MEDITERRANEAN ACTION PLAN

UNITED NATIONS ENVIRONMENT PROGRAMME

STATE OF THE MEDITERRANEAN MARINE ENVIRONMENT

MAP Technical Reports Series No. 28

UNEP
Athens, 1989

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This volume is the twenty-eighth issue of the Mediterranean Action Plan Technical Report Series.

This series contains selected reports resulting from the various activities performed within the framework of the components of the Mediterranean Action Plan: Pollution Monitoring and Research Programme (MED POL), Blue Plan, Priority Actions Programme, Specially Protected Areas and Regional Oil Combating Centre.

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Chapter 1

INTRODUCTION

1(a) AIMS OF THE REPORT

The aims of this report are twofold: input into a global review on the state of the marine environment and contribution to the UNEP-sponsored Action Plan for the protection of the Mediterranean Sea.

The IMO/FAO/UNESCO/WMO/WHO/IAEA/UN/UNEP Joint Group of Experts on Scientific Aspects of Marine Pollution (GESAMP) is currently finalizing its second global review on the State of the Marine Environment[1/]. The review is of global nature, covering the world oceans, and will be based primarily on scientific information of a global, general nature. In addition, the review will include factual information from various oceanic regions, highlighting the specific regional problems in an overall global context. In order to provide an input into the preparation of the global review, a series of fourteen regional reports were prepared, following the general format of the global review.

The assessment of the state of the marine environment is a standing goal of the Action Plan for the protection of the Mediterranean Sea. Thus the preparation of the report is also a contribution towards this goal.

Small task teams of scientists were set up, involving primarily experts from the relevant regions, to prepare these regional reports under the joint overall co-ordination of the United Nations Environment Programme (UNEP), the Food and Agriculture Organization of the United Nations (FAO) and the Intergovernmental Oceanographic Commission (IOC), and with the collaboration of a number of other organizations. The present document is the product of the Task Team for the Mediterranean region (see section 1(c)) of this report).

1/ The first review prepared by GESAMP was published in 1982 as UNEP Regional Seas Reports and Studies No 16 and as GESAMP Reports and Studies No 15.

1(b) GEOGRAPHIC COVERAGE

For the purposes of this report, geographic coverage basically follows the definition from the Convention for the Protection of the Mediterranean Sea against Pollution (Barcelona Convention) (UN, 1982) which in its article 1 states:

"For the purposes of this Convention, the Mediterranean Sea Area shall mean the maritime waters of the Mediterranean Sea proper, including its gulfs and seas, bounded to the west by the meridian passing through Cape Spartel lighthouse, at the entrance of the Straits of Gibraltar, and to the east by the southern limits of the Straits of the Dardanelles between Mehmetcik and Kumkale lighthouses."

Fig. 1 presents the Mediterranean Sea with its major interactive parts and adjacent seas.

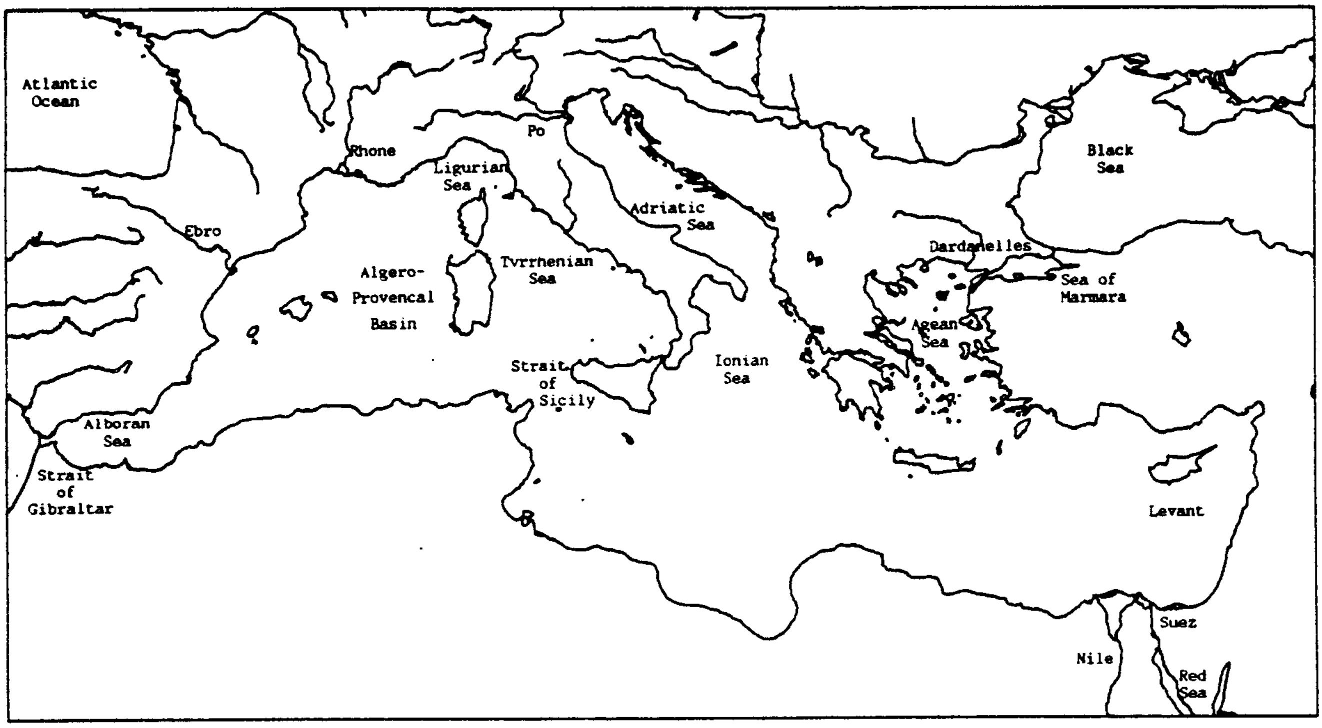


Fig. 1 The Mediterranean Sea

1(c) PREPARATION OF THIS REPORT

In consultation between OCA/PAC and the Co-ordinating Unit for the Mediterranean Action Plan, a Task Team was constituted for the preparation of this report. Mr L. Jeftic, Senior Marine Scientist of the Co-ordinating Unit, was designated to co-ordinate the work of the Task Team as its Rapporteur.

The other members of the Task Team were:

- Mr M. Bernhard, Centro Ricerche Energia Ambiente, La Spezia, Italy;
- Mr A. Demetropoulos, Ministry of Agriculture and Natural Resourses, Nicosia, Cyprus;
- Mr F. Fernex, Laboratoire de Géodynamique Sous-marine, Villefranche-sur-Mer, France;
- Mr G.P. Gabrielides, FAO, Co-ordinating Unit for the Mediterranean Action Plan, Athens, Greece;
- Mr F. Gasparovic, Zagreb, Yugoslavia;
- Mr Y. Halim, University of Alexandria, Research Centre, Alexandria, Egypt;
- Mr D. Orhon, Turkish National Committee on Water Pollution Research and Control, Istanbul, Turkey; and
- Mr L.J. Saliba, WHO, Co-ordinating Unit for the Mediterranean Action Plan, Athens, Greece.

Each Task Team member drafted certain parts of this report. A contribution to the report was also received from R. Fukai, Monaco.

The Task Team members reviewed the first and second drafts of the report which was prepared and edited by L. Jeftic, who also prepared and edited the final version of this report.

A broad range of literature was considered by the Task Team members during the preparation of this report. It included open scientific literature, information available through documentation of UNEP, MED POL, Blue Plan, Priority Actions Programme, Regional Oil Combating Centre and available grey literature.

A list of acronyms and symbols and a subject index are given in the Appendix.

Chapter 2

CHARACTERISTICS OF THE REGION

Geographic setting

The Mediterranean Sea lies (46°N, 30°N, 6°W and 36°E) between Europe, Asia and Africa and without the Black Sea covers about 2.5 million km^2, with an average depth of about 1.5 km and a volume of 3.7 million km^3.

About 30% of the surface area and 50% of the total volume is contained between a 2 and 3 km depth contour. In contrast, the area with a shallower than 200 m contour constitutes more than 20% of the total area of the Mediterranean Sea but contains less than 1.5% of the total volume (Menard and Smith, 1966).

The Mediterranean Sea consists of a series of interacting parts and adjacent seas, with two major basins, Western and Eastern. In the Western Mediterranean (about 0.85 million km^2) such parts are the Alboran Sea, the Algero-Provençal basin, the Ligurian Sea and the Tyrrhenian Sea. In the Eastern Mediterranean (about 1.65 million km^2) such parts are the Adriatic Sea, the Ionian Sea, the Aegean Sea and the Levant (Fig. 1).

The Mediterranean Sea is connected with (and separated from) the Atlantic by the Strait of Gibraltar (15 km wide and 290 m deep), with the Sea of Marmara by the Dardanelles (between 450 m and 7.4 km wide and 55 m deep) and with the Red Sea by the Suez Canal (120 m wide and 12 m deep).

The maximum length of the Mediterranean Sea from Gibraltar to Syria is about 3,800 km and the maximum distance in the north-south direction from France to Algeria about 900 km, yet one is never further than 370 km from the coast, and most often, considerably less, with more than half of the Mediterranean Sea being less than 100 km from the coast.

Geological and climatic characteristics

The Mediterranean basin, situated at the centre of a very complex mosaic formed by the tectonic plates sliding under one another, is subject to heavy seismic and volcanic activity whose consequences for human life and society are a permanent feature of the region. The young relief and the close contact and interpenetration of the sea and the mountains have had significant consequences: few large plains, little good agricultural land, ports and harbours tightly hemmed in between sea and rock, few broad fluvial basins. With the exception of the south-east and some 3,000 km along the Libyan and Egyptian coasts where the Saharian platform directly meets the sea, there are mountains everywhere, sometimes virtually uninterrupted, plunging in numerous places directly into the sea (UNEP, 1987).

In the North, the sea areas are surrounded by mountains from the Sierra Nevada ranges and the Pyrenees in the northwest, the Alps and the Apennines in the north and the Balkan and Anatolian mountains in the northeast. While there are large alluvial plains associated with the Ebro, Rhône and Po rivers, the Mediterranean is essentially bounded by mountainous coasts sloping steeply to the sea. In the southern regions the African Atlas mountains are barriers along the Western Mediterranean, but the remainder of the southern coast is deserts with no high barriers to affect air flow. This imbalance of geomorphology is an external factor affecting the ecology of the Mediterranean (Miller, 1983).

Major Mediterranean rivers (Ebro, Rhône, Po and Nile) drain geological terrains far removed from the present coastline. Although few in number, these major fluvial sources account for very large volume of sediment (over 50 million tons annually) injected into the system. On the other hand, the highly irregular coast, much of which is fronted by high mountain barriers, is distinguished by short, often torrential rivers draining small areas on a highly seasonal basis.

The Mediterranean is a transitional area climatically, with a temperate, damp climate in the north and an extreme arid climate in the south. Orographic rains on the European coasts contrast markedly with minimal annual rainfalls in the southern regions of less than 100 mm. The disparity in the amounts and occurrences of precipitation is influenced by the topography of the land and the climatic conditions of the area (Miller, 1983).

The northern sectors of the basin, lying within the zone of prevailing western winds, are characterized by spring and autumn showers that curtail the summer drought, and have a moderate climate. Rainfall intensity and duration decrease both from west to east and from north to south. Temperature, on the other hand, increases from north to south and from west to east. Rainfall throughout the region is seasonal, with a marked minimum in summer.

Annual surface winds in the Mediterranean are generally from the north and west. The combination of dry winds and sunny days, which occurs as often as 250 times a year, produces a strong evaporating influence over the entire surface of the Mediterranean that counteracts the effects of precipitation and runoff (Miller, 1983).

Circulation

The surface current system of the Mediterranean shows a migration of Atlantic water, with salinity slightly above 36, towards the east with numerous spin-off eddies along the way (Miller, 1983). The annual thermal changes of surface waters are very large and control the density of surface waters and the basic characteristics of the annual biocycle. There is no surface return system from the east to the west.

The return of Mediterranean water is by way of Levantine intermediate water and Mediterranean deep water flowing from east to west and spilling over the sill of Gibraltar into the deep Atlantic. Such intermediate and deep water is produced by very pronounced evaporation processes which gradually transform surface water with salinity slightly above 36 into denser water with salinity of 38.4 or more. Deep sea water in the Mediterranean has a temperature between 12.5^{o} and $13.5^{o}C$ in the west and between 13.5^{o} and $15^{o}C$ in the east with salinity between 38.4 and 39.

The estimated turnover time for Mediterranean waters is 80 years. The basic nature of the Mediterranean circulation system contains components of strong vertical convections which determine the distribution of salinity and produce vertical recycling of nutrients and other dissolved substances (Miller, 1983). When winter storms lower surface temperature in the western Mediterranean to 12°C, deep convection can take place; in the Algero-Provençal basin it was traced to the depth of 2,000 m.

The Mediterranean is characterized by very weak tides, with tidal amplitudes which are very small by world ocean standards. The Mediterranean is often considered a tideless sea; this however gives the wrong impression since although the tidal elevations are almost insignificant, the energy of the tides is not (Hopkins, 1985).

Sea level in the Mediterranean is lower than in the Atlantic, progressively decreasing from Gibraltar towards the North Aegean, with maximum differences of about 80 cm (Miller, 1983).

Water balance of the Mediterranean Sea

The Mediterranean Sea has a deficient hydrological balance, with loss through evaporation exceeding the input of water through run-off and precipitation. This deficiency is mainly compensated by the flow of Atlantic surface waters through the Strait of Gibraltar.

On the input side of the water balance are the net inflow through the Strait of Gibraltar, the net inflow through the Dardanelles, river run-off and precipitation. On the negative side of the balance there is evaporation.

The actual flow through the Strait of Gibraltar is about 1.5 million m^3s^{-1} in each direction with net inflow representing only about 3% of the figure (41,000 m^3s^{-1}, Table 1, Annex). The net inflow through the Dardanelles is about 6,000 m^3s^{-1} (Table 1, Annex).

The river run-off in the Mediterranean is estimated at about 15,000 m^3s^{-1} of which 92% flows from the northern shore and the rest from the southern shore. The Northwest Mediterranean and the Adriatic Sea receive about 70% of the total Mediterranean river water input (Table 1, Annex).

The input of freshwater into the Mediterranean is estimated at about 31,000 m^3s^{-1} (Table 1, Annex). Yearly rainfall decreases from west to east and from north to south, varying between more than 1500 mm yr^{-1} (Alps, Pyrenees and western part of Yugoslavia) to less than 100 mm yr^{-1}.

The above figures bring the total input of water into the Mediterranean to approximately 93,000 m^3s^{-1}.

Evaporation, which is the main factor of the negative balance is estimated at about 93,000 m^3s^{-1} for the Mediterranean (Table 1, Annex). Most of the evaporation occurs during winter and spring, due to the prevailing strong and dry continental winds and is closely associated with the process of deep water formation.

The precipitation and run-off contribution to the water balance is exceeded by evaporation by about 1 m yr^{-1}. Since Gibraltar constitutes the only access for the renewal of sea water lost through evaporation, the increasing salinity of the Mediterranean water is due to the evaporation of the lower salinity water introduced from the Atlantic (Miller, 1983).

Within the Mediterranean Sea the Strait of Sicily (150 km wide and about 400 m deep) connects the Western with the Eastern Mediterranean. It is estimated that the actual flow through the Strait of Sicily is about 1 million m^3s^{-1} in each direction, with net inflow representing only about 4% of this figure (42,000 m^3s^{-1}, Table 1, Annex).

Chemical characteristics

Although the Mediterranean Sea is of a semi-enclosed nature, it does not have a chemistry of its own. Since residence time of the Mediterranean waters is about 80 years, most of the elements have plenty of time to tour the Mediterranean Sea. The most outstanding differential characteristic of the Mediterranean when compared to the Atlantic is its high salinity, as a result of evaporation, which is only surpassed in the Red Sea and Dead Sea (Cruzado, 1985).

Another well-known characteristic of the Mediterranean Sea is the relatively low concentrations, even in the deeper waters, of some biologically important chemical constituents. This is caused by the continuous wash-out through the Strait of Gibraltar which receives poor surface Atlantic water and exports relatively rich deep Mediterranean water. After approximately 80 years, almost all the substances dissolved in this surface water have undergone an increase in concentration of about 4.7% and then they flow back into the Atlantic at depth.

A fundamental characteristic of Mediterranean water is its impoverished nutrient concentration. No deep nutrient-rich Atlantic waters take part in the Mediterranean circulation. Since it is only the upper 150 m or so of Atlantic water which provide replenishment for the Mediterranean Sea, the only increase in the concentration of nutrients is due to river input and agricultural run-off or pollution (Miller, 1983).

Phosphate values in the Mediterranean vary from 0.1 to 0.5 ug at l^{-1} with very few definitive patterns other than the occurrence of higher values in deep water. The eastern Mediterranean has a smaller range of phosphate content than the western (Miller, 1983).

Biological characteristics

The Mediterranean is relatively poor, not in variety, but in the quantity of organisms produced. In a surface layer of water of about 100 m in depth phytoplankton changes inorganic ions of nutrients into organic matter. Phytoplankton reacts rapidly to any increase in available nutrients and its growth is limited by the concentration of nutrients. The principal nutrients, such as nitrogen and phosphorus, are often limiting and, together with inorganic carbon, are the basic elements from which the synthesis of organic matter in the natural environment takes place. It is commonly accepted that photosynthesis is slowed by the scarcity of a specific nutrient and that there may be a surplus of others. One of the main causes for the low nutrient content of the Mediterranean as compared with major oceans is that surface Atlantic waters, which are low in nutrients enter through the Strait of Gibraltar to compensate for evaporative losses. At the same time the Mediterranean loses deep water, which is rich in nutrients, to the Atlantic. Colder years tend to be more productive, partly because mixing may reach a greater depth and incorporate more nutrients, and partly because the formation of deep water may occur over a larger area.

Characteristically maximum bioproduction is at about 100 m depth in summer, just at the limit where the dim light is matched by the increased concentration of nutrients. The surface of the Mediterranean receives an average solar radiation of 1.5 million Kcal $m^{-2}yr^{-1}$. Average primary production, in the Western basin, corresponds to an assimilation of 50 g C $m^{-2}yr^{-1}$, which is approximately equal to 660 Kcal, i.e. only 0.04% of the input. The water is full of light, but organisms can barely use it (Margalef, 1985).

Primary productivity can, however, be unusually high at the mouths of rivers and along the coasts in winter time, at the arrival of layers of water produced by mixing in the Golfe du Lion, and in large eddies where deep water comes close to the surface. Phytoplankton sinks and many of the cells are grazed by animals. The remainder die and decompose and together with faeces, moults, dead animals and material from land, contribute to the detritus of the sea. Typical figures show that in the Mediterranean there are 25 mg l^{-1} of dissolved inorganic carbon, 0.5 to 1.5 mg l^{-1} of dissolved organic carbon, close to 1 mg l^{-1} of particulated suspended carbon and only 0.1 mg l^{-1} of living carbon. Much of the organic dissolved matter comes from the excretion of phytoplankton. Algae usually give off from 10 to 30% of the assimilated carbon in soluble form. Part of it is used by bacteria (Margalef, 1985). Many marine sediments are anoxic. Natural conditions favourable to the formation of sediments rich in organic matter are found in regions of upwelling or near estuaries. In these areas, high primary production results in accumulation of detrital material on the sea floor and in development of anaerobic conditions. Much organic matter can thus be preserved, in spite of ventilation of the overlying waters (Cruzado, 1985).

Zooplankton basically eats phytoplankton. The animals are able to sweep up diluted food, consisting of discrete particles suspended in a volume of water. These animals utilize between 20 and 90% of the ingested food. The unused food, together with faeces, moults and excretory products, contributes to secondary bacterial food chains. Up to one third of ingested food is used in growth and reproduction, the rest is respired. Simple swimming around takes a considerable amount of energy. The oligotrophic character of the Mediterranean Sea determines its low zooplankton biomass, compared with similar Atlantic areas. In the Mediterranean, three different, and relatively isolated, subsystems can be identified (in terms of the structure of phytoplankton and zooplankton communities, along with their production and fertilization characteristics): the open sea, mainly influenced by enriching mechanisms which operate on a global scale, like the winter mixing and deep water formation intensity; coastal waters, which are more affected by wind-induced upwelling, rivers and land run-off; and embayments, in which the planktonic production is strongly influenced by urban effluents and stability conditions.

The general trends of zooplankton distribution (in which the Mediterranean areas are not affected by continental enrichment) show an increasing abundance toward the south-west end of the Western basin. In the Alboran Sea the abundance of zooplankton contrasts with the low values of biomass observed on the Atlantic side of the Gibraltar Strait, so the Alboran fertility probably depends more on local upwelling and the effect of the cyclonic gyre than on the influence of the Atlantic waters entering into the Mediterranean (Estrada et al, 1985).

Benthic communities differ according to the nature of the bottom (soft or hard). The communities found on, or within, shifting sediment have to be repeatedly regenerated. Thus food is easily exported, or lost in old sediment. On a coherent substrate, the benthos grows slowly and maintains a significant biomass, more important than the primary production or trapping of food elsewhere. Such benthic communities are, in fact, comparable to terrestrial ones. Most benthic fishes are associated with long food chains, their contribution to production and transfer of energy being low. However, the very nature of benthos adjusts fish biomass and makes their food extraction relatively efficient (Margalef, 1985).

Although the Mediterranean Sea is relatively poor in the quantity of organisms produced, it is very rich in its variety; its fauna is characterized by many endemic species and is considerably richer than that of the Atlantic coasts. The percentage of endemism is very high for the sessile or sedentary groups such as ascidians with 50.4% (Pérès and Picard, 1964), sponges with 42.4% (Vacelet, 1981), hydroids with 27.1% (Pérès and Picard, 1964), echinoderms with 24.3% (Tortonese, 1985) but it is also considerable for the other groups such as decapod crustaceans with 13.2% (Pérès and Picard, 1964; Pérès, 1967) and fishes with 10.9% according to recent data given by Tortonese (1985). The great richness of the Mediterranean fauna with its many endemic species vis-à-vis the Atlantic coasts, which have extremely low endemism, leads to the conclusion (Briggs, 1974) that the Mediterranean basin has probably functioned as a primary centre for the evolution and radiation of the eastern Atlantic warm temperate fauna. According to this hypothesis a large contingent of the Atlantic coast species, possibly the majority, must have come from the Mediterranean (Sarà, 1985).

The annual yield of marine animals, both pelagic and demersal, obtained by Mediterranean fishermen amounts to 0.3 - 0.4 tons of fish per km^2 of sea. This is equivalent to about 40 mg of organic carbon per m^2 yr^{-1}. It is, however, a long way down from the primary production and corresponds to less than 0.1% of it. On the basis of the conventional loss of 10:1 for each food link, this means an average of three food links. On a world basis the same proportion holds: a primary production estimated at 36 x 10^9 t of carbon, yields an amount of fishes and other sea food equivalent to 8 x 10^6 t of organic carbon. Mediterranean fishermen are as efficient as the best of their colleagues. It is sobering to compare the catch of fishes (40 mg C $m^{-2}yr^{-1}$) with decomposable organic carbon that the Mediterranean gets from the neighbouring lands, with a generous helping from man and towns (close to 1,000 mg C $m^{-2}yr^{-1}$) (Margalef, 1985).

The biological productivity of the Mediterranean Sea is known to be among the lowest in the world. It is true that primary productivity in the central parts of the Mediterranean Sea, and in many of the coastal areas away from the influence of major rivers or urban agglomerations, is rather low and that nutrient concentrations in the deep waters of the Mediterranean, especially of the Eastern basin, are also very low. However, fishing activities in the Mediterranean Sea have been going on for centuries, adapting themselves to the local conditions in such a way that a very high ratio catch/primary production exists. Several factors may contribute to this high efficiency; among them, the distribution in time and space of the fertilizing mechanisms.

The present climate guarantees that for a long time to come the Mediterranean Sea will continue to be an evaporating area. As long as this is so, Atlantic water will continue to flow in from the west, replenishing the moisture lost by excess evaporation. This means that almost any substance introduced into the surface environment of the Mediterranean Sea, unless it is volatile or miscible within the layer of water that leaves the Mediterranean, will remain within its boundaries.

The introduction of substances foreign to Mediterranean waters is essentially, though not exclusively, from land-based sources. Airborne particles can reach the sea by way of such atmospheric transport as dust storms or fallout from precipitation.

Waste loads of domestic sewage, industrial discharges and agricultural run-off are probably the major contributors polluting the Mediterranean. The uneven distribution of runoff and precipitation along the northern coasts of the Mediterranean Sea, combined with the northern concentrations of population and industrial activity, contributes a waste load of pollutants to Mediterranean waters that is confined first to the northern coasts and then is spread and recirculated through the natural processes of advection and convection.

Eutrophication

Eutrophication is one of the phenomena which are of particular interest for the Mediterranean.

The Mediterranean is well-adapted to avoid excessive eutrophication. It loses deep water, relatively rich in mineralized or recycled nutrients, and receives surface Atlantic water, in which most nutrients have been used before entering Gibraltar. The situation is exactly the opposite of that in the Baltic, where ecological mechanisms tend to recycle and accumulate large amounts of nutrients.

The self-purifying capacity of the marine waters is directly related to the processes that control oxygen balance. This balance may be easily broken, giving rise to an oxygen-producing surface layer and an oxygen-consuming bottom layer. This is further complicated by the fact that the oxygen produced in the shallow euphotic zone is greatly reduced by turbidity and tends to escape to the atmosphere, while the organic matter produced tends to settle, increasing the oxygen consumption of the deeper layers. Downward transport of oxygen may be severely limited by restricted diffusion due to generally concurrent salinity gradients.

When sewage is continuously discharged, in excess of the self-purification capacity, into a coastal zone with restricted circulation, the oxygen cycle is broken. The oxidation of organic matter then proceeds through anaerobic pathways and the zone rapidly becomes a nuisance, turbid and foul-smelling and devoid of natural life. Such a nuisance can be prevented by limiting the quantities or organic matter and nutrients discharged, to well below the self-purification capacity of the recipient water body.

Mediterranean waters are oligotrophic except perhaps in the neighbourhood of large rivers, and sediments have in general a low organic carbon content due to the low biological production of the waters and to the presence of high oxygen concentrations in deep waters. Therefore, local oxygen deficiencies are always connected with eutrophication sources, mostly discharges of raw or treated urban effluents. Their distribution around the region is uneven, with a maximum in the north-west and in the Adriatic Sea and a minimum on the southern shores. Owing to the strong stratification of surface waters, eutrophication is more acute in summer, when ambient nature nutrient concentrations are low and oxygen transport through the thermocline strongly reduced. Winter mixing allows for the required vertical transport of oxygen to keep the deep waters and the sediments oxidized all over the Mediterranean Sea (Cruzado, 1985).

Benthic communities

Mediterranean benthic communities in the coastal region are often strongly influenced by human activities. These communities are diversified, principally on account of the infinite variety of environmental conditions found in the Mediterranean - climatological, bathymetric, hydrodynamic, substrate, oligotrophic, local contributions of terrestrial matter, etc.

Depending on whether they are established on soft-bottomed or on rocky substrates, benthic communities are subjected to well-characterized and dominant environmental factors. Man-made modifications result in immediate repercussions. The communities established on soft-bottomed substrates are dependent essentially on the nature of sediment and the processes of sedimentation, all of which are largely conditioned by the quality and quantity of sediment influx, and by hydrodynamism, both of which could be modified directly or indirectly by human activity. The communities established on hard-bottomed substrates are conditioned by a group of factors of similar importance. This has resulted in a tremendous diversity in these communities, at least at the fine level; it is thus more difficult to study and understand the mechanisms which govern their distribution and evolution.

The conditioning factors are:

- hydrodynamism, which on a jagged coastline can alter within the space of a few metres;

- nature of the substrate: rock quality gradient, cavernous nature etc;

- illumination, which does not depend solely on depth.

These factors do not evolve independently of each other. Pollution, sedimentary influx and direct human activity all interfere and could modify the community in a radical manner (Bellan, 1985).

Chapter 3

MARINE CONTAMINANTS

3(a) CONCENTRATIONS (LEVELS AND DISTRIBUTION) IN WATER, SEDIMENT AND BIOTA

Trace elements

A large number of trace elements potentially harmful to the marine environment and through seafood to man was studied in the Mediterranean. Priority was, however, given during the planning of MED POL phase I to mercury and cadmium, since preliminary surveys had shown that both occur in marine biota in high concentrations and hence these two elements were considered especially harmful. Levels of mercury and cadmium have recently been extensively reviewed in two documents on the assessment of the state of pollution of the Mediterranean Sea (UNEP/FAO/WHO, 1987; UNEP/FAO/WHO, 1987a).

Sea water

Trace metals determined in sea water samples from the Mediterranean showed that Cd ranges from 0.02 to 0.7, Cu from 0.04 to 5.8 ug l^{-1} and Zn from 0.02 to 10 ug l^{-1} (Huynh-Ngoc and Fukai, 1979). Kremling and Petersen (1981) found narrower ranges: Cu from 0.11 to 0.43 ug l^{-1}, Fe from 0.12 to 0.46 ug l^{-1}, Mn from 0.05 to 0.84 ug l^{-1} and Zn from 0.2 to 0.76 ug l^{-1}, but for Cd much higher levels from 3.2 to 30.5 ug l^{-1}. In coastal waters, concentrations vary widely with Pb levels up to 20 ug l^{-1}, Cd up to 1.4 ug l^{-1}, Cu up to 50 ug l^{-1}, Cr up to 6.7 ug l^{-1}, Ni up to 9 ug l^{-1} and Zn up to 36 ug l^{-1} in very polluted areas (reviews: UNEP, 1985; UNEP/FAO, 1986) (Tables 2 and 3, Annex). Recent preliminary data seem to show a difference in Cd and Pb concentrations in waters from the Mediterranean and from the Atlantic in the Strait of Gibraltar and in waters of the western and eastern basin in the Strait of Sicily (Copin-Montegut <u>et al.</u>, 1985). Sea water concentrations for arsenic range from about 1 to 4 ug As-T l^{-1}. "Reactive As" ranges between 1 and 3.5 ug As l^{-1} (Stoeppler <u>et al.</u>, 1981). In other oceans As-T levels range from about 1 to 2 ug l^{-1} (review: WHO, 1986). Due to the lack of sea water standards for trace elements at the very low sea water concentrations, the accuracy of the sea water data is uncertain (See section 3c).

Sediments

Sediment concentrations are several orders of magnitude higher than sea water concentrations. Data on trace element levels in sediments from open sea areas are rare. Whitehead <u>et al.</u> (1985) examined coastal sediments taken during the Calypso cruise in 1977 and data from the literature. These authors suggest the following levels (in mg kg^{-1} DW) as background: Cr = 15, Cu = 15, Zn = 50, Cd = 0.15, Pb = 25. Concentrations for arsenic in coastal sediments can reach up to 10 ppm (DW) which compares well with concentrations observed in other coastal sediments for which a range of 3 to 14 ppm (DW) are reported (review: WHO, 1986). Deep sea sediments are reported to have higher levels of arsenic: up to 120 ppm (DW) with a world average of 20 to 30 ppm.

The data available show that higher levels are found in estuarine sediments near discharges of industry and that the levels decrease towards the open sea. In several cases multi-element analysis has been carried out. However, it is not just anthropogenic sources that can influence sediment concentrations. The mineralogical composition of the marine sediments and the natural geochemical composition of adjacent coastal terrestrial environments can increase trace element levels in coastal sediments above background levels (reviews: UNEP/FAO 1986; Bernhard, 1983). In Tables 4 and 5 (Annex) the levels for several coastal areas are summarized.

Biota

Following the "mussel-watch" programme, the mussel M. galloprovincialis has been used as a pollution indicator in the MED POL phase I programme. A wide range of concentrations has been observed. Background concentrations for mussels are difficult to establish because they can reflect very local conditions. Cu concentrations in mussels of four MED POL areas (II, IV, V, VIII) (Fig. 2) have a mean of all samples of about 1300 ug kg^{-1} FW with ranges comparable to those reported for the North Sea. The mean of all Cd concentrations in mussels was 120 ug kg^{-1} FW (excluding 5% of the highest values). The mean of all Zn concentrations in mussels was 27000 ug kg^{-1} FW. Also here, the ranges are similar to those observed for the North Sea and the mean of all Pb levels was 800 ug kg^{-1} FW (review: UNEP/FAO, 1986; ICES, 1974; ICES, 1977; ICES, 1977a). Cd, Cu, Zn and Pb levels in M. barbatus, another pollution indicator of the MED POL programmes, are considerably lower for Cd (mean of all samples in areas II, IV, VII, VIII, X: 46 ug kg^{-1} FW), Cu (mean of all samples in areas II, IV, VII, VIII, X: 600 ug kg^{-1} FW), Zn (mean of all samples in areas II, IV, VII, VIII, IX, X: 3900 ug kg^{-1} FW) and Pb (mean of all samples in areas II, X: 70 ug kg^{-1} FW). Several other organisms have been analyzed; their data together with details of the above mentioned data are shown in Tables 6 to 14 (Annex). Total arsenic (AS-T) concentrations in marine fishes from the Mediterranean range between 8 and 70 mg As-T kg^{-1} FW with Sepia officinalis reaching up to 370 mg As-T kg^{-1} FW (Stoeppler et al., 1981). The same authors observed levels up to 630 mg As-T in the flatfish Limanda limanda in the North Sea. "Typical levels" for fish should be in the range of 1 to 10 mg As-T kg^{-1} FW (review: WHO, 1986).

Mercury

Mercury is of special importance for the Mediterranean because several countries bordering the Mediterranean have laws which set a limit for the Hg-Total concentration in seafood and, as will be shown below, many fish and shellfish species caught in the Mediterranean exceed this limit. Therefore, if the laws were enforced, large parts of the catch would be withheld from the market. For example, France has a legal limit of 0.5 mg Hg-T kg^{-1} FW and Italy 0.7 mg Hg-T kg^{-1} FW. The high intake of mercury through seafood is reflected in higher Hg levels in the hair and blood of persons eating considerable amounts of seafood than of those eating little or no seafood. Therefore, the high Hg levels in certain Mediterranean seafood species present a legal and possibly a sanitary protection problem in addition to any effects these levels may have on marine organisms and ecosystems.

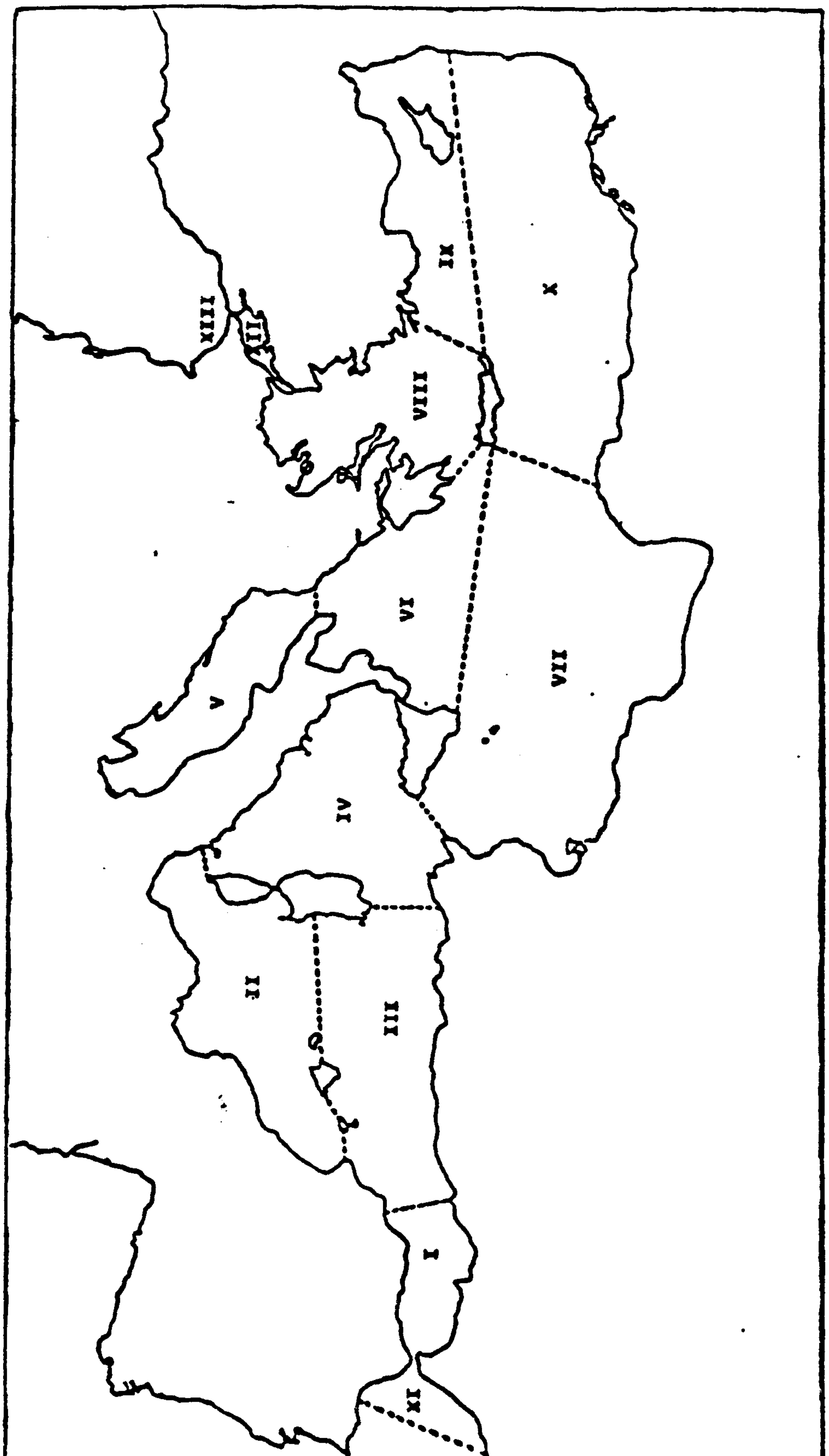


Figure 2 - MED POL areas

Sea water

Sea water concentrations vary over a wide range and the use of different methods without intercomparison or intercalibration with a sea water standard makes comparison of the data difficult, if not impossible. Older data, i.e. prior to 1980, report means up to 120 ug Hg-T l^{-1} and ranges even higher, but recent data have also high means: total dissolved Hg may reach 8 ug l^{-1} and reactive Hg or Hg determined with anodic stripping voltametry can result in means of 10 ng l^{-1}. Levels of various Hg forms from other oceans are in general lower than the Hg concentrations observed in the Mediterranean, but the accuracy of the data cannot be ascertained until quality control with standards or intercalibrations has been carried out (Table 15, Annex).

Sediments

Not many data on open sea sediment concentrations have been collected in the Mediterranean Sea. When considering these data one has to bear in mind that the analytical procedures differ among authors and only few authors report on quality control. Different extraction procedures have been used and only few (e.g. Robertson et al., 1972 and Kosta et al., 1978) have determined total Hg concentrations. The use of different pretreatments (extraction methods) by the various authors makes the results not strictly comparable, but the order of magnitude can be assumed to be right. The few data available today show that 0.05 to 0.1 mg Hg-T kg^{-1} DW may be considered a typical background value for the Mediterranean. Industrial sources and the frequent natural geochemical anomalies in the Mediterranean influence the Hg distribution in the marine sediments adjacent to these sources. Near river mouths, due either to anthropogenic or natural sources, sediments show higher levels. "Hot spots" (up to 5 ppm) have been observed near several coastal towns and most probably more "hot spots" will be found in a systematic survey. Near chlor-alkali plants and other petrochemical industries high concentrations (up to 200 ppm in the St. Gilla Lagoon, Cagliari, Sardinia) have been determined but the extention of these high Hg levels is limited in space. After 10 to 20 km background levels are reached again. High Hg levels are observed near geochemical anomalies and the high influence of rivers draining geochemical Hg anomalies such as the Mt. Amiata and the Idrija region (up to about 50 ppm) has been shown in the sediments adjacent to the river mouths (Tables 16 and 17, Annex).

Biota

Comparing general data on the Hg-T concentration in biological species which present typical seafoods from the North Atlantic with those from the Mediterranean show that in general Mediterranean fishes have higher Hg levels (Tables 18 and 19, Annex).

In fact only the means of the Hg levels in plaice from the Atlantic are higher than 500 ug Hg-T kg^{-1} FW, while the means of several of the Mediterranean species do exceed this level. Since Hg is an accumulative contaminant i.e. the Hg concentrations increase with age of specimen, better comparisons are obtained by confronting Hg concentrations in specimens of the same species caught in the Western Mediterranean and in the Atlantic. The first data, showing that mercury concentrations were higher in pelagic fishes from the Mediterranean than in the same species from the Atlantic, were published in the early seventies by Thibaud and Cumont and collaborators (review: Bernhard and Renzoni, 1977). These data were later confirmed by data obtained by other authors. In fact there exist now several sets of data for different species which compare Hg concentrations versus weight of specimens. The clearest evidence comes from the Hg concentrations in bluefin tunas; it shows two distinct populations: a "high-mercury" and a "low-mercury" population (Fig. 3). The small tuna collected north of Sicily, the medium size tuna from the Adriatic and from the Ligurian Sea as well as a part of the large tuna caught in the tuna traps situated in Sicily and Sardinia belong to the "high-mercury" population. Another group of tuna belongs to the "low-mercury" population. It is important to note that tuna belonging to the "high-mercury" and the "low-mercury" populations were both caught off Sicily and off Sardinia, but in the Strait of Gibraltar only (!) tuna belonging to the "low-mercury" were caught. The migration pattern of bluefin tuna can explain the origin of these two tuna populations. Fisheries biologists studying these migration patterns have maintained for some time that Atlantic tuna enter the Mediterranean for spawning and leave again through the Strait of Gibraltar (e.g. Sara, 1973). Recently Thibaud (1979) has analyzed several hundred tunas from the French Mediterranean coast and found that, with two exceptions, all belonged to the "high-Hg population". In order to understand better the differences in mercury levels between the Mediterranean and Atlantic biota Buffoni et al. (1982) and Bernhard (1985) constructed a very simple model of the mercury uptake and the loss of simplified tuna foodchain by using sardine data from the Western Mediterranean only. This model shows that methylmercury (MeHg) increases with the age (size) of the marine organism. This is best shown in the data on sardines (Fig. 4).

Comparing the dotted lines in Fig. 3 with those in Fig. 4 shows that the model predicts that the percentage of MeHg increases in higher trophic levels (i.e. tuna). Recently the prediction that the percentage of MeHg increases with age has been confirmed in muscle tissue of Norway lobsters and bonitos (Capelli et al., 1987), sardines, mackerels and bonitos (Cerrati, 1987). The model also suggested that the higher concentrations in the Mediterranean fish should be due to higher Hg concentration in plankton and in sea water from the Mediterranean. Bernhard and Renzoni (1977), Buffoni et al. (1982) and Bernhard (1985) suggested that the higher Hg levels in marine organisms observed in different Mediterranean regions are principally due to the inputs of mercury into the marine environment from the various Hg geochemical anomalies present in the Mediterranean area and that anthropogenic sources have significant but only very local influence. However, published data on sea water and plankton reveal no differences between samples collected in Mediterranean and Atlantic areas. This is primarily due to the fact that the analysis of Hg in sea water presents still great difficulties and hence the accuracy of the Hg determination is uncertain. These difficulties are evident from the large variability of the data published (Table 15, Annex). The analysis of net plankton samples presents other problems. These samples are mixtures of organisms of various ages which belong also to different levels of the foodchain. The development stages caught and the species composition depend on the sampling technique used (especially on the pore size and towing speed). Again the wide range of data illustrates these difficulties (Table 20, Annex). In order to compare plankton organisms it is not sufficient to compare mixed plankton samples but, like in larger marine organisms, size versus Hg concentration relationships must be compared. In fact, Fowler (1985) has shown with some very limited data that the Hg concentration of euphausids, as was to be expected, increases with size (Table 21, Annex). Fowler (1985), Fowler (1985a), Aston and Fowler (1985) and Aston et al. (1986), however, have criticized the prediction of the above mentioned model on the grounds that the published data on sea water and plankton do not show the predicted differences. Although acknowledging the analytical difficulties, the authors nevertheless maintain that the published data are sufficient to refute the prediction.

