNEP, Athens, Greece, in co-operation with FAO and WHO. 121pp.

UNEP (1995c). Assessment of the State of Eutrophication in the Mediterranean Sea (First Draft). Document UNEP/(OCA)/MED WG.89/Inf.5. Joint Meeting of the Scientific and Technical and the Socio-Economic Committees, Athens, 3-8 April 1995. UNEP, Athens, Greece, in co-operation with FAO and WHO. 208pp.

UNEP (1995d). The Presence of the Tropical Alga *Caulerpa taxifolia* in the Mediterranean Sea. Document UNEP/(OCA)/MED WG.89/Inf.9. Joint Meeting of the Scientific and Technical and the Socio-Economic Committees, Athens, 3-8 April 1995. UNEP, Athens, Greece. 24pp.

UNEP (1995e). Final Act of the Conference of Plenipotentiaries on the Amendments to the Convention for the Protection of the Mediterranean Sea against Pollution, to the Protocol for the Prevention of Pollution of the Mediterranean Sea by Dumping from Ships and Aircraft and on the Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean. Document UNEP(OCA)/MED IG.6/7. UNEP, Athens, Greece. 409pp. (in Arabic, English, French and Spanish).

UNEP (1995f). Multilateral Treaties in the Field of Environment to which Mediterranean Countries are Parties. Document UNEP/(OCA)/MED WG.89/Inf.8. Joint Meeting of the Scientific and Technical and the Socio-Economic Committees, Athens, 3-8 April 1995. UNEP, Athens, Greece. 13pp.

UNEP (1995g). Guidelines for Integrated Management of Coastal and Marine Areas, with Special Reference to the Mediterranean Basin. **UNEP Regional Seas Reports and Studies**, 161. UNEP Priority Actions Programme, Regional Activity Centre, Split, Croatia. 80pp.

UNEP (1995h). MAP Co-operation with Non-Governmental Organisations (NGOs). Document UNEP/(OCA)/MED WG.89/8. Joint Meeting of the Scientific and Technical and the Socio-Economic Committees, Athens, 3-8 April 1995. UNEP, Athens, Greece. 7pp.

UNEP (1995i). Report of the expert meeting on endangered species in the Mediterranean. Montpelier, France, 22-25 November 1995. Document UNEP(OCA)/MED WG. 100/3. UNEP Specially Protected Areas, Regional Activity Centre, Tunis. 7pp. + Annex VI.

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UNEP/ECE/UNIDO/FAO/UNESCO/WHO/IAEA (1984). Pollutants from Land- Based Sources in the Mediterranean. **UNEP Regional Seas Reports and Studies**, 32. UNEP, Nairobi, Kenya. 94pp.

UNEP/FAO/WHO (1987). Assessment of the State of Pollution of the Mediterranean Sea by Mercury and Mercury Compounds./Evaluation de l'Etat de la Pollution de la Mer Méditerrannée par le Mercure et les Composés Mercuriels. **MAP Technical Reports Series**, 18. UNEP, Athens, Greece. 354pp.

UNEP/FAO/WHO (1989). Assessment of the State of Pollution of the Mediterranean Sea by Cadmium and Cadmium Compounds./Evaluation de l'Etat de la Pollution de la Mer Méditerrannée par le Cadmium et les Composés de Cadmium. **MAP Technical Reports Series**, 34. UNEP, Athens, Greece. 175pp.

UNEP/FAO/WHO/IAEA (1989). Assessment of Organotin Compounds as Marine Pollutants in the Mediterranean./Evaluation des Composées Organostanniques en tant que Polluants du Milieu Marin en Méditerrannée. **MAP Technical Reports Series**, 33. UNEP, Athens, Greece. 185pp.

UNEP/FAO/WHO/IAEA (1991a). Assessment of the State of Pollution of the Mediterranean Sea by Organohalogen Compounds./Evaluation de l'Etat de la Pollution de la Mer Méditerrannée par les Composés Organohalogènes. **MAP Technical Reports Series**, 39. UNEP, Athens, Greece. 224pp.

UNEP/FAO/WHO/IAEA (1991b). Assessment of the State of Pollution of the Mediterranean Sea by Organophosphorus Compounds./Evaluation de l'Etat de la Pollution de la Mer Méditerrannée par les Composés Organophosphores. **MAP Technical Reports Series**, 58. UNEP, Athens, Greece. 122pp.

UNEP/IAEA (1992). Assessment of the State of Pollution of the Mediterranean Sea by Radioactive Substances./Evaluation de l'Etat de la Pollution de la Mer Méditerrannée par les Substances Radioactives. **MAP Technical Reports Series**, 62. UNEP, Athens, Greece. 133pp.