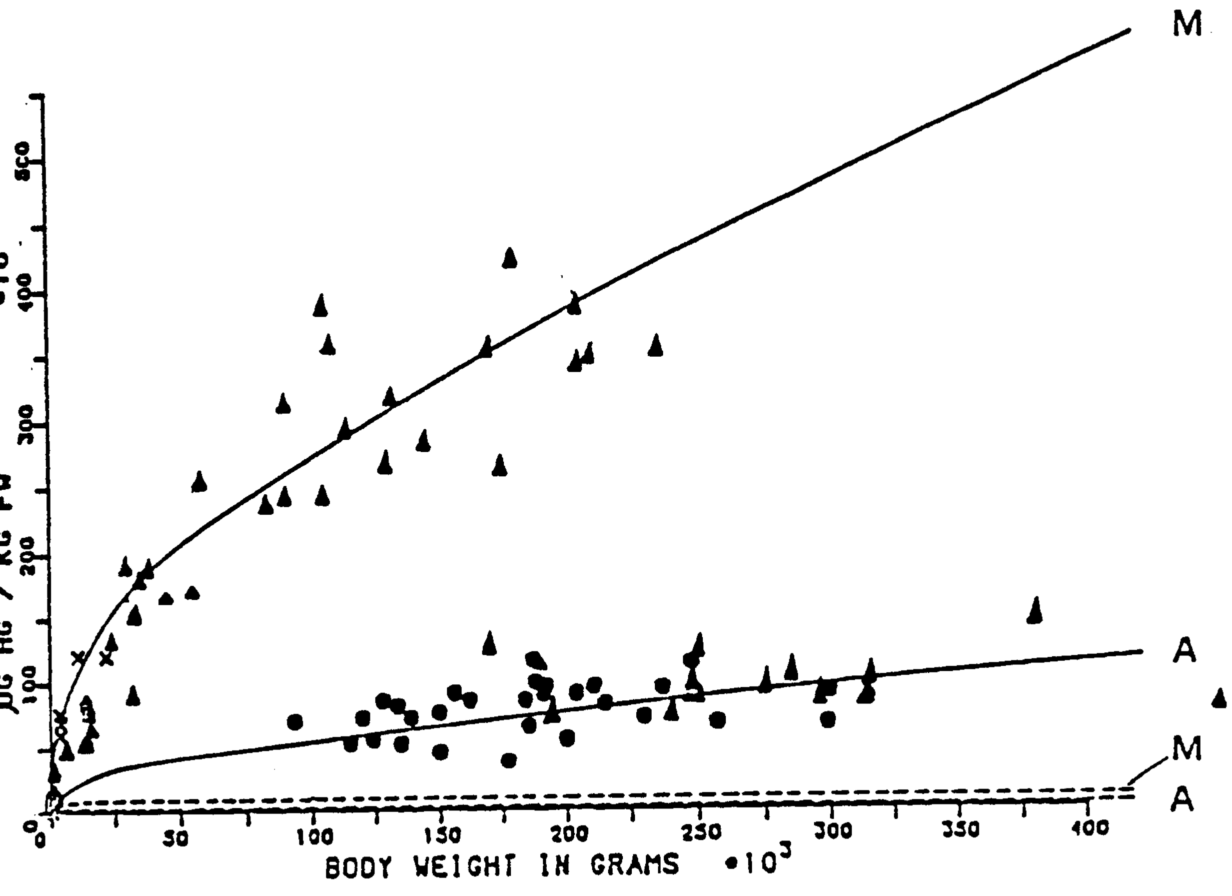


Fig. 3 Total mercury concentrations in Thunnus thynnus from the Strait of Gibraltar (O), Tyrrhenian Sea ( ) and Spanish coast (x). The continuous line shows total Hg concentrations calculated by a model; intermittent line shows inorganic Hg concentration calculated by a model. M: prediction for Mediterranean tuna, A: prediction for Atlantic tuna (Bernhard, 1985)

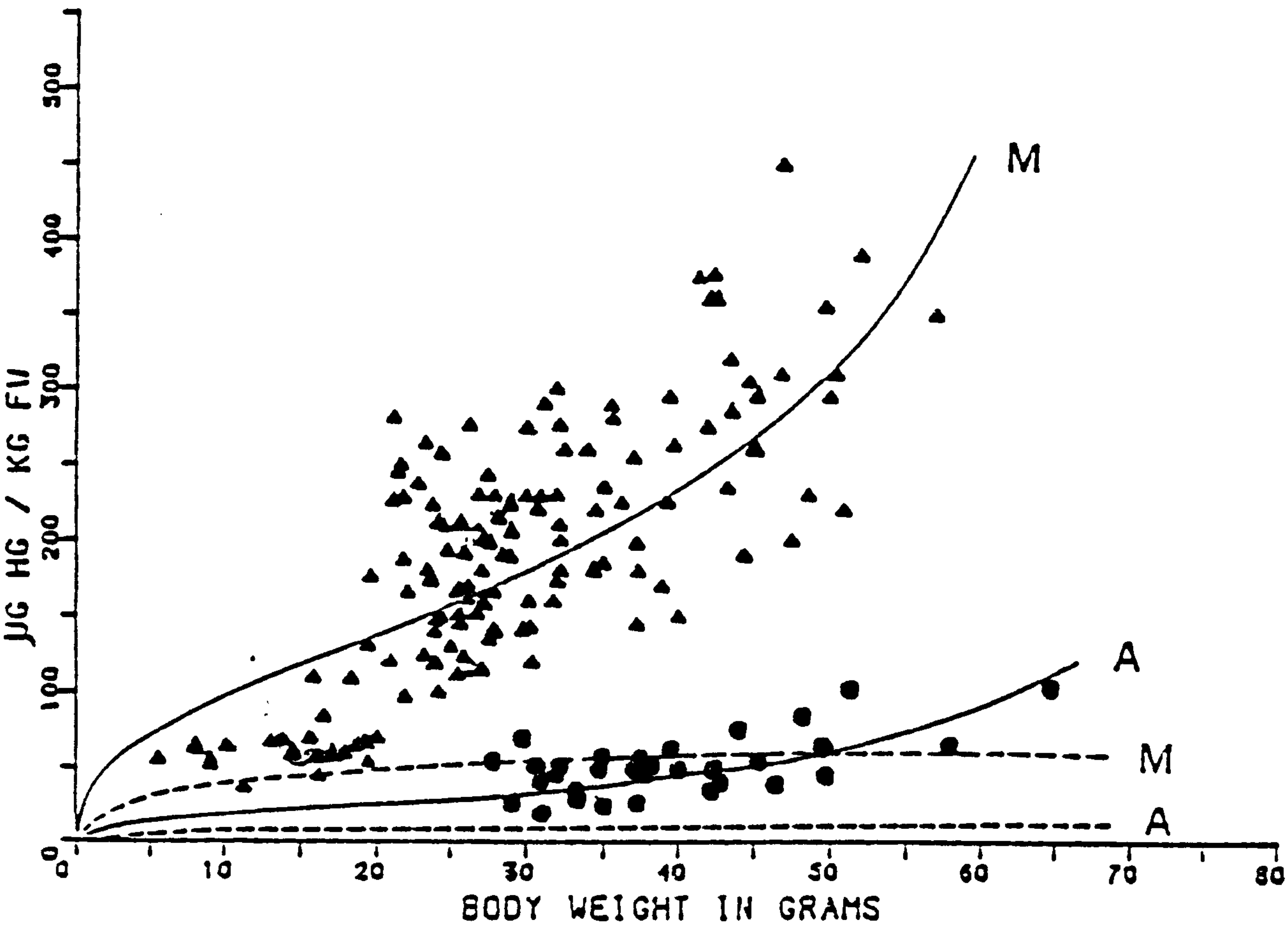


Fig. 4 Total mercury and concentrations in Sardina pilchardus from the Strait of Gibraltar, (O), Tyrrhenian Sea ( ). The continuous line shows total Hg concentrations calculated by a model; intermittent line shows inorganic Hg concentration calculated by a model. M: prediction for Mediterranean tuna, A: prediction for Atlantic tuna (Bernhard, 1985).

Similar but not so marked differences in Hg levels have been observed in mackerel and anchovy from the Mediterranean and the Atlantic. These species are also pelagic. In all three species the specimens from Gibraltar, and for the mackerel also those from the North Sea (from Scheveningen and Helgoland), have lower concentrations than the specimens from the Mediterranean. In the Adriatic Sea near Fano lower Hg concentrations have been observed than in the Tyrrhenian Sea. The levels in specimens from Sanremo-Monaco lie between the Fano and the Tyrrhenian Sea ones. Also for *Sepia officinalis* the concentrations in specimens from the Tyrrhenian Sea are higher than concentrations in specimens from Gibraltar and Scheveningen. This time however the levels of sepias from the Chioggia (Adriatic Sea) are higher than the ones from the Tyrrhenian. Kosta *et al.* (1978) and Majori *et al.* (1967) have shown that the counterclock circulation in the Gulf of Trieste, which is due to the releases from the Idrija Hg anomaly, influences the Hg concentration in mussels on the Western shore of the Adriatic. Possibly sepias from Chioggia receive higher amounts of Hg than the pelagic sardines and anchovies from the more southern Fano.

Interesting are recent data on mussels which show that the methylmercury (Najdek and Bazulic, 1986) and total mercury (Tusnik and Planinc, 1986) in mussels from the Yugoslav coasts decreased with dry weight. These observations are different from those made in other marine organisms where generally the Hg concentrations increase with weight.

The highest Hg concentrations have been observed in marine mammals (Table 22, Annex). A comparison between animals of the same species and of about the same size shows that here also Mediterranean specimens have higher Hg levels than Atlantic specimens.

Man

Astier-Dumas and Cumont (1975) studied the seafood consumption in four French regions. They found that persons eating more than three meals week^{-1} had higher Hg levels in their hair (mean (5) = 7.60 $\pm$ 3.4 ppm) than persons consuming less seafood (mean (6) = 1.1 $\pm$ 0.6 ppm).

Paccagnella *et al.* (1973) selected the population of Carloforte (Sardinia) for an epidemiological study, because its average consumption of seafood was about 4 times the national Italian average and because, during the summer months, fresh tuna meat was consumed. From 6,200 residents 195 persons chosen at random agreed to give information about their food habits, take a medical examination and allow a blood and hair analysis. Based on mercury analysis of tuna and other seafoods and the seasonal seafood consumption patterns it was estimated that the average weekly intake of mercury in the summer was 150 ug and in the winter 100 ug. The group with the highest consumption (14 seafood meals per week) had an estimated weekly mercury intake of 700 ug in the summer and 460 ug in the winter. Their average hair mercury level was 11 mg Hg kg $^{-1}$ (range: "not detected" to 60 mg kg^{-1}), which fits well with the (WHO, 1976) estimate that of an average intake of 300 ug Hg week^{-1} the hair level would be about 6 mg Hg kg^{-1}.

Riolfatti (1977) compared hair mercury levels in an inland town with a coastal town, where 13% of the 52 persons examined had consumed more than four fish meals per week. One man in the coastal town had hair levels which fell within the range of possible earliest effects (WHO, 1976), i.e. his hair concentration was about 45 mg Hg kg^{-1} and six others reached hair concentrations between 16 and 20 mg kg^{-1}. In the inland town relatively high hair concentrations were also observed. One woman had about 30 mg kg^{-1} and three had levels between 16 and 25 mg kg^{-1} despite the fact that none of the persons examined in the inland town had consumed more than 2 fish meals per week. As no quality assurance of the analytical method was carried out and the results are unusually high no conclusions can be drawn.

Bacci et al. (1976) studied the total and methylmercury concentrations in blood, urine, hair and nails of 16 persons from the town of Vada, who consumed from 0 to more than 6 meals of seafood per week. The fish came from the banks of the Vada river about 10 km West of the Solvay chlor-alkali plant. As expected, the mercury concentrations increased with the amount of seafood meals consumed. The concentration in the hair ranged from 4 to 110 mg Hg kg^{-1}.

Nauen et al. (1983) estimated the amount of mercury intake from a food consumption study on the basis of a survey in three Italian locations. Information on individual seafood consumption over a period of 20 days was matched with analytical data on Hg levels in the fish and shellfish consumed. Special attention was given to fishermen and their families. Applying a consumer risk simulation model the authors found that a high percentage of the persons interviewed exceeded their daily allowance, among them many children. In fact the maximum intake for an individual was estimated for a 3-year old child which reached 8.6 times the daily tolerable allowance.

Halogenated hydrocarbons

Air

PCB concentrations in air averaged 0.23 ng m^{-3} in a 1975 and 0.07 ng m^{-3} in a 1977 cruise (UNEP/FAO/WHO/IAEA, 1989). These levels are of the same order of magnitude as those found in Central Pacific (0.2 - 0.3 ng m^{-3}), the Antarctic (0.1 - 0.25 ng m^{-3}) and Bermuda (0.2 - 0.65 ng m^{-3}). Over Rijeka the dominant component were PCBs (1.3 to 12 ng l^{-1} Aroclor equivalent), followed by DDT(0.6 to 1.7 ng l^{-1}), DDE (0.1 to 1.3 ng l^{-1}), DDD (0.04 to 0.3 ng l^{-1})and Dieldrin (0.02 to 0.1 ng l^{-1}). In the other regions, the PCBs ranged from 0.03 to 1 ng PCBs m^{-3} (Table 23, Annex).

Sea water

Sea water samples had a concentration range from 0.2 to 38 ng PCBs l^{-1} (Table 23, Annex). The levels of the other halogenated hydrocarbons are too low for a quantitative determination (Elder and Villeneuve, 1977). Risebrough et al. (1976) found considerably lower PCB levels in sea water samples near the French coast showing the difficulties inherent in comparing data from different authors without intercalibration. In the Northern Adriatic coastal waters in 50 samples analyzed between 1977 and 1978 most concentrations were below the detection limits of 0.05 ng DDT l^{-1} and 0.1 ng PCBs l^{-1} (Picer and Picer, 1979). Lindane levels off-shore in the eastern basin ranged from 0.06 to 0.12 ng l^{-1}. The higher concentrations were observed near terrestrial run-offs and river inputs. Particulate matter had higher concentrations than the sea water dissolved phase.

Sediments

Concentrations of PCBs in the top centimeter of open sea cores sampled in the Eastern and Western Mediterranean ranged from 0.8 to 9.0 ug PCBs kg^{-1}DW (Table 23, Annex). So far in coastal sediments only examples for "hot spots" can be sited. In many other similar situations high concentrations are likely to be found. The examples concern high sediment concentrations near the sewage outfalls of Marseille (up to 16000 ug PCBs kg^{-1}DW) and Athens (up to 800 ug PCBs kg^{-1}DW), near larger towns such as Nice (up to 1165 ug PCBs kg^{-1} DW), Naples (up to 3200 ug PCBs kg^{-1} DW) and Augusta (up to 460 ug PCBs kg^{-1}DW). However, in the case of the Marseille outfall, these high levels drop to background levels at about 10 km from the source (review: Fowler, 1986). Coastal sediment concentrations from the Central Mediterranean had the following levels:

	DDT total		HCH total	
	mean	range	mean	range
area IV	7.8	(0.6 - 26.9)	2.5	(0.1 - 27.4)
V	4.5	(NDc - 47.8)	1.1	(0.2 - 4.6)
V	11.5	(NDc - 39.4)	0.9	(0.5 - 1.1)
VI	12	(2.4 - 35.5)	0.1	(0.1 - 2.6)
VIII	245	(7.1-1895)	0.6	(0.4 - 0.8)
IX	12	(0.4 - 29)	0.2	(0.2 - 0.3)
X	390	(1 -780)	0.7	

The asymetric range about the mean indicates that "hot spots" were found in the surveys in the areas such as the coast from Toulon to Marseille, the Neapolitan harbour, the Gulf of Venice, the Pula area, the Rijeka Bay, the Saronicos Gulf, etc.

Biota

Means of PCBs available in marine organisms range from 1.5 to 815 ug PCBs kg^{-1} FW. More numerous data are available only for the mussel and the red mullet. Both in mussel and in mullet MED POL area II seems to have the highest concentrations, but there must exist "hot spots" since maxima are very high despite relatively low means. In mullet the lowest level means and maxima are observed in areas IX and X. Means of pp DDT range from 0.1 to 343 ug kg^{-1} FW with <u>Thunnus thynnus</u> having the highest levels. Again high maxima indicate "hot spots". pp DDD^{-1} means range from 0.4 to 325 ug kg^{-1} FW and pp DDE from 1.5 to 600 ug kg^{-1} FW; tuna always presents the highest mean. Asymetric distribution of minima and maxima about the mean indicates a skewed distribution. Dieldrin means range from 0.4 to 6.2 ug kg^{-1} FW, Aldrin means from 0.2 to 2 ug kg^{-1} FW, Hexachloro/cychlohexane from 0.7 to 20 ug kg^{-1} FW and Lindane from 0.4 to 19 ug kg^{-1} FW. Where data are available for several areas and the same organism, area X seems to have the lowest mean and lowest maximum (Table 24, Annex).

Petroleum hydrocarbons

Sea water

In general, dissolved/dispersed petroleum hydrocarbons (DDPH) in water samples collected off-shore have concentrations below 10 ug DDPH l^{-1}, but very high concentrations have also been found occasionally in off-shore waters (Table 25, Annex). GC-determination on open sea samples (Phycemed cruises) showed that the petrogenic hydrocarbons' aliphatic fraction ranged between 1.1. and 4.5 ug l^{-1} and the aromatic one from 0.1 to 0.8 ug l^{-1}. For instance, between Castellon and Cartagena in the Western Mediterranean along 9 transects, station means varied between 0.06 and 8.25 ug l^{-1}. Near the shore, particularly near industrialized areas or river mouths, concentrations can be well above 10 ug DDPH l^{-1}. In the inner part of the harbour of Taranto (Mar Piccolo) concentrations varied between 0.1 and 36 ug l^{-1}. The data from the Adriatic refer only to the Rijeka Bay, Sibenik and Split. In unpolluted areas, values are 0.5 ug l^{-1} or below. In polluted areas, up to 50 ug l^{-1} have been determined (IR determinations gave much higher concentrations: up to 1100 ug l^{-1}). In the Central Mediterranean, recent offshore values ranged from 9.3 to 28 ug l^{-1}, but older data had maxima up to 425 ug l^{-1}. Recent nearshore values had concentration ranges very similar to the recent offshore concentrations (Libyan coast). In the Eastern Mediterranean along the Greek coasts, concentrations varied from 0.1 to 2.6 ug l^{-1} with the highest concentrations in harbour areas. In the Aegean Sea concentrations ranged from 0.15 to 1.4 ug l^{-1}, but with some "hot spots" far from major land-based sources with levels up to over 10 ug l^{-1}. In Greek harbours very high IR data have been obtained. Also along the Turkish coast concentrations varied over a wide range (0.02 to 40 ug l^{-1}), with high off-shore concentrations most probably caused by direct discharges from ships. In Israel, near harbours, oil refineries, river mouths, etc. 10 to 20 ug l^{-1} were reported. Near Cyprus, concentrations ranged from 25 to 40 ug l^{-1}. Similar high concentrations were also determined in coastal waters off Egypt. Obviously, discharges from ships can greatly influence the concentrations in offshore waters (review: UNEP/IMO/IOC, 1987). In general, it appears that recent concentrations are lower, but the data so far available are insufficient for a statistical treatment.

The limited data on floating tar show arithmetic mean levels ranging from 0.5 to 16 mg m^{-2} in offshore areas and much higher concentrations in nearshore waters (10 to 100 mg m^{-2}). The Eastern basin appears most heavily contaminated. Also tar on beaches was relatively high but only data for the Eastern Mediterranean exist (review: UNEP/IMO/IOC, 1987).

Sediments

Petroleum hydrocarbon data in sediments range from 1 to 62 ug aliphatics g^{-1} sediment and 2 to 66 ug aromatics g^{-1} sediment along the Spanish coast outside harbours, oil terminals and river mouths. Two samples from the central part of the western basin suggest background levels in the order of 1.2 ug g^{-1} aliphatics and 0.6 ug g^{-1} aromatics. Offshore sediments from Cyprus (90 m depth) ranged from 0.114 to 1.35 ug g^{-1} and somewhat lower values are reported from Iskenderun Bay, Turkey. Too few data are available to obtain a distribution pattern of petroleum hydrocarbons in the Mediterranean sediments (review: UNEP/IMO/IOC, 1987).

Organisms

Only very few studies on petroleum hydrocarbons in marine organisms are available. Mussels collected near Palamos, Barcelona and in the Ebro Delta (8 to 3200 ug g^{-1} DW in the saturate fraction) are much higher than in fishes. Mullus barbatus (5.8 to 22 ug g^{-1}) has somewhat higher concentrations than pelagic fishes such as Merluccius sp.. Trachurus sp. and Engraulis encrasicholus (review: UNEP/IMO/IOC, 1987).

Microbial pollution of shellfish and shellfish-growing waters

The monitoring of 17 shellfish-growing areas of six collaborating laboratories, taking into consideration only those stations where at least 10 analyses yr^{-1} were carried out, showed that during the years 1976 to 1981 the application of WHO/UNEP interim criteria resulted in 63% of the stations being evaluated as satisfactory from the point of view of the microbiological quality of their waters and only 7% from the point of view of the microbiological quality of the shellfish flesh itself. The WHO/UNEP criteria permit the sale of shellfish for direct consumption when one gram of shellfish flesh does not contain more than 2 faecal coliforms (FC) and less than 10 FC per 100 ml in 80% of the sample water taken in the shellfish-growing area and less than 100 FC per 100 ml in the remaining 20% of the water samples. Although the areas, not chosen at random, are not representative for the Mediterranean shellfish growing areas, the data nevertheless demonstrate that the shellfish flesh analysis is more restrictive than the water quality analysis and only a very small amount of the shellfish can be sold without further purification (review: UNEP/WHO, 1986) (Table 26, Annex).

Microbiological quality of recreational waters

From 1976 to 1981, thirty collaborating laboratories surveyed the microbiological quality of recreational waters. The areas surveyed were located mainly on the Italian western coast, the western Yugoslavian coast and the Israeli coast. Hence conclusions drawn from the data cannot be extrapolated to other areas we must also take into consideration the fact that the distribution of the indicator organisms may be subject to very local conditions of hydrological parameters. Nevertheless 12500 samples were analyzed and these data will give some indication on the microbiological conditions of the recreational waters of the Mediterranean. The criteria for characterizing recreational waters as suitable for bathing are the following: The faecal coliform (FC) concentrations of at least 10 water samples collected during the bathing season should not exceed (UNEP, 1981):

a) 100 FC per 100 ml in 50% of the samples, and
b) 1000 FC per 100 ml in 90% of the samples

313 stations were surveyed during the period in question and 80% of the stations were found acceptable for bathing (UNEP/WHO, 1985) (Table 27, Annex).

Radioactive substances

Excluding natural radionuclides which occur everywhere on the earth's surface as well as in its interior, the anthropogenic input of radioactive substances into the marine environment has been restricted and controlled, except in the case of nuclear weapon testing and accidents. In fact, radioactive substances resulting from nuclear installations are rare pollutants on which severe control and monitoring of their releases has been exercised, although their data has not always been published.

The largest quantities of radioactive wastes are, in general, produced during the nuclear fuel reprocessing, followed by those in nuclear power production, but at much lower levels; those from research reactors, hospitals, etc. are normally negligible. Since there is no operating fuel reprocessing plant on an industrial scale in the Mediterranean region, most of the intended radioactive releases into the marine environment have originated from nuclear power plants, which are in operation only in four Mediterranean countries on its northern coast (France, Italy, Spain and Yugoslavia). Most of these power plants (approximately 25 units) are located along large rivers, such as the Rhône, Po, etc., so that radioactive effluents released from these installations are transported to the Mediterranean by the various river systems. It has been estimated, however, that the river input of artificial radionuclides, including soil erosion, is approximately 4% of the total input during the pre-Chernobyl period, the major input being that through wet/dry atmospheric fallout originated from nuclear explosion tests (Fukai et al., 1981). Thus, the anthropogenic radioactive releases from nuclear installations constitute only a minor source of artificial radioactivity in the Mediterranean, except for some special local situations.

The atmospheric fallout (wet and dry) resulting from the Chernobyl accident significantly affected the Mediterranean inventories of some long-lived radionuclides like ^{137}Cs, etc., but not those of others. Most of the radionuclides brought into the Mediterranean region by the Chernobyl fallout were short-lived fission products such as ^{95}Zr, ^{95}Nb, ^{103}Ru, ^{132}Te, ^{131}I, ^{141}Ce, etc. which decayed quickly or in the course of 1986. Even the levels of medium-lived radionuclides such as ^{110m}Ag, ^{106}Ru, ^{134}Cs, ^{141}Ce, etc. in marine environmental matrices became very low due to their dispersion within the environment and their physical decay during the same period (Ballestra et al., 1987). In 1988 only a few radionuclides resulting from the Chernobyl accident remain measurable in the marine environment.

In Fig. 5 typical activity concentration ranges of ^{137}Cs and $^{239+240}Pu$ in Mediterranean seawater, sediments and biota during the pre-Chernobyl period are given. At Monaco, for example, the activity concentration of ^{137}Cs in surface seawater increased from 3 mBq l^{-1} to a maximum of 50 mBq l^{-1} on 7 May 1986 after the Chernobyl accident. The mean residence time of the Chernobyl ^{137}Cs in the seawater was only 9.5 days. Similarly, in various species of seaweed the ^{137}Cs activity concentrations increased from 0.5-1 Bq kg^{-1} to 10-50 B_q kg^{-1} dry weight with a mean residence time of 70-350 days; an increase from 1 Bq kg^{-1} to 30 Bq kg^{-1} dry weight with a mean residence time of 20 days was observed in mussels. On the contrary no detectable change in the activity concentration of $^{239+240}Pu$ was observed during the same period (Holm et al., 1988; Whitehead et al., 1988).

Although available data are too scarce for covering the entire Mediterranean, rough estimates for inputs of ^{137}Cs through various routes can be estimated by extrapolating existing data. The estimated values of cumulative inputs of ^{137}Cs for the past 25 years in 1985 (Holm et al., 1988a) are as follows:

Atmospheric Input	10 PBq
River Input	0.4 PBq
Inflow from the Black Sea	0.1 PBq
Inflow from the Atlantic	1.5 PBq
Total:	12.0 PBq

Although the errors associated with the extrapolation are hard to quantify, these are probably in a range of 20-30%.

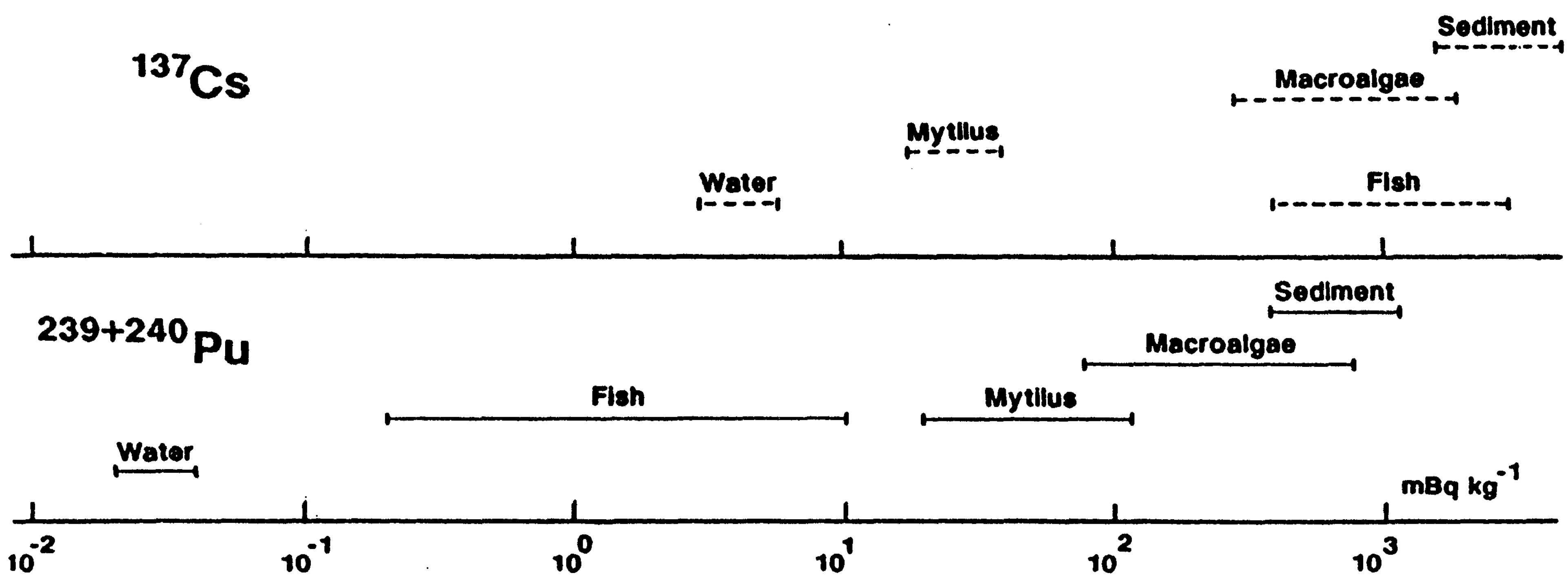


Fig. 5; Typical activity concentration ranges for ^{137}Cs and $^{239+240}Pu$ in Mediterranean seawater, sediment and biota. Activity concentrations for sediment and biota are expressed on dry weight basis. Sediment values are for surface sediment (0-5 cm) collected at depths between 200-500m.

Another approach can be made to estimate the inventory of ^{137}Cs in the Mediterranean on the basis of measurements of ^{137}Cs on depth profiles of water column and sediment cores. Again, the coverage of these data for the entire Mediterranean is not sufficient for deducing a precise inventory. Nevertheless taking the average values for these profiles and area of the Mediterranean, one can calculate the water column and sediment inventories as 11.4 PBq and 0.5 PBq respectively, which amount to the total inventory of 11.9 PBq in 1985 (Holm et al., 1988a). Considering the errors associated with these estimates, an excellent numeral agreement between the cumulative input for 25 years and the existing inventory is likely to be coincidental. However, the agreement in the order of magnitude indicates that the general approaches adopted are not grossly wrong. The accuracy of these estimations will be substantially improved when more data will have been made available for a better coverage of the entire Mediterranean region.

The total deposition of ^{137}Cs and ^{134}Cs from the Chernobyl fallout at Monaco was 1400 Bq m^{-2} and 720 Bq m^{-3} respectively in 1986 (Ballestra et al., 1987). Since the deposition was very uneven over the Mediterranean region and was determined only at a few locations, it is difficult to extrapolate these data to the entire Mediterranean. A rough estimate, however, indicates that the Mediterranean inventory of ^{137}Cs was increased by 25-40% through the Chernobyl fallout.

The above example of the inventory estimates for ^{137}Cs demonstrates that the releases of radioactive substances from nuclear installations in the Mediterranean region represent only a minor fraction of the total input and inventory.

Dumping of radioactive substances is not foreseen for the Mediterranean Sea and the release of liquid low-level radioactive wastes is severely restricted hence only very small amounts will reach the marine environment from normal operations of nuclear reactors installed near the coast and those which release radionuclides into rivers discharging into the Mediterranean.

In order to obtain further information on the behaviour and fate of radionuclides introduced into the marine environment, the existing control and monitoring of radioactive releases should be continued and, if necessary, strengthened in the future depending on the development of nuclear industry in the Mediterranean region.

3(b) TRANSPORT AND FLUXES ACROSS BOUNDARIES

Inputs from land-based sources classified according to "domestic", "industrial", "agriculture" and "carried by rivers" into the ten Mediterranean regions and into the entire Mediterranean have been estimated very approximately by the MED POL X project (UNEP/ECE/UNIDO/FAO/UNESCO/WHO/IAEA, 1984). Estimates were made for: Total discharged Organic matter (BOD, COD), Nutrients (phosphorus and nitrogen), Specific Organics (detergents, phenols, mineral oil), Metals (Hg, Pb, Cr, Zn), Suspended matter (TSS), Pesticides (organochlorines) and Radioactivity (T, other nuclides). Estimates for the entire Mediterranean showed that 60 to 65% of the total load comes from coastal sources. Of this percentage half originates in industry and about a quarter each from domestic sewage and agriculture. Phosphorus and nitrogen derives 75 to 80% from riverine inputs. One third of the detergents stems from coastal sewer outfalls and two-thirds are discharge from rivers. Hg is mainly discharged through rivers and only about 8% from coastal sources. However, data on industrial discharges are limited. 50% of the Cr and two-thirds of the Zn is introduced from rivers. Most of the metal loads in the coastal zone come from industry and lesser amounts are contributed by domestic sewage. Considerable amounts of metals are transported naturally into the Mediterranean. The loads of persistent pesticides derive from surface run-offs with one-third being DDT compounds, HCH compounds and from other organochlorines. Cyclodienes account for only about 5%. These regional inputs of pollutants have to be integrated with studies of local depositions, since the latter will be mainly responsible for effects on marine ecosystems and on the amounts transported via the seafoods to the human population.

Trace elements

Atmosphere transport was studied during the Etna and Phycemed cruises in the Western Mediterranean (Arnold et al., 1983). From the anomalous enrichment of Ag, As, Au, Cd, Cr, Hg, Sb, Se, Pb and Zn the authors concluded that anthropogenic aerosols mainly from the industrial areas of Western Europe are the main atmospheric deposition of trace elements. Only for Se the contribution from the volcanic activity of Mt. Etna appears predominant. The results obtained for Pb, Zn, Cr, and Hg indicate that the atmospheric flux to the entire Western Mediterranean is of the same order of magnitude as the rate of riverine and coastal inputs in the dissolved form. These regional atmospheric deposits of trace elements have to be integrated with studies of local depositions, since the latter will be mainly responsible for effects on marine ecosystems. Some examples exist for particular areas of the Mediterranean. Palumbo and Iannibelli (1985) compared atmospheric deposition and "hydric" input from run-off and outfalls into the Bay of Naples. They estimated that the following amounts are received by the bay:

	in metric tons month^{-1}		
	Fe	Cu	Zn
atmospheric deposition	23	1.2	1
"hydric" input	73.9	11.4	8.7
atmospheric in % of "hydric"	31	10.5	11.5

Another example is supplied by the discharges received by the lagoons of Venice (Bernardi et al., 1985). The Northern, Central and Southern lagoons received a total of 415 Mtons of Fe yr^{-1}, 4 Mtons of Ni yr^{-1}, 5.5 Mtons of Pb. Hg estimates were not given since the situation prevalent during measurements was considered too extreme for an estimation.

Halogenated hydrocarbons

Atmospheric transport into the sea was deduced from PCB determinations in air and wind direction at Monaco. Winds from non-industrialized areas (North) had lower PCB concentrations than winds coming from the Western industrialized part of France (UNEP/FAO/WHO/IAEA, 1989). Other sources consist of agricultural run-offs, discharges with river water and direct releases from industries and sewage systems. In river waters (Po, Rhône) PCBs had concentrations around 0.1 to 0.3 ug PCBs l^{-1}. In 1976-77 MED POL X made some very approximate estimates on the total load of chlorinated pesticides, i.e. excluding PCBs, from land-based sources and these were 50 to 200 t yr^{-1}, with higher levels in the MED POL areas II to V than in the other areas.

Petroleum hydrocarbons

The atmosphere receives petroleum hydrocarbons from volatilization of the petroleum hydrocarbons present in the sea and from various land-based anthropogenic sources; it exports petroleum hydrocarbons onto the sea surface through deposition. Ho et al. (1983) have estimated the annual input of hydrocarbons (HC) into the Western Mediterranean:

	in mg HC m^{-2} yr^{-1} wet	dry
aromatic HCs	0.04 - 0.44	0.03 - 0.3
total HCs	0.8 - 16.7	0.5 - 9.4

An estimation of the flux of petroleum hydrocarbons in the sea was attempted with sedimentation traps nearshore of Monaco. Zooplankton faeces should under these conditions transport 8 to 9 ug cm^{-2} yr^{-1}. At 100 meters depth, the flux should be 0.8 to 1 and at sediment level (250 m depth) about 0.9. This indicates that only 10 % of the petroleum hydrocarbons transported downwards reach the sediments. Biodegradation by microorganisms is responsible for this diminished flux and only the most refractory part of the HC will reach the sediments. Residence time of HCs in surface waters was estimated to about 0.6 years and the residence time calculated from faeces and sediment trap materials suggested one year.

3(c) QUALITY ASSURANCE, DATA VALIDATION AND MANAGEMENT

The IAEA International Laboratory for Marine Radioactivity in Monaco prepares and distributes, in the framework of the MED POL programme, biological and sediment samples for intercalibration exercises. Based on these exercises certain data on heavy metals and halogenated hydrocarbons in marine organisms were excluded from processing.

Trace elements

In the absence of any intercalibration exercise or reference sample, all sea-water measurements must be interpreted with caution. Different methods for the determination of trace elements in sea water and, especially, different extraction methods used in sediment analysis make comparisons of the data reported difficult. In particular the very low levels of trace elements in sea water increases the hazard of sample contamination. Trace element levels may be too low as well as too high and they are not representative of coastal pollution since from many polluted areas no samples have been taken and analyzed. Levels in biota must be more reliable since the laboratories participating in the MED POL programme have carried out extensive intercalibrations with biological matrices supplied by the International Laboratory for Marine Radioactivity in Monaco (e.g. Fukai et al., 1978; Fukai et al., 1979; IAEA, 1978; IAEA, 1980; IAEA, 1985). The results of these intercalibrations were used to exclude dubious data in the compilation of the concentrations of Cu, Zn, Pb and Cd shown in Tables 6 to 13 (Annex).

Halogenated hydrocarbons

In the framework of a world-wide intercalibration of an oyster sample (Ma-M-1/oc) the Mediterranean laboratories achieved a standard deviation of about 30% from the "probable concentration" estimated by 7 experienced laboratories (Fukai et al., 1979). Considering in particular the difficulties involved in matching the different pikes of PCBs with a commercial standard solution, this standard deviation can be considered acceptable. Data in Table 24 (Annex) do not include data from laboratories which produced bad intercalibration results.

Petroleum hydrocarbons

Intercalibration for DDPH (Dissolved/Dispersed Petroleum Hydrocarbons) was held in Barcelona and resulted in a standard deviation of 33 % at a concentration of 1.65 ug l^{-1} of chrysene equivalent (two outliers were excluded) which was considered satisfactory. However, the significance of fluorescence measurements is questionable since the method responds also to biogenic compounds and therefore it is only useful for the identification of "hot spots" (UNEP/IMO/IOC, 1987).

Microbiological methods

Six intercalibration exercises have been carried out comparing results obtained by the membrane filtration method and the multiple-tube method (UNEP/WHO, 1986a). The experience obtained during these intercalibrations showed that the dilution of the samples before analysis and the identification and counting of colonies or positive tubes are the two factors mainly influencing the precision of the two microbiological methods. Careful conducting of the test will result in microbial concentrations whose 95% confidence interval is defined by 1.15 times above and below their mean values.

Chapter 4

HUMAN ACTIVITIES AFFECTING THE SEA

4(a) DISPOSAL OF URBAN AND INDUSTRIAL WASTE WATERS

The Mediterranean Sea serves, at a steadily growing pace, as the recipient of a multitude of waste discharges from residential areas, touristic complexes and industrial activities. In fact, records show a substantial increase in recent years, both in volume and composition of liquid wastes discharged into the Mediterranean Sea. Especially, there is enough evidence that municipal wastewater has changed during the last several decades in composition, not only through the increased amount of household chemicals, but also through the discharge of varying amounts of industrial waste into public sewers. Direct discharges of domestic and industrial wastes in the coastal zone is not the only concern. Agricultural run-offs and rivers flowing into the Mediterranean Sea are also responsible for substantial waste loads of organic and inorganic origin.

In the past, the most common system of waste water disposal into the Mediterranean coastal zone has been by marine outfalls without any prior treatment. This system of disposal is based on the processes of initial dilution and waste water dispersion with simultaneous biochemical self-purification in the sea water. This approach has been subject to criticism, because of the potential danger of local ecosystem disturbances and of the bioaccumulation of toxic substances in the sea organisms. Consequently, there is an increased trend among the Mediterranean countries to install waste water treatment plants along the coastal zone. There are no recent data to indicate the coastal population currently served by treatment plants. Table 28 (Annex) reflects the situation on the basis of a questionnaire survey conducted in 1978 (UNEP, 1987b): The table indicates that only 50% of the 78 Mediterranean municipalities responding to the questionnaire possessed a treatment facility prior to 1978. Table 29 (Annex, UNEP, 1987b) shows evolution in the period from 1975 to 1980 of access of urban and rural population to sanitary services (sewer connections, septic tanks and adequate sanitation). Table 30 (Annex) shows a recent evaluation of a similar nature for the Turkish Mediterranean Area (Kavasogullari et al., 1987). The survey identifies 22 population centres of 10,000 inhabitants or more along the coastal zone and 11 towns situated on 6 rivers discharging into the Mediterranean totalling 5,295,000 inhabitants. This figure is very likely to increase at least threefold due to touristic activities during half the year. Accordingly, a waste water discharge of 4.8×10^{8} m^{3} yr^{-1} is computed from domestic sources only, contributing a BOD load of 1.5×10^{5} t yr^{-1}. As shown on the Table, around half the population is served by a sewerage system and a much smaller fraction by a marine outfall or a treatment facility. Recently, the establishment of sewage treatment plants in all cities around the Mediterranean with more than 100,000 inhabitants and appropriate outfalls and/or treatment plants in all towns with more than 10,000 inhabitants has been adopted as a matter of priority by all Mediterranean countries (UNEP, 1985a). Consequently, newer installations of waste water disposal are expected to involve biological treatment. It should be pointed out however that the problem of waste water disposal is not conceived along the same lines in all the Mediterranean countries. Especially in countries with a dry climate, land treatment prevails since waste water discharge is considered primarily within the framework of the total water balance of individual regions.

As regards the magnitude of pollution from land-based sources, all data available so far refer to a survey made in 1977 (UNEP/ECE/UNIDO/FAO/UNESCO/WHO/IAEA, 1984) (Table 31, Annex). In this survey, an approximative Mediterranean assessment of the pollution load is made by categorizing major contributing sources, namely, domestic wastes, industrial waste water, agricultural run-offs and river discharges. The total input budget is computed for volume, organic matter, nutrients, specific organics, metals, suspended matter, pesticides and radioactivity. The evaluation is effected through indirect estimates, on the basis of country surveys, statistical information and other data sources. The geographical distribution of pollution loads is also taken into consideration on the basis of 10 regional entities into which the Mediterranean Sea is subdivided according to UNEP's monitoring and research programme.

For domestic sewage, population centres of 10,000 inhabitants or more are selected for study under the assumption that smaller settlements are usually not sewered and would contribute only marginal amounts. Per capita rates of 82-550 l $caput^{-1}$ day^{-1} for wastewater flow and 27-70 gr $caput^{-1}$ day^{-1} for BOD load are used for polluting load assessment. Similar computations are made for other pertinent parameters. The computed domestic load is then reduced to account for:

- the fact that only about 50 percent of the population is connected to a sewerage system and non-sewered populations would not contribute to direct discharges to the sea;

- the fraction of the sewered population not discharging directly into the sea but elsewhere;

- waste reduction due to existing sewage treatment facilities.

As far as water volumes are concerned, contribution from coastal sources is minimal in comparison with river water discharges: a total of 420 x 10^9 m^3 yr^{-1} is discharged from rivers and 2 x 10^9 m^3 yr^{-1} and 6 x 10^9 m^3 yr^{-1} from domestic and industrial polluters respectively. Touristic activities in the region are evaluated as yielding around 350 x 10^6 m^3 yr^{-1} of waste water which is roughly one sixth of the total domestic sewage discharge (UNEP, 1987). For the load of organic matter expressed in terms of biochemical and chemical oxygen demand, the opposite was observed: about 60 to 65 percent of the total load is generated from coastal sources while the rest was due to river discharges. Of the 1500 x 10^3 t yr^{-1} of biochemical oxygen demand in the coastal area, 900 x 10^3 t yr^{-1} is associated with industrial sources, only 500 x 10^3 t yr^{-1} is found to be of domestic origin and the rest is attributed to agricultural run-offs. The latter and the river discharges are the major sources for phosphorus and nitrogen loads totalling 1400 t yr^{-1}. The detergent load of 60 x 10^3 t yr^{-1} is largely due to household uses. Approximately 1/3 of this total input derives from coastal zones and 2/3 from inland zones via rivers. Industrial sources are primarily responsible for heavy metal discharges, significant for their toxicity and bioaccumulation. Data evaluated for mercury, lead, chromium and zinc show that inputs are largely due to river discharges. In addition, considerable amounts of metals are transported naturally into the Mediterranean Sea, as background contributions. Another issue of concern is the discharge of pesticides. The survey computes the total load of persistent organochlorine compounds carried out by surface run-off directly or through rivers into the Mediterranean Sea as 90 t yr^{-1}. In a similar FAO study carried out in 1977, a total load of 148 t yr^{-1} is given for the same group of pollutants. In this study, the discharges of the most significant groups of pesticides are evaluated as shown on Table 32 (Annex) (UNEP, 1987).

Pollution by petroleum hydrocarbons is of special importance for the area. Major sources of oil pollution in the Mediterranean may be listed as follows (UNEP/IMO/IOC, 1987):

1. natural seeps and erosion of sedimentary rocks;

2. spills and operational (produced water) discharges from offshore petroleum production facilities;

3. refinery and oil storage wastes;

4. marine transportation, including:

   (a) operational discharges from tankers (ballast, slop tanks and tank washing water);

   (b) terminal and bunkering operations (e.g. spillages, pipeline or storage tank ruptures);

   (c) dry-docking;

   (d) bilges and fuel oil from ships (machine space bilges, fuel oil sludges, oily ballast from fuel tanks); and

   (e) accidental spills from tankers and other ships.

5. pleasure watercraft;

6. ocean dumping;

7. precipitation from the atmosphere;

8. municipal waste waters;

9. industrial waste waters (non-refinery);

10. urban runoff;

11. river-borne pollution.

As this list shows, input of petroleum hydrocarbons in the Mediterranean, ranges from diffuse chronic inputs (terrestrial runoff and natural seeps) to large point source releases (e.g. tanker spills).

In the light of load assessment results summarized above and data related to pollution monitoring in the receiving waters, it may be concluded that the main water body of the Mediterranean Sea is relatively clean and pollution is of concern locally in highly populated coastal areas. This statement is illustrated by a recent survey on the Gulf of Trieste (Olivotti, et al., 1986). The Gulf receives the sewage of nearly 400,000 people. Evaluations of possible impairment of beneficial uses such as bathing and shellfish cultivation have shown that only less than 20% of the Gulf shoreline and less than 5% of the Gulf surface is polluted on the basis of criteria contained in EEC directives and WHO/UNEP recommendations, although in certain zones floatables and oil pollution pose serious problems. In the Mediterranean, the region where the heaviest pollution loads are discharged is the north-western basin, bordered by 3 industrialized countries and also receiving major river discharges. In addition to the considerable amounts of organic matter and suspended solids, industrial waste discharges are also responsible for the release of significant loads of other types of pollutants, such as heavy metals, phenols, mineral oils and hydrocarbons. From among the consequences of industrial activities, the greatest concern is for mineral oil and heavy metal pollution.

Although the Mediterranean Sea is on the whole a clean water body, effective action needs to be decided upon and undertaken in order to fight serious local pollution problems. Direct monitoring of marine waters is now carried out to identify possible sources of pollution with a view to taking appropriate measures. This approach should be coupled with comprehensive quantitative waste surveys on significant polluting sources, in order to obtain more reliable data and come up with more effective measures to control pollution at the source.

4(b) DEVELOPMENT OF COASTAL AREAS AND OTHER LAND USE PRACTICES

The Mediterranean region can in general and in spite of fairly pronounced differences between the northern and the southern parts be regarded as one of the more developed regional seas.

The perspective of Mediterranean development has been studied in the frame of the Blue Plan, one of the components of the Mediterranean Action Plan. Development scenaria of the Mediterranean for the year 2025 were prepared. Such scenaria concerning environment and development and their mutual relations have been prepared according to consistent sets of hypotheses on the population, economic growth, environmental policies and cooperation among the various coastal states. The findings of these scenaria highlight a number of salient points, both warnings and challenges for the future of the region. Most of the information contained in this chapter (4b) was collected and published by Blue Plan Regional Activity Centre (UNEP, 1987; UNEP, 1987a; UNEP, 1987b; UNEP, 1988b).

Eighteen countries lie on the shores of the Mediterranean, and their littoral regions are under the immediate influence of the Mediterranean Sea and also directly influence the sea environment. This region, together with the coastal sea belt represent the Mediterranean coastal area or region (Fig. 6) (UNEP, 1987b). Some of the countries lie almost entirely within this Mediterranean region (Italy, Albania, Greece, Lebanon, Cyprus, Malta) while others also lie on the shores of other seas (Spain, France, Turkey, Israel, Egypt and Morocco). Some of the countries are, via their interior, linked with confluences of rivers flowing into other seas (Yugoslavia, Syria). Libya, Tunisia and Algeria have interiors drawn deeply to distant desert regions, but these countries are, in general, linked with the coast of the Mediterranean Sea.

In the global regional breakdown and statistics, the region of the Mediterranean countries is located in several regions linked primarily with the continent within which they are located. This, to a major extent, makes the gathering of statistical data for the Mediterranean region difficult. A similar or even greater difficulty lies in the demarcation between coastal areas and the interior, so that the collection of data on development and the environment of the coastal area of the Mediterranean is, for the most part, an exercise which only began in recent years.

The length of the Mediterranean coastline is about 46,000 km of which about 19,000 km is coastline of the Mediterranean islands. The contact between the land and the sea is very intensive. The ratio of the straight coastline with respect to the real coastline is very high (Greece and Yugoslavia) and frequently exceeds 1:5. In some countries the length of the coastline of islands with respect to the coastline of the continent exceeds 50% (Greece, Italy, Yugoslavia). The shores of the countries in the south and east of the Mediterranean are far less developed than in the countries on the northern coast of the Mediterranean (Fig. 7 and Table 33, Annex) (UNEP, 1987b).

The total number of inhabitants of all 18 states surrounding the Mediterranean Sea amounted to 351 million in 1985, and 132 million of this number live directly in the coastal area (Table 34, Annex) (UNEP, 1987a).

As much as 37.2% of the total number of inhabitants of the Mediterranean countries live in the Mediterranean coastal regions and these coastal regions cover an area of 1,491,977 km^2, or 17.5% of the total area (88,528,914 km^2) of all Mediterranean countries (Table 35, Annex) (UNEP, 1987a).

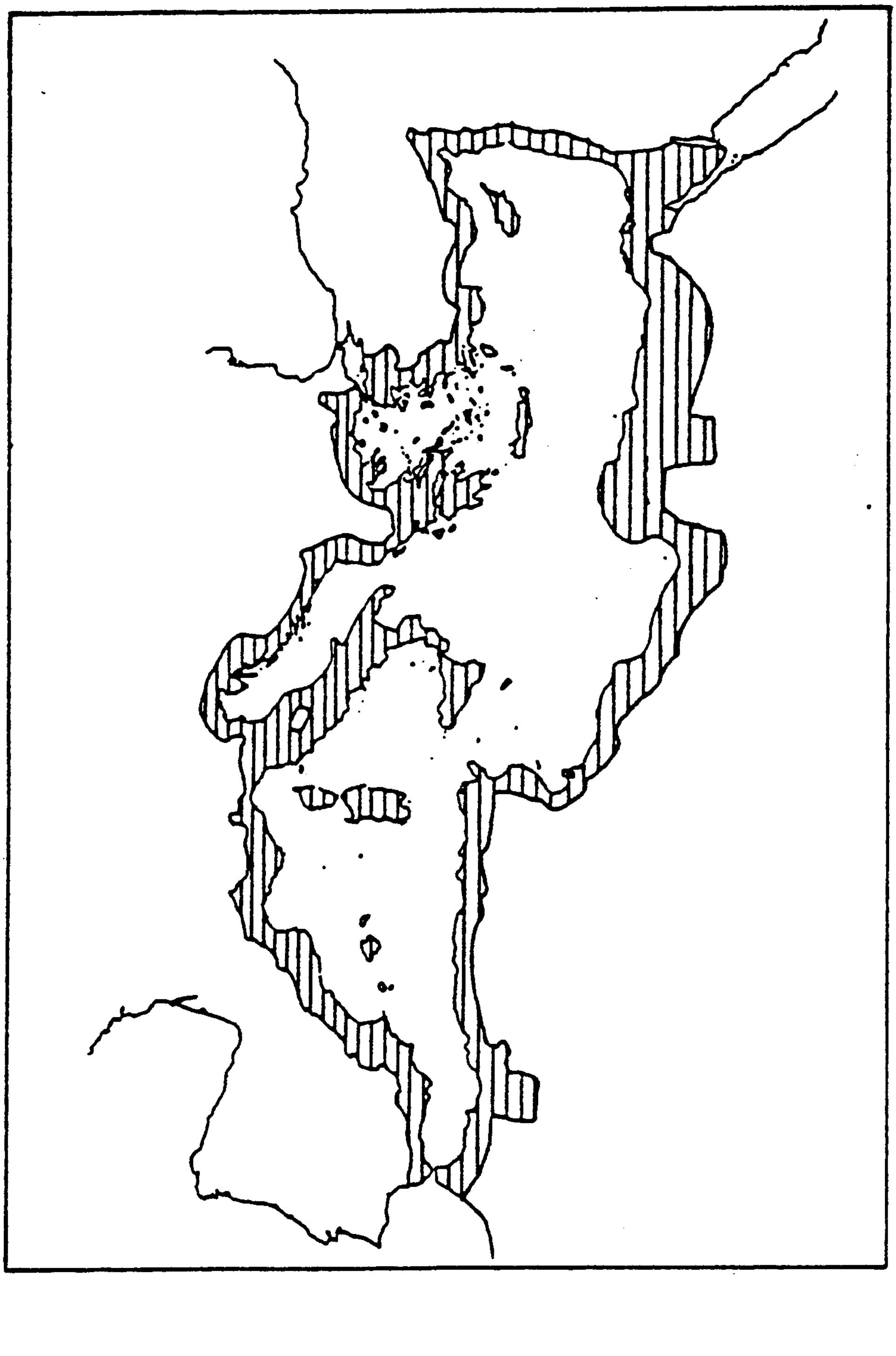


Fig. 6 : The Mediterranean regions (UNEP, 1987b)

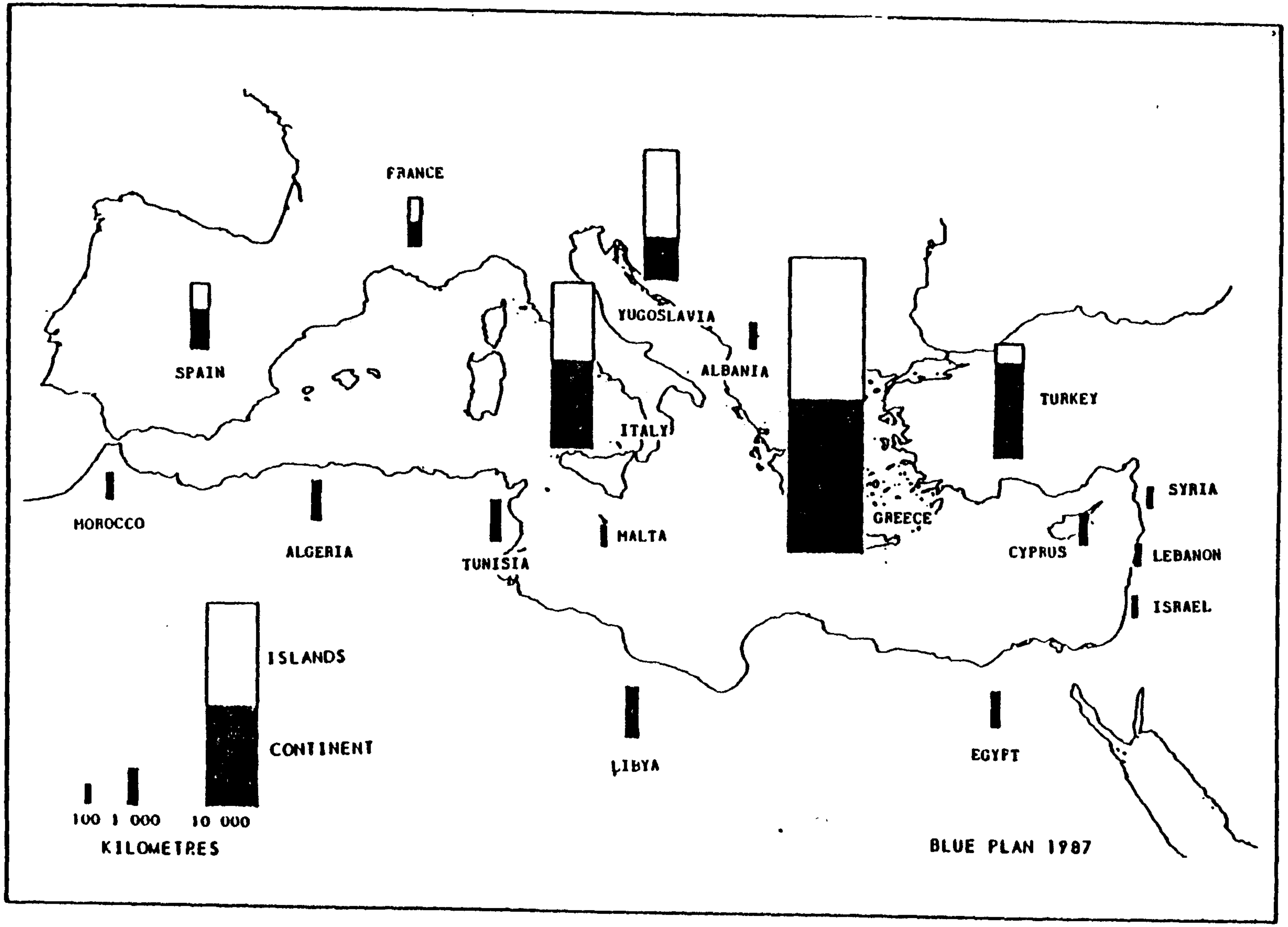


Fig. 7 : The Mediterranean coastline (UNEP, 1987b)

The tendency of growth of the number of inhabitants on the shores of the Mediterranean is very pronounced in eastern and southern Mediterranean countries. According to one average projection, the population in the Mediterranean can be expected to grow from 323 million in 1980 to 433 million in the year 2000 and 547 million inhabitants in 2025 (Fig. 8) (UNEP, 1987a). This phenomenon will lead to a shift in the centre of concentration of the Mediterranean population from the northwest (Spain, France, Italy) to the eastern and southern parts of the Mediterranean (Egypt, Turkey, Algeria).

The characteristic feature of the age-group structure of the population is a very high share of the younger age groups in the south and the east of the Mediterranean (37-49% in the south and the east and 21-26% in the north), and this fact indicates the difficulties arising in the securing of education and the creation of new jobs for this population.

Life expectancy at birth in 1985 was close to or over 70 years in the countries in the northern part of the Mediterranean, and close to or somewhat below 60 years in the countries of the east and the south. Among the countries in the eastern part of the Mediterranean, Israel has all the features of the countries from the northwest (Table 36, Annex) (UNEP, 1987a).

The population density of the coastal regions is, as a rule, greater than in the interior and amounts to between 250 inhabitants per km^2 to as much as 1,000 inhabitants per km^2 in the Nile delta.

In the post-war period the development of the Mediterranean region has been extremely pronounced and it was accompanied by an intensified industrialization and the development of tourism. This has intensified the otherwise pronounced trends of the strengthening of urban agglomerations lying in the coastal areas or in the immediate hinterland. This resulted in the creation of great urban agglomerations on the coast, the immediate interior or in the region of the flows of the major Mediterranean rivers, as for example Alexandria, Algiers, Athens, Barcelona, Beyrouth, Genoa, Ismir, Marseille, Naples, Rome and Tunis.

Out of the total population of the Mediterranean coastal regions in 1980 the majority was made up by the urban population, with an average share of 57% and a growth tendency with the existing trend up to almost 76% in 2025 (UNEP, 1987).

Increased urbanization will to a significant extent be reflected in an increase of household and industrial pollution. In the countries of the southern Mediterranean almost the entire increase of the urban population will take place in the cities in the coastal regions (Table 37, Annex) (UNEP, 1987a).

The wide variation in natural political and economic systems (both past and present) within the region, as well as the variation in disposable resources therein have resulted in great differences in the level of development of Mediterranean countries. The context of highly developed industrial countries in the northwest (France, Italy, Spain), countries on the way to completing their industrialization (Greece, Yugoslavia, Turkey), as well as developing countries in the east and south regions of the Mediterranean (Israel, as an industrial country, represents an exception in the east) represents in the global regional economic pattern an illustration of the North-South relationship. Despite the great links with Europe and the pronounced expansion of the European Economic Community, the infuences of other strong economic centres have a significant impact on the further course of the development of Mediterranean countries.

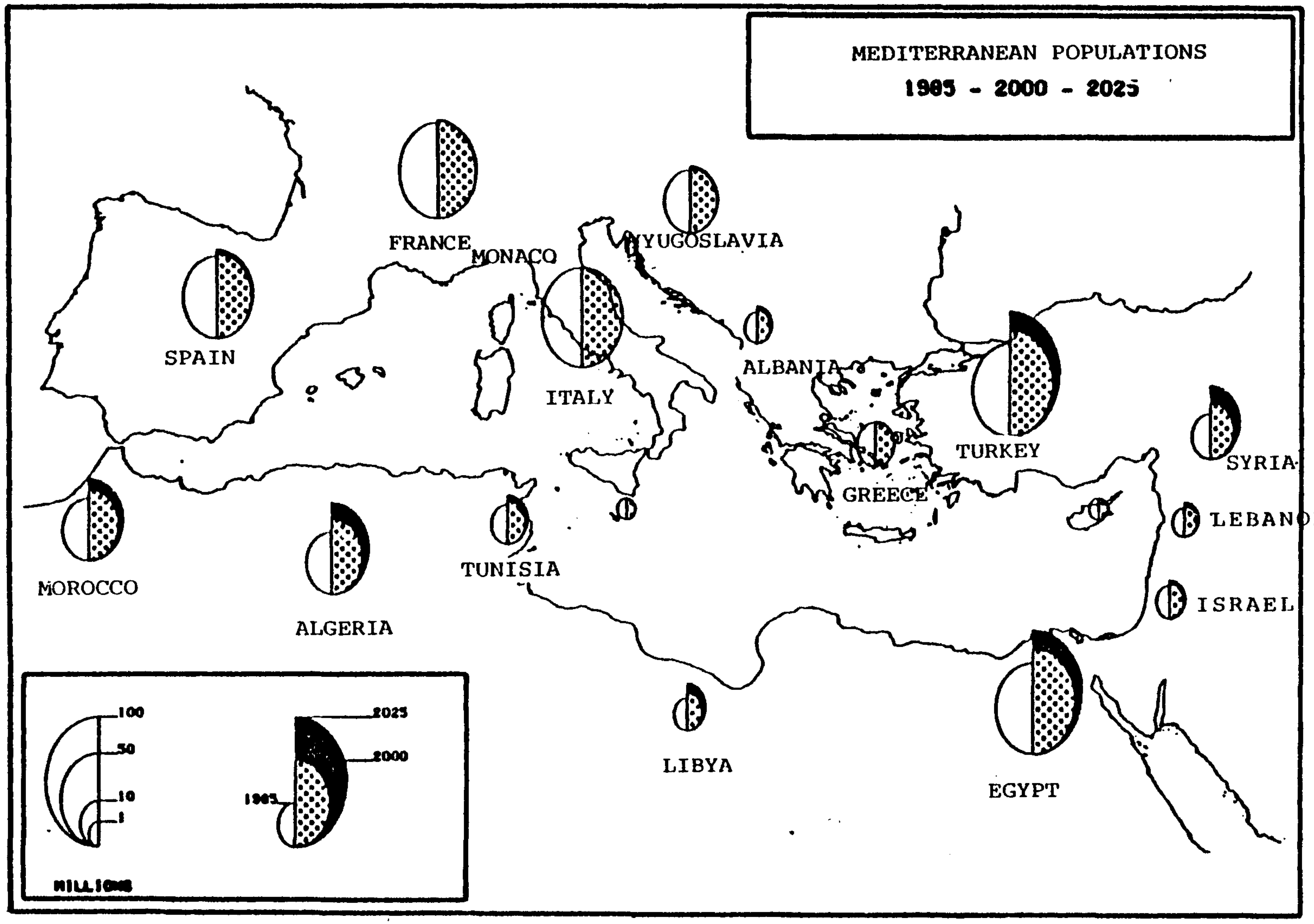


Fig. 8 : The Mediterranean population (UNEP, 1987a)

The state of development of the Mediterranean countries is illustrated in Table 38 (Annex) with the level of Gross National Product per capita (GNPC) (UNEP, 1987a). From the GNPC figures it is clear that in 1984 the gross national product per capita varied between US $ 670 (Morocco) and US $ 9,760 (France).

A GNPC greater than 4,000 dollars has been recorded in France, Italy, Israel and Spain while the other countries (except Libya) have recorded values between US $ 1,200 and 2,500 . As a result of a major production of oil, Libya's GNPC of US $ 8,520 represents an exception; however, in spite of this fact, other indicators clearly show that it belongs to the group with all the characteristics of developing countries. Table 39 (Annex) (UNEP, 1987a) represents the structure of employment in individual Mediterranean countries.

In the majority of the Mediterranean countries the coastal regions (including the regions of the confluences of rivers flowing into the Mediterranean Sea) represent the focal points of development and construction. This is particularly pronounced in the southern countries, where all the efforts aimed at the development of the interior have come across great difficulties (the exception here being Morocco).

In European countries of the Mediterranean which stretch far into the interior of the continent, to the shores of other seas or to the confluences of rivers flowing into other seas (Spain, France, Yugoslavia, Turkey, Morocco), the centres of development lie outside the coastal belt of the Mediterranean. Nevertheless, even in these countries we find that the process of the littoralization of the coastal regions is becoming all the more pronounced.

The development and construction in the coastal region manifest themselves mainly in the vicinity of cities and ports, so that the coast which has not been developed as ports or towns has been utilized for tourism.

The Mediterranean region is a relatively poor source of raw material. Several countries can be classified among the medium output petroleum producing countries (Libya, Algeria, Egypt), (Table 40, Annex) (UNEP, 1987a) and Morocco is the world's third largest producer of phosphates, Albania the third largest producer of chrome, while Spain is the world's second largest producer of mercury. The natural gas reserves in Algiers rank fourth in the world.

The exploration for petroleum and natural gas in the sea-bed of the Mediterranean have so far given optimistic results with regard to the reserves of natural gas, and less so with regard to petroleum reserves. The layers of coal in the coastal area of the Mediterranean are insignificant.

Out of the total world reserves of petroleum, amounting to 94,853 megatons, 4,887 megatons lie in Mediterranean countries (Libya 2,959; Algeria 644; Egypt 531; Tunisia 232; Syria 223; Italy 114 megatons), (Table 41, Annex) (UNEP, 1987a), and out of the total world reserves of natural gas amounting to 96,553 billion cubic metres 4,571 billion cubic metres lie in Mediterranean countries (Libya 728; Algeria 3,000; Egypt 235; Tunisia 85; Syria 124; Italy 210). The transport of petroleum and natural gas has necessitated the construction of numerous pipelines. As a result of relatively significant but nevertheless limited reserves it is estimated that the energy requirements in the period after the year 2000 will to a large extent need to be met by thermal power stations fired by coal or powered by nuclear reactors.

The Mediterranean region is the greatest tourist destination region in the world. The total number of international (107 million, Table 42, Annex; UNEP, 1987a) and domestic tourists in the Mediterranean countries as a whole in 1984 amounted to some 213 million realizing a total of 4,209 million overnight stays. Receipts and expenditures due to such flow of tourists is shown in Tables 43 and 44 (Annex) (UNEP, 1987a).

In the coastal region in 1984 number of domestic and international tourists amounted to 97 million persons (52 million international and 45 million domestic) realizing 1,400 million overnights and according to the various scenarios, these figures will increase to between 121.4 and 184.3 million tourists by the year 2000 with a corresponding number of overnights of between 1,712 and 2,731 million. The estimates for the year 2025 range from a low of 173 million tourists and a high of 341 million, with the number of overnights ranging between 2,081 and 4,838 million (UNEP, 1987).

Tourism is the greatest user or "consumer" of the Mediterranean coast despite the fact that there exists a tendency of powerful concentrations even in tourist development.

These tourists are accommodated in 5,082,000 hotel beds and 28,223,000 beds in other forms of accommodation facilities. All these accommodation facilities take up 2,187,890,000 m^2 of space on the coast. Water consumption in 1984 amounted to 569 million m^3.

According to all estimates and elaborated scenarios, it is expected that the number of tourists in the Mediterranean countries could amount to between 268 million and 409 million in the year 2000. In the year 2025 the number of tourists could amount to between 379 and 758 million (UNEP, 1987).

Such an increase in the number of tourists is necessarily accompanied by the taking up of undeveloped coastal areas, an increase in the water consumption and increases in the amount of solid and liquid wastes. Pressure for tourist development in many countries has been focused on sandy beaches. As a result, sandy beach and adjacent sand-dune habitats have been greatly disturbed and animals and plants dependent on them have been endangered, e.g. turtles.

Existing tourist facilities have been constructed for operations in the peak season covering two summer months (July and August) and can, in the future, receive the entire increase in the number of tourists with the provision that these tourists be evenly distributed all year round.

The differences in the level of development of the closer and more distant hinterland have influenced the development of transport in the Mediterranean region. The main flow of traffic in these forms has been concentrated in the northwest region of the Mediterranean (Spain, France, Italy), followed by the northeast region (Yugoslavia, Greece, Turkey).

Out of the total 2,155 trading ports in the world, 183 lie on the Mediterranean. However, only 18 of these ports account for some 90% of the total maritime transport of goods on the Mediterranean (Table 45, Annex) (UNEP, 1987a). Some 22% of the total world petroleum traffic transits through the Mediterranean (UNEP/IMO/IOC, 1987).

The road and railway transport and infrastructure is developed on the European coast of the Mediterranean, and less so on the eastern and southern shores of the Mediterranean Sea. The modernization of road transport in the east-west direction has taken place in the northwest region of the Mediterranean, but remains undeveloped in the northeastern, eastern and southern regions. There is a deficiency in the communications between the coastal regions of the Mediterranean by means of modern road links with the more distant interior, particularly in the eastern European Region, which is the starting point for the linking of the European part of the Mediterranean with the regions in Asia Minor and Africa. In this region plans are being made and construction is being undertaken with respect to the building of modern road links between the Baltic and the Middle East and Africa. Considerations concerning the great projects of the linking of river communications (the Danube) with the Mediterranean are also taking place, as well as those concerning the linking of Europe with Africa either by means of a tunnel or a bridge.

Railway and road communications built in the past have frequently been constructed in the immediate vicinity of the coast and they frequently cut across high quality beaches. Air traffic is fairly developed but mainly in the north-south direction. The coastal links in the east-west direction are, as a rule, very poor, so that an airplane journey of only several hundred or even several tens of kilometres can be very complicated (e.g. as between Sicily and Tunisia).

Private car traffic is greatly on the increase and the number of cars is rapidly growing in almost all countries (Tables 46 and 47, Annex) (UNEP, 1987b).

In the coastal region of the Mediterranean there is a relative scarcity of agricultural land, but the existing agricultural land is of a very high quality (Table 48, Annex) (UNEP, 1987b).

In the Mediterranean region the majority of the countries have a food production deficit and are thus forced to import a significant amount of food, mainly from non-Mediterranean countries. The natural conditions in many of the Mediterranean countries are such that they need to take into account the existence of a permanent deficit in their foodstuffs balance. The number of the total and active agricultural population is constantly declining (Table 49, Annex) (UNEP, 1987a). The deficit of the basic foodstuff, wheat, has frequently in the countries in the south led to such a state where some high-grade areas are being used for the cultivation of wheat instead of specific Mediterranean crops.

There is an increasing use of fertilizers and insecticides and pesticides which pollute the land and the water and drain from the coastal areas into the Mediterranean Sea (Table 50, Annex) (UNEP, 1987a).

The water resources are relatively powerful in the northern part of the Mediterranean and weak in the eastern and southern regions (with the exception of Egypt). The basic water problem manifests itself, in principle, in two ways: towards a search for new resources (tectonic water in the south) and towards a rational utilization of existing resources (a proper distribution among various users: the prevention of the loss of and the pollution of water: multifaceted utilization and recycling of water: the introduction of new, economically justified sources - from seawater, use of solar energy) (Tables 51-53, Annex) (UNEP, 1987b).

The forests in the coastal region have in the majority of cases a limited economic significance, but are very important for the preservation of the soil; they also play a significant role with respect to the landscape and recreation.

In the forests of the Mediterranean region forest fires are frequent. Their causes include changes in the culture of the soil, a stronger concentration of the population (including tourists) in the narrow coastal belt, the depopulation of the immediate coastal region, summer drought, carelessness, and in recent times speculative and criminal motives (Tables 54 and 55, Annex) (UNEP, 1987b).

The realized development of construction and urbanization of the Mediterranean has not been accompanied by corresponding measures for the protection of the environment from pollution, from inadequate development of land on the coast, the protection of the coast from erosion (Table 56, Annex) (UNEP, 1987b) as well as from the effects of development in the interior.

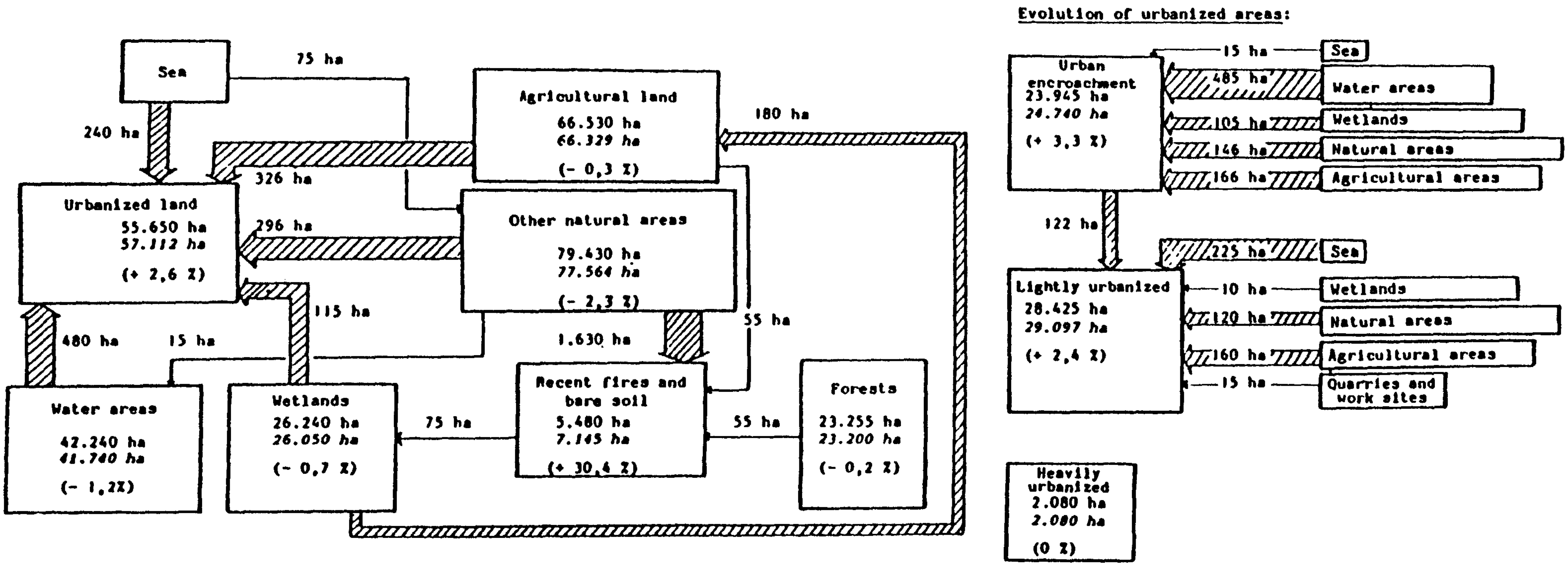
According to some estimates, some 1-2% of the agricultural land is lost annually as a result of the development of towns, ports and industries. Statistics on land use practices in the Mediterranean countries are given in Table 57 (Annex) (UNEP, 1987b). Changes in land use patterns in two areas in the Mediterranean are given in Figs. 9 and 10 (UNEP, 1987b).

Some 85% of the waste waters from the larger cities is drained untreated into the sea. This figure does not take into account the polluters from the Ebro, Rhône, Po and other rivers, whose share amounts to some 40% of all polluters. A significant share of modern equipment for the purification of waste water does not function properly. The solid wastes from cities and industry are not dumped or treated properly and thus cause the pollution of underground waters and aquifers.

The growth of cities and the development of industry, particularly tourist development, has taken up an enormous percentage of the coast. Transport corridors on the coast either invade the coast or prevent access to it. The taking up of the coastline in some regions amounts to as much as 90% (the French Riviera, the regions around Alexandria, Athens, Barcelona, Istanbul, Marseille, Naples).

Tourist development in the Spanish continental and insular coast amounts to 42% of the coast. The taking up of the coast suitable for the development of tourism and cities in Yugoslavia amounts to some 20%. The Catalonian coast, with a total length of 580 kilometres, has suffered from tourist development of 337 kilometres and urban, port and industrial development along a further 50 kilometres.

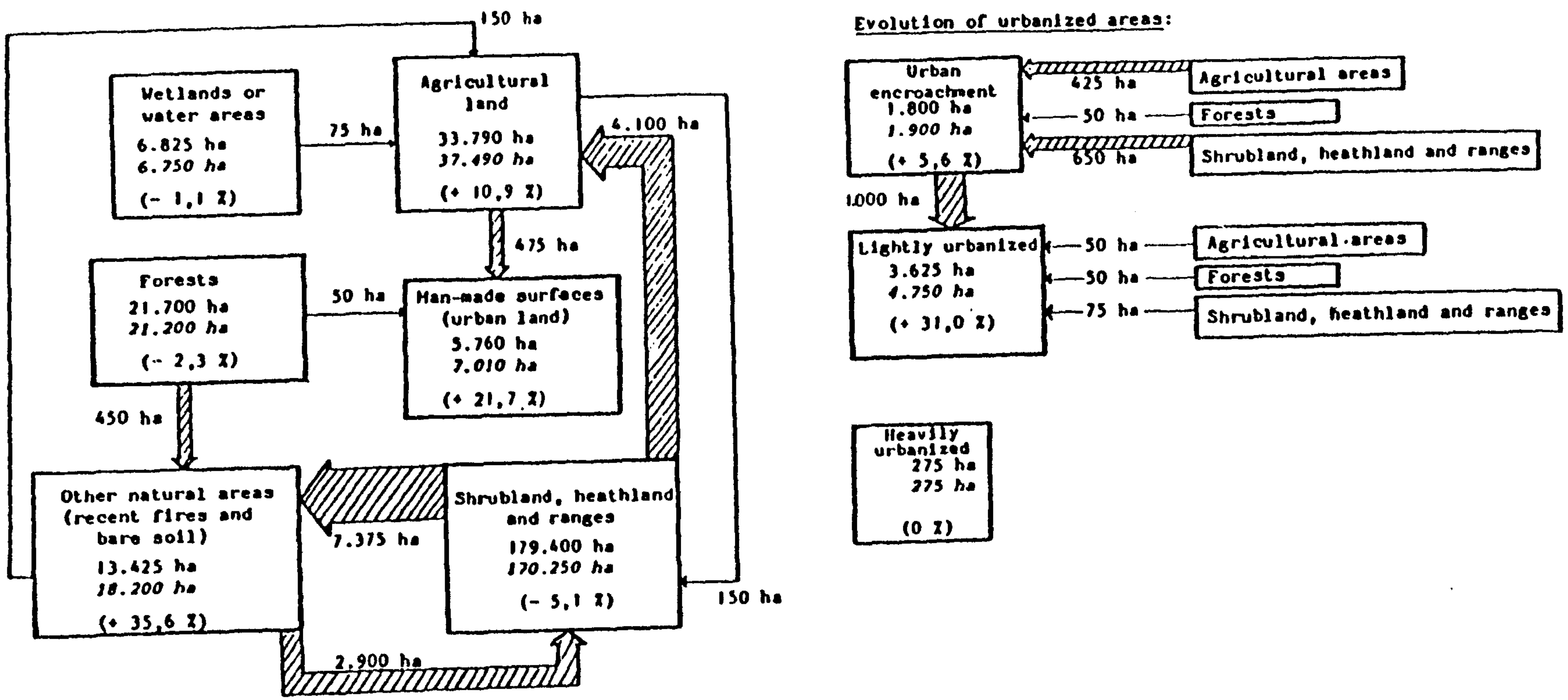
In recent decades a growing amount of attention has been paid to the protection of individual land and sea areas with the aim of preserving the natural and cultural heritage, as well as the balance in natural systems. Protected areas in the Mediterranean region are presented in Fig. 11 (UNEP, 1987b) and Table 58 (Annex) (UNEP, 1987b). Information on national parks in the Mediterranean countries is given in Fig. 12 and Table 59 (Annex) (UNEP, 1987b). Information on wetlands of international importance, MAB biosphere reserves and UNESCO world heritage sites is given in Fig. 13 (UNEP, 1987b).