UNEP/IAEA (1994). Data Quality Review for MED POL: Nineteen Years of Progress. **MAP Technical Reports Series,** 81. UNEP, Athens, Greece. 79pp.

UNEP/IAEA/FAO (1992). Organohalogen Compounds in the Marine Environment: A Review.

MAP Technical Reports Series, 70. UNEP, Athens, Greece. 49pp.

UNEP/IOC (1988). Assessment of the State of Pollution of the Mediterranean Sea by Petroleum Hydrocarbons./Evaluation de l'Etat de la Pollution de la Mer Méditerrannée par les Hydrocarbures de Pétrole. **MAP Technical Reports Series**, 19. UNEP, Athens, Greece. 130pp.

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UNEP/IUCN (1990). Report on the status of Mediterranean marine turtles. **MAP Technical Reports Series**, 42. UNEP, Athens, Greece. 204pp.

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UNEP/Marseille (1995). Protection du Patrimoine Archéologique Sous- marin en Méditerranée. 100 Sites Historiques d'Intérêt Commun Méditerranéen. Documents Techniques V. AMPHI, Atelier du Patrimoine, Marseilles, France. 88pp.

UNEP/UNESCO/FAO (1988). Eutrophication in the Mediterranean Sea: Receiving Capacity and Monitoring of Long-Term Effects./Eutrophisation dans la Mer Méditerranée: Capacite Réceptrice et Surveillance Continue des Effets à Long Terme. **MAP Technical Reports Series**, 21. UNEP, Athens, Greece. 200pp.

UNEP/WHO (1991a). Epidemiological Studies Related to Environmental Quality Criteria for Bathing Waters, Shellfish Growing Waters and Edible Marine Organisms (Activity D). Final Report on Project on Relationship between Microbial Quality of Coastal Sea Water and Rotavirus-induced Gastroenteritis among Bathers (1986-1988). **MAP Technical Reports Series**, 46. UNEP, Athens, Greece. 56pp.

UNEP/WHO (1991b). Epidemiological Studies Related to Environmental Quality Criteria for Bathing Waters, Shellfish Growing Waters and Edible Marine Organisms (Activity D). Final Report on Epidemiological Study on Bathers from Selected Beaches in Malaga, Spain (1988-1989). **MAP Technical Reports Series**, 53. UNEP, Athens, Greece. 127pp.

UNEP/WHO (1995). Assessment of the State of Pollution in the Mediterranean Sea by Carcinogenic, Mutagenic and Teratogenic Substances and Proposed Measures. **MAP Technical Reports Series**, 62. UNEP, Athens, Greece. 238pp.

UNEP/WHO (1996). Survey of Pollutants from Land-Based Sources in the Mediterranean. Document UNEP(OCA)/MED WG.104/Inf.10. Meeting of MED POL Coordinators, Athens, 18-22 March 1996. UNEP, Athens, Greece. 36pp. + Annex

UNEP/WMO (1994). Assessment of Airborne Pollution of the Mediterranean Sea by Sulphur and Nitrogen Compounds and Heavy Metals in 1991. **MAP Technical Reports Series**, 85. UNEP, Athens, Greece. 304pp.

UNESCO (1988). Eutrophication in the Mediterranean Sea: Receiving Capacity and Monitoring of Long-Term Effects. Report and Proceedings of a Scientific Workshop, Bologna, Italy, 2-6 March 1987. **UNESCO Reports in Marine Science,** 49. UNESCO, Paris. 195pp.

United Nations (1983). The Law of the Sea. United Nations Convention on the Law of the Sea, with Index and Final Act of the Third United Nations Conference on the Law of the Sea. United Nations, New York. 224pp.

United Nations (1995). 1993 Energy Statistics Yearbook. United Nations, New York. 494pp.

WB/EIB (1989). Environmental Priorities for Sustainable Development: Managing a Shared Heritage and a Common Resource (draft). World Bank-European Investment Bank Environmental Program for the Mediterranean. 78pp. + 10 Figures.

WB/EIB (1990). The Environmental Program for the Mediterranean: Preserving a Shared Heritage and Managing a Common Resource. World Bank-European Investment Bank. 93pp.

WHO (1994). Guidelines for Health-Related Monitoring of Coastal Recreational and Shellfish Areas. Part I: General Guidelines. Document EUR/ICP/CEH 041(2). World Health Organization, Regional Office for Europe, Copenhagen, in co-operation with UNEP. 55pp.