Key : 42.240 ha = Area in 1975
41.740 ha = Area in 1980

Source : Blue Plan (from the Ministry of the Environment, France, 1985)

Fig. 9 : Modifications on the Languedoc-Roussillon and Provence-Alpes-Côte d'Azur coastal strip land use over a depth of 0-5 km from the coast, 1975-1980 (from a comparison of LANDSAT satellite pictures) (UNEP, 1987b)



Key : 6.825 ha = Area in 1972
6.750 ha = Area in 1983

Source : Blue Plan (from the Ministry of the Environment, France, 1985)

Fig. 10 : Modifications on the Corsican coastal strip land use over a depth of 0-5 km from the coast, 1972-1983 (from a comparison of LANDSAT satellite pictures) (UNEP, 1987b)

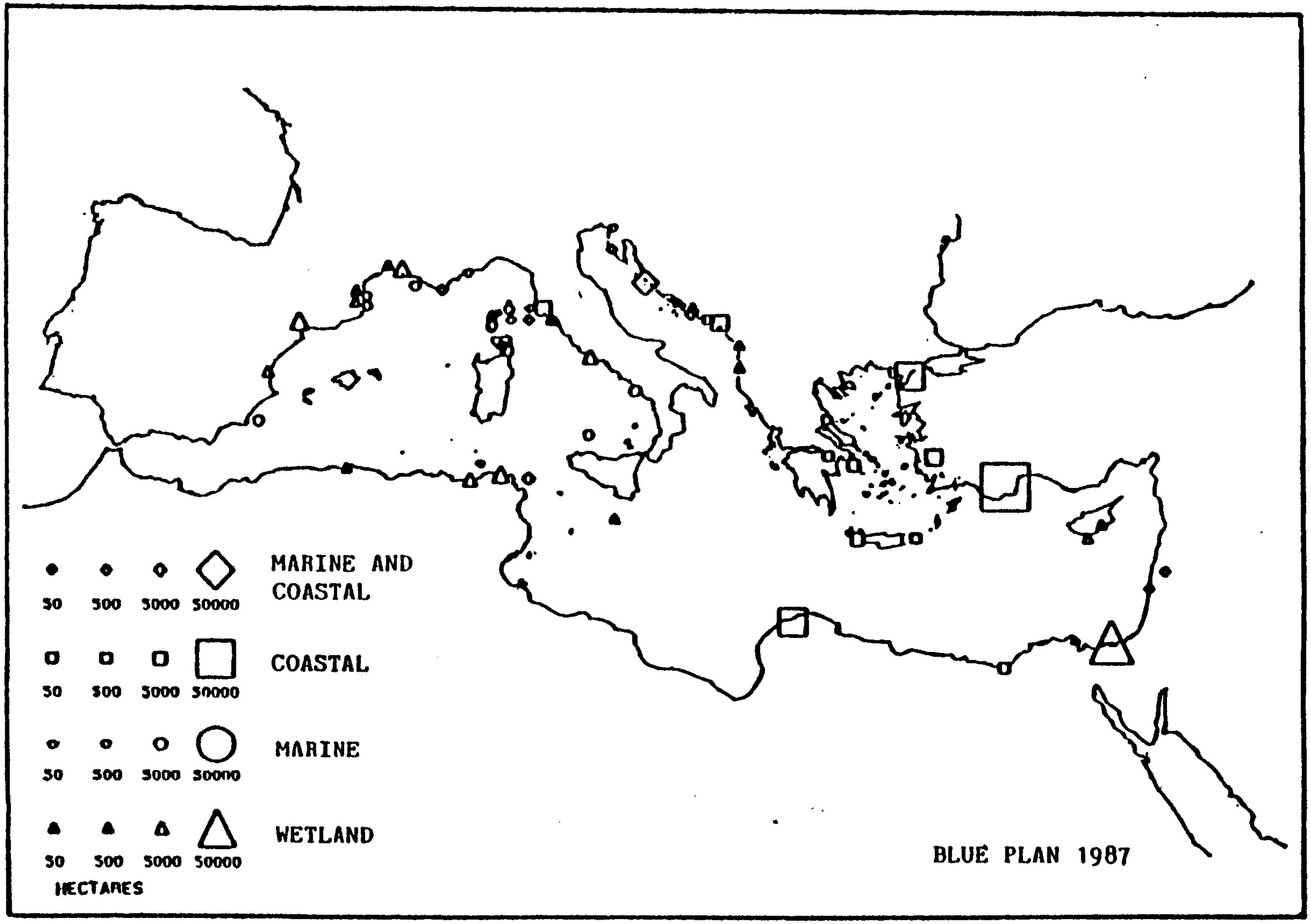
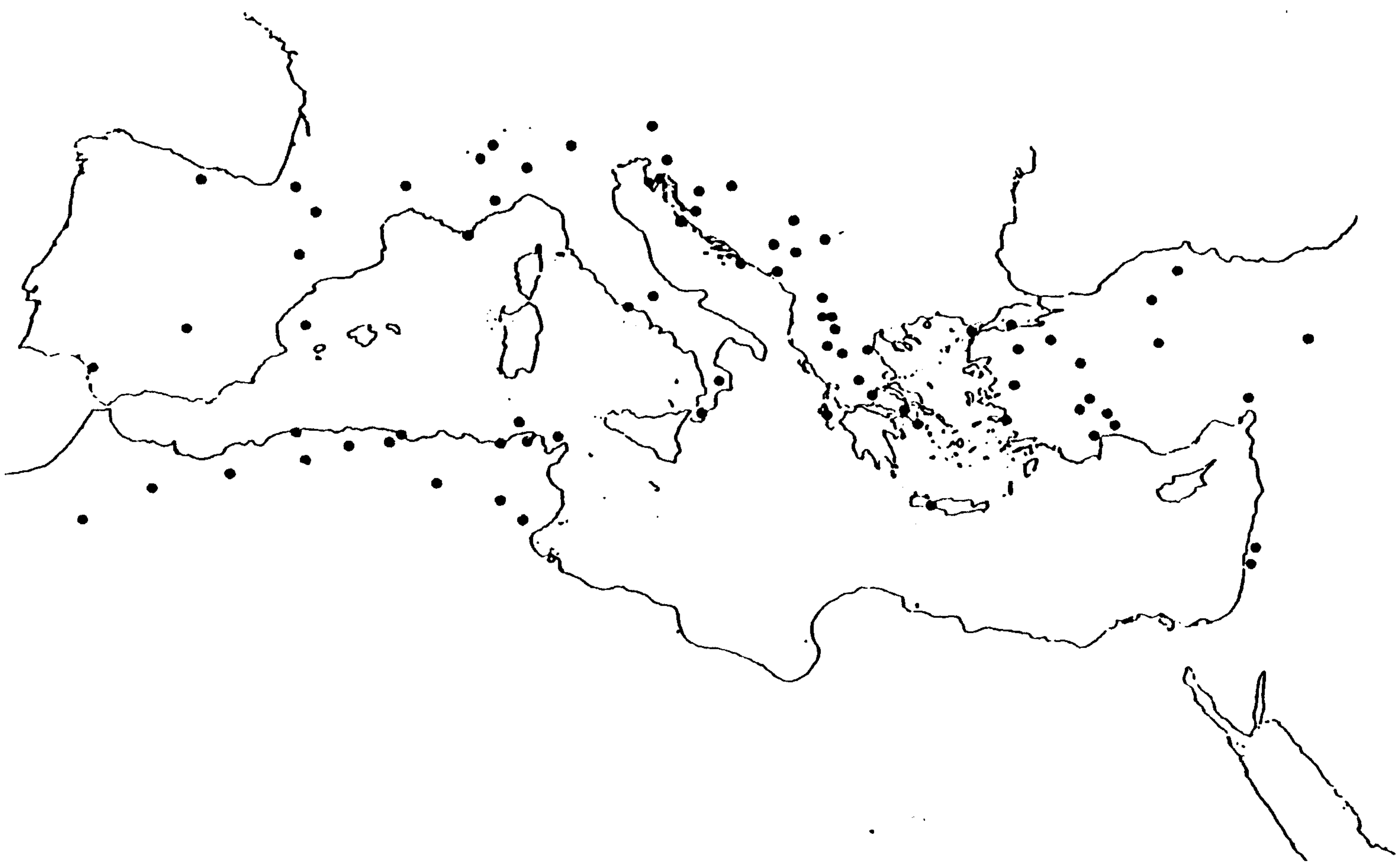


Fig. 11 : Protected areas on the Mediterranean coast, 1986 (UNEP, 1987b)



Source : Blue Plan (from national reports on the environment
State of the Environment

Fig. 12 : National parks : (1980-1985) (UNEP, 1987b)

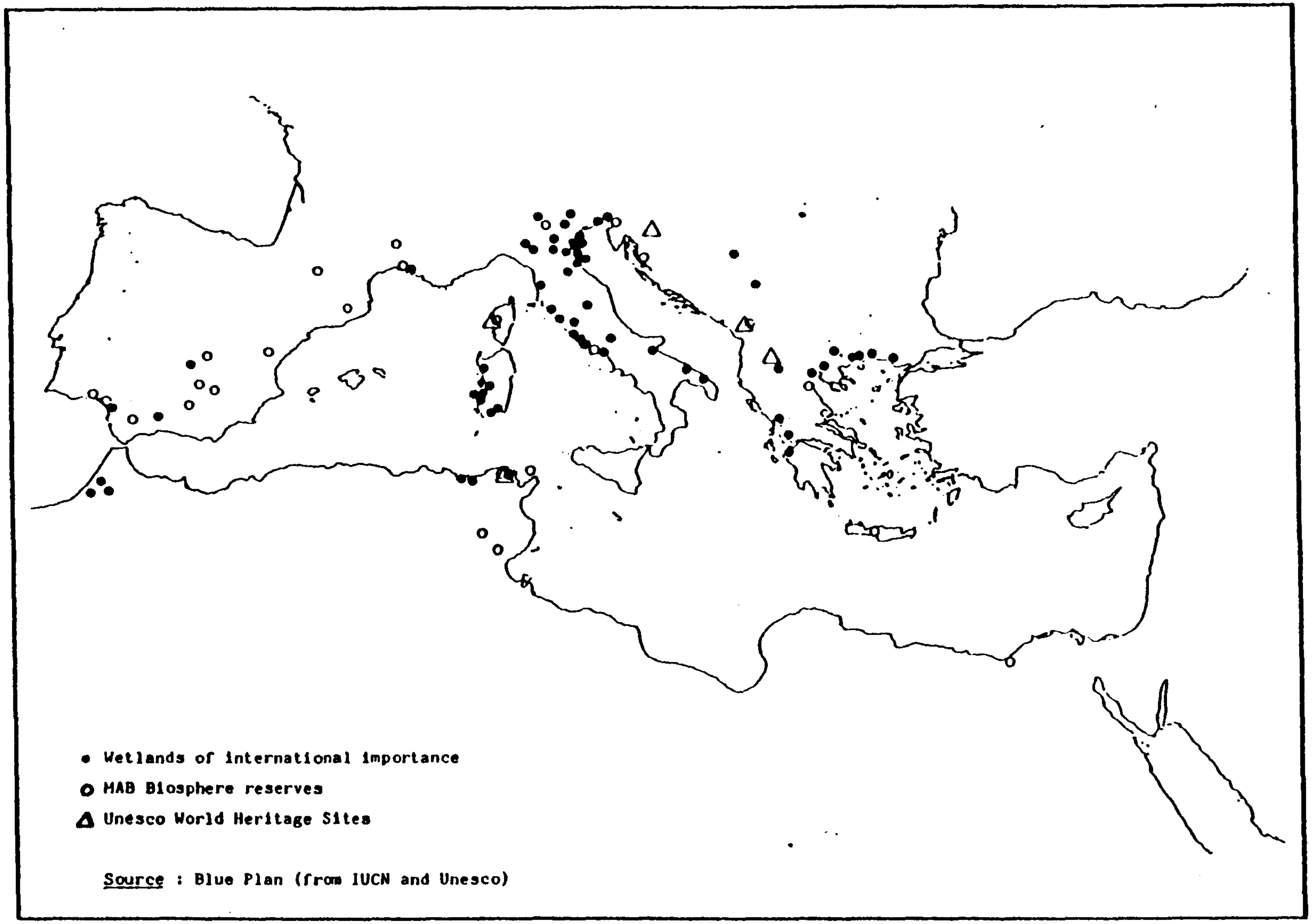


Fig. 13 : Wetlands of international importance, MAB biosphere reserves and UNESCO world heritage sites (1986) (UNEP, 1987b)

The existing trends of development could lead to a situation whereby the Mediterranean countries will between the years 2000 and 2025 have a total of 545 million inhabitants in comparison with the present total of 335 million, a consumption of 1000 million tons of petroleum equivalents in comparison with the present consumption of 500 million tons, the use of 150 million cars in contrast to the present number of 50 million, to an overall urbanization of the coast of 95%, as well as to an increase in the number of tourists from the present 100 million to between 200 and 250 million tourists on the Mediterranean (UNEP, 1987).

Such an increase in the population, the shift in the centre of population (the number of inhabitants) from the northwest (Spain, France, Italy to the south and east (Turkey, Egypt, Algeria, Morocco) will lead to increased energy needs, particularly electric energy, so that it will probably become necessary to build some 150-200 thermal energy stations, primarily fired by coal and to a lesser extent by nuclear reactors. In view of the need for vast quantities of water for the cooling of these thermal power stations, these will, particularly in the south, need to be built in the coastal region. The need for the creation of new jobs will require heavy industrialization which, in the southern regions of the Mediterranean, will be concentrated in the coastal areas.

4(c) MANIPULATION OF HYDROLOGICAL CYCLES

Estimates of the total riverine input of water vary between 16,000 $m^3 s^{-1}$ and 14,000 $m^3 s^{-1}$. The largest part flows into the eastern basin, in the range of between 10,500 $m^3 s^{-1}$ and 9,000 $m^3 s^{-1}$, (Table 1, Annex) (IHP/MED/3, 1978).

This table also shows the water balance, clearly demonstrating the importance of evaporation in the Mediterranean Basin and drainage area. There is also a great difference between northern and southern river inputs, with most of the flow entering in the northern parts.

Time variability of the inflow is related to evaporation, climatic variability and human interferences to flow. Two types of human interference have influenced the amount of water reaching the coast, namely irrigation and increased evaporation through dam construction. This is demonstrated in the case of the Nile.

The natural flow of the Nile was approximately 2,800 $m^3 s^{-1}$ at Cairo. After construction of several dams and, in particular the Aswan dam, the flow of the river at Cairo was reduced to about 1,500 $m^3 s^{-1}$. In fact, much of that water does not reach the Mediterranean, due to the intense irrigation. One of the two branches of the Nile is closed. It is very difficult to determine precisely the delivery of Nile water to the Mediterranean; this is also the case of many other rivers, because of the very considerable use of the water for irrigation purposes.

There is a general tendency in Mediterranean countries to reduce the flow of rivers into the Mediterranean Sea, through dam construction and diverting of river branches: this has also been done in Spain (Tage-Segura), in Italy (Sinni), in Israel (Yarkon-Neguev) and through irrigation which is very considerable in Israel.

There is a large imbalance between runoffs from the northern shore, draining 92 per cent of the water that flows into the Mediterranean Sea, and the southern shore, draining only the remaining 8 per cent. This difference arises mainly from differences in yearly precipitation since the size of the areas drained is quite similar. The area of the Mediterranean that receives the largest input through river runoff is the Adriatic Sea, followed by the Northwest Mediterranean, receiving between them nearly 70 per cent of all the river discharges. These two areas are followed by the Aegean, the Tyrrhenian and the Ionian Seas (20%). The North African coast, including runoff from the Nile, receives less than 10%.

Main Mediterranean rivers with their watershed are shown in Fig. 14 and Table 60 (Annex) (UNEP, 1987b). A list of rivers draining into the Mediterranean with the respective flow and drainage areas is given in Table 61 (Annex) (UNEP/ECE/UNIDO/FAO/UNESCO/WHO/IAEA, 1984).

The influence of large changes of the river flow and input to the coastal zone is noted both on the coastal zone dynamics and on the ecological system, and especially the bio-production. The dynamics are influenced by the density changes which in turn give rise to changes in the system of currents and the mixing conditions. This can also have a great influence on the biological

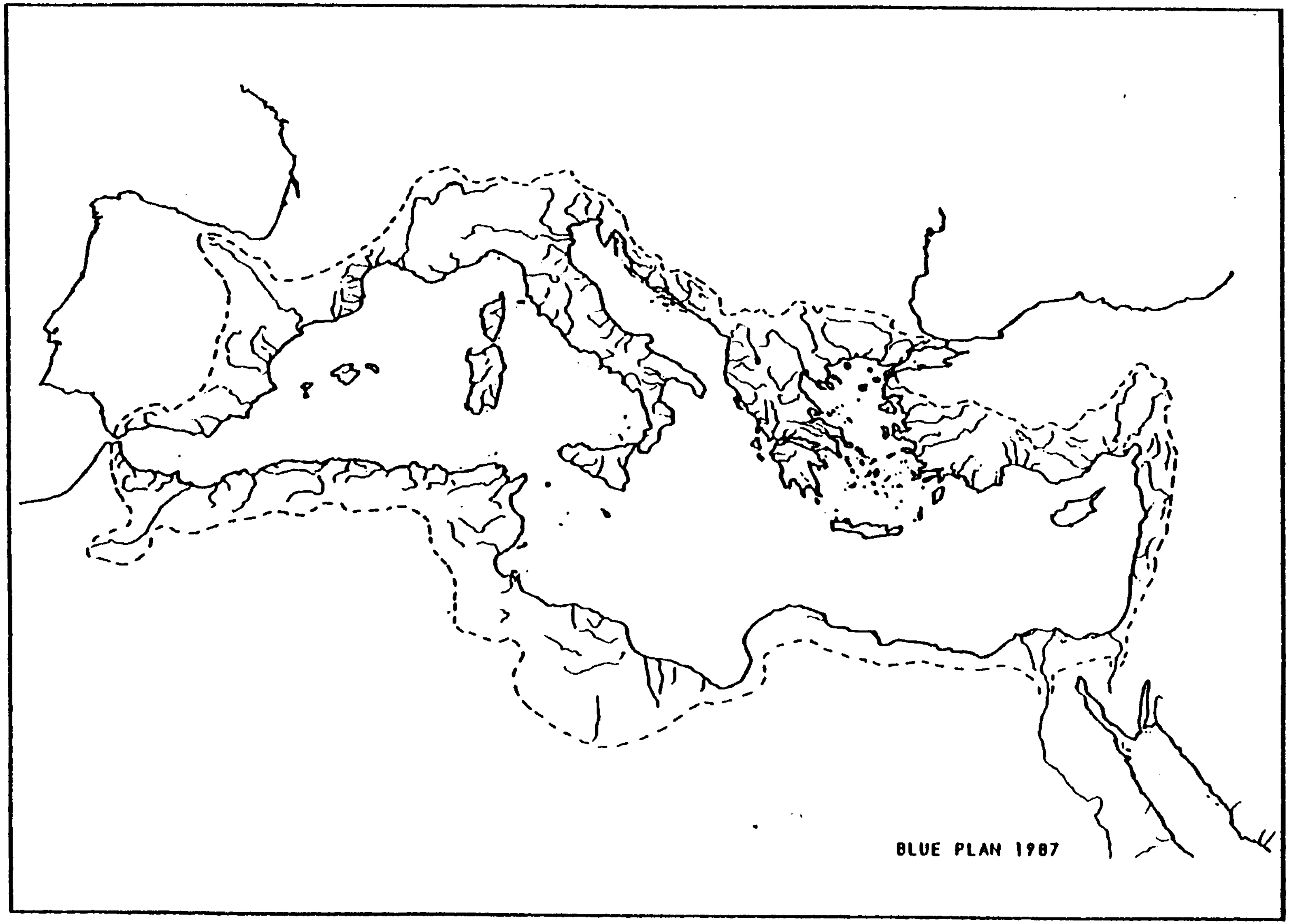


Fig. 14 : Main rivers of the Mediterranean basin (UNEP, 1987b)

system. The changes in biological production are due to changes in the input of nutrients and suspended matter. The suspended matter carries considerable amounts of substances influencing production and its conditions (Table 62, Annex) (UNEP, 1987b).

Again, the most drastic effects have been observed in the Nile. The oceanographic properties of the South-eastern Mediterranean and the productivity of living resources in the Nile Delta and associated areas have changed considerably (see chapter 5(c)).

4(d) DISPOSAL OF CONTAMINATED SEDIMENTS, MINE TAILINGS AND SOLID INDUSTRIAL WASTES

Among the many types of waste generated by industrial activities, solid waste and sludge have a particularly important place. The amount of solid waste increases greatly as industrial production expands and diversifies. Furthermore, there exists sufficient evidence to show that some of the industrial waste is toxic to humans. Finally, legislation providing directives for a cleaner environment by more stringent effluent limitations has made treatment and disposal of industrial waste more important, difficult and costly. Indirectly, higher levels of liquid waste treatment produce an increased mass and volume of contaminated sludge to be managed, so that solid waste disposal systems must not only handle more material, but must be operated much more efficiently.

Solid waste and contaminated sludge of industrial origin are difficult to define and subdivide more specifically: Specific properties of the waste involved, the sources, treatment and disposal options as well as hazard can all be given priority while attempting such an inventory. In a general sense, a global classification may be offered as shown in Table 63 (Annex). Sludge from wastewater treatment facilities of industrial installations is conventionally grouped into biological sludge and physical chemical sludge. Biological sludge is to some extent similar to its counterpart generated by domestic plants. However, biological treatment units must be protected by necessary physical/chemical pretreatment units from industrial wastewater that contains toxic elements adversely affecting biological degradation. This aspect makes the quantity and quality of physical/chemical sludge from industries considerably different from those of primary sludge from domestic plants. In this context, several industry-specific sludges may be cited.

Considering the necessary link between solid waste disposal and the envisaged common measures for regulating industrial wastewater discharge, there is a need to re-classify industrial waste and contaminated sludge into hazardous and non-hazardous waste in the Mediterranean region. This need stems from the fact that a significant portion of waste generated through industrial activities presents:

- short-term acute hazards, such as acute toxicity, corrosivity or risk of fire or explosion; or

- long-term environmental hazards, including chronic toxicity, carcinogenicity, resistance to biodegradation, and potential to pollute the environment by irreversible and cumulative processes.

The concept of hazardous waste is not entirely recognized and implemented in the Mediterranean region. In some areas, most hazardous residues such as solvents, organic chemicals, acids, alkalies, spent catalysts and inflammable solids are currently discharged directly to the sewerage network or disposed of through open dumping. In most countries however, there is substantial effort to fully incorporate this concept in the existing waste management policy. For example, a recent survey in Turkey (Watters, 1982) identified significant hazardous waste generation in the Istanbul Metropolitan Area, requiring special collection and disposal technology (Table 64, Annex).

One of the most illustrative attempts to classify and quantify industrial waste and contaminated sludge in the Mediterranean region is a study conducted for the Alexandria Metropolitan Area in Egypt (Hamza and Gallup, 1983). The industrial waste classification scheme consisted of 4 major classes, divided into 28 subcategories as shown in Table 65 (Annex). The data presented on the table show that inorganic and food residues represent 10.8 percent and 3.3 percent respectively, while the hazardous wastes are only in the order of 0.4 percent of the total industrial waste potential of the Alexandria Metropolitan Area.

As may be noted from Table 63, most wastes, such as wastepaper, residues from batteries, canneries and poultry plants, among others, do not represent a direct hazard to the environment as they have no harmful constituents. Hazardous wastes, however, contain specific pollutants of known toxic effects to the environment. The primary origin of specific pollutants in the Mediterranean region is the chemical industry, including:

- heavy chemicals, with fertilizers, primary plastics, rubber etc.,
- other bulk materials such as non-ferrous metals and pulp,
- speciality chemicals,
- chemical preparations.

Economic production of heavy chemicals and other bulk materials, as may be typified by petrochemicals, requires large installed capacities on relatively few sites. Furthermore, as feed stocks and chemical reactions used are well defined, the qualitative and quantitative assessment of non-recovered materials is relatively easy to establish, enabling an effective monitoring of waste control. The monitoring of speciality chemical plants however, such as pharmaceuticals, fine chemicals, dyes, paints and glues, poses significant problems because the production processes are very complex and the number of non-utilizable by-products in certain cases considerable.

One of the most important pollutants that Table 65 does not cover is lubricating oils. The importance of lubricating oils can be associated to their serious adverse effects on the environment but more so to the difficulty of defining and implementing a management programme that will adequately cover their assessment, collection, re-use or safe disposal. Lubricating oils are usually of lubricant base stocks, a fraction of crude petroleum and synthetic chemical additives. They are essential for many industrial and transportation purposes, as well as for many other uses. The industries that generate the most used oil are the primary metals, fabricated metal products, machinery, electrical equipment, transportation equipment, chemical products and rubber and plastics products industries. Automobiles, trucks, buses and heavy machine equipment all use oil and therefore dealerships, service stations and garages all generate used oils. Both railroads and airplanes also use lubricants. Used lubricating oils may be either re-used or disposed of: They may be re-used as lubricants and as fuel or fuel supplements and for miscellaneous other purposes. Disposal possibilities range from indiscriminate dumping to hazardous waste management. At this stage there are no data to show the quantity and sources of lubricating oils discharged in the Mediterranean area. Serious efforts are noted however on a regional scale, suggesting progressive national measures concerning the definition, source assessment, control of lubricating oils and industrial used oil policies (UNEP/UNIDO, 1987).

Another important source of specific pollutants for the Mediterranean area is the extraction and processing of minerals and fuels. Most ore mining sites generate effluents or spills which, without preventive measures, severely upset ambient water quality. Typical pollutants from ore mining are toxic metals and sulphuric acid from weathered sulphidic ores, sulphuric acid and certain organic chemicals from pyritic coals and alkaline earths, metal sulphates and chlorides from rocksalt deposits. Extraction of a particular mineral is often confined to a few sites. Similar pollution is generated by plants for processing and upgrading ores, generally located near the extraction site.

In the extraction of certain minerals, large amounts of spoil are produced, requiring for disposal considerable areas of land. Currently used or abandoned spoil deposits may generate polluted drainage waters which pose particular control problems both from a technical and legal standpoint.

In certain industrial activities, large amounts of residues of different type and nature are generated. In cases where the amount of generation is too large, it becomes difficult if not impossible to store them on land and often sea dumping disposal methods are practiced. Most of the solid residues or slurries are of inorganic nature and the impact of this type of practice on the receiving environment, not so noticeable in the short range, still remains a controversial issue among practitioners and scientists. The discharge of "Cassidaigne" in the French coastal zone may be cited as one of the most remarkable examples of this kind. There, more than 10^6 t yr^{-1} of residues from the treatment of bauxites, often called "red sludge", is discharged into the Cassis Canyon at a depth of 350m, by means of a pipeline system 7.7 km away from the shore. The material contains around 300 g l^{-1} of solid matter, principally composed of iron oxides, aluminium, silicium and to a lesser extent titanium oxide. A number of studies conducted around the discharge zone and especially in the water body in the vicinity of the discharge revealed no signs of appreciable pollution, as measured levels of possible important contaminants did not exceed natural background concentrations (Courau et al., 1973; Fernex and Added, 1982).

Discharge of dangerous organic substances such as aromatic hydrocarbons, phenols and sulphur containing compounds is of importance for the area, due to extraction of petroleum resources and processing of crude oil. Severe risks are encountered from time to time due to accidental spills at well sites or during transportation.

Although recognized with its full importance, there is an evident lack of data to quantify the magnitude of the problem created by industrial waste, contaminated sludge and ore tailing in the Mediterranean area. Despite this, a number of methods are currently used for their treatment and disposal. The disposal options defined for municipal solid waste also apply to non-hazardous solid waste of industrial origin. It is commonly agreed that special care should be taken when dealing with hazardous waste because of the potential consequences arising from disposal operations. In this context, it has been recommended that the programmes and measures to be developed in the Mediterranean region to control liquid wastewater discharges should be accompanied by complementary measures dealing with the treatment and disposal of solid and especially hazardous waste, mainly arising from the primary activities themselves (WHO, 1986).

There are many legal procedures adopted by different countries in accordance with their waste disposal practices in the Mediterranean area. These differences may be explained by different cultural, constitutional and economic backgrounds. As regards the dumping of waste in the Mediterranean Sea, a prior authorization by national authorities is required, under the terms of the 1976 Protocol for the Prevention of Pollution of the Mediterranean Sea by Dumping from Ships and Aircraft.

4(e) DISPOSAL OF SOLID MATTER (LITTER)

Sources of municipal solid waste in the Mediterranean area generally relate to land use and zoning. For an accurate assessment of the problem, a rational source classification differentiates between residential, commercial, open areas and agricultural sources. Food wastes, rubbish, ashes and residues, demolition and construction wastes are generated to a different extent. The semi-solid waste and sludge from water and wastewater treatment facilities are sometimes included in this classification. Since their collection is not the responsibility of most municipal agencies for solid waste management and their nature is such that it involves a totally different approach of handling and treatment before disposal, however, a separate consideration appears to be more appropriate for these two types of wastes.

A number of factors influences the quantity of municipal solid waste, including geographic location, season of the year, frequency of collection, the use of home grinders, the habits and economic status of the people. Marked differences occur in the amounts of waste produced in the countries of the region. Table 66 (Annex) illustrates the approximate quantity of the solid waste generated and method of disposal in a few Mediterranean countries (UNEP, 1987). It has been estimated that municipal solid waste generation varies within a range of 0.5-2.0 kg $caput^{-1}$ day^{-1}, with an average of 1.0 kg $caput^{-1}$ day^{-1}. Making allowance for the expected increase in ash content, a specific output of 0.8 kg $caput^{-1}$ day^{-1} is considered for the solid waste management study of Istanbul (Watters, 1982). The above average figure yields a global daily generation rate of 44000 t day^{-1} for the area, not considering sludge from treatment works. Table 67 (Annex) shows the differences observed in the municipal solid waste composition, generated by two cities of apparently similar size. The differences may be explained by the noticeable trend towards a wider use of solid fuel for domestic heating in one of the cities.

The problem of sewage treatment is successfully solved only if the sludges are disposed of without endangering the environment. The approximation that a municipal sewage plant treating the sewage from a medium-sized town with a population of 100,000, with an additional industrial load of 100,000 population equivalent produces 400 m^3 day^{-1} of sludge containing 12 t day^{-1} of dry matter may give an idea of the magnitude of the problem in the area (EEC, 1984).

Different treatment and disposal methods are currently practiced for municipal solid waste. The number of treatment methods available is normally limited by the type of the final disposal. For example, compaction of the raw waste to reduce its volume is desirable if landfill is to be the final disposal method, but the same process will reduce the efficiency of incineration. Separation of materials such as glass, metals, plastics and paper is another form of pretreatment, either for reclamation of these materials, or because they would not react properly to the subsequent disposal treatment method. Another consideration for treatment is to use a method for size reduction, providing not only smaller volumes but also uniformity and better suitability to the disposal option. In this connection, the fact that the major incentive in solid waste handling is resource recovery becomes more and more recognized in the Mediterranean region; namely, recovery for re-use, recovery for heat and recovery for other purposes where the waste material recovered has changed its character but, nevertheless, may be used in another process. Disposal of sludge from treatment works is generally evaluated along the same concepts as those for solid waste. However, because of the former's high water content and potential environmental incompatibility, a totally different sequence of appropriate treatment methods is currently used before final disposal: Sludge volume must be reduced and its degradable constituents stabilized so that it can eventually be used or stored without damage to the environment.

Landfill disposal of solid waste and sludge is frequently practiced in the area. Leaching presents often a problem: In most landfills, the leachate is composed of the liquid produced from the decomposition of the wastes and liquids entering the landfill from external sources. Depending on ambient conditions many contaminants of organic and inorganic origin, reaching high concentrations, may be found in leachates. In general, it has been found that the quantity of leachate is a direct function of the amount of external water entering the landfill. Leachate formation and movement is often a threat for groundwater quality and may sometimes reach surface waters causing extensive local pollution problems. There is a tendency to eliminate this problem with proper siting and construction of sanitary landfills.

Sea disposal of solid wastes has always been a controversial issue. Within the past few years, the idea that the sea is a gigantic sink, in which wastes of all types can be dumped has been discarded. One of the main reasons is that many solid waste components, including paper, wood, plastic and rubber, will float to the surface. In connection with beneficial uses currently practiced along the shores of the Mediterranean Sea, the presence of large quantities of floating solid wastes is unacceptable from an aesthetic and environmental standpoint.

4(f) MARINE TRANSPORT OF OIL AND OTHER HAZARDOUS SUBSTANCES

Oil pollution is not a new phenomenon in the Mediterranean. Natural seeps have existed over geological times, particularly in the northeastern ports. However, the oil pollution of anthropogenic origin is substantial and considerable amounts are frequently observed. The Mediterranean has so far been spared from major oil spills. However, a large number of minor accidental or deliberate spills occurs each year in connection with oil transport activities within the region. Pollution is observed along the tanker routes, particularly in the eastern ports of the sea (IOC, 1981).

Deliberate release of oil into the world's oceans from marine operations or land-based activities is relatively more important than accidents involving single massive input of oil (Table 68, Annex). Although there is an almost total absence of data for the relative importance of the different sources in the Mediterranean, the deliberate chronic oil pollution is considered far more important compared to accidental pollution (Jeffery, 1974; Le Lourd, 1977).

In 1979, Le Lourd estimated that the amount of oil released into the Mediterranean was between 0.5 and 1 million tons yr^{-1}, with half discharges from the coast and half in the open sea. These represent about a fifth of the global marine oil inputs (around 4 million tons), which are released in a region representing no more than 1% of the total world oceans' surface. Other authors (Longé, 1980) evaluated this quantity at 1.7 million tons, which is probably overestimated.

Le Lourd's estimate was based on local tanker practices and remains a reasonable figure. The amount of oil transported over the world's oceans has considerably increased (Table 69, Annex) but despite this there has been a significant reduction of the quantity of oil discharged into the sea during transportation, due to the entering into force of the MARPOL Convention. Based on these estimates and on the 350 million tons of oil crossing the Mediterranean each year (Smith, 1975) it can be assumed that oil entering the Mediterranean by these practices is around 330 x 10^3 tons (Table 70, Annex). Even a figure of 500 x 10^3 tons has not been considered unreasonable by IMO (UNEP/IMO/IOC, 1987).

The international Convention for the Prevention of pollution from ships, 1972, as modified by the Protocol of 1978 (MARPOL 73/78) entered into force on 2 October 1983. MARPOL 73/78 lays down discharge criteria for all oil tankers of 150 gross tons and above.

Table 71 (Annex) shows Mediterranean states which are Contracting Parties to the Barcelona Convention with number of tankers above 10,000 dwt and their percentage of world fleet by carrying capacity at 31.12.83.

Since there are eight Barcelona Convention States which are not Contracting Parties to MARPOL 73/78 and there have been reports of inadequate facilities in the ports of some of the Contracting States, it must be assumed that not all the Mediterranean ports meet the reception facility requirements prescribed for special areas by MARPOL 73/78.

However, nations responsible for over 80% of the carrying capacity of the world tanker fleet and 75 % by number of tankers are parties to MARPOL 73/78, which means that all those states accept that the Mediterranean Sea is a special area and that it is an offence under their national law for ships of their flag to fail to comply with the requirements of the Convention.

4(g) EXPLOITATION OF NON-LIVING MARINE RESOURCES

Oil and gas prospecting and production

The main non-living resources which are exploited in the Mediterranean Sea are oil and gas. A vast portion of the Continental Shelf has been thoroughly prospected and several oil wells have been bored for research purposes. Oil search in the Mediterranean has been going on for almost twenty years (Fig. 15), (Table 72, Annex).

In North Africa, prospecting and exploitation of oil concessions represent about 8% of the Continental Shelf's total area (0-200 m) (Michel, 1986).

Only a few prospecting bores have been attempted off the coasts of Morocco. At the present time, no concessions have been granted by Algeria. However, Tunisia's fields off the Gulf of Sousse and Gabès are exploited in a relatively intensive way; during 1985, nine exploratory wells were drilled, three of them encountered gas and oil shows. Seven development wells have been put into exploitation.

In Libya five exploratory wells were drilled during the year 1985, two of which leading to oil discoveries.

In Egypt, the Abuqir Gas Field yields almost 1.5 x 10^9 m^3 yr^{-1}. Several dozens of exploratory or development wells are bored each year. During 1985, three exploratory wildcats discovered oil. Furthermore, 115,800 t of condensate oil were extracted.

In the Mediterranean Middle East countries, only Turkey does any prospecting, particularly in the Gulf of Iskenderun, where a wildcat well was drilled in 1985 (Hemer and Gohrbandt, 1986).

Several areas of the Mediterranean are producing oil and gas. In Greece, in the province of Thrace (near the Turkish border) one particular oil field yields 1.5 million tons yr^{-1}. Research in the Ionian Sea is very advanced (Yarbrough, 1986).

Prospecting has been carried out in the Yugoslavian portion of the Adriatic, mainly in the northern part, near Rijeka. During 1985, offshore exploration drilling yielded quite significant discoveries out of 12 wells. On the Italian side, several deposits of oil and especially gas are being exploited. During 1985, five new offshore bores have reached gas. Calabria (Taranto Gulf) and Sicily (Sicilian Channel) have fields which are also being exploited. Here, development drilling progressed during 1985, and AGIP discovered oil. The Italian offshore oil production may reach 10^6 t yr^{-1} and the gas production 14 x 10^9 m^3.

There is also very active prospecting in the Gulf of Valencia, in the area adjoining the Ebro delta. Production in the Spanish region of the Mediterranean could exceed 2 million tons of oil. Four development oil wells were completed during 1985, and one oil discovery was made.

Fig. 15 - Mediterranean areas with oil drilling activities

areas with important exploratory activity (wildcat drillings)

areas with drilling to exploit and/or develop hydrocarbon accumulations

The oil pollution coming directly from these prospection and exploitation fields is, at present, negligible in comparison with other sources (Le Lourd, 1979; Pasquet, 1980; UNEP, 1987).

The exploitation of sands and gravel

It is very difficult to obtain information concerning the exploitation of sands and gravel in the sea. In most cases, it refers to only small exploitations, the duration of which is necessarily limited in time.

However, in several places of the Mediterranean, the banks are subjected to the phenomenon of erosion. Where tourist zones are concerned, the rebuilding of beaches is sometimes done with sand extracted from an area adjoining the continental shelf. Such is the case of certain beaches in Continental Spain or the Balearic Islands. A similar project has been set up for the Northern Adriatic. In particular, for the Emilia-Romagna region an important geological, financial and legal study (Preti et al., 1985) has shown that, in a chosen area at 40m deep, 40 km in the East of Ravenna, it is possible to exploit $10^6 m^3$ of sand yearly without major ecological damage.

Survey studies have been carried out in France. Resources off the Côte d'Azur (between Toulon and Cannes) have been estimated at 150 million m^3. However, for ecological reasons, the exploitation project has been abandoned. The reserves of sands and gravel in the Gulf of Lion are undoubtedly bigger, but studies aimed at evaluating them have not yet been made (Augris and Cressard, 1981; Blanc, 1977).

A large scale exploitation is in progress in Tunisia. A large quantity of sand (approximately 10,000 m^3 day^{-1}) is extracted from the Gulf of Tunis for the purpose of partly filling up the Lake of Tunis. One should hope that damages to the littoral zone as well as to the herbaceous plants of the Gulf (*Posidonia*) will not be too severe.

In Israel, the extraction projects have been abandoned because of the coastal erosion risks (Rhorlich and Goldsmith, 1986).

Salt production

The world salt consumption is 200 x 10^6 t yr^{-1}, more than 50% of which is for human consumption use (Bergier and Hahling, 1982). About 50 or 60% of this amount is extracted from fossil deposits, 20 to 30% from sea water by solar evaporation, 20 to 25% by refining (Mollat, 1966; Multhauf, 1978). The average human consumption is 3 to 5 kg $caput^{-1}$ yr^{-1}. Other salt uses may average 6 or 7 kg $caput^{-1}$. Salt is also employed for the production of solvents, plastics, pesticides (chlorinated hydrocarbons), soda, sodium etc. In addition to common salt, other dissolved substances are simultaneously extracted (by sequential evaporation): sulfate, bromine, magnesium (Balas, 1984).

Production of the leading salt-producing Mediterranean nations (1978):

France	7.2 X 10^6 t (6 in 1973); about 30% of sea salt; Industry employs 60% of the production;
Italy	4.6 X 10^6 t; about 35 to 40% is sea salt;
Spain	3.5 X 10^6 t; about 90% is sea salt;
Egypt	about 10^6 t (mainly from lagoons).

The production of other Mediterranean countries is smaller (the Dead Sea production has not been taken into account).

It is obvious that sea water must be unpolluted in order that salt be suitable for human consumption.

4(h) EXPLOITATION OF LIVING MARINE RESOURCES

The Mediterranean Fisheries produce about 800,000 tons of fish or 1.0% of the world's fish production. The value of this production is however high, reaching about 5% in terms of value of the world catch.

The exploitation of the fish resources of the Mediterranean is very intensive in most areas and demersal resources in particular are often overfished. The production of fish in the Mediterranean has been increasing slowly (Table 73, Annex). This increase is the result mainly of increases in the production of small pelagic fish while the production of demersal fish is more or less constant.

The management of fisheries in the Mediterranean in general has not kept pace with the development and better management of fisheries, including the limitation of fishing activities and the proper implementation of fishing seasons. Such regulation is likely to result in substantially higher catches as has been proven by the implementation of such measures in Cyprus where production practically doubled by the introduction of measures protecting juveniles (Garcia and Demetropoulos, 1986).

Fishing operations are sustained in many areas by the high prices of fish as demand for fish exceeds the Mediterranean production significantly.

Fishing is often on a small scale basis and consequently the number of persons dependant on fishery resources is high, although there are few statistics available on manpower and none for the region as a whole.

Fishing operations are often on a "hand to mouth" basis and socioeconomic pressures as a consequence have hindered the introduction of rational management measures. Many administrations are now aware of the need to introduce stricter management measures especially measures that relate to the limitation of fishing activities, fishing seasons etc. The introduction of such measures has been promoted by the FAO General Fisheries Council for the Mediterranean and although much work has been carried out by various bodies of the Council, tangible results on the national level are few.

It is clearly apparent that the level of overexploitation is such that many fisheries depend on the zero-class of fish and often on juvenile fish that are just being recruited (resulting in a loss of potential yield by catching fish when they are too young). This is particularly the case in the Adriatic and Central Mediterranean. It has been estimated that in the sea around Italy the standing biomass is about 20% of that of comparable waters (e.g. Tunisian waters) as a result of heavy overfishing (FAO, 1987). Under these conditions it is obvious that increases in production and in particular of demersal fishes can only be achieved through the rational management of resources and not through heavier exploitation.

The fishing fleets vary in size and composition from country to country reflecting the nature and size of the resources exploited. Generally, the fleets have excess fishing capacity. The overall size of the fishing fleets exploiting the Mediterranean, in the absence in many cases of even basic statistics, is to a large degree subject to conjecture. This is particularly so in the case of the small scale fisheries which form a large part of the fleet of many Mediterranean countries.

Trawling in the Mediterranean has been one of the major, if not the main, activity that has led to overexploitation of the limited demersal resources available on the generally narrow continental shelf that characterizes most of the Mediterranean Sea (FAO, 1978). This intensive trawling and the efforts to extend the trawling grounds have led to legal, but more often illegal, encroachments on nursery grounds. This is very apparent in the destruction of the Posidonia (*Posidonia oceanica*) meadows (Ardizzone and Pelusi, 1984). These extensive sea grass belts start at about 5-10 metres depth, though in some areas they start practically from the shore, and extend down to about 30-40 metres. They are important areas for breeding and as nursery grounds for many fish, molluscs and crustacea and a valuable habitat for many other species for the whole of the lifespan. The rhizome systems of *Posidonia* form sizable hills underwater, several metres high in some instances. Trawling on the border of these meadows and sometimes on them with special devices has resulted in their degradation in several areas of the Central and Western Mediterranean in particular. Although the degree to which this has happened is under study there is little doubt, on the evidence so far available, that the concern shown for the protection of the *Posidonia* meadows is justified. Legislative measures aimed at protecting nursery grounds from trawling, within a set distance from the shore or above a certain depth, exist in several countries and their more general adoption and the stricter implementation of the relevant legislative provisions would also protect the *Posidonia* habitats. Damage is also caused by shore seines and other scratching gear deployed sometimes on these grounds.

Trawling exploits demersal resources in some cases practically from the shore down to about 800 metres. There is little documentation to suggest that serious damage is caused to habitats by trawling in deeper waters though undoubtedly this has some impact on benthic species especially sedentary ones.

Other forms of fishing activity also have, though on a more local level, an impact on marine habitats. Blocks and stones for example used in the "canizatti" fishing for Dolphin fish (*Coryphaena hippurus*) are systematically cut off and "litter" large areas of sea bed. Whether the impact of this is detrimental e.g. by physically prohibiting trawling, or beneficial by doing so is debatable.

Drift nets, fortunately not as yet widely used in the Mediterranean, are often lost and continue fishing, thus destroying resources and at times catching endangered species such as the Leatherback, Green and Loggerhead turtles. These are also caught during normal fishing operations with floating long lines commonly used for catching swordfish in several countries (Italy, Greece and Cyprus among others).

The expansion of fishing activities for small pelagics, which can support increases in fishing activities (FAO, 1978; FAO, 1987) and higher levels of exploitation, is hindered by consumer preferences and for as long as the marketing of these fish faces problems dramatic increases in production are not likely. Most small pelagics, like all demersals, are used for human consumption in the Mediterranean and the quantities and concentrations available are such as to prevent or limit their use towards fishmeal production. Consumer preferences do not change rapidly and are unlikely to do so in the foreseeable future. As a result of the state of the stocks of small pelagic fish any impact on sea birds, which to a large degree depend on these stocks, is likely to be small for the time being.

The impact of the fishing fleet on the direct pollution input into the Mediterranean, though not quantified as yet, is expected to be small if we take into consideration the probable size of this fleet in relation to the volume of merchant shipping and pleasure craft in this sea.

The direct pollution from the fishing fleet consists mainly of bilge waters, solid waste (mainly garbage), synthetic netting, twines and ropes and lost "make do" buoys (often empty containers and polystyrene blocks), which are often washed up on beaches.

The newly established but fast growing marine aquaculture sector, having to a large degree overcome the hatching and larval rearing problems, is likely to have several effects on the environment. It may have a direct but limited impact as far as pollution goes. Its effluents (or input into the sea in the case of cage-culture) contain mainly organic material caused by intensive feeding and are unlikely to have more than a local effect. More important will be the added competition for space along the already pressed Mediterranean coastline. This is particularly so in the case of extensive cultures encroaching on coastal lagoons, salt marshes and coastal wetlands. These are in themselves endangered habitats on which for example many species of waterfoul depend.

The introduction of exotic species suitable for marine aquaculture and their accidental escape into estuaries, lagoons and the sea may result in introducing into the Mediterranean new species; the desirability of this is questionable and it should be carefully studied. Exotic species such as Penaeus monodon and other penaeids are already being experimented with in the Mediterranean.

These introductions combined with the migration of Red Sea species through the Suez canal can potentially have a very significant effect on the biota of the Mediterranean. The migration through the Suez canal has already had an impact on the Eastern Mediterranean with Red Sea species such as Siganus spp, Holocentrus ruber, Upeneus mollucensis, Sphyraena obtusata, Penaeus spp and Portunus pelagicus; it already has had an impact on commercial catches. More incipient changes in communities are also to be expected.

Red coral and Sponges

Red coral is collected from depths of about 30 to 130 metres in the west basin. Though official statistics are not available, a figure of 67 tons is mentioned (Bouvier and Content, 1986). Collection of red coral is carried out by divers who cause no other damage than to the resource itself. Fishing for red coral is undertaken also with scratching apparatus (Italian cross or St. Andrew's cross). This has been documented as causing damage on deeper reefs (on gorgonians etc.) where it is mainly used. Some countries have already banned scratching gear while others that are tolerating it have introduced stricter control measurers (Charbonnier and Garcia, 1984).

Scratching gear (Gangava) has also been banned for similar reasons for the collection of sponges in traditional sponge fishing countries (Greece, Cyprus, Turkey).

It is apparent that although the living resources of the Mediterranean are the potential victim of pollution and environmental degradation, the activities that relate to the exploitation of these resources themselves cause environmental degradation. This is most apparent in the case of the destruction of the *Posidonia* beds by trawling. It is also apparent that the damage caused to reefs by scratching apparatus in fishing for red coral and to turtle stocks by floating long lines is of concern, as are the problems posed by the fast developing marine aquaculture sector on coastal lagoons and wetlands and by the introduction of exotic species into the Mediterranean.

Chapter 5

BIOLOGICAL EFFECTS

5(a) EUTROPHICATION AND ASSOCIATED PHENOMENA

The term "eutrophication" is borrowed from the limnological terminology. In the marine environment, the term in its broad sense is used to designate the primary and secondary impacts of excessive enrichment with nutrient salts. The concept should only apply to marine environments showing the following symptoms:

- the rate of plant production (macro-algae, phytoplankton) exceeds that of consumption by herbivores;

- dissolved oxygen is abnormally low or depleted, often with formation of hydrogen sulphide;

- the ecosystem structure is disrupted, showing abnormal diversity and dominance indices and a change in the species composition.

Land-based sources discharging of nutrients into the Mediterranean basin are of three types, river input, agricultural run-off, and domestic-industrial waste water input. The respective impacts of river input and domestic industrial waste water inputs on the ecosystem are basically different. River discharge, when not in a confined coastal zone, usually spreads over vast sea areas, enhancing productivity, while becoming gradually diluted. Domestic-industrial waste water contributes a negligible 2% to the total fresh-water input to the Mediterranean basin (Table 31, Annex), but its concentration in nutrients is one order of magnitude higher. Domestic-industrial effluents appear to contribute about 20% and 17% respectively to the total nitrogen and phosphorus inputs. Domestic waste waters in the Mediterranean usually remain restricted to the vicinity of the outlets of effluents, their heavy load of suspended materials rapidly settling to the bottom. Their impact on both pelagic and benthic ecosystems, therefore, is more localized but more severe.

Eutrophication, as reported for embayments and estuaries around the Mediterranean, is mostly associated with the release of untreated domestic-industrial waste water (UNEP/UNESCO/FAO, 1988). The symptoms range from mild to severe: alterations of the ecosystem structure involving the biomass, the specific diversity, the dominance of indicator species, outbursts of heavy, often almost monospecific, blooms or "red tides", the development of anoxic and azoic conditions. Such symptoms are either sporadic or seasonally recurrent. Some representative examples are outlined below.

The "lac de Tunis", a salt water lagoon receiving municipal water from the city of Tunis, exhibits extreme symptoms of eutrophication in summer. Massive growth of the chlorophyte Ulva covers a third of the lagoon surface, and the water column (1m in depth) becomes anaerobic, with blooms of red sulfur-reducing bacteria. A vigorous release of hydrogen-sulphide follows and fish-kills may amount to 10% of the total lagoon yield. Nearly a third of the lagoon is occupied by the reef-building, detritus-feeder polychaete Ficopomatus (Mercierella) enigmatica. The reefs harbour epizoan invertebrates, epiphytic algae and a rich microbial flora. This association releases large amounts of ammonia to the water. The heavy discharge of nutrients and organics from the city accompanied by a rapid turnover of nitrogen and a very slow flushing rate, create one of the most severely eutrophied Mediterranean environments (UNESCO, 1984).

The north Adriatic environment is predominantly governed by the discharge of the river Po and a number of smaller rivers, approximating 15% of the total fresh-water input to the Mediterranean basin. Heavy phytoplankton blooms are historically known to occur in the North Adriatic ("mare sporco") during spring or autumn. Severe eutrophic conditions, however, appear to be restricted to semi-closed bays receiving domestic waste water and to the area downstream from the Po outlet, along the Emilia-Romagna coast (Figs. 16 and 17) (Table 74, Annex). The Central and South Adriatic remain poorer in nutrients than the Ionian Sea (Stirn et al., 1974; Stirn, 1988, Marchetti et al., 1988).

On the other hand, the increased nutritional input into the North Adriatic has had beneficial effects on some commercially exploited species. During the last 20 years, the mediolittoral and the infra-littoral along the entire coast of the Istrian peninsula became covered with dense populations of the filter-feeding shellfish Mytilus sp. and Crassostrea sp. The stocks of small pelagic fish (anchovy and pilchard) are steadily increasing per unit fishing effort (Stirn, 1987).

Kastela Bay, which receives waste waters from Split in the North-east Adriatic, has developed distinct symptoms of eutrophication. Primary productivity nearly doubled from 1962 to 1977 (from 115 to 206 g C m^{-2}) and the phytoplankton standing crop increased by a factor of ten in the meantime. Its composition shows the dominance of small diatom species which were inexistant before 1972: Nitzschia seriata, Skeletonema costatum and Leptocylindrus danicus. In summer 1980, a red tide of Gonyaulax polyedra reached 18 x 10^6 cells l^{-1}. This outbreak lasted for a few days and was followed by a near anoxicity in the bottom water layer and mass mortality of fish (Pucher-Petkovich et al., 1978).

Pronounced summer eutrophication is recurrent in Elefsis Bay in the North of Saronikos Gulf near Athens. This results from the impact of the Keratsini outfall, draining domestic waste water from the city, and from thermohaline stratification. The Bay remains strongly stratified from June to October. In winter, dissolved oxygen is relatively high in the bottom water, dropping to depletion in summer. The average ratio of total nutrients to background open water values is slightly over 10. An intense growth of diatoms and dinoflagellates develops in the Bay, abruptly declining towards the open sea. The zooplankton biomass drops to zero from August to October, recovering the normal values in January-April. Acartia clausi makes up 90-99% of the population. A parallel seasonal trend is shown by the benthic macrofauna. In summer, the central azoic zone of the bay widens in area and the benthic invertebrates become restricted to the shallow coastal belt (Yannopoulos, 1976; Zarkanella, 1979).

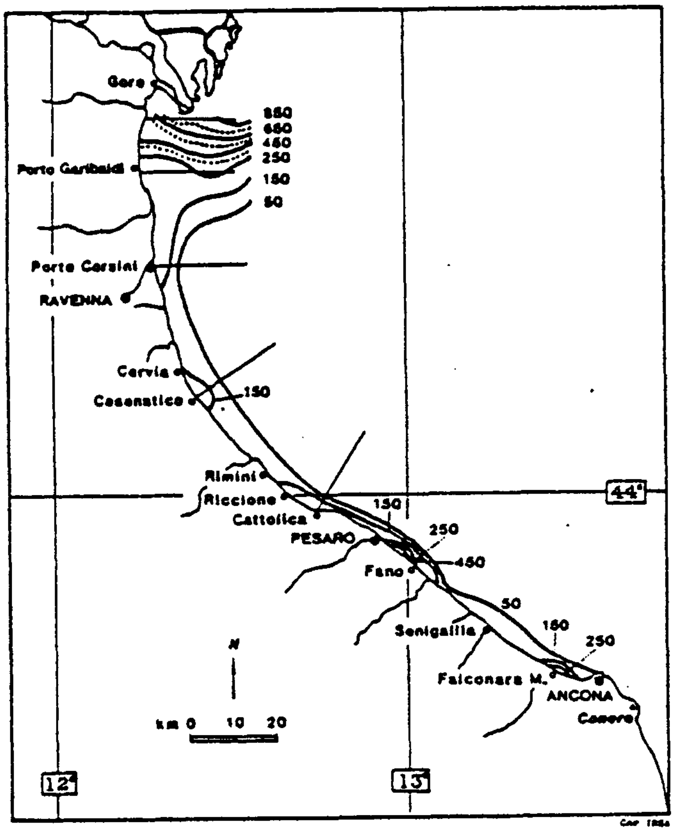


Fig. 16 - Surface chlorophyll values measured between October 22 and 27 in coastal waters of Emilia Romagna and Marche. Values are expressed in mg l^{-1} of chlorophyll *a*. (Marchetti *et al.*, 1988)

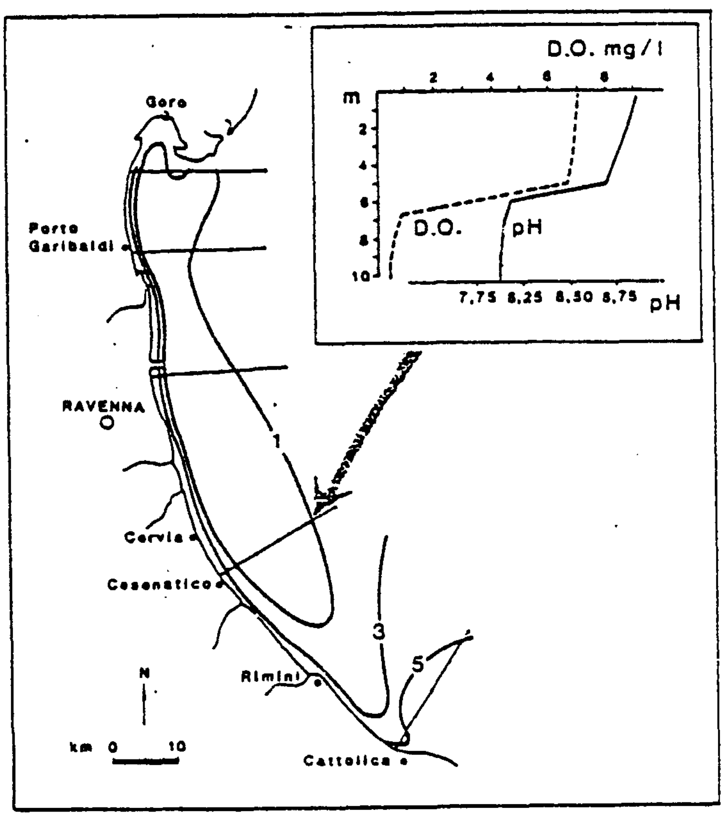


Fig. 17 - Dissolved oxygen values measured in deep coastal waters of Emilia Romagna during August 1982 (Marchetti *et al.*, 1988)

A distinction must be made between abnormally dense multispecies phytoplankton blooms and "red tides", caused by the proliferation of a dinoflagellate species. Several features confirm the significance of "red tides" and abnormal blooms as symptoms of eutrophication. In all instances, such abnormally dense outbreaks can only be sustained by abnormally massive inputs of nutrient salts and organics. The outbreaks are triggered by the onset of stable stratification, quiet weather and rising temperature. Most of the reported cases from the Mediterranean are recurrent phenomena, reappearing in the same season, at the same localities in successive years, lasting from a few days to several weeks.

There are abundant records of "red tides" along the coasts of the Mediterranean basin (Table 75, Annex): from Castellon and the coast of Spain, from Banyuls/mer and Juan-les-Pins in France, from the coast of Emilia-Romagna and Kastela bay in the North Adriatic, from Izmir Gulf in Turkey, from the East harbour in Alexandria, Egypt, and from Malta. Abnormally heavy blooms due to mixed populations occur at the Rhône and Po outlets; they also used to occur along the Nile delta. Chloromonadine species are also responsible for some of the outbreaks. Similar outbreaks occur in salt and brackish lagoons and estuaries, such as the lagoon of Venice and several other Italian lagoons, the "lac de Tunis", the lakes on the Island of Mljet in the Adriatic and the two Nile estuaries.

Secondary effects follow the outbreak and subsidence of red tides and abnormal blooms. The sinking of massive amounts of senescent cells that follows and their subsequent decay in the deeper water layer result in a rapid depletion in dissolved oxygen. Fish mortality, following the development of red tides has been reported from some Mediterranean localities: Izmir Bay, Kastela Bay, Emilia-Romagna, Tunis lagoon. Since no transmissible toxins through the food chain have been reported, it is likely that such mortalities result from oxygen depletion in semi-closed embayments, the release of H_2S and possibly from the smothering of fish gills by the sinking cells.

Eutrophication is a local rather than a regional problem in the Mediterranean Sea. It is frequent in the North Adriatic, Izmir Bay, Elefsis Bay, the lagoon of Tunis and in all such areas where the rate of input of domestic-industrial waste water exceeds that of the exchange with the open sea. The main symptoms consist in the disruption of the community structure, the excessive macro- and micro-algal production and the development of anoxicity in the subsurface layer. The open sea oligotrophic Mediterranean waters, however, remain in sharp contrast with the conditions prevailing in its peripheral embayments.

5(b) PUBLIC HEALTH EFFECTS

The impact of marine pollution on human health can be broadly classified into the following cause/effect categories:

(a) ingestion of microbiologically polluted sea water (mainly during bathing in coastal areas affected by sewage discharge), which may result in disease or disorder of the gastro-intestinal tract, caused by bacterial or viral pathogens having a relatively low infective dose.

(b) contact with microbiologically polluted sea water or sand (again in coastal recreational areas similarly affected) which may result in disease or disorder affecting parts of the body other than the gastro-intestinal tract, mainly caused by bacterial or fungal pathogens.

(c) consumption of polluted seafood which, in the case of microbiological contamination due to the effect of sewage discharge on the area of harvest, may result in acute gastro-intestinal disease or disorder, caused by bacterial or viral pathogens, including those having a relatively high infective dose. In the case of chemical contamination, mainly originating from industrial effluents affecting fishing or culture areas, a variety of adverse health effects may result from relatively long-term exposure, depending on the particular chemical contaminant involved, the amount and frequency of intake, the duration of the total exposure period, and the results of interaction with other chemical contaminants taken in through any route from both marine and other sources of origin.

In very general terms, the public health problems arising from marine pollution that affect the Mediterranean region can be described as basically of the same nature as those prevailing elsewhere. However, a number of problems are accentuated to various degrees. In the first place, the intrinsic characteristics of the Mediterranean Sea itself make it particularly prone to pollutant retention in general. The prevailing hydrodynamic characteristics also lead to pollutant accumulation in the coastal zone, thereby leaving the bulk of such pollutants where they can be most conducive to adverse effects on human health. Socio-economic conditions, including industrial development and the impact of tourism, create special health problems originating from marine pollution when coupled with the fact that the sea constitutes a major recreational amenity throughout most of the coastal zone of the region. In addition, relatively high levels of certain pollutants are known to occur, in some cases originating from natural as well as anthropogenic sources.

The risks to public health arising from bathing in microbiologically polluted coastal recreational waters in the Mediterranean have been well documented, and most countries currently possess legislation or administrative measures to control the microbiological quality of such waters. The degree of control, including both the standards and criteria laid down and the frequency of regular monitoring to ensure the observance of statutory requirements, varies from country to country, and the only minimum common denominator currently agreed on at joint regional level is a standard based on only one bacterial indicator organism (faecal coliforms). In many countries, this is not the only parameter but, by and large, the main microbiological parameters on which quality standards and criteria are based, are still the orthodox indicator bacteria which were originally developed for drinking water (as opposed to sea water) quality.

Research carried out over the last few years within the framework of the Long-term Programme of Pollution Monitoring and Research in the Mediterranean Sea (MED POL Phase II) has provided substantial information on hazards to public health through bathing in microbiologically contaminated waters, and has similarly identified a number of problems which are not easily solved through the application of what can be termed standard orthodox methodology. Furthermore, a number of prevailing differences within the region itself, as well as their possible impact on the evaluation of health risks, have also been brought to light (WHO/UNEP, 1988).

As a result of epidemiological studies performed in an attempt to find a definite correlation between coastal recreational water quality and health effects, correlations previously established between the microbiological quality of the water in terms of levels of bacterial indicator organisms and the incidence of gastro-intestinal diseases and disorders have been generally confirmed. However, most studies were only, out of necessity, performed on a pilot scale, and their number and range of geographical distribution do not necessarily make their results applicable to the whole of the Mediterranean area. In addition, they have pin-pointed the need for comparatively large scale studies, involving large population samples to improve control over a miscellany of confounding factors which make it difficult to prove a definite cause/effect relationship. The situation as regards diseases other than those involving the gastro-intestinal tract is more complicated. In many Mediterranean countries, a certain proportion of bathers (both local populations and tourists) suffer from infections of the ear, eye, skin and upper respiratory tract immediately or shortly after bathing. It has similarly been confirmed that a number of diseases, mainly fungal dermatoses, can be contracted through contact with polluted sand on beaches, and this matrix has therefore also been identified as an important one in preventive and control programmes. However, no definite correlation has been established so far between levels of the commonly used bacterial indicator organisms in coastal recreational waters (which provide an index of the degree of sewage pollution of such waters) and the incidence of non-gastrointestinal diseases among bathers. In most studies, no correlation at all could be established and, furthermore, in many cases, the relative pathogens could not be detected in the sea water (even when sampling was performed during or immediately after peak beach population densities) (WHO/UNEP, 1986).

The public health risks arising out of pollution of coastal recreational waters in the Mediterranean are also complicated through evaluation difficulties. The standard methods for determination of bacterial concentrations in current use were originally developed for drinking water. Sea water in various parts of the Mediterranean has been shown to have a naturally occurring bacterial flora, some species of which give identical reactions to those given by indicator organisms, thus leading to inaccurate counts and, eventually, to incorrect evaluation of the situation at any given time.

The position regarding bathing waters can be summarized as follows: An increasing awareness about public health risks has led the relevant authorities of the countries of the region to step up their control measures, or to introduce them when not already existent. Countries have agreed on a common minimum standard which, though temporary, at least provides a beginning. The general situation which emerges from country reports (some of which are published by the national authorities) shows an upward trend in the proportion of acceptable beaches (EEC, 1988). Various problems have come to light regarding the establishment of proper quality criteria and standards and the methodology for proper evaluation, and steps are being taken towards their eventual solution. A proper correlation between water quality and health effects must still, however, be established through the performance of carefully controlled epidemiological studies.

One major factor to be taken into account when determining the reliability or otherwise of coastal recreational water quality standards in the Mediterranean region is the normally long exposure period of bathers, as compared to other, more temperate regions where the water temperature is lower. This factor renders it inadvisable to rely on international standards developed primarily on the basis of conditions prevailing in other regions where this particular risk factor is not so pronounced.

Public health problems in connection with the consumption of raw shellfish still arise regularly in the Mediterranean region, though no major epidemic has been reported for a number of years. Legislation controlling the quality of shellfish waters has improved over the last five years and, while control measures in the various countries differ in both scope and degree of enforcement, the main shellfish-producing countries in the region currently have strict legislation controlling the quality of both shellfish areas and the shellfish themselves at the post-harvest marketing stage either specifically, or as part of general food quality and safety regulations. While some countries demand compliance with limit values for several microbiological parameters, others base their evaluation mainly on one bacterial indicator organism (faecal coliforms)(UNEP/WHO, 1985; UNEP/WHO, 1986a) and, though perhaps to a lesser extent, the methodological and related problems as described for coastal recreational waters would also apply to shellfish waters.

Of the main public health problems caused by chemical pollution of the Mediterranean marine environment, mercury poisoning can still be described as the major hazard originating practically exclusively from contaminated seafood. In this particular case a significant proportion of mercury originates from natural, as opposed to anthropogenic sources. In the first assessment of the state of pollution of the Mediterranean Sea by mercury (UNEP/FAO/WHO, 1983), the conclusions reached after considering general mercury levels in seafood and consumption figures based on annual catches was that, by and large, populations in general did not appear to be at risk. On the other hand, there was evidence that specific population groups, particularly fishermen and their families in coastal fishing areas, could be consuming amounts of fish and other seafood which, on the basis of their mercury content, could result in an intake exceeding acceptable levels.

Analysis of the levels of mercury in various species of seafood, performed as part of a pilot study on selected coastal areas in three Mediterranean countries (Greece, Italy and Yugoslavia), which commenced in 1984, did not confirm the previous assumption, that the bulk of the total mercury content of seafood was in the form of methylmercury (which is one of the most toxic forms of mercury). On the contrary, there was a considerable variation in the proportion of methylmercury to total mercury among the species analyzed. The results of analysis of seafood species from two areas along the Adriatic coast of Yugoslavia for both total mercury and methylmercury, performed within the framework of the pilot study, are shown in

Tables 76 and 77 (Annex) (WHO/FAO/UNEP, 1987). Dietary surveys on selected human population samples in the areas studied in all three countries showed a reasonably wide variation in fish and seafood consumption habits and, from amounts recorded as being consumed, indicate that in these and in similar areas, two population types could be considered as constituting potential high-risk groups: firstly adult male fishermen, particularly those spending a considerable proportion of their time at sea and, during this period, consuming a diet consisting principally of fish; secondly pregnant women forming part of fishing families who, while generally consuming lesser amounts of fish, have this offset, both by their lesser bodyweight and by the greater sensitivity of the foetus to mercury. Samples of hair taken from indicated individuals from within populations selected for dietary surveys showed increased levels of hair mercury as compared to low or non-fish eating control groups. Although most subjects tested showed hair mercury levels below acceptable limits, a number of individuals, particularly adult fishermen, had elevated levels which could be considered as showing cause for concern (WHO/FAO/UNEP, 1987). So far no comprehensive studies have been conducted in the region to correlate fish and seafood consumption, hair and/or blood mercury levels, and clinical symptoms possibly attributable to mercury poisoning. A detailed protocol for such studies has been prepared, and future studies will now follow two major approaches - geographical expansion of pilot studies to determine the extent of the potential problem in the region, and correlation of preliminary screening results with clinical tests to provide an indication of the actual problem, if any (see also chapter 3a).

The situation regarding adverse health effects as a result of consumption of seafood polluted by chemicals other than mercury is still less clear. Several chemicals known to be discharged into the sea in relatively large quantities, and which are accumulating in Mediterranean seafood, can, and generally do, reach man through routes other than marine food chains. The adverse health effects caused by several of these chemicals are well documented. However, in many cases, it would be difficult to ascribe the origin of their intake as solely, or even mainly, the consumption of contaminated seafood, as levels so far recorded in fish throughout the region are not high enough to give cause for serious concern, particularly when the levels recorded in other (sometimes staple) foodstuffs are generally higher. There is, however, always an element of risk to heavy consumers since amounts of any particular chemical taken in through excessive seafood consumption may well represent the difference between safety and potential hazard, when considered along with amounts taken in from other sources.

5(c) LONG-TERM IMPACTS

Long-term build-up and the consequences of man-made alterations of the environment can only be assessed where long term investigations provide conclusive observations on populations and community structure. Although an enormous amount of data on pollution in the Mediterranean Sea has been published in the last decade, an assessment of the effects of long term accumulation of pollutants still faces several constraints. Most of the results obtained provide data on pollutant levels in fish, bivalves and crustaceans and much less on pollution impacts on communities and populations. The areas where such investigations have been carried out are geographically scattered and separated by large gaps. Information is increasing about a limited number of coastal localities, while vast areas, including the whole deep Mediterranean basin, remain poorly investigated.

All confined or semi-confined Mediterranean localities adjacent to large urban centres appear to be the site of progressive build-up, as a result of continued uncontrolled anthropogenic release. This is observable in the Bay of Algiers, the "lac de Tunis", the Bay of Abu-Kir near Alexandria, the Bay of Izmir in Turkey, the North Adriatic, the coastal belt along the North coast of the West Mediterranean.

Yearly surveys carried out in the Bay of Izmir since 1972 show the effects of gradual build-up on the bottom fauna. The diversity index, the species richness and their abundance are in sharp contrast between the inner and outer bay, allowing a distinction between a "polluted" and a "transitional" zone. In a later phase, spots of heavy pollution appear in the inner bay, while the polluted zone gradually expands outward. Polychaete worms are dominant in the polluted zone, polychaetes and molluscs in the transitional zone. Seasonal and yearly fluctuations are superimposed on this trend. The inner bay becomes completely azoic in summer, recovering in autumn-winter (Kocatas, 1978; Kocatas *et al.*, 1985; Kocatas *et al.*, 1986).

The North Adriatic is characterized by a highly stable benthic community, with a high biomass and a high diversity. This stability appears to be disrupted, as a result of the interplay of several factors aggravated by eutrophication and industrial pollution. The Bay of Muggia is drastically impoverished and the benthic community in Koper Bay completely altered. In September 1974 scattered areas of decaying organisms were observed south of Venice. Extensive areas of mass mortality were reported in autumn 1977 and in September 1980, large areas of faunal impoverishment appeared on the side of the Gulf of Trieste. In September 1983, catastrophic mass mortality occurred again, providing evidence that this "graveyard" phenomenon is becoming a recurrent event. A surface area of about 250 km2 in the North Adriatic is becoming azoic (Ghirardelli *et al.*, 1974; Stachowitsch, 1984).

The characteristic Mediterranean *Posidonia oceanica* ecosystem appears to be heavily impacted upon and on its way to extinction in the vicinity of large urban centres. The degradation of this ecosystem results from a combination of factors: a) encroachments in the upper infralittoral zone and the areas of coastal development of commercial and sporting harbours and marinas, b) the dumping of dredging material, smothering the *P. oceanica* meadows c) disposal of urban and industrial waste water through large outfalls. In the Gulf of Fos-Marseille, where this ecosystem has been monitored since 1948, degradation lead to extinction of the meadows over large areas. Surviving meadows have lost their vitality and their area of spread on the inner shelf is continuously eroded at both its upper and lower margins (Pérès, 1984). The associated sessile epifauna is drastically reduced.

Number of sessile epifaunal species on degraded and non-degraded P. oceanica meadows (Eugène, 1978, in Pérès, 1984).

Depth	non degraded	degraded
10-20 m	96	18
28-33 m	75	11

In Bogasco, East of Genoa, the meadow density is reduced and a remarkable reduction in the mean length of the leaves is observed in a strip 30-40 m wide on both sides of the sewer. This is attributed to the early loss of leave apices eroded by an intense epiphyte covering resulting from the increased nutrient input (Sarà, 1987). The direct impact of the major Keratsini effluent (Saronicos Gulf) and of coastal development activities led to the disappearance of P. oceanica from the East of Salamis island and from the vicinity of Piraeus. Remnant patches show a reduced leaf index and bundle density and a heavier settlement of epizoans (Hydrozoa and Bryozoa) (Panayotidis, 1987).

Profound and irreversible perturbations of the ecosystem and the biological economy of the Levantine Sea were caused by two man-made alterations of the environment: the opening of the Suez Canal in 1869 and the damming of the river Nile in 1965. Since the opening of the Canal, about 170 Indo-Pacific species have successfully established themselves in the East Mediterranean basin. With the lowering of the salinity barrier in the Bitter Lakes, the immigration rate appears to be increased and the area of extension of the immigrant forms now reaches up to Turkey, Cyprus and Greece (there is one record from the Adriatic Sea) to the North, and to the Gulf of Sidra to the South-West. Competition between the migrants and the corresponding indigenous species for their ecological niches led, in several cases, to the dominance of the former over the latter. The flux of Indo-Pacific species has enriched the East Mediterranean with several economically valuable fish (e.g. Mugil seheli, Sphyraena obtusata, Siganus siganus) and crustaceans (e.g. the crab Neptunus pelagicus and the shrimp Penaeus japonicus (Halim, 1974).

In the pre-dam era, the annual release of 30 to 50 km3 of Nile water to the Levantine Sea was immediately followed by the onset of a heavy diatom bloom enduring from July to November and by the enhancement of production at all higher trophic levels. The "Nile stream" extended its fertilizing effect to the Asiatic coast of the Levantine basin up to Lebanon, and at times, further North. The damming of the river and the subsequent reduction of its outflow resulted in a drastic reduction in the primary productivity and in a general impoverishment, particularly in the fisheries yield. The Sardinella landings dropped to about 2-5%. On the other hand, the absence of fresh-water dilution favoured the extension of the Indo-Pacific immigrants (Halim, 1960; Halim et al., 1967).

The distinction between short and long term natural trends and the alterations resulting from human interference are often problematic. Two examples will be recalled. Both concern an abnormal population burst that maintains itself over several years, gradually or suddenly dropping to normal or subnormal levels, with no apparent relation to human activity. Since 1983, public concern around the Mediterranean has been aroused by the occurrence of massive swarms of the jellyfish Pelagia noctiluca (Axiak and Civili, 1986). This so-called "Pelagia phenomenon", first recorded in 1977, reached a maximum intensity in 1980-1983, extending to the French and Italian coastline, the Central Mediterranean, the Adriatic and the Greek waters. Several hypotheses have been advanced, including localized eutrophication, a change in the equilibrium between the species and its predators or competitors and hydroclimatic changes favouring its development. No conclusive evidence however of a relation to anthropogenic activities has been presented. Moreover, such localized swarms are not unprecedented and past observations go back to the last two centuries. At present, the "Pelagia phenomenon" appears to be waning. Another example is provided by the American blue-crab, Callinectes sapidus which first appeared in the East Mediterranean in the 40's. Being a widely tolerant diadromous species, it rapidly displaced the stenohaline Neptunus pelagicus, developing into a vigorous and abundant population in both marine and brackish waters. For an unknown reason, its population started to decline in 1970 and has almost disappeared since (Halim, 1974).

Coastal vegetation in the presidential estate of S. Rossore in Tuscany near Pisa appears to be deteriorating since the early 1960s. The symptoms were described by Gellini et al. (1987) and referred to the synergistic effect of contaminants, derived from a near-by effluent, and sea salt in marine aerosols deposited on leaves. Several observations confirm this interpretation:

(a) the damage becomes more intensified from autumn to winter, the season of the "Libeccio" sea winds;

(b) the damage appears at first in the vegetation fringing the sea, gradually progressing landward. Sheltered trees remain unaffected.

(c) the time succession of the symptoms is also typical.

Following a strong sea wind, the leaves become covered with a whitish deposit of aerosol and dust. They gradually become yellowish, dropping within a few days.

In order to validate this interpretation, simulation of the observed symptoms was attempted, followed by chemical analysis of the needles. Healthy Pinus Pinaster needles were sprayed with NaCl (15 to 120 g l^{-1}) and sodium dodecylbenzensulfonate (5 to 20 000 mg l^{-1}), separate or combined:

a. NaCl alone at 30 g l^{-1} had no significant effect, except for small necrosis spots at the needle tips;

b. the detergent alone bleaches the needles, leaving irregular yellow spots;

c. the combined action of the detergent and of NaCl causes considerable damage, closely resembling the observed symptoms. Both ionic and non-ionic detergents proved to be equally harmful when combined with NaCl.

The observed damages to the coastal vegetation therefore appear to be essentially due to the synergistic action of sea salt with detergents. The presence of the latter, and possibly of other contaminants, alters the defense mechanisms allowing halophytes to grow normally along the coast. Absorption and accumulation of chloride in the needles is significantly increased (Fig. 18) (Gellini et al., 1987; Bigot et al., 1987).

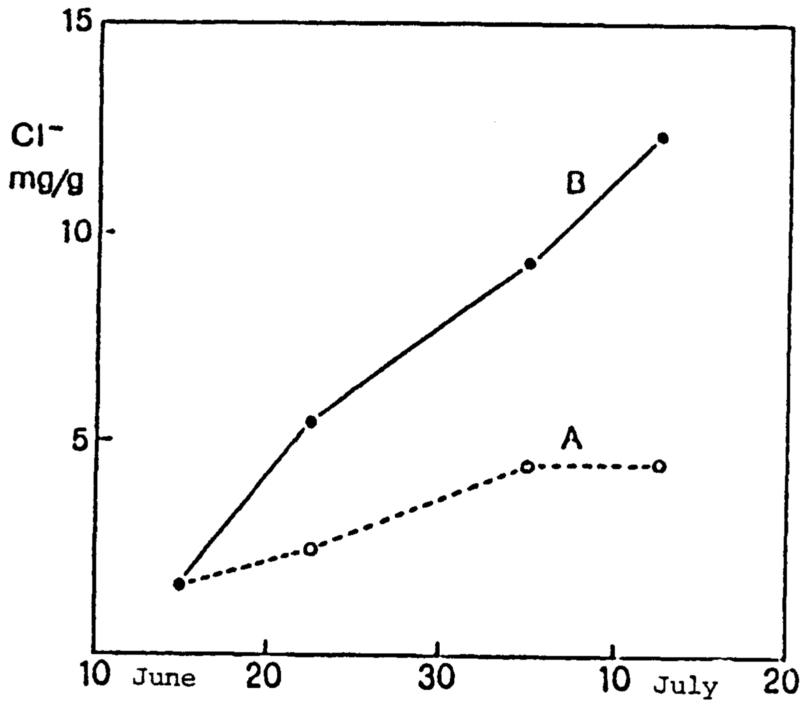


Fig. 18 - Needles of the Pinus Pinaster: Cl^- values in the needles. Plants sprayed with NaCl (A) or NaCl + sodium dodecylbenzensulfonate (B) (Gellini et al., 1987)

5(d) DAMAGED HABITATS AND RESOURCES AND THEIR POTENTIAL FOR RECOVERY AND REHABILITATION

In contrast to the information that is available on the effects of pollution on ecosystems and habitats in the Mediterranean (some of it resulting from the MED POL Phase I and II component of the Mediterranean Action Plan) and elsewhere, the information on the recovery and rehabilitation of habitats is sparse, probably reflecting a lack of tangible examples to study.

The complexity of habitats is such that it is often essential to have baseline information to evaluate the degree of recovery of a damaged habitat. For much of the Mediterranean and more so for the coasts of developing countries such information is limited or non existent. Nonetheless, there is some evidence that the recovery of at least certain habitats is possible. The speed of recovery, however, may vary significantly depending on the habitat and on environmental conditions.

Studies on the effects of thermal effluents have indicated that even a seasonal recolonization of an area affected by lethal temperatures is possible, for some species at least (Hadjichristophorou and Demetropoulos, 1988). The colonization of artificial reefs, albeit a somewhat better documented subject, indicates a succession of population states before a "balance" is reached. This may be relevant to the recovery of certain kinds of rocky habitats. Colonization is, in this case also, quick, though one cannot claim that such colonization can be anything more than an indication of the speed at which certain species move in to occupy a niche and that several years may elapse before balanced populations of the various species that make up the biota of a habitat, are achieved.

Undoubtedly the recovery of habitats is dependent on the extent of the damage and the area affected.

The regression and often the disappearance of *Posidonia oceanica* from stretches of coastline resulting from trawling (often illegal) (Ardizzone and Pelusi, 1984) (see also chapter 4h) and pollution may take many years to reverse if indeed such recovery is possible as the seeds of this sea grass are carried by currents and recovery "upstream" of the prevailing current may well prove impossible unless artificially carried out. Recovery can start fairly quickly in areas where *Posidonia* flowers and seeds. The seeding of *Posidonia* in the North-West Mediterranean is in itself still subject to studies. Vegetative reproduction is slow (3-4 cm yr^{-1}) and reproduction by this method may take, under natural circumstances, many decades if not centuries for the recovery of the *Posidonia* meadows in parts of this area (Meinesz and Lefevre, 1984). In Morphou Bay (Cyprus) three years after the mining effluents (Iron oxides and hydroxides) that blanketed the sea bed stopped being discharged into the Bay, lumps of live *Posidonia* were noticed in several areas by fishermen. A very good example is the regeneration of a *Posidonia oceanica* bed, partly destroyed by a bomb explosion in 1943, which has been monitored at intervals. Originally a dense bed growing at 6 to 15 m in the inner Villefranche Bay (Fig. 19), it was destroyed over a circular area 85 m in radius. The site was surveyed by photography in 1946, 1955 and 1963. In 1982, it was accurately surveyed and mapped by scuba divers (Meinesz and Lefevre, 1984) (Fig. 20). The destroyed area appears to have been slowly recolonized by drifting cuttings, growing into circular patches over the grid of dead rhizomes, most of the patches ranging from 0.5 to 3.5 m in diameter (Fig. 21).

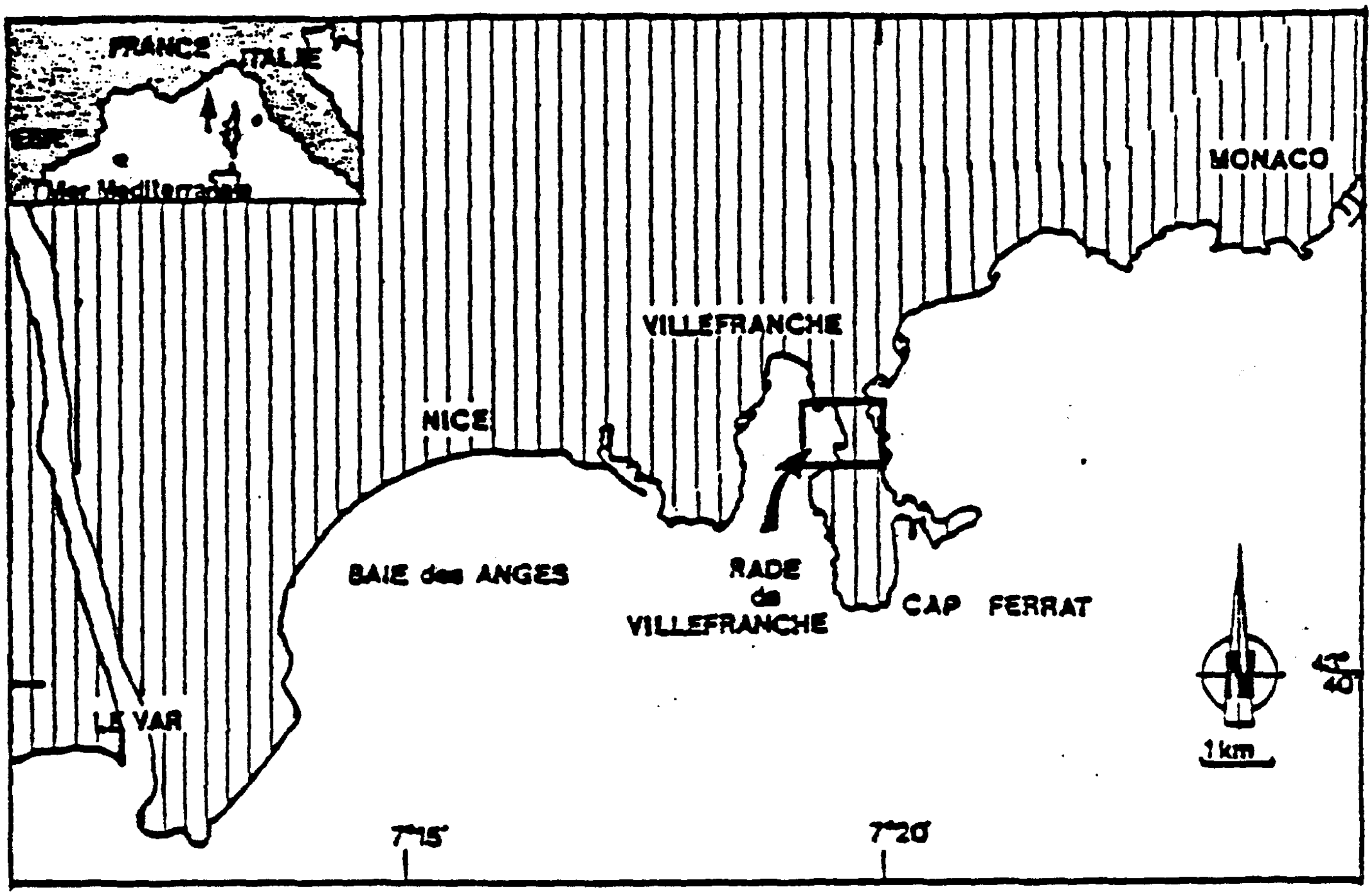


Fig. 19 - Location of the impacted zone (Meinesz and Lefevre, 1984)

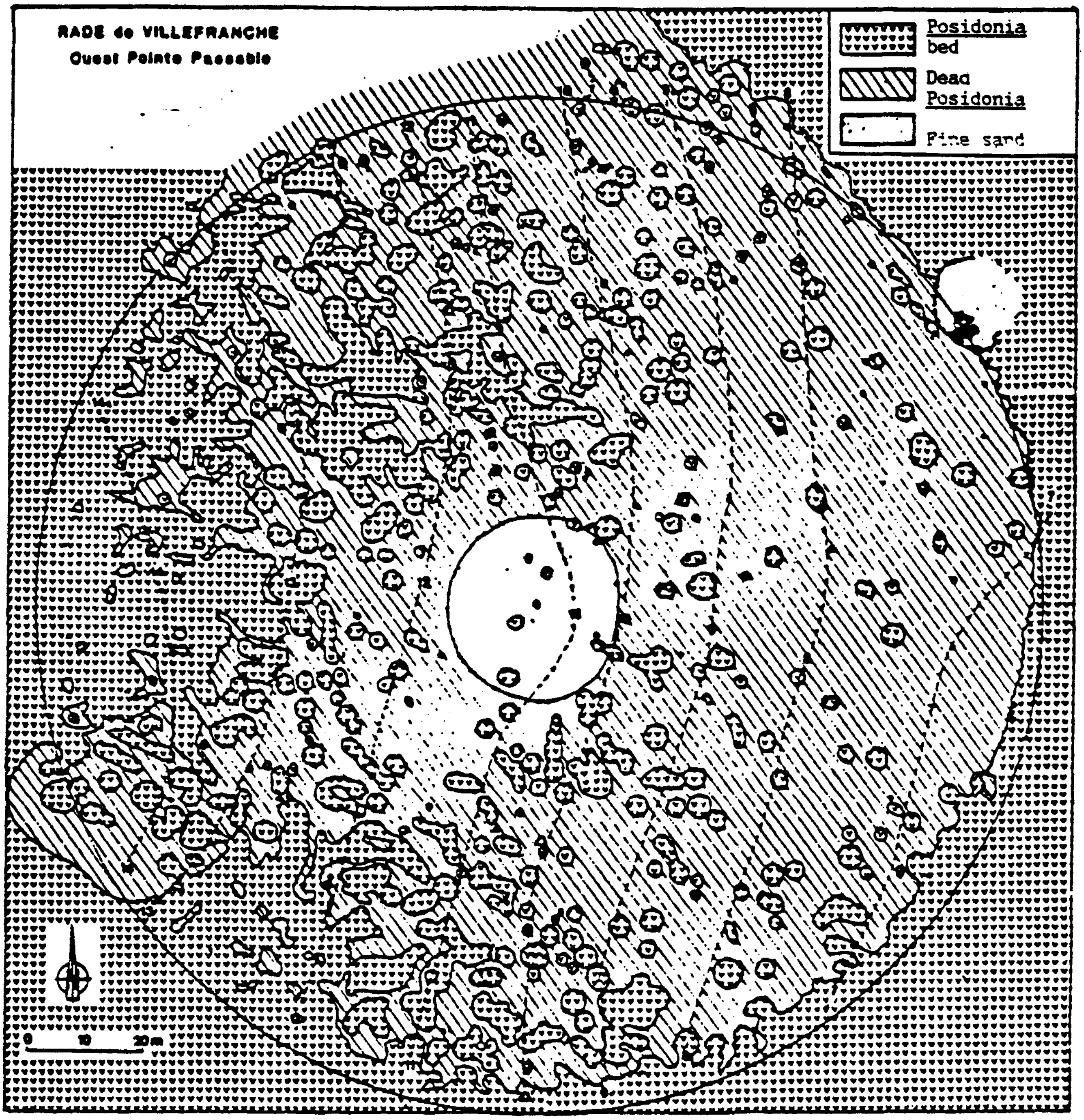


Fig. 20 - Detailed mapping of the impacted zone in 1984 (1:1000)
(Meinesz and Lefevre, 1984)

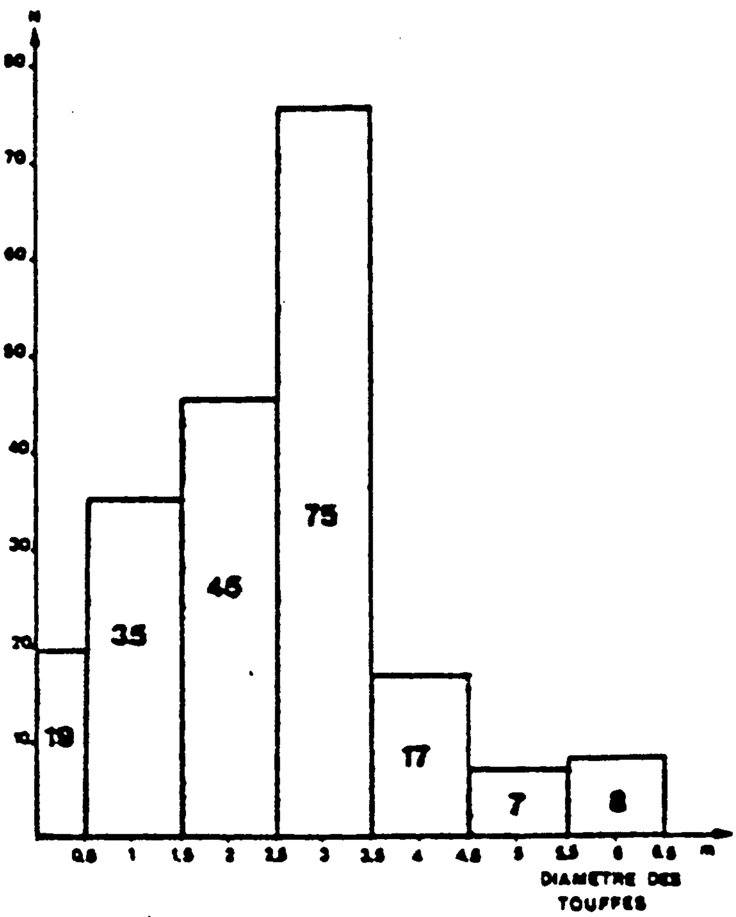


Fig. 21 - Histogrammes of the diameters of Posidonia bundles located in the upper part of the impacted zone (10.5 to 5.0 m depth). After Meinesz and Lefevre (1984)

Assuming a regular centrifugal growth from each cutting, the integrated rate of growth over 40 years would be of 3.75 cm yr^{-1}, and complete regeneration of the dead area would require some 120-150 years (Meinesz and Lefevre, 1984). The estimated horizontal growth rate of P. oceanica rhizomes, however, appears to be too slow. Caye (1980) observed a rate of 5 to 10 cm yr^{-1}.