WHO (1995). Health Risks from Marine Pollution in the Mediterranean. Part I: Implications for Policy Makers. Document EUR/ICP/EHAZ 94 01/MT01(1). Part II: Review of Hazards and Health Risks. Document EUR/ICP/EHAZ 94 01/MT01(2).World Health Organization, Regional Office for Europe, Copenhagen, in co-operation with UNEP. 246pp.

WHO/UNEP (1990). Carcinogenetic, Mutagenic, and Teratogenic Marine Pollutants: Impact on Human Health and the Environment. **Advances in Applied Biotechnology Series,** 5. Gulf Publishing Company, Houston, Texas, USA. 284pp.

Williamson, P. (1992). Global change: reducing uncertainties. Coastal connections. pp.19-21 in: International Geosphere-Biosphere Programme (of the International Council of Scientific Unions). IGBP Secretariat, Royal Swedish Academy, Stockholm, Sweden. 40pp.

WRI (1994). World Resources 1994-1995. A report by the World Resources Institute in collaboration with UNEP and UNDP. Oxford University Press. New York, Oxford. 400pp.

Yilmaz, A., Yemenicioglu, S., Saydam, C., Tugrul S., Basturk, O. and Salihoglu, I. (ms, 1995). Trends of pollutants in the north-eastern Mediterranean, southern coast of Turkey. (Submitted to FAO as a forthcoming book chapter).

List of Acronyms and Abbreviations

BP	Blue Plan
CAMP	Coastal Area Management Programme
CEC	Commission of the European Communities
COS	Carbonyl Sulphide
DBT	Dibutyltin
DDD	Dichlorodiphenyldichloroethane
DDE	Dichlorodiphenyldichloroethene
DDT	Dichlorodiphenyltrichloroethane
DMS	Dimethyl Sulphide
DMSP	Dimethylsulphonium Propionate
DYFAMED	Dynamique et Flux Atmosphériques en Méditerranée occidentale
ECE	Economic Commission for Europe
EEC	European Economic Community
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EIB	European Investment Bank
EROS	European River-Ocean System
ERS	Environment Remote Sensing
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
GAW	Global Atmospheric Watch
GESAMP	Group of Experts on the Scientific Aspects of Marine Protection
GFCM	General Fisheries Council for the Mediterranean
GIPME	Global Investigation of Pollution in the Marine Environment
GIS	Geographical Information System
GOOS	Global Ocean Observing System
GRT	Gross Registered Tons
HCB	Hexachlorobenzene
HCH	Hexachlorohexane
HOC	Hydrophobic Organic Chemicals
IAEA	International Atomic Energy Agency
ICCAT	International Commission for the Conservation of Atlantic Tunas
ICES	International Council for the Exploration of the Sea
IFEN	Institut français de l'environnement
IGPB	International Geosphere-Biosphere Programme
IMO	International Maritime Organisation
IOC	Intergovernmental Oceanographic Commission (of UNESCO)
IPCC	Intergovernmental Panel on Climatic Change
IPSU	International Council of Scientific Unions
IUCN	International Union for the Conservation of Nature
LBS	Land-based sources

MAB	Man and the Biosphere Programme (of UNESCO)
MAP	Mediterranean Action Plan
MARPOL	International Convention for the Prevention of Marine Pollution from Ships
MAU	Mediterranean Assistance Unit
MBT	Monobutyltin
MED 21	Agenda 21 for the Mediterranean
MED POL	Mediterranean Pollution Monitoring and Research Programme
MEL	Marine Environment Laboratory
METAP	Mediterranean Technical Assistance Programme
NGO	Non-Governmental Organization
OECD	Organisation for Economic Cooperation and Development
OP	Organophosphorus
PAH	Polycyclic Aromatic Hydrocarbons
PAP	Priority Actions Programme
PCB	Polychlorinated biphenyls
PH	Petroleum Hydrocarbons
PVC	Polyvinylchloride
RAC	Regional Activity Centre
REMPEC	Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea
ROCC	Regional Oil Combating Centre
SPA	Specially Protected Areas
TAC	Total Allowable Catch
TBT	Tributyltin
TPE	Tons of Petroleum (oil) Equivalents
TPT	Triphenyltin
TURF	Territorial User Rights of Fishermen
UN	United Nations
UNCED	United Nations Conference on Environment and Development
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNIDO	United Nations Industrial Development Organisation
WB	World Bank for Reconstruction and Development
WCRP	World Climate Research Programme
WHO	World Health Organisation
WMO	World Meteorological Organization
WRI	World Resources Institute
WW	Waste Water

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