Following the control of a chlor-alkali effluent in the North Tyrrhenian Sea (Rosignano Solvay) and the drop in mercury release in 1973 (Renzoni, 1976) environmental recovery has been followed over ten years by means of bio-indicator organisms (Bacci et al., 1986). The time needed for complete recovery to the natural background level has been estimated by trend analysis with reference to a remote, unaffected area. Since 1973, the mercury release was reduced from 35-40 kg day^{-1} to 1-2 kg day^{-1} in 1975-76 (Renzoni, 1976) and finally to less than 0.1 kg day^{-1}. Limpets (Patella sp), crabs (Pachygrapsus marmoratus) and fish (small non-migratory scorpion fish, Scorpaena porcus and the rainbow wrasse, Coris julis) were collected at the same stations as previously and analyzed for mercury. The elimination half periods, $T_{1/2}$, were computed applying the relations: $C_t = C_a e^{-kt}$ and $T_{1/2} = \ln 2\ K^{-1}$, k being the recovery rate constant in yr^{-1}, T time in years, C_t the level at any time t and C_a the original level (Table 78, Annex and Fig. 22). The results show that decontamination of a heavily polluted marine environment by mercury requires a considerable time. Recovery to the reference level of the two fish species is estimated to require 23.2 to 23.8 yr^{-1}. Less time is required for Patella (13.4-14.0 yr^{-1}) and P. marmoratus (15.2 yr^{-1}).

The gulf of la Ciotat, East of Marseille, provides a well documented case of slow recovery of the benthic community after disruption caused by indiscriminate dumping of dredging material from La Ciotat harbour, and by the building of a new breakwater. The area was surveyed and mapped before the dumping in 1959, then just after in 1962 and once more ten years later in 1972. The 1959 survey showed remarkably stable communities, which in 1962 became profoundly disrupted, with complete disappearance of certain bottom communities. The impact of the new breakwater built on 10 m deep bottoms, extended to the communities down to 60 m depth. In 1972, a new equilibrium appears to have been reached. The dumped material was in the process of being repopulated, a process that still required several years (Picard and Bourcier, 1976).

A soft bottom community was studied in Cagliari, Sardinia, before, during and six months after extensive dredging operations (Bonvicini Pagliai et al., 1985) while the recovery of the malacofauna of the same site was further surveyed two years later (Curini-Galletti, 1987). It is apparent from this work that the pioneer community established itself very quickly. Within two months after dredging the basic stock of species was present in the dredged area. The evolution of the communities however is evidently a much longer process and the predredging community structure was not achieved within the two years covered by the latter study. Marked fluctuations in species composition in nearshore soft bottom communities however make the evaluation of the recovery difficult. In the particular case studied marked fluctuations in the settlement of Corbula gibba were observed also in the "control" area. This species, albeit at a juvenile stage, is the dominant species in the recolonization and is apparently present constantly in areas subject to dredging.

The author of the latter paper (Curini-Galleti) concludes that the kind of community studied, i.e. a nearshore soft bottom one, is well adapted to react to even apparently catastrophic disturbances of the environment (implying dredging).

It may be worth noting that molluscs have been put forward (Gambi et al., 1982) as efficient descriptors of benthic communities since they are easily identifiable and therefore provide an "economic" way of assessing patterns of recruitment and trophic successions in benthic communities.

Similar quick recolonization rates were observed in muddy sand sediments in an in situ experiment carried out in the Fos gulf (Arnoux, et al., 1985). This experiment involved the planting of trays with heavily polluted sediments containing high organic and heavy metal loads (Table 79, Annex) on the sea bed at 4 m depth.

This study also concentrated on molluscs only and the recolonization rates though relatively slow during the first two months increased quickly in the following 4 months of the six month experiment (Fig. 23); the authors conclude that the colonization and dynamic processes of the mollusc populations do not depend on the concentrations of pollutants in the solid phase but are related to the release of these pollutants from the interstitial water of sediments (Fig. 24) which in turn is induced by variations in the ambient conditions and particularly by variation in salinity.

The rate and pattern of recolonization of an anoxic and azoic sediment has also been experimentally investigated by transfer to a healthy environment near Marseille (Diaz-Castaneda, 1986). The sediment was placed in polyethylene trays and the trays maintained at 5 m depth for a year, two trays being removed each month and examined for pollutants (trace metals, ammonia, orthophosphate) and organisms. Recolonization was preceded by a lag-period of two months during which gradual oxydation of the organic matter in sediment took place with liberation of many of the pollutants. This period was followed by the appearance of opportunistic colonizers which settled in the sediment. First appeared adult crustaceans, Amphipoda in particular (Gammarus aequicauda, Microdeutopus bifidus and Corophium runcicorn), which remained dominant over 3 months. They were followed by a progressively diversified polychaete population. Mollusca were the last comers. Factorial analysis showed a trend towards similarity with the surrounding environment. By the end of the year diversity and species composition became identical with that of the surrounding environment, but not the relative proportions of the species.

On the other hand it must also be noted that the destruction of certain kinds of habitats may be irreversible. This is probably the case in the destruction of breeding beaches for turtles by urban or tourist development; here, the disappearance of a species from an area may be permanent and even the artificial reintroduction of the species to areas in which it used to breed may prove unsuccessful.

The natural recolonization and rehabilitation of special habitats, such as coastal wetlands which do not have a common stock of species from which to draw on for recolonization purposes (such as is available in the sea), may well prove impossible. These can probably only be reestablished after considerable care and artificial reintroductions and even in that event success is uncertain.

In view of the targets of the MAP more information on the speed and degree of recovery of a variety of habitats would be useful in forecasting and assessing the results of measures intended at reducing pollution and improving and managing the marine environment. Great care should be taken of special habitats such as coastal wetlands or habitats the destruction of which may well have a permanent effect on the species relying on them.

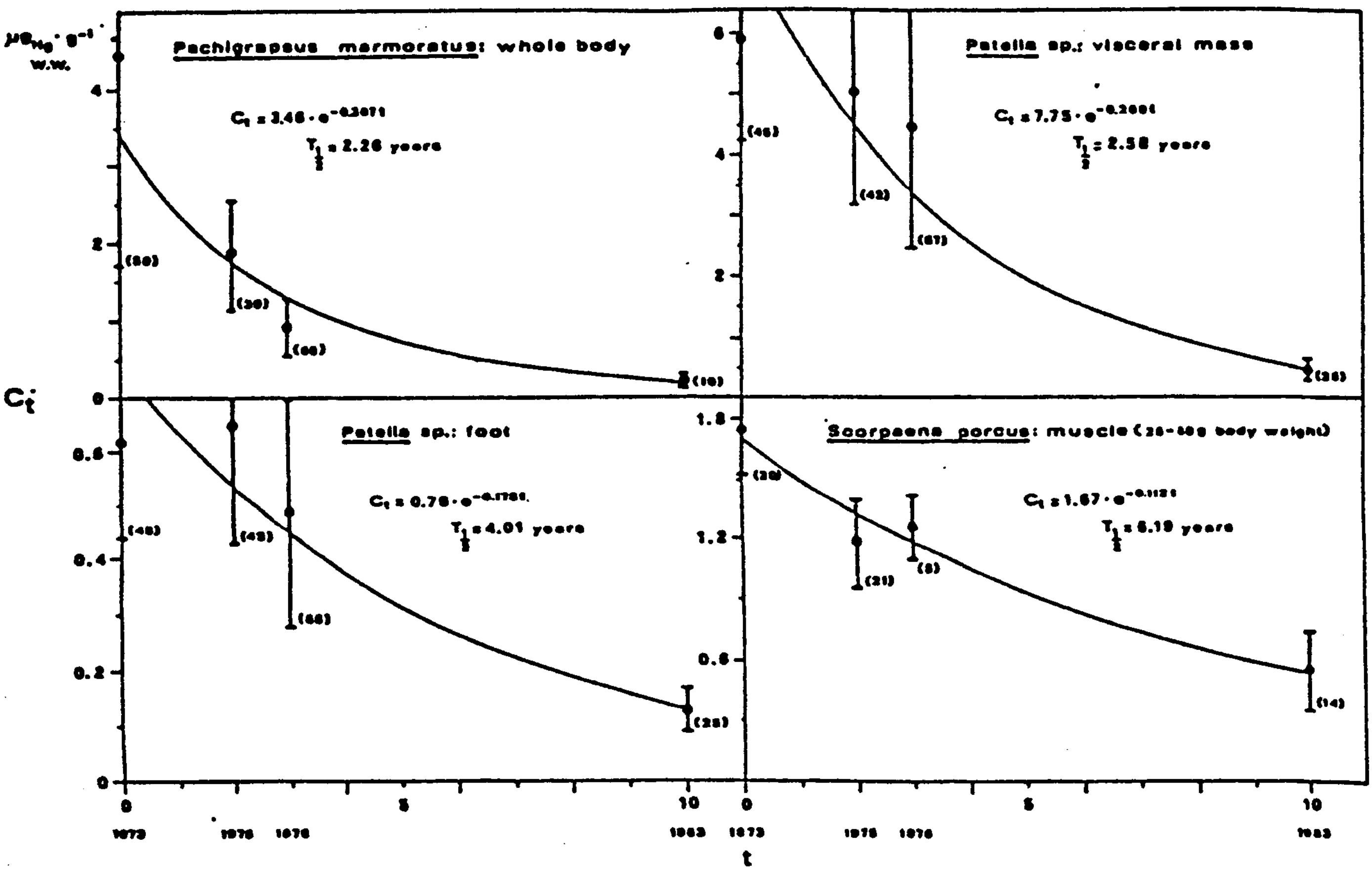


Fig. 22 - Recovery trends by various kinds of bioindicators from the Rosignano Solvay area (Bacci et al., 1986)

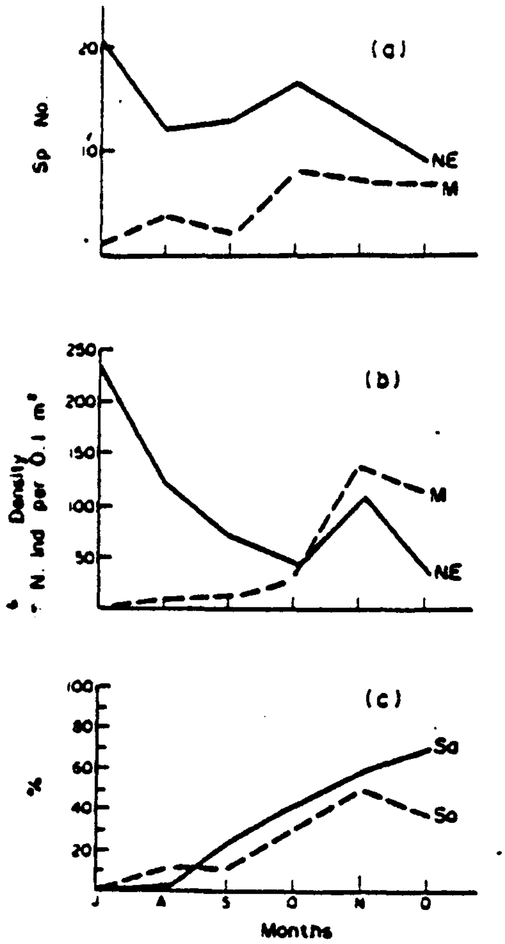


Fig. 23 - (A,B) Evolution of specific richness and density, respectively, of the mollusc fauna in the modules (M) and the natural environment (NE) during the study period (C) Similarity coefficients (Sa. Sanders coefficient. So. Sorensen coefficient) between the above assemblages. Source : Arnoux <u>et</u> <u>al</u>., 1985)

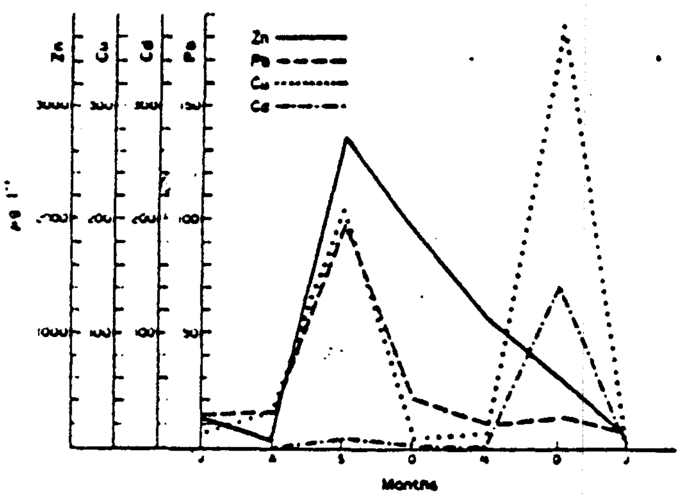


Fig. 24 - Variation of the studied interstitial water heavy metal concentrations in the modules (Arnoux <u>et</u> <u>al</u>., 1985)

5(e) ACCIDENTS AND EPISODIC EVENTS (UNEP, 1988)

1. Introduction

At the time of creation of the UNEP/IMO Regional Oil Combating Centre (1976), the data on oil spills and accidents likely to cause spillages in the Mediterranean region were not systematically collected. Obviously, the major accidents (Marlena, 1970; Trader, 1972; Maydala, 1971; Suzy, 1972; Theodoros V, 1974; John Colocotronis, 1974) were recorded and reported by mass media and clean-up specialists, but the overall picture of the situation regarding marine oil pollution (and pollution by other harmful substances) in the Mediterranean did not exist.

By signing the Protocol concerning co-operation in combating pollution of the Mediterranean Sea by oil and other harmful substances in case of emergency, the coastal States inter alia assumed responsibility to inform each other systematically on cases of marine pollution and accidents likely to cause it.

In order to form a comprehensive and realistic account of marine pollution caused by maritime transport in the region, the Centre started (in August 1977) collecting data from reports of its Focal Points on spills and accidents likely to cause spillages. Such "List of alerts and accidents recorded at the Regional Oil Combating Centre" is published annually by the Centre.

It did not take long to realize that despite the good intentions of signatories of the Protocol, the influx of information was very uneven and a lot of spills or accidents remained unreported. In addition, most of the reports were received with significant delays (weeks, months).

It was quite easy to understand the reasons: the people facing an accident or a threat posed by an oil spill had more important priorities and did not bother to inform the Centre (or anyone else) on the events. Considering that at that time, the Centre had just started its operations and that regional co-operation was still in its infancy, they should not be blamed for forgetting to follow the word of the Protocol.

As a consequence, the Centre, more often than not, learned about oil spills in the Mediterranean from newspaper, radio or TV reports or from specialized publications. In order to overcome this situation, the Centre signed (in 1982) a contract for immediate reporting of all shipping accidents causing or likely to cause a spillage in the region with LLOYD's of London. Information received from this source and complemented by reports from national Focal Points on sightings of spills in their territorial waters, enabled the Centre to make a more reliable account of oil pollution in the region.

Each year, the Centre updates its "List of Alerts and Accidents" which is then disseminated to all its Focal Points. The list includes information on the date and place of spill or accident, the source of information, the type and quantity of pollutant, actions taken and consequences of the incident.

It is believed that at present the data on accidents collected at the Centre reflect realistically the situation in the Mediterranean region.

Unfortunately, the same cannot be said on the state of operational pollution, i.e. deliberate discharges of oil and oily waters from ships in both territorial waters of the Mediterranean coastal States as well as in international waters. The pollution created by deliberate discharges of oil or other harmful substances, which is certainly more significant than that caused by accidental spillages, is very irregularly reported and the picture obtained from these reports can hardly be regarded as true.

The reason for this is the lack of permanent surveillance of territorial waters in the majority of the coastal States and practical non-existence of any surveillance in high seas outside territorial waters.

2. Summary of data on spills and accidents recorded at ROCC between August 1977 and December 1987

Operation Discharges	:	46
Accidents	:	94
Total Number of Reports	:	140

The following tables present the annual distribution of operation discharges and accidents recorded at ROCC:

YEAR	TOTAL REPORTS	OPERAT. DISCHARGE	ACCIDENTS				
			TOTAL	OIL SPILLED	%	NO SPILLAGE	%
1977 (08-12)	6	2	4	4	100	-	-
1978	11	3	8	6	75	2	25
1979	10	3	7	7	100	-	-
1980	12	4	8	6	75	2	25
1981	22	9	13	7	54	6	46
1982	12	4	8	2	25	6	75
1983	20	8	12	5	42	7	58
1984	10	3	7	5	71	2	29
1985	16	5	11	5	45	6	55
1986	9	2	7	4	57	3	43
1987	12	3	9	4	44	5	56
TOTAL (77-87)	140	46	94	55	59	39	41

Oil spillages have been reported in 101 cases (46 operational and 55 accidents). The quantities of spilled oil were estimated as follows:

	TOTAL	OPERATIONAL DISCHARGES	ACCIDENTS
UNKNOWN	54	36	18
0 - 100 m^3	23	4	19
100 - 1,000 m^3	14	6	8
1,000 - 10,000 m^3	6	-	6
More than 10,000 m^3	4	-	4

4 major spills (more than 10000 m^3 of oil spilled) were:

M/T INDEPENDENTA	15 Nov. 1979	BOSPHORUS (Turkey)	94,600 t (most burnt)
M/T IRENES SERENADE	23 Feb. 1980	NAVARINO BAY (Greece)	40,000 t
M/T JUAN A. LAVALLEJA	28 Dec. 1980	ARZEW (Algeria)	39,000 t
M/T CAVO CAMBANOS	05 July 1981	OFF CORSICA (France)	18,000 t

2.1 Operational Discharges

Total number of reported operational discharges: 46

This figure represents 33% of all reports received at ROCC. According to these reports estimated quantities of oil spilled in deliberate discharges were:

36 :	unknown	(78% of reports)
4 :	less than 100 m^3	(9% of reports)
6 :	100 - 1,000 m^3	(13% of reports)

2.2 Accidents

The total number of accidents reported to ROCC between August 1977 and December 1987 was 94, which represents 67% of all reports. Oil was not spilled in all of these accidents:

Accidents with spillage	:	55 (59%)
Accidents without spillage	:	39 (41%)

The sizes of spills caused by accidents and registered in the Mediterranean in the past eleven years were as follows:

Unknown	18 accidents (33%)
0 - 100 m^3	19 accidents (34%)
100 - 1,000 m^3	8 accidents (15%)
1,000 - 10,000 m^3	6 accidents (11%)
more than 10,000 m^3	5 accidents (7%)

Causes of accidents reported to ROCC have been divided in 4 groups:

- groundings and/or sinkings
- fires and/or explosions
- collisions and/or rammings
- other causes

The last category includes for example, pipeline leakages, accidents during loading/offloading and structural failures. Some of these accidents caused leakages of oil from land installations which however ended up in the sea.

The following table summarizes the distribution of accidents by cause in the 1977-1987 period:

TYPE OF ACCIDENT	NUMBER OF REPORTED ACCIDENTS	% OF TOTAL ACCIDENTS	ACCIDENTS WITH OIL SPILLED
Grounding	32	34	15
Fire	23	25	7
Collision	17	18	12
Other	22	23	21
TOTAL	94	100	55

The analysis of figures in the preceding Table shows that 47% of all reported groundings or sinkings resulted in an oil spill; so did 30% of fires and explosions, 72% of collisions and rammings and 95% of accidents caused by other reasons. Ignoring the last category (*), it can be concluded that the highest risk of oil spillage is related to collisions while only one third of fires or explosions actually cause spillage of oil.

The following Table gives an annual review of accidents by cause for the 1977-1987 period:

	TOTAL No. OF ACCIDENTS	GROUNDINGS SINKINGS	%	FIRE EXPLOSION	%	COLLISION RAMMING	%	OTHER	%
1977 (08-12)	4	-	-	-	-	1	25	3	75
1978	8	5	63	1	12	1	12	1	12
1979	7	2	29	-	-	5	71	-	-
1980	8	3	37	2	25	3	37	-	-
1981	13	2	15	6	46	1	8	4	31
1982	8	4	50	4	50	-	-	-	-
1983	12	3	25	2	17	3	25	4	33
1984	7	2	29	2	29	-	-	3	43
1985	11	4	36	4	36	1	9	2	18
1986	7	4	57	1	14	-	-	2	29
1987	9	3	33	1	11	2	22	3	33
TOTAL (77-87)	94	32	34	23	25	17	18	22	23

(*) The accidents in this category occurred exclusively in oil terminals, tank farms, harbours or land installations and oil spillages were not the result of damages to ship(s). It is quite certain that accidents of this type are reported only in cases when the oil actually reaches the sea. Accordingly, the accidents in this group should not be regarded as marine casualties.

Figure 25 shows the geographical distribution of accidents reported to ROCC since August 1977 and Table 80 (Annex) lists all accidents causing spills above 500 t, between August 1977 and December 1986.

Tankers have been involved in 67 accidents, which represent 71% of all accidents reported to ROCC in this period. One might expect that the entry into force of Annex I of the MARPOL 73/78 Convention (2 October 1983), which inter alia stipulates measures for minimizing pollution from oil tankers due to damages (protective location of segregated ballast tanks, tank size limitations, arrangement of cargo tanks etc.) would reflect on tanker data accidents. The analysis of reports on spills shows that 58% of tanker accidents registered prior to October 1983 resulted in spillage of oil, while the percentage for the period after that date is 56%. Although the improvement of 2% does not seem to have met the expectations, further analysis of the same reports reveals another significant difference: the spills registered in the latter period are mainly of smaller size. The following Table illustrates the difference:

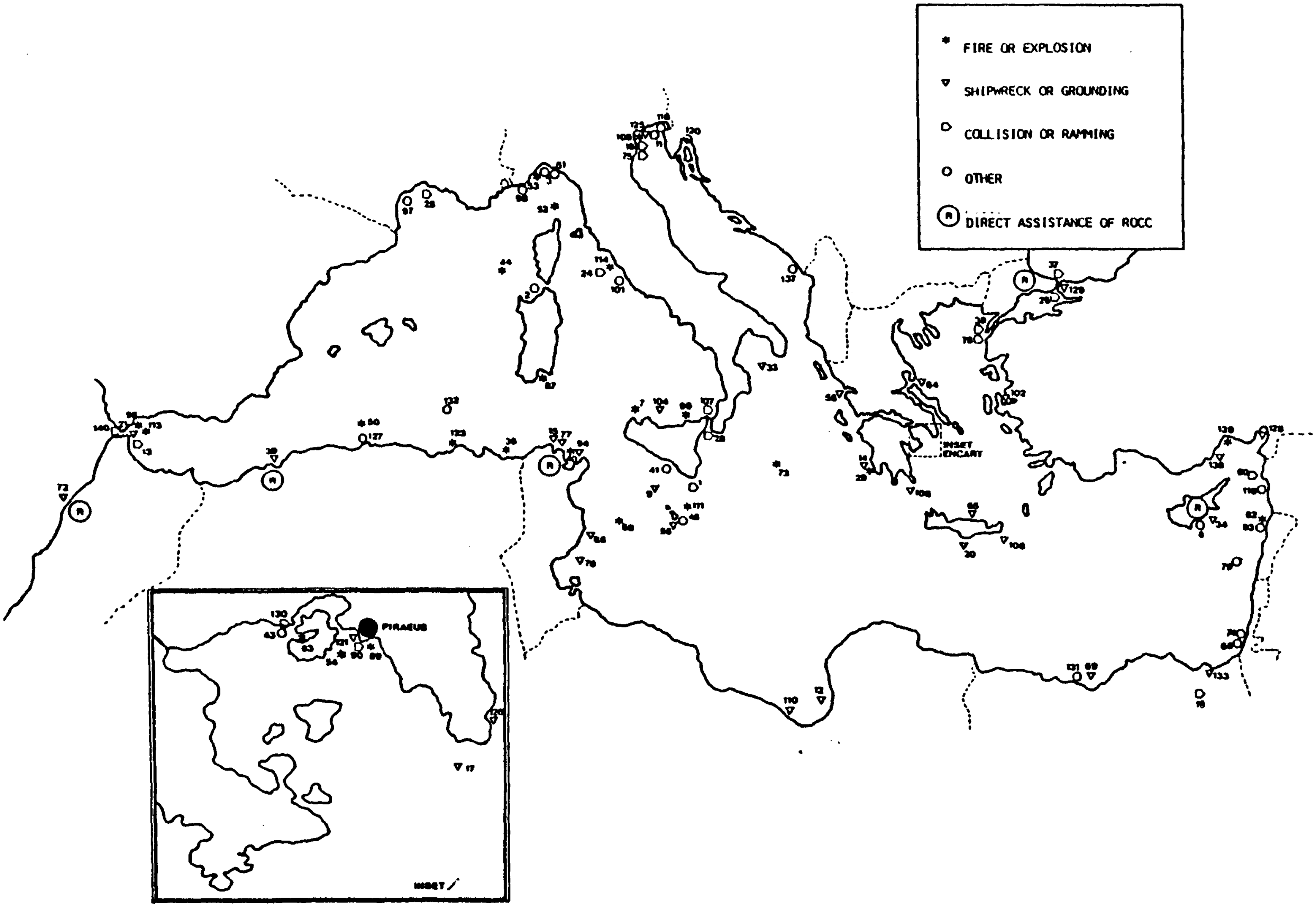
Period	Sizes of spills caused by tanker accidents				
	Unknown	<100	100 - 1,000	1,000 - 10,000	$>10,000$
Aug. 77-Sept. 83	6	5	3	5	4
Oct. 83-Dec. 87	5	7	2	1	-

It is hoped that the trend indicated by the above figures will continue in the coming years not only for tankers but for all accidents and spills.

Nevertheless, it is worth repeating that in spite of all the improvements in ship building technology, navigation and related legislation, the risk of accidents and hence oil spills, will exist as long as oil is used as fuel or carried as cargo on board ships.

Compared to oil pollution, marine chemical pollution is a relatively recent phenomenon where the amount of chronic operational pollution is in many cases more serious than that of accidental pollution. The possible sources are various and the variety of transported products is on the increase. In most accidents, the ecological risk is secondary, generally preceded by the problem of protecting and saving human lives. No global statistics on maritime transport of chemical products in the Mediterranean exist. Some national figures do exist but the section on unidentified products (which are probably the most dangerous) covers usually more than 20% of the data reported. One can state however that:

- liquefied Gas (natural Gas and Petroleum Gas) constitutes a separate category where maritime transport presents minor chronic pollution and where the risk of accident (higher for Petroleum Gas) is generally well shouldered by the carriers;



<u>Fig. 25</u> : Accidents (by type) reported to ROCC since August 1977 (figures correspond to the numbers indicated in the list of alerts and accidents (UNEP, 1988)

- chemical products are most frequently transported in bulk;
- chemical compounds like benzene and its by-products, transported in bulk in cosiderable quantities, can be a source of accidental pollution causing serious ecological consequences.

Chapter 6

PREVENTION AND CONTROL STRATEGIES IN THE FRAME OF THE MEDITERRANEAN ACTION PLAN

Although the environmental problems of the oceans have a global dimension, a regional approach to solving them was adopted in the United Nations Conference on the Human Environment (Stockholm, 1972) and in subsequent Governing Council of UNEP decisions. This approach focuses on specific problems of high priority to the States of a given region, thereby responding more readily to the needs of Governments and helping to mobilize more fully their own national resources. It was considered that undertaking activities of common interest to coastal States on a regional basis should, in due time, provide the basis for dealing effectively with the environmental problems of the oceans as a whole.

The Mediterranean region was selected by UNEP as a high priority area and the Mediterranean Action Plan formally adopted by the Governments of the region in Barcelona in February 1975 formed the prototype for similar programmes in other regions, each tailored to specific needs in scope and implementation.

The Mediterranean Action Plan (UNEP, 1985b) aims at protecting the interests of the governments of the region through the identification and solution of common environmental problems while respecting, and wherever so required, assisting in, the particular requirements of each individual country. From the very beginning, the Mediterranean Governments have actively participated in the formulation and development of the programme at both policy and technical levels, and since 1979 through regular assessed contributions. Periodic intergovernmental meetings are convened to review progress effected in the implementation of agreed on workplans, and to introduce appropriate adjustments in tone with the needs of Governments.

The Mediterranean Action Plan's activities in the various countries of the region are implemented by national institutions formally designated by their respective Governments. UNEP acts as the overall coordinator of the programme in its capacity as the Secretariat to the 1976 Barcelona Convention for the protection of the Mediterranean Sea against pollution and its related protocols (UNEP, 1982), and is also entrusted with the management of the Mediterranean Trust Fund, in which Government contributions to the programme are deposited. Implementation of the various components of the programme, in conformity with recognized practice, is effected in cooperation with the whole United Nations system, and a number of UN Specialized Agencies, particularly FAO, UNESCO, WHO, IOC, IMO, WMO and IAEA, are responsible for the technical implementation of those aspects of the programme falling within their respective recognized fields of competence.

The general strategy for pollution prevention and control in the Mediterranean region has been, and still is, firstly to generate a sense of awareness of both common and specific problems through their identification and acceptance in terms of cause-effect relationship, and secondly, to assist in developing the mechanism for their solution or alleviation.

For action at joint regional level 17 Mediterranean Countries (all except Albania) and EEC have adopted and ratified the Convention for the protection of the Mediterranean Sea against pollution (Barcelona Convention), which provides the framework for legal agreements covering specific pollution prevention and control aspects. The Barcelona Convention entered into force on 12 February 1978.

Four protocols related to the Convention are currently in force:

- protocol for the prevention of pollution of the Mediterranean Sea by dumping from ships and aircraft (Dumping Protocol) (adopted and signed in Barcelona on 16 February 1976 along with the Convention and entered into force on 12 February 1978);

- protocol concerning cooperation in combating pollution of the Mediterranean Sea by oil and other harmful substances in cases of emergency (Emergency Protocol) (adopted and signed in Barcelona on 16 February 1976 along with the Convention and entered into force on 12 February 1978);

- protocol for the protection of the Mediterranean Sea against pollution from land-based sources (LBS Protocol) (adopted and signed in Athens on 17 May 1980, entered into force on 17 June 1983).

- protocol concerning Mediterranean specially protected areas (SPA Protocol) (adopted and signed in Geneva on 3 April 1982, entered into force on 23 March 1986).

Activities in connection with the technical implementation of the emergency protocol are coordinated through a UNEP/IMO Regional Oil Combating Centre established in Malta in 1976, those concerning the specially protected areas protocol through the Regional Activity Centre established in Tunis in 1985.

The strategy for enabling implementation of the convention and protocols, particularly the specific aspects of the latter, in the various countries, is to provide detailed assessments and evaluations of the situation in the Mediterranean with regard to specific pollutants and to recommend joint measures to be adopted and implemented by Governments. This is particularly important with regard to the land-based sources protocol, which binds the Parties to formulate and develop such measures (UNEP, 1982). Detailed assessments, including concrete recommendations for measures to be taken by the Mediterranean Governments were completed for microbial pollution (UNEP/WHO, 1985; UNEP/WHO, 1986), mercury (UNEP/FAO/WHO, 1987); cadmium (UNEP/FAO/WHO, 1987a), petroleum hydrocarbons (UNEP/IMO/IOC, 1987), used lubricating oils (UNEP/UNIDO, 1987) and organotin compounds (UNEP/FAO/WHO/IAEA, 1988). Similar assessment studies are being prepared on other subjects, in particular on pollution by organophosphorus compounds, organohalogen compounds and persistent synthetic materials. Common measures for the protection of the Mediterranean Sea against microbial pollution were adopted, by the Contracting Parties to the Barcelona Convention, for recreational waters (UNEP, 1985a) and shellfish growing waters (UNEP, 1987c) as well as common measures against pollution from mercury (UNEP, 1987c). Preparation of detailed assessments for particular pollutants listed in Annex I ("Black list of substances") and Annex II ("Grey list of substances") of the LBS Protocol, as well as preparation of common measures to be proposed to Contracting Parties for adoption, is being done in accordance with the Calendar of implementation adopted by the Contracting Parties (Table 81, Annex).

The collection of scientific data and their evaluation has been one of the most essential components of the Mediterranean Action Plan, and is achieved through the Programme of monitoring and research in the Mediterranean Sea (MED POL) approved by Governments in 1975 (PHASE I, 1975-1980) and 1981 (PHASE II, 1981-1990). The programme is being used as a tool to achieve a practical degree of coherence among methodologies utilized in pollution monitoring in the various countries and enhance comparability of results, as well as to develop the scientific and technical capabilities in the developing countries of the region, thus enabling them to carry out the essential aspects of environmental management practices. In addition, other necessary data on the Mediterranean marine environment are obtained through research projects in the various countries. The strategy employed best is to utilize the programme's restricted financial reserves by providing catalytic assistance to national institutions, enabling them to obtain the balance from home sources.

Through the common Mediterranean monitoring programme of MED POL 14 Mediterranean countries are at present submitting data to the Mediterranean Co-ordinating Unit in Athens. Such data are used for the preparation of detailed assessments reports and for the preparation of common measures to be proposed to Contracting Parties.

Implementation of the land-based sources protocol also requires the development of comprehensive guidelines in waste management practices. The strategy is to develop such guidelines, based on already existing work from the global viewpoint and adapted to general Mediterranean conditions through MED POL research and other inputs, designed both to avoid duplication of effort at basic level and to allow for the necessary modifications to suit individual national or local requirements.

At the overall environmental management level, the Blue Plan, implemented through the Regional Activity Centre in Sophia Antipolis established in collaboration with the Government of France in 1979, has provided a number of scenarios on various aspects of Mediterranean activities, as part of an interdisciplinary prospective study aimed at the correlation of socio-economic development within the region with environmental preservation. The Priority Actions Programme Regional Activity Centre in Split, established in collaboration with the Government of Yugoslavia in 1982, deals with priority actions in a number of approved fields, particularly in sub-regional and national projects in areas where the state of existing knowledge is sufficient to justify concrete practical action.

Overall realization of the strategies being employed demands a high degree of coordination among the various components of the Mediterranean Action Plan at organizational level, as well as a continuous process of collaboration with Governments of the region. Its degree of success so far can be seen both in the light of national marine pollution prevention and control legislation which has been developed in the various countries of the region during the last decade, and in the light of the Declaration adopted at Ministerial level by the Contracting Parties at their Fourth Ordinary Meeting in Genoa in September 1985, reproduced in Table 82 (Annex).

Chapter 7

IMPLICATIONS OF CLIMATIC CHANGES IN THE MEDITERRANEAN REGION

The environmental problems associated with the potential impact of expected climatic changes may prove to be among the major environmental problems facing the marine environment and adjacent coastal areas in the future. Therefore, in six regions covered by the UNEP Regional Seas Programme (Mediterranean, Caribbean, South Pacific, South Asian Seas, South-East Pacific and East Asian Seas), Task Teams were established and entrusted with the preparation of studies on the possible impact of climatic changes on the ecological systems as well as on the socio-economic structures and activities.

The intended objectives of the studies were:

- to examine the possible effects of the sea level changes on the coastal ecosystems (deltas, estuaries, wetlands, coastal plains, coral reefs, mangroves, lagoons, etc);
- to examine the possible effects of increased temperature on the terrestrial and aquatic ecosystems, including the possible effects on economically important species;
- to examine the possible effects of climatic, physiographic and ecological changes on the socio-economic structures and activities; and
- to determine areas or systems which appear to be most vulnerable to the above changes.

The regional studies were intended to cover the marine environment and adjacent coastal areas influenced by or influencing the marine environment.

The studies were expected to be based on:

- the best available existing knowledge and insight into the problems relevant to the subject of the study;
- assumptions accepted at the UNEP/ICSU/WMO International Conference in Villach, 9-15 October 1985 (Bolin *et al.*, 1986), i.e. increased temperature of 1.5-4.5°C and sea level rise of 20-140 cm before the end of the 21st century (for the purposes of these studies a temperature increase of 1.5°C and a sea level rise of 20 cm by the year 2025 were accepted, with the understanding that these estimates may have to be revised on the basis of new scientific evidence); and
- several detailed case studies, which would constitute the substantive annexes of the studies.

At the Joint meeting of the Mediterranean Task Team and of the co-ordinators of the other five Task Teams following papers prepared by the Mediterranean Task Team members, were presented (Split, 3-8 October 1988) (UNEP, 1988a)

- Future climate of the Mediterranean Basin with particular emphasis on changes in precipitation;

- Predictions of relative coastal sea level change in the Mediterranean based on archaeological, historical and tide gauge data;

- Impact of a future rise in sea level on the coastal lowlands of the Mediterranean;

- Change in vegetation and land-use;

- Implications of climatic change for land degradation in the Mediterranean;

- Physical oceanography aspects and changes in circulation and stratification;

- Hydrological aspects and impact on fresh water resources;

- Effects of the sea-level rise on coastal ecosystems, including those under special protection, as well as on threatened and migratory species;

- Implications of climatic changes on the socio-economic activities in the Mediterranean coastal zone.

- Bibliography on effects of climatic change and related topics;

In addition, the following case studies were prepared and presented at the Split Meeting:

- Implications of climatic changes on the Nile Delta;

- Implications of climatic changes on the Po Delta and Venice Lagoon;

- Implications of climatic changes on the Gulf of Lion;

- Implications of climatic changes on the Ebro Delta;

- Implications of climatic changes on the Garaet el Ichkeul and Lac de Bizerte;

- Implications of climatic changes on the Inner Thermaikos Gulf;

After a thorough discussion, which followed the presentation of chapters and case studies, the following conclusions and recommendations were adopted (UNEP, 1988a; G. Sestini et al., 1989):

- a global mean eustatic rise in sea level of around 20 cm by 2025 would not, in itself, have a significant impact on the Mediterranean coasts, except in local situations (e.g. lagoons). However, local sea level changes could be up to five times this amount because of land subsidence and other factors. The negative effects of this impact will be greatest in low lying areas, deltas and coastal cities which are particularly vulnerable to climatic change. This vulnerability is increased by adverse socio-economic conditions, the effects of which will be superimposed upon those of climatic change. Governments should be aware of the increasing risk of catastrophic situations during the coming decades;

- there are still some uncertainties concerning climatic change in the Mediterranean and better assessments of the problem will be available not before 5-10 years. It is generally believed that in connection with an increase in temperature of 1.5°C by 2025, potential evapotranspiration will increase throughout the Mediterranean. There are also indications that there could be a decrease in precipitation in the southern part of the Mediterranean and an increase in the northern part;

- a 1.5°C increase in temperature would result in an increase of land degradation, a deterioration of water resources, a decline in agricultural production and damage to natural terrestrial and aquatic ecosystems. It could also alter marine circulation, both in the Mediterranean and the Atlantic, and thus affect marine productivity and the pattern of dispersal of pollutants;

- the future impacts of non-climatic factors on the society (e.g. population increases, present development plans) may far exceed the direct impacts of a change in climate. Non-climatic factors will cause continuous increases in society's vulnerability to climatic stress in the Mediterranean, particularly in the southern part. Both, non-climatic effects and changes in climate, will increase the probability of catastrophic impact events, and bring forward the date of their occurrence;

- in order to develop a strategy for responding to the impacts of the change, it is essential to identify those parts of the Mediterranean coastal regions where understanding of these impacts is still inadequate;

- more attention should be paid to the conservation of soil, groundwater and wetland resources in the Mediterranean because they contribute substantially to environmental stability. The overall adverse effects of large dam schemes and groundwater abstraction on the downstream human settlements and ecosystems and on the Mediterranean Sea itself have not been adequately considered in past planning. Future plans for large dams should be scrutinized more closely in the perspective of climatic change;

Taking into account the presentations relevant to the potential impact of climatic changes on the Mediterranean Basin and the discussions which followed, the meeting recommended:

- the development of a specific model (scenario) of climatic changes in the Mediterranean;

- analysis of:

    - the relations between local to regional scale weather and climate and larger scale features of the general circulation;

    - the frequency, patterns and mechanisms of cyclogenesis;

    - the trends in precipitation, potential evapotranspiration, etc; and

  - the frequencies of extreme events (high temperatures, high and low precipitation, storms and storm surges, etc.) and how these frequencies relate to mean climatic conditions in order to help in predicting future changes in extreme event probabilities;

- the study of trends in sea level by satellite imagery, additional tide level gauges and archaeological studies of constructions which were built in the past and are at present under the water;

- a comprehensive and quantitative review of the impact of climate change:

  - on the hydrology and water resources (including water quality) of the rivers feeding the Mediterranean Sea;

  - on the water (fresh/salt and Mediterranean/Atlantic) balance of the Mediterranean Sea; and

  - on the exploitation and future management of water resources in the Mediterranean Basin;

- field studies on the effects of climatic change on degradation of soils.

Chapter 8

COSTS OF POLLUTION CONTROL

There is no systematic study of the cost of pollution control in the marine environment in the Mediterranean.

In this chapter an attempt will be made to consider the cost of combating certain aspects of Mediterranean pollution; furthermore, some examples, for which information is available, will be given to illustrate the cost for preventing and combating pollution in the Mediterranean.

Treatment and disposal of sewage of Mediterranean coastal cities

The establishment of sewage treatment plants in all cities around the Mediterranean with a population of more than 100,000 and of appropriate outfalls and/or treatment plants for all towns with a population of more than 10,000 inhabitants is one of the ten targets specified in the Genoa Declaration on the Second Mediterranean Decade adopted by the Contracting Parties during their Genoa Meeting (UNEP, 1985a) (Table 82, Annex).

The objective here is to reduce substantially municipal pollution, since a high percentage of the sewage of Mediterranean coastal cities flows into the sea inadequately treated.

Recent examples (Marseilles, Barcelona, Istanbul) showed that the price of such initiatives is extremely high but that the results are quick and very encouraging.

According to the information available in the Mediterranean Co-ordinating Unit there are 539 Mediterranean coastal cities with a population of over 10,000. The total population of these cities is 48 million. The total coastal population of the Mediterranean is about 132 million, which means that about 37% of the coastal population lives in coastal settlements with more than 10,000 inhabitants.

In order to estimate the cost of the treatment and disposal of sewage of the Mediterranean coastal cities the following criteria were used:

- the cost of construction and maintainance of the sewage collection system was not considered;

- no attempt was made to identify cities which already have treatment plants and submarine outfalls; calculations were made on the assumption that treatment plants and submarine outfalls have to be constructed for all coastal cities;

- only cities with a population exceeding 10,000 were considered which means that 37% of the total coastal population (132 million) was considered;

- for cities with a population between 10,000 and 50,000 it was assumed that a primary treatment plant and a submarine outfall of adequate length will be constructed;

- for cities with a population of over 50,000 it was assumed that secondary treatment plants and submarine outfalls of adequate length will be constructed;

- the cost of construction, maintainance and depreciation of treatment plants was calculated for the year 1987. Calculations were done on the basis of the information received (Tedeschi, 1988) which included cost of construction of primary and secondary treatment plants (per capita), maintainance and depreciation (per capita per year) against population (between 5,000 and 1,000,000) expressed in Austrian schillings in 1973. An inflation factor (1987/1972) of 2.03 was used (as obtained from Austrian sources). The conversion of Austrian schillings into US dollars was based on the UN official exchange rate of 12.2 (Nov. 1987);

- the cost of construction of the submarine outfall for the primary and secondary treatment plants was calculated for the year 1987. Calculations were done on the basis of the information received (Tedeschi, 1988) which included cost of construction of the submarine outfall for the primary and secondary treatment plants (total, fixed and per capita) against population (between 5,000 and 1,00,000) expressed in Italian liras in 1972. An inflation factor (1987/1972) of 9.9 was used (as obtained from Italian sources). The conversion of Italian liras into US dollars was based on the UN official exchange rate of 1390 (Oct. 1987);

- for the cost of maintainance and depreciation the period of ten years was used;

- treatment cost, maintainance and depreciation for cities with a population of over one million inhabitants were calculated on the basis of the per capita cost for a population of one million, multiplied by the appropriate population number. Extrapolation from the graph was not possible as cost hit zero at an approximate population of two million.

On the basis of the above assumptions calculations were done for each of the 539 Mediterranean coastal cities with a population exceeding 10,000.

The results of the calculation of construction costs of treatment plants and submarine outfalls for each Mediterranean country are presented in the following Table:

CONSTRUCTION COSTS OF TREATMENT PLANTS AND SUBMARINE OUTFALLS

COUNTRY	NUMBER OF COASTAL CITIES	POPULATION (thousands)	TREATMENT PLANT CONSTRUCTION COST (thousands US$)
ALBANIA	4	146	24,820
ALGERIA	35	3,561	356,640
CYPRUS	4	255	39,200
EGYPT	11	3,637	238,710
FRANCE	36	2,798	328,620
GREECE	27	4,568	369,780
ISRAEL	15	1,454	193,820
ITALY	254	15,471	1,790,240
LEBANON	7	1,910	185,900
LIBYA	16	2,036	243,590
MALTA	11	155	26,500
MONACO	1	27	3,860
MOROCCO	3	519	64,170
SPAIN	62	5,767	621,180
SYRIA	4	394	50,020
TUNISIA	20	2,963	399,380
TURKEY	19	2,021	221,150
YUGOSLAVIA	10	585	82,210
TOTAL	539	48,267	5,139,790

The same calculations, but presented by population range, are given in the following Table:

CONSTRUCTION COSTS OF TREATMENT PLANTS AND SUBMARINE OUTFALLS

POPULATION RANGE	NUMBER OF COASTAL CITIES	TREATMENT PLANT CONSTRUCTION COSTS (thousands US$)
10,000 - 20,000	215	513,470
20,001 - 50,000	171	732,430
50,001 - 100,000	74	819,640
100,001 - 1,000,000	70	2,039,420
1,000,001 - 3,000,000	9	1,034,830
TOTAL	539	5,139,790

The above Tables show that the total cost for all cities with a population exceeding 10,000 comes to about US$ 5 billion.

The above estimates include only cities with a population of over 10,000; this means 48 million inhabitants, leaving 84 million out of these considerations. If it is assumed that half of the 84 million live in settlements of 5,000 to 10,000 inhabitants and if for the sake of calculation we further assume that the average population of this segment is 7,500 we arrive at the figure of 5,600 cities with a population of 42 million. For these 5,600 cities with an average population of 7,500, the total cost of construction, maintainance and depreciation of the primary treatment plants and adequate submarine outfalls would be about US$ 8.6 billion.

Assuming that the adequate disposal of sewage for settlements with a population of below 5,000 (42 million) would cost half of what it would cost for settlements with a population of 5,000 - 10,000, we arrive at a very rough estimate of about US$ 18 billion as the cost of treatment and disposal of sewage for the 132 million inhabitants of the Mediterranean coastal region.

Assuming further that the cost of a system on land for the collection of all sewage before treatment and disposal is at least as high as treatment and disposal, it can be estimated that the total cost of collection, treatment and disposal of sewage for the Mediterranean coastal settlements is in the order of US$ 36 billion. For a total Mediterranean population soon to reach 400 million this is an investment of US$ 100 per person to be spread over a 10 years period.

<u>Reception facilities for dirty ballast waters and other oily residues received from tankers and ships in ports of the Mediterranean</u>

This activity is one of the 10 targets specified in the Genoa Declaration on the Second Mediterranean Decade adopted by the Contracting Parties during their Genoa meeting (UNEP, 1985a) (Table 82, Annex).

Its objective is to prevent marine pollution by hydrocarbons caused by discharges from ships. This is a common UNEP/IMO goal. It is reflected in the Barcelona Convention (UNEP,1982) and the MARPOL 73/78 Convention which designated the Mediterranean Sea as a Special Area. The implementation of this activity is important since the majority of Mediterranean ports do not meet the MARPOL 73/78 requirements for reception facilities.

The MAP/UNEP secretariat submitted a document to the Fourth Ordinary Meeting of the Contracting Parties (UNEP, 1985a) with a projected cost of US$ 141 million (1984 prices) to cover 58 ports in the Mediterranran region.

The EEC response to the Genoa Declaration resulted in the implementation of two projects for floating reception facilities in Rijeka (Yugoslavia) and Patras (Greece).

Similar EEC initiatives are underway to install reception facilities in Port Said (Egypt) and Tunis (Tunisia). Other Mediterranean coastal States expressed their interest in this activity.

<u>Forest fires</u>

Forest fires are a very serious problem during the summer period in the Mediterranean Coastal region.

Available statistics for financial losses due to forest fires (Table 83, Annex), collected by the Blue Plan (UNEP, 1987b), show that reasonably good information exists only for Spain and Italy for the period 1979-1983. In that period losses due to forest fires for Spain were US$ 1.6 billion and for Italy US$ 192 million. Losses for France for the period 1979-1981 were US$ 439 million and for Turkey for the period 1981-1985 US$ 176 million.

On the other hand expenditures for investment in fire-fighting (Table 84, Annex) for the period 1978-1983 (information was not available for 1980) totalled US$ 189 million for Spain, US$ 55 million for Italy, US$ 146 million for France and US$ 258 million for Turkey (1981-1985).

For Spain, France, Italy and Turkey reported losses from forest fires were about US$ 2.4 billion and reported investment for fire-fighting about US$ 650 million. This means that the combined cost of financial losses and investment for fire-fighting stood at about US$ 3 billion.

Calculation of the average annual cost of losses from forest fires and investment in fire-fighting (on the basis of all reported data from Spain, Italy, France and Turkey, Tables 83 and 84, Annex) gives a figure of approximately US$ 670 million as the annual total for all mentioned countries.

Recovery and protection of the Po river

The Italian "Inter-regional Permanent Conference for the recovery and protection of the hydrographic basin of the Po river", whose members are the Prime Minister, the Ministers for Environment, Public Works, Agriculture and Health and the Presidents of the four regions involved (Lombardia, Piemonte, Emilia Romagna and Veneto) decided during a meeting on 18 October 1988, to distribute 300 billion liras (approximately US$ 220 million) among four regions involved in the clean-up operation for the recovery and protection of the hydrographic basin of the Po river. The funds have been earmarked for this activity by the 1988 Italian financial law and are now under discussion regarding practical implications and use.

The funds were agreed to be used for five types of interventions: treatment of organic pollutants, reduction of polluting discharges coming from animal farms, protection of drinking water reservoirs, proper utilization of protected areas and definition of the plan for the recovery and disposal of wastes.

The meeting also discussed the content of a long-term plan for the recovery of the basin which should be ready by mid 1989. The funds which should be made available for 1989-1991 are about 730 billion liras for 1989 (approximately US$ 530 million), 1170 billion liras for 1990 (approximately US$ 850 million) and 1150 billion liras for 1991 (approximately US$ 830 million). In the implementation of the plan, full coordination with the ongoing sub-regional activities related to the eutrophication problems of the Adriatic was considered essential for its success.

In summary, Italy is planning to spend about US$ 2.4 billion over the period 1988 to 1991 for the recovery and protection of the Po river.

Chapter 9

SUMMARY

The Mediterranean Sea is a semi-enclosed water body with a surface area of 2.5 million km^2, an average depth of 1.5 km and a volume of 3.7 million km^3. Its coastal population is about 130 million and additionally as one of the leading resort areas in the world, hosts more than 100 million tourists every year. Consequently, it serves, at a steadily growing pace, as the recipient of a multitude of waste discharges from residential areas, touristic complexes and industrial activities.

a. Marine contaminants

The two indicator organisms (Mytilus galloprovincialis and Mullus barbatus) of the MED POL programme had the following over-all concentration mean and ranges (ug element kg^{-1} FW):

	M. galloprovincialis		M. barbatus	
	mean	range	mean	range
Cd	120	5 - 1060	34	1 - 590
Cu	1300	70 - 6000	400	2.5 - 2700
Pb	800	50 - 16100	70	25 - 610
Zn	27000	2500 - 97700	3900	100 - 7400
Hg	230	4 - 7000	695	2 - 7900

With the exception of mercury concentration which increases with age of the specimen and position in the foodchain, mussels had higher trace metal concentrations than the red mullet.

In the two indicator organisms the overall weighted mean and the ranges (ug chlorinated hydrocarbon (kg^{-1} FW) were the following:

	M. galloprovincialis		M. barbatus	
	mean	range	mean	range
PCBs	100	5 - 2622	275	ndc - 8000
pp/DDT	9	ndc - 1015	22	ndc - 205
pp/DDD	13	ndc - 440	13	ndc - 180
dieldrin	0.9	0.1- 56	205	ndc - 35

The asymetric distribution of the ranges about the mean indicate "hot spots".

Due to the lack of reference standards and the use of different analytical methods, the concentrations of trace metals and of chlorinated hydrocarbons in seawater and sediments must be considered with caution and typical concentrations cannot be identified. The concentrations of trace metals and of chlorinated hydrocarbons in biota are more secure because extensive intercalibrations have been carried out.

The concentrations of petroleum hydrocarbons in sea water, sediments and organisms vary over a wide range. Part of this variability must be attributed to methodological difficulties in determining the actual concentrations present. There seems to be a tendency that recent determinations resulted in lower levels. However, the great variability of the data and the not uniform geographic distribution of the data do not allow a statistical treatment of the results obtained so far. Especially, the data base on petroleum hydrocarbons in sediments and organisms is very limited.

Thirty collaborating national laboratories monitored the microbiological quality of coastal recreational waters between 1976 and 1981. The areas surveyed were scattered, and located irregularly mainly in the northern part of the regional coastline. A total of 12,500 samples were taken and 80% of the 313 stations monitored were found to comply with the WHO/UNEP interim criteria developed, insofar as faecal coliform concentrations were concerned (not more than 100 FC per 100 ml in 50% of the samples and not more than 1000 FC per 100 ml in 90% of the samples) (UNEP/WHO, 1985).

Because of the relatively small number of recreational areas monitored in relation to the total existing in the region, as well as their uneven geographical distribution, conclusions drawn from evaluation of data cannot be extrapolated to other areas, nor can they be taken as in any way representative of conditions prevailing in the region as a whole. They do provide an indication of the microbiological quality of recreational waters in specific localities prevalent during the period under review and also should be viewed within the proper context of the pilot nature of the exercise in question.

Evaluation of the results of monitoring of microbial pollution of shellfish and shellfish-growing waters in 17 shellfish areas in the Mediterranean, carried out by 6 collaborating national laboratories between 1976 and 1981, showed that, for stations with at least 10 analyses per year, 63% of these were satisfactory in terms of compliance with the interim criteria developed by WHO/UNEP for water quality (below 10 FC per 100 ml in 80% of the samples, and below 100 FC per 100 ml in the remaining 20%). However, only 7% complied with the criteria for shellfish quality (not more than 2 FC per gram of flesh). The stations cannot be considered as representative of Mediterranean shellfish areas in general, nor can the percentage compliance figures be taken as any indication of the overall regional situation. The data, however, demonstrate the more restrictive nature of shellfish criteria as opposed to those for water quality and that only a very small amount of shellfish can be safely sold without further purification (review: UNEP/WHO, 1986).

b. Human activities affecting the sea

The only comprehensive survey of pollution of the Mediterranean Sea from Land-based sources was made in 1977 (UNEP/ECE/UNIDO/FAO/UNESCO/WHO/IAEA, 1984). As far as volumes are concerned a total discharge of 420 x 10^9 m^3 yr^{-1} is noted from rivers, 2 x 10^9 m^3 yr^{-1} from domestic and 6 x 10^9 m^3 yr^{-1} for industrial polluters. Touristic activities in the region are evaluated to yield about 0.35 x 10^9 m^3 yr^{-1} of waste water (UNEP, 1987).

For the load of organic matter, expressed in terms of biochemical and chemical oxygen demand, about 60 to 65% of the total load is generated from coastal sources while the rest is due to river discharges. Of the 1500 x 10^3 t yr^{-1} of biochemical oxygen demand in the coastal area, 900 x 10^3 t is associated with industrial sources, only 500 x 10^3 t yr^{-1} is found to be of domestic origin and the rest is attributed to agricultural run-offs. The latter and the river discharges are the major sources for phosphorus and nitrogen loads totalling 1400 t yr^{-1}.

The detergent load of 60 x 10^3 t yr^{-1} is largely due to household uses. Approximately 1/3 of this total input derives from coastal zones and 2/3 from inland zones via rivers.

The total load of persistent organochlorine compounds carried out by surface run-off directly or through rivers into the Mediterranean Sea was estimated by survey as 90 t yr^{-1} and by similar study of FAO (UNEP, 1987) as 570 t yr^{-1}.

It is estimated (UNEP/IMO/IOC, 1987) that 635,000 tonnes of petroleum hydrocarbons reach the Mediterranean Sea per year out of which 330,000 tonnes as spilled oil from tankers, ballasting and loading operations, bilge and tank washings, 270,000 tonnes as land-based discharges (160,000 from municipal and 110,000 from industrial sources) and 35,000 tonnes as atmospheric deposition.

Oil spillages have been reported in 101 cases (46 operational and 55 accidents) in the period from 1977 to 1987, with four major spills.

Eighteen countries lie along the shore of the Mediterranean and their littoral regions are under the immediate influence of the Mediterranean Sea and also directly influence the sea environment.

The total number of inhabitants in the 18 states surrounding the Mediterranean Sea amounted to 351 million in 1985, 132 million of this number living in the coastal area (UNEP, 1987a). The tendency of growth of the number of inhabitants on the shores of the Mediterranean is very pronounced in eastern and southern Mediterranean countries. According to one average projection, the population in the Mediterranean can be expected to grow from 323 million in 1980 to 433 million in the year 2000 and 547 million in 2025 (UNEP, 1987a).

The Mediterranean region is the greatest tourist destination region in the world. The total number of international (107 million, Table 42, Annex; UNEP, 1987a) and domestic tourists in the Mediterranean countries as a whole in 1984 amounted to some 213 million realizing a total of 4,209 million overnight stays. Receipts and expenditures due to such flow of tourists is shown in Tables 43 and 44 (Annex) (UNEP, 1987a).

In the coastal region in 1984 number of domestic and international tourists amounted to 97 million persons (52 million international and 45 million domestic) realizing 1,400 million overnights and according to the various scenarios, these figures will increase to between 121.4 and 184.3 million tourists by the year 2000 with a corresponding number of overnights of between 1,712 and 2,731 million. The estimates for the year 2025 range from a low of 173 million tourists and a high of 341 million, with the number of overnights ranging between 2,081 and 4,838 million (UNEP, 1987).

The Mediterranean fisheries produce about 800,000 tonnes of fish or 1% of the world's fish production. The value of this production is however high reaching about 5% of that of the total world catch.

c. Biological effects

Eutrophication, as reported for embayments and estuaries around the Mediterranean, is mostly associated with the release of untreated domestic/industrial waste water. Eutrophication is a local rather than a regional problem in the Mediterranean Sea. It is frequent in the north Adriatic, Izmir Bay, Elefsis Bay, the lagoon of Tunis and in all such areas where the rate of input of domestic-industrial waste water exceeds that of the exchange with the open sea. The main symptoms consist in the disruption of the community structure, the excessive macro- and micro-algal production and the development of anoxicity in the subsurface layer. The open-sea oligotrophic Mediterranean waters, however, remain in sharp contrast with the conditions prevailing in its peripheral embayments.

Long-term build-up and the consequences of man-made alterations of the environment can only be assessed where long term investigations provide conclusive observations on populations and community structure. Although an enormous amount of data on pollution in the Mediterranean Sea has been coming out in the last decade, an assessment of the effects of long term accumulation of pollutants remains faced with several constraints. Most of the results obtained provide data on pollutant levels in fish, bivalves and crustacenas and much less on pollution impact on communities and populations. The areas where such investigations have been carried out are geographically scattered and separated by large gaps. Information is increasing about a limited number of coastal localities, while vast areas, including the whole deep Mediterranean basin, remain poorly investigated.

All confined or semi-confined Mediterranean localities adjacent to large urban centres appear to be the site of progressive build-up of pollution, as a result of continued uncontrolled anthropogenic release. This is observable in the Bay of Algiers, the "lac" of Tunis, the Bay of Abu-Kir near Alexandria, the Bay of Izmir in Turkey, the north Adriatic, the coastal belt along the north coast of the West Mediterranean.

Profound and irreversible perturbations of the ecosystem and the biological economy of the Levantine Sea were caused by two man-made alterations of the environment: the opening of the Suez Canal in 1869 and the damming of the river Nile in 1965. Since the opening of the Canal, about 170 Indo-Pacific species have successfully established themselves in the East Mediterranean basin. The damming of the river and the subsequent reduction of its outflow to 5-7% resulted in a drastic reduction in the primary productivity and in a general impoverishment, particularly in the fisheries yield. The Sardinella landings dropped to about 2-5%.

The complexity of habitats is such that it is often essential to have baseline information to evaluate the degree of recovery of a damaged habitat. For much of the Mediterranean and more so for the coasts of developing countries such information is limited or non existent. Nonetheless, there is some evidence that the recovery of at least certain habitats is possible. The speed of recovery, however, may vary significantly depending on the habitat and on environmental conditions. Undoubtedly the recovery of habitats is dependant on the extent of the damaged, in terms of the degree of damage and the area affected. Two examples of recovery are presented in Chapter 4(d) of this report.

As in other regions, the main human health problems associated with marine pollution in the Mediterranean arise from contact with polluted water and/or sand in bathing beaches and consumption of chemically or microbiologically contaminated seafood. In the case of bathing beaches, the general situation has improved during the last decade as a result of the stricter enforcement of acceptable water quality standards in a number of countries coupled with measures to reduce sewage pollution at source. However, hard epidemiological evidence is still required for the exact correlation of water quality with observed adverse health effects, especially in relation to those non-gastrointestinal diseases where so far incidence appears to be unrelated to the concentrations of indicator organisms currently being monitored in coastal waters.

The situation regarding microbiological contamination of shellfish has similarly improved through stricter control measures enforced by the main shellfish-producing countries in the region. At overall level, however, there is still a wide variation in monitoring requirements in terms of mandatory parameters, and there are also (as is the case with recreational waters) a number of methodological problems in seawater analysis and pathogen/indicator relationships which still have to be solved.

Adverse health effects through consumption of chemically contaminated seafood appear to be restricted to relatively heavy seafood consumers. The range and level of such effects still has to be determined, not only in cases such as mercury where the main source is seafood, but also for other contaminants where intake through seafood consumption, when combined with that from other staple food-sources may result in excesses over tolerable intake levels.

d. Prevention and control strategies in the frame of the Mediterranean Action Plan

The Mediterranean region was selected by UNEP as a high priority area and the Mediterranean Action Plan formally adopted by the Governments of the region in Barcelona in 1975.

The Mediterranean Action Plan (UNEP, 1985b) aims at protecting the interests of the governments of the region through the indentification and solution of common environmental problems while respecting the particular requirements of each individual country. For action at joint regional level 17 Mediterranean countries (all except Albania) and EEC have ratified the Convention for the protection of the Mediterranean Sea agans pollution (Barcelona Convention), which provides the framework for legal agreements covering specific pollution prevention and control aspects.

The strategy for enabling implementation of the convention and related protocols (four are currently in force), particularly the specific aspects of the latter, in the various countries, is to provide detailed assessments and evaluations of the situation in the Mediterranean with regard to specific pollutants and to recommend joint measures to be adopted and implemented by governments. This is particularly important with regard to the land-based sources protocol, which binds the Parties to formulate and develop such measures (UNEP, 1982).

e. Implications of climatic changes in the Mediterranean region

The problem of implications of climatic changes was studied in the Mediterranean and a set of 15 papers were prepared of which six deal with particular Mediterranean localities (deltas of the rivers Ebro, Nile, Po and Rhone, the Thermaikos Gulf and the Ischkeul/Bizerte lakes).

The general conclusion of these studies is that a global mean eustatic rise in sea level of around 20 cm by 2025 would not, in itself, have a significant impact on the Mediterranean coasts, except in local situations (e.g. lagoons). However, local sea level changes could be up to five times this amount because of land subsidence and other factors. The negative effects of this impact would be greatest in low lying areas, deltas and coastal cities which are particularly vulnerable to climatic change. This vulnerability is increased by adverse socio-economic conditions, the effects of which will be superimposed upon those of climatic change. Governments should be aware of the increasing risk of catastrophic situations during the coming decades. The future impacts of non-climatic factors on the society (e.g. population increases, present development plans) may far exceed the direct impacts of a change in climate. Non-climatic factors will cause continuous increases in society's vulnerability to climatic stress in the Mediterranean, particularly in the southern part. Both, non-climatic effects and changes in climate, will increase the probability of catastrophic impact events, and bring forward the date of their occurrence.

f. Cost of pollution control

There is no systematic study of the cost of pollution control in the Mediterranean marine environment, but an attempt was made to consider the cost of combating certain aspects of Mediterranean pollution.

The total cost of collection, sewage treatment and disposal for Mediterranen coastal population is estimated at US$ 36 billions.

The cost of establishing reception facilities for dirty ballast waters and other oily residues received from tankers and ships in ports of the Mediterranean is estimated at about US$ 140 millions.

Calculation of the average annual cost of losses from forest fires and investment in fire-fighting (on the basis of all reported data from Spain, Italy, France and Turkey) gives a figure of approximately US$ 670 millions.

REFERENCES

Alpha, M., C. Caristi, G. Cimino and M. Zino (1982), Heavy metals in Ionian and Tyrrhenian waters from a section of the Sicilian coast. Mar. Poll. Bull., 13:399-400.

Ardizzone, G.D. and P. Pelusi (1984), Yield and damage evaluation of Bottom Trawling on Posidonia Meadows. In GIS POSIDONIA PUBL. FR. Boudouresgue C.F., A. Jeudy de Grissac and J. Oliver (Eds.), pp. 63-72.

Arnold, M., A. Seghaier, D. Martin, P. Buat-Menard and R. Chesselet (1983), Géochimie de l'aérosol marin au-dessus de la Méditerranée occidentale. Journ.Etud.Pollut.CIESM., 6(1982):27-37.

Arnoux, A., H. Chamley, D. Bellan-Santini, J. Tatossian et C. Diana (1983), Etude minéralogique et chimique des sédiments profonds de la Méditerranée occidentale (Mission BIOMEDE II). Journ.Etud.Pollut.CIESM., 6(1982):385-394.

Arnoux, A., G. Stora and C. Diana (1985), In situ Experimental Study of the Evolution and Recolonisation of Polluted sediments. Mar. Pollut. Bull., 16 (8):313-8.

Astier-Dumas, M. and G. Cumont (1975), Consommation hebdomadaire de poisson et teneur du sang et des cheveux en mercure en France. Ann. Hyg. L. Fr. - Med. et Nut. 11:135.

Aston, S. R. and S. W. Fowler (1985), Mercury in the open Mediterranean: evidence of contamination. Science Total Environment, 43:13-26.

Aston, S. R., S. W. Fowler and N. Whitehead (1986), Mercury biogeochemistry in the Mediterranean marine environment; an assessment of contamination. In: FAO/UNEP/WHO/IOC/IAEA Meeting on the biogeochemical cycle of mercury in the Mediterranean (Siena,27-31 August 1984). Rome: FAO Fish. Rep. (325) Suppl. pp. 8-20.

Augris, C. and A. P. Cressard (1981), Les granulats du plateau continental. "La Gestion Régionale Sédiments", Sém. Nat., Doc. Bur. Rech. Géol. et Min. (BRGM, Orléans); 30; 29-33.

Axiak, V. and F.S. Civili (1986), The MED POL Jelly-fish programme. A review Rapp. Comm. int. Mer Méditerranée, 30 (2).

Bacci, E., G. Angotzi, A. Bralia, L. Lampariello and E. Zanette (1976), Etude sur une population humaine exposée au methylmercure par la consommation de poisson. Rev. Inter. Oceanogr. Medicale 41/42:127-141.

Bacci, E., F. Baldi, R. Bargagli and C. Gaggi (1986), Recovery trends in a mercury polluted marine area. Papers presented at the FAO/UNEP/WHO/IOC/IAEA Meeting on the Biogeochemical Cycle of Mercury in the Mediterranean. Siena, Italy, 27-31 Aug. 1984. FAO Fish. Rep. (325) Suppl., pp.20-28.

Baker, C. W. (1977), Mercury in surface waters of seas around the United Kingdom. Nature 270:230-232.

Baker, J.M. (1983), Impact of oil pollution on living resources. The Environmentalist 3, Suppl. No.4.

Balas, D. (1984), Méthodes de production de sel marin et de dérivés bromés et magnésiens à partir des marais salans. Centre Océanol. Bretagne, Brest; Groupe Et. et Rech. Minéralisat. au Large; 2e sém.; 341-357.

Ballestra, S., E. Holm, A. Walton and N.E. Whitehead (1987), Fallout deposition at Monaco following the Chernobyl accident. J. Environ. Radioactivity, 5, pp. 391-400.

Barghigiani, C., R. Ferrara, A. Seritti, A. Petrosino, A. Masoni and E. Morelli (1981), Determination of reactive, total and particulate mercury in the coastal waters of Tuscany (Italy) by atomic fluorescence spectrometry. Journ.Etud.Pollut.CIESM., 5(1980):127-130.

Bellan, G. (1985), Effects of pollution and man-made modifications on marine benthic communities in the Mediterranean: A Review. In: M.Moraitou-Apostolopoulou and V. Kiortsis (Eds.), Mediterranean Marine Ecosystems, Plenum Press, New York, pp. 163-194.

Bergier, J.F. and A. Hahling (1982), Une histoire de sel. Product. Office du Livre, Fribourg; Presse universit. France; 250p.

Bernardi, S., F. Costa, S. Vazzoler, Z. Vincenzi, R. Cecchi, G. Ghermandi, and G. Magnoni (1985), Lagoon of Venice: Fresh water and pollutant transfer. Journ.Etud.Pollut.CIESM., 7(1984):91-97.

Bernhard, M. (1983), Levels of trace metals in the Mediterranean. Journ.Etud.Pollut.CIESM., 6(1982):237-243.

Bernhard, M. (1985), Mercury accumulation in a pelagic foodchain. In: Environmental Inorganic Chemistry, Matertell, A. E. and K. J. Irgolic, (Eds.) Weinhein: Verlag Chemie. pp. 349-358.

Bernhard, M. and A. Renzoni (1977), Mercury concentration in Mediterranean marine organisms and their environment: natural or anthropogenic origin. Thalassia Jugosl., 13:265-300.

Bigot, L., P. Grossoni and R. Gellini (1987), La frange de contact entre la terre et la mer. Bull. d'Ecologie, 18/2, Soc. d'Ecologie, Colloque Int. "Ecologie Littorale Mediterranéenne", Marseille-Luminy, 1986, pp. 221-222.

Blanc, J. (1977), Recherches de sédimentologie appliquée au littoral du Delta du Rhône. Centre nat. pour Exploit. des Océans, Paris XVIe, et Centre Universitaire Luminy-Marseille. 69p.

Bloom, N. and E. A. Crecelius (1983), Determination of mercury in seawater at sub-nanogram per liter levels. Mar. Chem. 14:49-59.

Bolin, B., B.R. Doos, J. Jager and R.A. Warrick (Eds) (1986), The greenhouse effect, climate change and ecosystems, Scope 29, J. Wiley and Sons, Chichester.

Bonvicini Pagliai, A.M., A.M. Cognetti Varniale, R. Crema, M. Curini Galletti and R. Vandini Zunarelli (1985), Environmental impact of extensive dredging in a coastal marine area. Mar. Poll. Bull. 16:483-488.

Bouvier Y. and J.P. Content (1986), A la poursuite du corail rouge, Greenpeace Bulletin (Paris), 26:4-5.

Breder, R., H. W. Nuernberg and M. Stoeppler (1981), Toxic trace metal levels in water and sediments from the estuaries of the Southern Ligurian and Northern Tyrrhenian coasts: a comparative study. Journ.Etud.Pollut.CIESM., 5(1980):285-292.

Briggs, J.C. (1974), Marine Zoogeography, McGraw-Hill, New York.

Brondi, M., R. Gradiani, C. Minguzzi and C. Orlandi (1986), Distribuzione degli elementi in tracce nel Golfo di Taranto. Zn, Cu, Pb, Cd, Cr, V, Mo, Ni, Co, Hg, Mn, Fe, U, ^{226}Ra, ^{210}Po nelle acque e nel particolato dell'ambiente marino costiero dei fiumi principali. In: Evoluzione dei litorali (Atti del Convegno) ENEA, pp.387-400.

Buat-Menard, P., M. Arnold, D. Baron, H. Benard and R. Chesselet (1981), Particulate trace metal chemistry in the open and the Western Mediterranean: a comparative study. Journ.Etud.Pollut.CIESM., 5(1980):1003-1009.

Buffoni, G., M. Bernhard and A. Renzoni (1982), Mercury in Mediterranean tuna. Why is their level higher than in Atlantic tuna? A model. Thalassia Jugosl. 18:231-243.

Capelli, R., V. Minganti and M. Bernhard (1986), Total mercury, organic mercury, copper, manganese, selenium, and zinc in Sarda sarda from the Gulf of Genoa. Sci. Total Environ., 63: 83-99.

Carter, D.B. (1956), The Water Balance of the Mediterranean and Black Sea. Publications in Climatology. 9 (3):127-174.

Caye, G. (1980), Sur la morphogénèse et le cycle végétatif de Posidonia oceanica (L.) Dalila. Thèse 3e cycle, Université d'Aix-Marseille II, 121 p.

Cerrati, G. (1987), Determinazione del mercurio oganico ed inorganico nel muscolo del fegato e nel cervello di organismi appartenenti ad une catena alimentare pelagica tramite spettrofotometria ad assorbimento atomico con fornetto di grafite e speciazione del mercurio organico per via gas-chromatografica. Thesis, Univ. Pisa.

Charbonnier D. and S. Garcia (Eds.) (1984), Small Report of the GFCM Technical Consultation on red coral resources of the Western Mediterranean and their rational exploitation. Palma de Mallorca, Spain, 13-16 December, 1983, FAO. Fisheries Report. (306):142p.

Copin-Montegut, G., P. Courau and E. Nicolas (1985), Distribution et transferts d'éléments traces en Mediterranée occidentale. Nouveaux resultats Phycomed. Journ.Etud.Pollut.CIESM., 7(1984):111-117.

Copin-Montegut, G., P. Courau and F. Laumond (1986), Occurrence of mercury in the atmosphere and waters of the Mediterranean. In: Meeting on the biogeochemical cycle of mercury in the Mediterranean. Rome: FAO Fish. Rep. No,. 325 suppl. FIPL/R325 (Suppl.) pp. 51-57.

Courau, P., F. Fernex and J. Poutiers (1973), Comportement d'un effluent en mer. Le cas du rejet de la Cassidaigne. In: Actes, 98e Congrès national des Sociétés savantes, Saint Etienne, pp. 121-129.

Cruzado, A. (1985), Chemistry of Mediterranean Waters. In: R. Margalef (Ed.), Western Mediterranean, Pergamon Press, Oxford, pp. 126-147.

Curini-Galletti, M.C. (1987), Recovery of a soft bottom community after extensive dredging I. Mollusca. In FAO Fish. Rep./FAO Rapp. Pêches (352) Suppl.: pp. 54-63.

Dalziel, J. A. and P. A. Yeats (1985), Reactive mercury in the Central North Atlantic Ocean. Mar. Chem., 15:357-361.

Diaz-Castaneda, V. (1986), Etude expérimentale de la recolonisation par des populations annélidiennes de substrats meubles pollués en Méditerranée. Rapp. Comm. internat. Mer Méditerranée, 30(2): 21p.

EEC (1984), Engineering Equipment and Automation Means for Waste Water Management in EEC Countries, UN, New York, 111 p.

EEC (1988), Quality of Bathing Waters 1983-1986, Fifth Report, Office for Official Publications of the European Communities, Luxembourg.

Elder, D. L. and J.P. Villeneuve (1977), Polychlorinated biphenyls in the Mediterranean Sea. Mar. Pollut. Bull. 8:19-22.

Estrada, M., F. Vives and M. Alcaraz (1985), Life and productivity of the open sea. In: R. Margalef (Ed.), Western Mediterranean, Pergamon Press, Oxford, pp. 148-197.

FAO (1978), Fisheries Report (204), Report of the Seventh Session of the Working Party on Resources Appraisal and Fishery Statistics of the General Fisheries Council for the Mediterranean (GFCM), Rome 30 Jan.-3 Febr. 141p.

FAO (1987), Marine Resources Service, Fishery Resources and Environment Division, Review of the state of world fishery resources. FAO Fish. Circ. (710) Rev. 5: 64p.

Fernex, F. and A. Added (1982), Travaux de Géochimie des Sédiments superficiels autour de la Partie supérieure du Canyon de la Cassidaigne, Laboratoire géodynamique sous-marine, Villefranche-sur-Mer.

Ferrara, R., A. Seritti, C. Barghigiani and A. Petrosino (1986), Mercury levels in the dissolved and particulate fractions of the Tyrrhenian Sea. Mar. Chem., 18:227-232.

Fisher, W., M.-L. Bauchot et M. Schneider (rédacteurs) (1987), Fiches FAO d'identification des espèces pour les besoins de la pêche. (Révision 1). Méditerranée et Mer Noire. Zone de pêche 37, Volume I. Végétaux et Invertébrés. Volume II. Vertébrés. Publication préparée par la FAO et la Commission des Communautés Européennes (Projet GCP/INT/422/EEC) financée conjointement par ces deux organisations. Rome, FAO. Vol. 1: 760p; Vol. 2: 761-1530.

Fitzgerald, W. F., G. A. Gill and A. D. Hewitt (1983), Air-sea exchange of mercury In: Trace elements in sea water. Wong, C. S., E. Boyle, K. W. Bruland, J. D. Burton and E. D. Goldberg, (Eds.). New York: Plenium Press pp. 297-315.

Fowler, S. W., B. Oregoni and J. LaRosa, (1976), Trace metals in pelagic organisms from the Mediterranean Sea. In: Activities of the Intern. Lab. Marine Radioactivity. Annual Rep. 1976 IAEA-187. Vienna: IAEA. pp. 110-121.

Fowler, S. W. (1985), Trace metal monitoring of pelagic organisms from the open Mediterranean Sea. In: Intern. Symp. Integrated Global Ocean Monitoring (MONOC) Tallin, USSR, 2-8 October 1983.

Fowler, S. W. (1985a), Assessing pollution in the Mediterranean Sea, In: Pollutants and their ecotoxicological significance. H. W. Nuernberg (Ed.), Chichester, Wiley, pp. 269-287.

Fowler, S. W. (1986), PCBs and the Environment.The Mediterranean marine ecosystem, In: PCBs and the environment, J.S. Waid (Ed.) Vol.3, Ch.8, CRC Press Inc., Boca Raton, Fl., pp. 209-239.

Fujita, M. and K. Iwashima (1981), Estimation of organic and total mercury in seawater around the Japanese Archipelago. Env. Sci. Technol., 15:929-933.

Fukai, R. and L. Huynh-Ngoc (1976), Trace metals in Mediterranean sea water. In: Activities of the Intern. Lab. Marine Radioactivity. Annual Rep. 1976 IAEA-187. Vienna: IAEA. pp. 122-132.

Fukai, R., D. L. Elder, B. Oregioni, D. Vas and J. P. Villeneuve (1979), Mediterranean intercalibration on trace element and chlorinated hydrocarbon measurements. Journ.Etud.Pollut.CIESM., 7(1984):595-598.

Fukai, R., S. Ballestra, M. Thein and J. Guion (1981), Input of transuranic elements through rivers into the Mediterranean Sea. Impacts of Radionuclide Releases into the Marine Environment. IAEA, Vienna.

Fukai, R., B. Oregioni and D. Vas (1978), Interlaboratory comparability of measurements of trace elements in marine organisms: results of intercalibration exercise on oyster homogenate. Oceanol. Acta., 1:391-396.

Fytianos, K. and G. S. Vasilikiotis (1983), Concentration of heavy metals in seawater and sediments from the northern Aegean Sea, Greece. Journ.Etud.Pollut.CIESM., 6(1982):151-155.

Gambi, N.C., E. Fresiaud and A. Giangrande (1982), Deserttor efficaci di cominita benthoniche, Nat. Sicil., 6 (Suppl.): 489-9.

Garcia S. and A. Demetropoulos (1986), Management of Cyprus Fisheries, FAO Fish. Tech. Pap. (250): 40p.

Gellini, R., F. Pantani, P. Grossoni and F. Bussotti (1987), L'influence de la Pollution Marine sur la végétation cotière italienne. Bull. Ecol. 182(2), pp. 213-219. Paris.

GESAMP (1982), The health of the oceans, UNEP Regional Seas Reports and Studies No.16, UNEP.

Ghirardelli, E., G. Giaccone and G. Orel (1974), Evolution des peuplements benthiques du Golfe de Trieste. Rev. Intern. Océanogr. Méd., 35-36:111-113.

Gill, G. A. and W. F. Fitzgerald (1985), Mercury sampling of open ocean waters at the picomolar level. Deep-Sea Res., 32:287-297.

Hadjichristophorou M. and A. Demetropoulos (1988) (in preparation), Final Report of Thermal Effluents on the Littoral Benthic and Fish Communities in the Vassiliko-Moni area. (MED POL Research Project).

Halim, Y. (1960), Observations on the Nile bloom of Phytoplankton in the Mediterranean. Jour. du Conseil Int. Explo. Mer, 26 (1): 57-67.

Halim, Y. (1974), The Nile and the East Levantine Sea, Past and Present. In: Recent Researches in Estuarine Biology. R. Natarajan (Ed.), New Delhi, pp. 76-84.

Halim Y., K. Guerguess Shoukry and H. H. Saleh (1967), Hydrographic conditions and plankton in the South East Mediterranean during the last normal Nile flood (1964). Int. Revue ges. Hydrobiol., 52 (3): 401-425.

Hamza, A. and J.D. Gallup (1983), Management of Industrial Solid Wastes in Alexandria, Egypt, Unpublished paper, 24 pp.

Hemer D. O. and K. H. Gohrbandt (1986), Oil and Gas Development in the Middle East in 1985. American Ass. Petroleum Geologists; 70:10; 1458-1478.

Holm, E., S. Ballestra and N.E. Whitehead (1988), Radionuclides in macroalgae at Monaco following the Chernobyl accident. Presented at Intern. Conf. on Environm., Radioactivity in the Medit. Area, Barcelona, May 1988.

Holm, E., R. Fukai and N.E. Whitehead (1988a), Radiocesium and transuranium elements in the Mediterranean Sea: Sources, inventories and environmental levels. Presented at Intern. Conf. on Environm., Radioactivity in the Medit. Area, Barcelona, May 1988.

Hopkins, T.S. (1985), Physics of the Sea. In: R. Margalef (Ed.), Western Mediterranean, Pergamon Press, Oxford, pp. 100-125.

Ho, R., J. C. Marty and A. Saliot (1983), Les hydrocarbures à l'interface air-mer en Mediterranée occidentale, 1981. Journ.Etud.Pollut.CIESM., 6(1982): 39-45.

Huynh-Ngoc, L. and R. Fukai (1979), Levels of trace metals in open Mediterranean surface waters - a summary report. Journ.Etud.Pollut.CIESM., 6(1982): 171-175.

IAEA (1978), Trace element measurements on sea plant (SP-M-1) and copepod (MA-A-1) (Supplement). Progr. Rep. no. 19. Intercalibration on analytical methods on marine environmental samples. Monaco: Intern. Lab. Marine Radioactivity (mimeographed).

IAEA (1980), Trace element measurements on fish-flesh sample (MA-A-2) (Supplement). Progr. Rep. no. 20. Intercalibration on analytical methods on marine environmental samples. Monaco: Intern. Lab. Marine Radioactivity (mimeographed).

IAEA (1985), Intercalibration of analytical methods on marine environmental samples. Trace element measurements on mussel homogenate (MA-M-2/TM). Monaco: IAEA Report no. 26 (IAEA/R1/126).

ICES (1974), Final Report of a Working Group for the international study of the pollution of the North Sea and its effects on living resources and their exploitation. Coop. Res. Rep. ICES no. 39.

ICES (1977a), The ICES co-ordinated monitoring programmes 1976 and 1977. Coop. Res. Rep. ICES no. 72.

ICES (1977b), The ICES Co-ordinated monitoring programme in the North Sea, Coop. Res. Rep. ICES no. 58.

IHP/MED/3 (1978), Water Balance of the Mediterranean Basin (prepared by the UNESCO Secretariat). Meeting of National Committees for the International Hydrological Programme of the Mediterranean Countries, Rome, 9-13 Oct. 1978. Mimeographed.

IMCO (1981), Petroleum in the marine environment. Inputs of petroleum hydrocarbon in the ocean due to marine transportation activities. Intergovernmental Maritime Consultative Organization.

IOC (1981), Global oil pollution. The IGOSS Pilot Project on Marine Pollution (Petroleum) Monitoring. (Levy, E.M., Ehrhardt, M., Kohnke, D., Sobtchenko, E., Suzuoki, T., Tokuhiro, A.) Intergovernmental Oceanographic Commission, Paris.

Jacques, G. and A. Sournia (1980), Red waters, due to phytoplankton in the Mediterranean Sea. Vie Milieu (A, B Biol. Mar., Oceanogr.) V.28-29 (2), pp.157-187.

Jeffery, P.G. (1974), Marine pollution from ships: Sources, effects and preventive measures. In: Proceedings of the Interparliamentary Conference of Coastal States on the Control of Pollution in the Mediterranean Sea (Camera dei Deputati, Rome), 5 p.

Kavasogullari, M., D. Orhon and A. Samsunlu (1987), Controlling Pollution from Land-Based Sources in the Turkish Mediterranean Coast - Legislative Aspects., Int. Symp. on Environmental Pollution and its Impact on Life in the Mediterranean Region, 6 - 11 September, Kavala, Greece.

Knauer, G. A. and J. M. Martin (1972), Mercury in a marine pelagic food chain. Limnol. Oceanogr. 17:868-876.

Kocatas A. (1978), Distribucion et évolution des peuplements benthiques du Golfe d'Izmir (Partie intérieure) soumis à de multiples pollutions. Journ.Etud.Pollut.CIESM., 4(1978): 417-421.

Kocatas A., Z. Ergen and T. Katagan (1985), Changes in the benthic communities due to various pollutants in Izmir Bay (Turkey). In: Proc. Meeting on the effect of pollution on marine ecosystems, Blanes (Spain) 7-11 Oct., 1985.

Kocatas A., Z. Ergen, T. Katagan, T. Koray, B. Buyukisik, S. Mater, I. Ozel, O. Ucal and M. Onen (1986), Rapp. Comm. int. Mer Méditerranée, 30 Workshop (2): 128 p.

Kosta, L., V. Ravnik, A. R. Byrne, J. Stirn, M. Dermelj and P. Stegnar (1978), Some trace elements in the waters, marine organisms and sediments of the Adriatic by neutron activation analysis. J. Radioanal. Chem., 44:317-332.

Kremling, K. and H. Petersen (1981), The distribution of zinc, cadmium, copper, manganese and iron in waters of the open Mediterranean Sea. Berlin, Gebrueder Borntraeger. "Meteor" Forsch. Ergebnisse, Reihe A/3 (23):5-14.

Kumagai, M. and H. Nishimura (1978), Mercury distribution in seawater in Minamata Bay and the origin of particular mercury. J. Oceanogr. Soc. Japan, 34:50-56.

Lacombe H. and P. Tchernia (1974), Hydrography of the Mediterranean. Consultation on the protection of living resources and fisheries from pollution in the Mediterranean, FAO, Rome 19-23 Feb.: 12 p.

Le Lourd, P. (1977), Oil Pollution in the Mediterranean Sea. Ambio, 6: 317-321.

Le Lourd, P. (1979), Les activités du Centre régional de lutte contre la pollution par les hydrocarbures pour la mer Méditerranée. Journ. Etud. Pollut. CIESM., 33-37.

Longé, J.P. (1980), Installations de réception de mélanges d'hydrocarbures en Méditerranée. Progr.Wat.Techn. 12:455-462.

McGill, D.A. (1969), A budget for dissolved nutrient salts in the Mediterranean Sea. Cahiers Océanographiques, 21 (6):543-554.

Majori, L., G. Nedoclan and G. B. Modonutti (1967), Inquinamento da mercurio nell'Alto Adriatico. Acqua + Aria 3:164-172.

Marchetti, R., G.F. Gaggino and A. Provini (1988), Red tides in the Northwest Adriatic. In: UNEP/UNESCO/FAO; Eutrophication in the Mediterranean Sea: Receiving capacity and monitoring of long-term effects. MAP Technical Reports Series No. 21. UNEP, Athens.

Margalef, R. (1985), Introduction to the Mediterranean. In: R. Margalef (Ed.), Western Mediterranean, Pergamon Press, Oxford, pp. 1-16.

Martin, J. M. and G.A. Knauer (1973), The elemental composition of plankton. Geochim. Cosmochim. Acta 37:1639-1653.

Matsunaga, K., M. Nishimura and S. Konishi (1975), Mercury in the Kuroshio and Oyashio regions and the Japan Sea. Nature 258:224.

Meinesz, A. and J.P. Lefeire (1984), Régénération d'un herbier de Posidonia Oceanica quarante années après sa destruction par bombe dans la Rade de Villefranche. In: International Workshop Posidonia oceanica Beds, Boudouresque C.F., A. Jeudy de Grissac and J. Oliver (Eds.) GIS Posidonie Publ. Fr. 39-44.

Menard, H.W. and S.M. Smith (1966), Hypsometry of ocean basin provences, J. Geophys. Res. 71: 4305.

Michel, R.C. (1986), Oil and Gas Developments in North Africa in 1985. American Ass. Petroleum Geologists; 70/10:1394-1411.

Miller, A. (1983), The Mediterranean Sea, A. Physical aspects. In: B.H. Ketchum (Ed.), Estuaries and Enclosed Seas, Elsevier, pp. 219-238.

Mollat, M. (1966), Géographie du sel. In: "Géographie Générale", A. Journaux, P. Desfontaines and M.J.B. Delamarre (Eds.); Encyclopédie de la pléiade, N.R.F., Paris; 1439-1450.

Morel, A. (1971), Caractères hydrologiques des eaux échangées entre le bassin oriental et le bassin occidental de la Méditerranée. Cahiers océanographiques, 23 (4):329-342.

Mukherji, P. and D. R. Kester (1979), Mercury distribution in the Gulf Stream. Science 204:66-67.

Multhauf, R. (1978), Neptunes Gift. A history of common salt. T.P. Hugues (Ed.), Johns Hopkins University Press, Baltimore and London.

Najdek, M. and D. Bazulic (1986), Preliminary investigations on methylmercury in bivalves of different size. In: FAO/UNEP/WHO/IOC/IAEA Meeting on the biogeochemical cycle of mercury in the Mediterranean. (Siena, Aug. 1984) FAO Fish. Rep. 325 (Suppl.):122-124.

Nauen, C., G. Tomassi, G. P. Santaroni and N. Josupeit (1983), Results of the first pilot study on the chance of Italian seafood consumers exceeding their individual allowable daily mercury intake. Journ.Etud.Pollut.CIESM., 6(1982):571-583.

Nauen, C., G. Tomassi and G. P. Santaroni (1980), Mercury levels in selected marine organisms from the Mediterranean. In: UNEP/FAO/WHO Meeeting of experts on environmental quality criteria for mercury in Mediterranean seafood. Geneva: UNEP, UNEP/MED-HG/6.

Olafson, J. (1983), Mercury concentrations in the North Atlantic in relation to cadmium, aluminium and oceanographic parameters. In: Trace metals in sea water, C. S. Wong, E. Boyle, K. W. Bruland, J. D. Burton and E. D. Goldberg (Eds.). New York: Plenum Press, pp. 475-485.

Olivotti, R., J. Faganelli and A. Malej (1986), Impact of Organic Pollutants on Coastal Waters, Gulf of Trieste, Water Science and Technology, 18(9):57-68.

Orhon, D. (1986), Disposal of Solid Waste and Slurry in the Mediterranean Area. In: Industrial Wastewater in the Mediterranean Area, WHO, Copenhagen.

Paccagnella, B., L. Prati and A. Bigoni (1973), Studio epidemiologico sul mercurio nei pesci e la salute umana in un'isola Italiana del Mediterraneo. L'Igiene Moderna 66:479-503.

Palumbo, A. and M. Iannibelli (1985), Atmospheric contribution to marine pollution in the Bay of Naples. Journ.Etud.Pollut.CIESM., 7(1984):63-71.

Panayiotidis, P. (1987), Etude de l'impact de la pollution sur les herbiers de Posidonia oceanica (L) Delile, dans le Golfe de Saronikos (Mer Egée, Grèce). Preprint, MAP Tech. Rep., Activity J.

Pasquet, R. (1980), Les pollutions marines accidentelles et leurs remèdes. Progr. in Water Technol. (I.A.W.P.R.), Pergamon Pr.; 12/1; 17.34.

Pérès, J.M. and J. Picard (1964), Nouveau manuel de bionomie benthique de la mer Méditerranée, Rec.Trav.St.Mar.Endoume, 47: 1.

Pérès, J.M. (1967), The Mediterranean benthos, Oceanogr. mar. biol. Ann. Rev., 5:449.

Pérès, J.M. (1984), La régression des herbiers à Posidonia oceanica. Int. Workshop Posidonia oceanica Beds, Bondouresque C.F., A. Jeudy de Grissac and J. Olivier, (Eds.), GIS Posidonie publ., Fr., 1:445-454.

Picard, J. and M. Bourcier (1976), Evolution sous influences humaines des peuplements benthiques des parages de la Ciotat entre 1954 et 1972. TETHYS 7(2-3) 1975 (1976): pp.213-222.

Picer, N. and M. Picer (1979), Monitoring of chlorinated hydrocarbons in water and sediments of the North Adriatic coastal waters. Journ.Etud.Pollut.CIESM., 4(1978):133-136.

Preti M., B. Villani, P. Colantoni, P. Mengozzi and P. Piccinetti (1985), Regione Emilia-Romagna. Ricerca di depositi sabbiosi sul fondo del Adriatico da utilizare per il ripascimento delle spiagge in erosione. IDROSER S.p.A., Bologna; 176p.

Pucher-Petkovich, T. and I. Marasovic (1978), Evolution de quelques populations diatomiques dans une aire soumise à l'eutrophisation (Adriatique Centrale). Rapp. Comm. Internat. Mer Médit. 26.

Renzoni, A. (1976), A case of mercury abatement along the Tuscan coast. Journ.Etud.Pollut.CIESM., 3(1976):95-97.

Rhorlich, V. and V. Goldsmith (1986), Sediment transport along the Southeast Mediterranean. Geo-Marine Letters, Springer Verl.; Vol.4.

Riolfatti, M. (1977), Ulteriori indagini epidemiologiche sulle concentrazioni di mercurio nel pesce alimentare e nel sangue e capelli umani. L'Igiene Moderna 70:169-185.

Risebrough, R. W., B. W. De Lappe and T. T. Schmidt (1976), Bioaccumulation factors of chlorinated hydrocarbons between mussels and seawater. Mar. Pollut. Bull. 7:225-228.

Robertson, D. E., L. A. Rancitelli, J. C. Langford and R. W. Perknins (1972), Battelle Northwest contribution to the IDOE base-line study. In: Workshop on baseline studies of pollutants in marine environment, Brookhaven Nat. Lab. 24-26 May 1972, pp. 231-274.

Sarà, M. (1985), Ecological factors and their biogeographic consequences in the Mediterranean ecosystems. In: M. Moraitou-Apostolopoulou and V.Kiortisis (Eds.), Mediterranean Marine Ecosystems, Plenum Press, New York, pp.1-18.

Sarà, M. (1987), Evaluation of the conditions of some Posidonia meadows in the North-Western Mediterranean Sea and eventual effects of pollutants on the associated fauna, Preprint, MAP Tech. Rep., Activity J.

Sara, R. (1973), Sulla biologia dei toni (Thunnus thynnus L.), modelli di migrazione ed osservazioni sui meccanismi di migrazione e di comportamento, Boll. Pesca Piscic. Idrobiol.: pp.217-243.

Selli, R., M. Frignani, C. M. Rossi and R. Viviani (1973), The mercury content in the sediments from the Adriatic and Tyrrhenian. Journ.Etud.Pollut.CIESM., :39-40.

Seritti, A., A. Petrosino, E. Morelli, R. Ferrara and C. Barghigiani (1982), The biogeochemical cycle of mercury in the Mediterranean. Part. I: Particulate and dissolved forms of mercury in the Northern Tyrrhenian Sea. Sci. Techn. Letters, 3:251-256.

Sestini, G., L. Jeftic and J. Milliman (1989), Implications of Expected Climate Changes in the Mediterranean Region: An Overview, UNEP Regional Seas Reports and Studies No 103, UNEP.

Smith, J.W. (1975), Oil spills from tankers. In: Proceedings of the Conference on Marine Ecology and Oil Pollution. IP and FSC, Aviemore, Scotland.

Stachowitsch (1984), Mass Mortality in the Gulf of Trieste. Community Destruction. Marine Ecology, 5(3):243-264.

Stirn, J. (1988), Eutrophication in the Mediterranean Sea. In: UNEP/UNESCO/FAO:Eutrophication in the Mediterranean Sea: Receiving capacity and monitoring of long-term effects. MAP Technical Reports Series, No. 21, UNEP, Athens.

Stirn, J., A. Avcin, J. Cencelj, M. Dorer, S. Gomiscek, S. Kveder, A. Malej, D. Meischner, I. Nozina, J. Paul and P. Tusnik (1974), Pollution problems of the Adriatic Sea. An interdisciplinary approach. Rev. Intern. Oceanogr. Méd., 35-36:21-78.

Stoeppler, M., C. Mohl and H. W. Nuernberg (1981), Total Arsenic in sea water and marine organisms: a comparative study from the Mediterranean Sea and selected regions of the oceans. Journ.Etud.Pollut.CIESM., 5(1980):281-283.

Tedeschi, S. (1988), private communication.

Thibaud, Y. (1979), Pollution par les métaux lourds en Méditerranée. Etude chez les poissons des mécanismes de contamination et de décontamination. Convention no. 75-08, Inst. Scientif. et Technique des Pêches Maritimes, Nantes.

Tixeront, J. (1970), Le Bilan Hydrologique de la Mer Noire et de la Mer Méditerranée. Cahiers Océanographiques 22 (3):227-237.

Tortonese, E. (1985), Distribution and Ecology of Endemic Elements in the Mediterranean Fauna (Fishes and Echinoderms), In: M. Moraitou-Apostolopoulou and V. Kiortsis (Eds.), Mediterranean Marine Ecosystems, Plenum Press, New York, pp. 57-84.

Tusnik, P. and R. Planinc (1986), Concentrations of trace metals (Hg, Cd) and their seasonal variations in Mytilus galloprovincialis from the Gulf of Trieste. Journ.Etud.Pollut.CIESM., 8(1986): 114.

UNEP (1980), Co-ordinated Mediterranean pollution monitoring and research programme (MED POL). Part 1: Summary, Scientific Report for Febr. 1975 to June 1980. Geneva.

UNEP (1981), Mediterranean environmental quality criteria (UNEP/WG.62/61). Athens.

UNEP (1982), Convention for the Protection of the Mediterranean Sea against pollution and its related protocols, UN, New York.

UNEP (1985), Report on the state of pollution of the Mediterranean Sea (UNEP/IG.56/Inf.4). Athens.

UNEP (1985a), Report of the fourth ordinary meeting of the Contracting Parties to the Convention for the Protection of the Mediterranean Sea against Pollution and its Related Protocols (UNEP/IG.56/5). Athens.

UNEP (1985b), Mediterranean Action Plan, UNEP.

UNEP (1987), Preliminary report on Blue Plan Scenarios (UNEP/W6.171/3), Blue Plan, Sophia Antipolis.

UNEP (1987a), Data base on the Mediterranean, Activities, Provisional document, Blue Plan, Sophia Antipolis.

UNEP (1987b), Environmental data on Mediterranean Basin (natural environments and resources), Provisional version, Blue Plan, Sophia Antipolis.

UNEP (1987c), Report of the fifth ordinary meeting of the Contracting Parties to the Convention for the Protection of the Mediterranean Sea against Pollution and its Related Protocols (UNEP/IG.74/5) Athens.

UNEP (1988), Statistics concerning marine oil pollution in the Mediterranean. Regional Oil Combating Centre, Malta.

UNEP (1988a), Report of the Joint Meeting of the Task Team on the implications of climatic changes in the Mediterranean and the Co-ordinators of Task Teams for the Carribean, South-East Pacific, South Pacific, East Asian Seas and South Asian Seas Regions, Split, 3-8 Oct. 1985, UNEP, Nairobi (UNEP (OCA) W6. 2/25).

UNEP (1988b), Futures of the Mediterranean Basin, Executive Summary and Suggestion for Action, Blue Plan, Sophia Antipolis.

UNEP/ECE/UNIDO/FAO/UNESCO/WHO/IAEA (1984), Pollutants from land-based sources in the Mediterranean. UNEP Regional Seas Reports and Studies No.32. Geneva.

UNEP/FAO (1986), Assessment of the present state of pollution by cadmium, copper, zinc and lead in the Mediterranean Sea (UNEP/WG.144/11). Athens.

UNEP/FAO/WHO (1983), Assessment of the present state of pollution by mercury in the Mediterranean Sea and proposed control measures (UNEP/WG.91/5). Athens.

UNEP/FAO/WHO (1987), Assessment of the state of pollution of the Mediterranean Sea by mercury and mercury compounds. MAP Technical Reports Series No. 18, Athens.

UNEP/FAO/WHO (1987a), Assessment of the state of pollution of the Mediterranean Sea by cadmium and cadmium compounds and proposed measures (UNEP/WG.160/9). Athens.

UNEP/FAO/WHO/IAEA (1988), Assessment of Organotin Compounds as Marine Pollutants and Proposed Measures for the Mediterranean (UNEP(OCA)/MED WG.1/7). Athens.

UNEP/FAO/WHO/IAEA (1989), Assessment of the State of Pollution of the Mediterranean Sea by organohalogen compounds and proposed measures (UNEP(OCA)/MED WG.3/Inf. 6), Athens.

UNEP/IMO/IOC (1987), Assessment of the present State of Pollution by Petroleum Hydrocarbons in the Mediterranean Sea (UNEP/WG.160/11). Athens.

UNEP/UNESCO/FAO (1988), Eutrophication in the Mediterranean Sea: Receiving capacity and monitoring of long-term effects. MAP Technical Reports Series No. 21. UNEP, Athens.

UNEP/UNIDO (1987), Assessment of Used Lubricating Oils in the Mediterranean Sea and Proposed Measures for their Elimination (UNEP/WG.160/7). Athens.

UNEP/WHO (1985), Assessment of the present state of microbial pollution in the Mediterranean Sea and proposed control measures (UNEP/WG.118/6). Athens.

UNEP/WHO (1986), Assessment of the state of microbial pollution of shellfish and shellfish-growing waters in the Mediterranean Sea and proposed measures (UNEP/WG. 144/10). Athens.

UNEP/WHO (1986a), Review of intercalibration exercises on microbiological methods for coastal water quality monitoring (UNEP/WG.144/Inf.6). Athens.

UNESCO (1984), Eutrophication in coastal marine areas and lagoons: a case study of "Lac de Tunis". UNESCO reports in Marine Science no. 29. Paris.

Vacelet, J. (1981), Les affinités du peuplement de spongiaries de la Méditerranée. In: Journ. Etud. syst. evol., Cagliari, 13 et 14 Oct. 1980, CIESM, pp. 29-30.

Vucetic, T., W. B. Vernberg and G. Anderson (1974), Longterm annual fluctuations of mercury in the zooplankton of the East Central Adriatic. Rev. Intern. Oceanogr. Medical. 33:75-81.

Watters, G. (1982), Solid Wastes Management in the Metropolitan Area of Istanbul, In: Proc., Behandlung, Verwertung und Beseitigung von Industriebwassern sowie-abfallen, Stuttgart.

Whitehead, N.E., S. Ballestra, E. Holm and L. Huynh-Ngoc (1988), Chernobyl radionuclides in shellfish. J. Environ. Radioactivity, Vol. 7, pp.107-121.

Whitehead, N.E., B. Oregioni and R. Fukai (1985), Background levels of trace metals in Mediterranean sediments. Journ.Etud.Pollut.CIESM., 7 (1984): 233-240.

WHO (1976), Environmental Health Criteria 1. Mercury. World Health Organization, Geneva.

WHO (1986), Environmental Health No. 8: Industrial Wastewater in the Mediterranean Area. WHO, Copenhagen.

WHO/FAO/UNEP (1987), Health Effects of methylmercury in the Mediterranean Area (ICP/CEH 054). WHO, Regional Office for Europe. Copenhagen.

WHO/UNEP (1986), Correlation between Coastal Water Quality and Health Effects (ICP/CEH 001 m06). WHO, Regional Office for Europe. Copenhagen.

WHO/UNEP (1988), Microbial pollution of Mediterranean coastal areas and associated health effects. (EUR/ICP/CEH 052). WHO, Regional office for Europe. Copenhagen.

Windom, H., F. Taylor and R. Stickney (1973), Mercury in North Atlantic plankton. J. Con. int. Explor. Mer, 35:18-21.

Yamamoto, J., Y. Kaneda and Y. Hikasa (1983), Picogram determination of methylmercury in seawater by gold amalgamation and atomic absorption spectrophotometry. Int. J. Environ. Anal. Chem., 16:1-16.

Yannopoulos, C. (1976), The annual regeneration of the Elefsis Bay zooplankton ecosystem, Saronikos Gulf. Rapp. Comm. int. Mer Médit. 23 (9):109-111.

Yarbrough, S.C. (1986), Oil and Gas Developments in Europe in 1985. American Ass. Petroleum Geologists, 70/10:1578-1610.

Zafiropoulos, D. and A. P. Grimanis (1977), Trace elements in Arcatia clausi from Elefsis Bay of the upper Saronikos Gulf, Greece. Mar. Pollut. Bull., 8:79-81.

Zarkanella, A.J. (1979), The effects of pollution-induced oxygen deficiency on the benthos in Elefsis Bay, Greece. Marine Environ. Res., 1979, pp. 191-207.

A N N E X

Table 1

Water balance of the Mediterranean basin (in m^3/s)
(IHP/MED/3, 9/8 1978).

Process	Tixeront 1970	McGill 1969	Carter 1956	Lacombe & Tchernia 1974	Morel(*) 1971
Evaporation	95,000(1)	-	92,000	-	70,000
Precipitation	28,000(3)	-	33,000	-	13,000
River Run-Off(**)	16,000(4)	-	14,000	-	9,000
Net Inflow through:					
Dardanelles	6,000(5)	6,000(5)	6,400	6,000(5)	6,000(5)
Gibraltar	45,000(6)	40,000(7)	38,500	54,400(8)	-
Strait of Sicily	-	-	-	-	42,000(6)
Total inflow through:					
Dardanelles	-	-	-	12,500	-
Gibraltar	-	-	1,870,000	1,187,500	-
Strait of Sicily	-	-	-	-	1,000,000

(*) Only for the eastern basin
(**) MED X estimate for total run-off is 14,000 for the whole Mediterranean and 10,500 for the eastern basin

(1) Estimated from studies made in the Lac de Tunis (Berkaloff, 1952)
(2) Based on Carter, 1956
(3) Estimated from pluviometric charts and sailors'accounts
(4) Direct measurements on some rivers and from pluviometric charts and area of all other river basins
(5) Based on Merz and Moeller, 1928
(6) Estimated by balance
(7) Based on Schink, 1967
(8) Estimated by salinity difference between incoming and outgoing waters and an estimate of mean flow through Gibraltar.

Table 2

Cadmium, Copper, Lead and Zinc concentrations in open waters of the Mediterranean (ug l^{-1}) (UNEP, 1985).

REGION	METHOD	Cadmium	Copper	Lead	Zinc	REFERENCE
I-II		0.004	0.11	-	-	Boyle *et al.*, 1984
II	ASV	0.15	0.4	-	2.7	Huynh-Ngoc and Fukai, 1978
II	Dowex/ Extraction/ AAS	0.06	1.6	-	-	Frache *et al.*, 1980
II		0.008	-	0.05-0.14	-	Copin-Montegut *et al.*, 1984
III	ASV	0.005-0.010	0.06-0.13	0.025-0.075	-	Laumond *et al.*,1982
	ASV	0.11	0.10	-	1.2	Huynh-Ngoc and Fukai, 1978
IV	ASV	0.11	0.18	-	0.9	"
	ASV	0.05-0.09	0.13-0.19	0.018-0.09	-	Nürnberg, 1977
IV-VI-VII		0.010	0.15	-	-	"
VI-VII	ASV	0.15	0.7	-	1.8	Huynh-Ngoc and Fukai, 1978
VIII	ASV	0.07	0.3	-	3	"
X	ASV	0.04	0.04	-	0.9	"

Table 3

Chromium and Nickel concentrations in Mediterranean coastal waters (ug l^{-1}) (UNEP, 1985).

REGION	METHOD Chemical form	Chromium	Nickel	REFERENCE
II	Dowex A-1/AAS		0.15-2.9	Frache *et al.*, 1976
Ligurian coasts	Filtration/Dowex A-1/AAS			
	Dissolved		0.27-9.0	Baffi *et al.*, 1982
	Particulate		0.15-0.89	
V	X-ray emission	0.68	1.3	Marijanovic *et al.*, 1982
VIII	Filtration/Chelex 100/AAS			
Evoikos, Gera	Dissolved	6.2-6.7	1.9	Scoullos and Dasenakis, 1982
Gulfs, Greece	Particulate	1.5-2.5	0.5	Scoullos *et al.*, 1982
Northern Greece	APDC-MIBK Extraction/AAS		0.5-1.5	Fytianos and Vasilikiotis, 1982

Table 4

Cadmium, Copper, Lead and Zinc concentrations in Mediterranean sediments (ug g^{-1} dry weight) (UNEP, 1985).

REGION	METHOD	Cadmium	Copper	Lead	Zinc	REFERENCE
II						
Var lagoon, France	$HF-HClO_4-HNO_3$	3.7	15.4	26.4	-	Chabert and Vicente, 1980
Coastal lagoon, Spain	63um	10-32	10-94	200-2000	500-6200	De Leon *et al.*, 1982
Spain	Conc.HNO_3	0.1-0.3	-	10-50	-	Peiro *et al.*, 1982
River Ebro Delta	HNO_3	0.12-0.37	7.9-21.5	22-48	33-104	Obiols and Peiro, 1980
River Rhône Delta	HNO_3-HClO_4	0.25-5	20-55	9	90-140	Added *et al.*, 1980; Cauwet and Monaco, 1982; Badie *et al.*, 1982
Marseille	200um $HCl-HNO_3$	1.8-3	29-34	28-1250	120-2550	Arnoux *et al.*, 1980a
Cannes	63um $HNO_3-H_3PO_4-HCl$	1.8-7	15-80	30-100	50-300	Ringot, 1982
Gulf of Nice	HNO_3-HCl	0.7-2.4	2.1-32	3-112	-	Flateu *et al.*, 1982
Italian Estuaries	HNO_3-HCl	0.21-0.55	33-53	30-43	-	Breder *et al.*, 1980
Offshore sediments	HNO_3-HCl	-	30-49	10-28	130-260	Arnoux *et al.*, 1980c,1982
	HNO_3	0.7-1.7	-	-	-	Frignani and Giordani, 1983
III						
Coast of Spain	-	0.02-10	4-230	23-3300	27-1050	De Leon *et al.*, 1984
IV						
Cagliari lagoon	0.4NHCl	-	10-70	64-670	-	Contu *et al.*, 1984
Offshore sediments	HNO_3	0.5-2.5	10-44	19-94	20-56	Frignani and Giordani, 1983

Table 4 (Cont'd)
Cadmium, Copper, Lead and Zinc concentrations in Mediterranean sediments (ug g^{-1} dry weight) (UNEP, 1985).

REGION	METHOD	Cadmium	Copper	Lead	Zinc	REFERENCE
V						
Gulf of Trieste	?	0.3-5.3	9-139	18-470	27-650	Majori et al., 1978
Gulf of Venice	HNO_3	0.1-3.1	34-37	5-54	48-450	Angela et al., 1980
Kastela Bay Yugoslavia	NAA 100um		14-42	-	53-1300	Stegnar et al., 1980
River Po delta	HNO_3	0.16-1.7	1.3-50	9.-73	24-244	Facardi et al., 1984
Mali Ston, Yug.	NAA	0.08-0.22	13-22	-	40-100	Vukadin et al., 1984
Offshore sediments	HNO_3	0.8-1.2	15-30	21-43	54-78	Frignani and Giordani, 1983
VI						
Patraikos Gulf, Greece	$HF-HNO_3$ $HClO_4$	-	23-100	10-40	280-430	Varnavas and Ferentinos, 1982
Kalamata Bay,Greece	$HF-HNO_3-HClO_4$	-	11-56	8-40	-	Varnavas et al., 1984
Gulf of Catania	HNO_3	2.2-4.6	3.8-2.5	4.5-19	25-236	Castagna et al., 1983
Offshore sediments	HNO_3	0.6-1.1	24-29	22.27	55-78	Frignani and Giordani, 1983
VIII						
Thermaikos-Kavala Gulf, Greece	63 um HNO_3-HClO_4	0.6-1.1	0.6-2.3	6-28	10-28	Fytianos and Vasilikiotis, 1982
Evoikos Gulf,	61 um 0.5N HCl	-	9	37	20	Scoullos and Dasenakis, 1982
Greece	55 um 0.5N HCl	-	-	-	7-95	Angelidis et al., 1980
Gera Gulf, Greece	61 um 0.5N HCl	-	8-160	9-122	12-390	Scoullos et al., 1982
Saronikos Gulf, Greece	55 um 0.5N HCl	-	-	-	5-1360	Angelidis et al., 1982
Thermaikos Gulf, Greece	45 um HNO_3	0.40-2.5	10-50	25-130	8-240	Voutsinou-Taliadouri, 1982
Pagassitikos Gulf, Greece	45 um HNO_3	-	30	30	130	Voutsinou-Taliadouri, 1982
East Aegean offshore	45 um HNO_3	-	20	15	40	Voutsinou Taliadouri, 1982
Izmir Bay	$HCl-HNO_3$	0.2-49	14-870	20-280	53-860	Uysal and Tuncer, 1984

Table 4 (Cont'd)
Cadmium, Copper, Lead and Zinc concentrations in Mediterranean sediments (ug g^{-1} dry weight) (UNEP, 1985).

REGION	METHOD	Cadmium	Copper	Lead	Zinc	REFERENCE
IX						
Erdemli, Turkey	HNO_3-$HClO_4$-HF	-	31	57	65	Balkas et al., 1978
Alexandria	?	2.8	48	190	180	El Sokkary, 1978
Alexandria Harbour	HNO_3HCl	-	27	-	53	El Sayed et al., 1980
Abu Kir Bay, Egypt	HNO_3	2	12	-	100	Saad et al., 1980
River Nile delta	HF-HNO_3	-	5-77	-	2-120	Moussa, 1982
	HCl-1N		6-74		20-100	Tomma et al., 1980
Cilician basin	HF-HNO_3-$HClO_4$	-	33-50	-	54-81	Ozkan et al., 1980
X						
Damietta estuary Egypt	HNO_3	0.16-2	29-280	-	20-425	Saad and Fahmy, 1984
Western Harbor Alexandria	HNO_3-$HClO_4$	7-64	30-1890	-	23-470	Saad et al., 1984
XIII						
Black Sea, Nearshore	HNO_3	1.3-4.8	10-100	22-88	37-250	Pecheanu, 1982
Offshore		2.8	52	37	75	Pecheaunu, 1982

Table 5

Chromium, Manganese and Nickel concentrations in Mediterranean sediments (ug g^{-1} dry weight) (UNEP, 1985).

REGION	METHOD	Chromium	Manganese	Nickel	REFERENCE
II					
River Ebro Delta	HNO_3	9.5-20	180-630	22-47	Obiols and Peiro, 1980
Rhône Delta	HNO_3-$HCLO_4$	30-50	-	20-28	Added _et al._, 1980
Marseille	200 um, HNO_3-HCl	7-230	-	-	Arnoux _et al._, 1980a, 1980b
Gulf of Fos	•	27-32	-		Arnoux _et al._, 1980a, 1980b
Offshore sediments	HNO_3-HCl	35-65	700-1300		Arnoux _et al._, 1980c, 1982
Offshore sediments	HNO_3	28-37	280-1500	-	Frignani and Giordani, 1983
IV					
Offshore sediments	HNO_3	9-26	260-2560	9-46	Frignani and Giordani, 1983
V					
Gulf of Trieste	?	67-75	304-593	8-68	Majori _et al._, 1978
Gulf of Venice	HNO_3	10-64	-	5-40	Angela _et al._, 1980
Offshore sediments	HNO_3	31-60	52-2340	46-122	Frignani and Giordani, 1983
VI					
Patraikos Gulf, Greece	HF-HNO_3-$HClO_4$	70-210		69-168	Varnavas and Ferentinos, 1982
Offshore sediments	HNO_3	31-33	83-1700	48-53	Frignani and Giordani, 1983

Table 5 (cont'd)

Chromium, Manganese and Nickel concentrations in Mediterranean sediments (ug g^{-1} dry weight) (UNEP, 1985).

REGION	METHOD	Chromium	Manganese	Nickel	REFERENCE
VIII					
Evoikos Gulf,Greece	61 um, 0.5N HCl	87	308	60	Scoullos and Dasenakis, 1982
Gera Gulf, Greece	61 um, 0.5N HCl	7.9-1830	80-570	-	Scoullos *et al.*, 1982
Saronikos Gulf,Greece	55 um, 0.5N HCl	45-480	-	-	Angelidis *et al.*, 1982
Thermaikos Gulf, Greece	45 um, HNO_3	90-235	-	100-335	Voutsinou-Taliadouri, 1982
Pagassitikos Gulf, Greece	"	110	-	165	"
East Aegean, offshore	"	85	-	145	"
IX					
Erdemli, Turkey	HF-HNO_3-$HClO_4$	534-595	115-787	79-586	Ozkan *et al.*, 1980
X					
River Nile Delta	HF-HNO_3	12-150	-	10-100	Moussa, 1982

Table 6

Copper concentrations (ug kg^{-1} FW) in *Mytilus galloprovincialis* ug kg^{-1} and in *Mullus barbatus* from various MED POL areas (UNEP/FAO, 1986).

Region	No. of samples	Minimum	Maximum	Mean	Standard Deviation
M. galloprovincialis:					
II	55	504	4800	1500	900
IV	85	70	6000	1900	1100
V	58	163	4400	1000	900
VIII	13	750	2800	1600	600
M. barbatus:					
II	153	200	1300	405	172
IV	208	2.5	1000	380	127
VII	10	360	2700	930	684
VIII	60	220	1470	600	280
X	23	69	2550	800	560

Table 7

Average copper concentrations (ug kg^{-1} FW) and standard deviation in Mediterranean marine organisms from various MED POL areas (UNEP/FAO, 1986).

Species	No. of samples	Mean	Standard Deviation
Mytilus galloprovincialis	204	1300	700
Donax trunculus	19	3500	1800
Nephrops norvegicus	303	5700	1900
Parapenaeus longirostris	22	8500	8000
Penaeus kerathurus	12	5200	2700
Engraulis encrasicolus	97	990	560
Mugil auratus	31	700	960
Mullus barbatus	444	400	140
Mullus surmuletus	20	600	540
Sarda sarda	27	2100	1700

Table 8

Zinc concentrations (ug kg^{-1} FW) in *Mytilus galloprovincialis* and *Mullus barbatus* from various MED POL areas (UNEP/FAO, 1986).

Region	No. of samples	Minimum	Maximum	Mean	Standard Deviation
M. galloprovincialis:					
II	26	13000	60200	28000	10700
IV	84	3150	63000	34000	11200
V	58	2500	64250	17000	12000
VIII	21	9200	97700	45000	24600
M. barbatus:					
II	132	100	7100	4000	970
IV	221	400	7000	4000	1000
VII	11	2700	5800	4300	860
VIII	40	2570	6890	3500	800
IX	12	3660	7400	5100	1040
X	23	3060	5870	4400	650

Table 9

Average zinc concentrations and standard deviation (ug kg^{-1} FW) in Mediterranean marine organisms from all MED POL areas (UNEP/FAO, 1986).

Species	No. of samples	Mean	Standard Deviation
Mytilus galloprovincialis	179	27000	13000
Donax trunculus	17	21000	17000
Nephrops norvegicus	279	15000	2800
Parapenaeus longirostris	19	11000	3400
Penaeus kerathurus	22	22000	16000
Carcinus mediterraneus	13	41000	29000
Engraulis encrasicolus	75	18000	6700
Mugil auratus	66	10600	15000
Mullus barbatus	435	3900	900
Mullus surmuletus	24	10000	14000
Upeneus molluccensis	13	2900	1100

Table 10

Lead concentrations (ug kg^{-1} FW) in *Mytilus galloprovincialis* and in *Mullus barbatus* from various MED POL areas (UNEP/FAO, 1986).

Region	No. of samples	Minimum	Maximum	Mean	Standard Deviation
M. galloprovincialis:					
II	101	50	6800	600	790
IV	85	50	16100	1800	2400
V	92	50	7825	840	1300
VIII	80	55	8260	1100	1500
M. barbatus:					
II	173	23	243	60	31
X	22	145	610	370	121

Table 11

Average lead concentrations and standard deviation (ug kg^{-1} FW) in Mediterranean marine organisms from all MED POL areas (UNEP/FAO, 1986).

Species	No. of samples	Mean	Standard Deviation
Mytilus galloprovincialis	344	800	800
Donax trunculus	19	1200	650
Mullus barbatus	435	70	45
Thunnus thynnus	53	117	170

Table 12

Cadmium concentrations (ug kg^{-1}) in *Mytilus galloprovincialis* and *Mullus barbatus* in various MED POL areas (UNEP/FAO, 1986).

Region	No. of samples	Minimum	Maximum	Mean	Standard Deviation
M. galloprovincialis:					
II	105	40	1060	190	120
V	72	25	475	160	100
VI	25	24	52	38	6
VIII	76	5	780	100	124
M. barbatus:					
II	136	1.0	590	50	90
VI	50	5.0	52	26	14
VII	11	5.5	49	17	15
VIII	46	15	162	47	39
X	21	14	65	39	14

Table 13

Average cadmium concentrations and standard deviation (ug kg^{-1}) in Mediterranean marine organisms (UNEP/FAO, 1986).

Species	No. of samples	Mean	Standard Deviation
Mytilus galloprovincialis	265	120	83
Mytilus edulis	10	85	34
Donax trunculus	16	80	26
Nephrops norvegicus	61	50	39
Parapenaeus longirostris	27	46	55
Engraulis encrasicolus	81	34	25
Merluccius merluccius	27	63	34
Mugil auratus	10	47	85
Mullus barbatus	318	34	28
Mullus surmuletus	218	140	83
Thunnus alalunga	38	23	6.5
Thunnus thynnus	111	38	43

Table 14

Heavy metals (ug g^{-1} dry weight*) in *Mytilus* from different regions of the Mediterranean Sea. Values given are ranges (Fowler, 1985).

Region	Cadmium	Copper	Zinc	Lead	Nickel	Chromium	Silver	Iron	Mercury	Refs see[1/]
North-west Mediterranean (Ligurian Sea)	0.4-5.9	2.4-154	97.644	2.4-117	0.9-14.1	0.5-28.8	0.1-18.9	149-2200	0.18-0.96	1, 2
Adriatic (Gulf of Trieste)	1.4-1.7	6.2-9.8	87-137	3.8-15				167-219	0.28-1.3	3
Aegean (Saronikos Gulf)	0.06-0.08	4.5	12-87		39	0.11-7.8	0.0009-0.01	17-32	0.06-0.2	4, 5
(Turkey)	6.6-12	36-64	336-452	83-110		26-55		308-356	0.89-1.1	6
South-west Mediterranean (Algeria)	0.3-6.5		7.2-71						0.25-0.63	7

* Where necessary, values were converted using a wet/dry weight ratio of 6.

1. Fowler and Oregioni, 1976
2. Stoeppler *et al.*, 1977
3. Majori *et al.*, 1979
4. Grimanis *et al.*, 1979
5. Papadopoulou and Kanias, 1976
6. Uysal, 1979
7. Aissi, 1979

Table 15
Selected mercury concentrations (ng l^{-1}) in sea water from the Mediterranean and other regions.

	n	mean	range	location	sampling depth	reference
Mediterranean						
open sea:						
Hg-T	3	92	62 - 110	Gibraltar	15 - 300	Robertson et al., 1972
Hg-T	47	10 M	5 - 17	NW Medit.	25 - 2500	Huynh-Ngoc and Fukai 1979
Hg-Td	4	25	20 - 30	Tyrrhenian	0 - 5	Fukai and Huynh-Ngoc 1976
Hg-Td	54	7.2	1.4 - 19.2	Tyrrhenian	0	Ferrara et al., 1986
Hg-T	2	120	90 - 140	Cyprus	15 - 300	Robertson et al., 1972
HG-R	56		0.1 - 50	W-Mediterr.	0 - 3000	Copin-Montegut et al., 1985
Hg-R	89	2	0.5 - 10	Ligurian	0 - 100	Copin-Montegut et al., 1986
Hg-Rd	46	2.9	0.5 - 5.9	Tyrrhenian	0	Ferrara et al., 1986
Hg-A	7	20	8 - 32	NW Medit.	0 - 5	Huynh-Ngoc and Fukai 1979
Hg-A	46	10	3 - 23	NW Medit.	25 - 2500	Aston et al., 1986
Hg-A	10	26	10 - 40	Tyrrhenian	0 - 5	Huynh-Ngoc and Fukai 1979
Hg-A	6	30	5 - 80	Ionian-Centr.	0 - 5	Huynh-Ngoc and Fukai 1979
Hg-A	3	40	15 - 80	Aegean	0 - 5	Huynh-Ngoc and Fukai 1979
Hg-A	4	16	12 - 20	S. Levantine	0 - 5	Huynh-Ngoc and Fukai 1979
Hg-P	41	2.3	0.3 - 8	Tyrrhenian	0	Ferrara et al., 1986
Hg-P	?	1.4	0.7 - 1.9	W-Ligurian	?	Buat-Menard et al., 1981
coastal areas:						
Hg-T	31	70	12 - 280(*)	Estuaries Tuscan riv.	0	Breder et al., 1981
Hg-T	19	2.25	1.4 - 5.6	N-Tyrr. coast	0	Barghigiani et al., 1981
Hg-Td	24	6.3	1.4 - 8.0	Tyrrh. coast	0	Ferrara et al., 1986
Hg-Td		46		Tyrrh. coast		Alpha et al., 1982
Hg-Td		93		Ionian coast		Alpha et al., 1982
Hg-T		6.5		Ionian coast		Brondi et al., 1986
Hg-T	20	9.6	1.7 - 12.2	Tuscan coast	0	Seritti et al., 1982
Hg-T	?	15 M	4 - 3.6	Tuscan coast	0	Seritti et al., 1982
Hg-R	46	1.5	0.5 - 9	Villefr. B.	?	Copin-Montegut et al., 1986
Hg-R	16	2.0	0.5 - 2.5	Tyrrh. coast	0	Ferrara et al., 1986
Hg-E	6	350 M	240 - 520	Thermaikos G.	0	Fytianos and Vasilikiotis, 1983
Hg-E	4	340 M	210 - 370	Kavala Gulf	0	
Hg-P	20	3	0.4 - 3.6	Tuscan coast	0	Seritti et al., 1982
Hg-P	13	3.4	1.5 - 8.0	Tyrrh. coast	0	Ferrara et al., 1986

Table 15 (Cont'd)

Selected mercury concentrations (ng l^{-1}) in sea water from the Mediterranean and other regions.

	n	mean	range	location	sampling depth	reference
Non Mediterranean						
open sea:						
Hg-T	47	2.2	+- 1.0	N. Atlantic	0 - 1730	Olafson, 1983
Hg-T	2		3.8 - 3.9	Japan Sea	0	Fujita and Iwashima, 1981
Hg-R	73	1.5	+- 0.7	N. Atlantic	0 - 1730	Olafson, 1983
Hg-R	16	ō1.0	0.4 - 2.0	NW. Atlantic	0 - 1000	Gill and Fitzgerald, 1985
Hg-R	81		0.9 - 6.2	North Sea	0	Baker, 1977
Hg-R		1.7	+- 0.7	S. Iceland		Olafson, 1983
Hg-R	16	0.5	0.3 - 0.7	N. Atlan.str.	0 - 4750	Dalziel and Yeats, 1985
Hg-R	16	0.4	0.26- 0.7	Sargasso.str.	0 - 2600	Dalziel and Yeats, 1985
Hg-R	24	4.1	+- 1.0	Gulf Stream	250- 4460	Mukherji and Kester, 1979
Hg-R	//	8	+- 4	Gulf Stream	0 - 750	Fitzgerald _et al._, 1975
Hg-R	13	ō0.35	0.23- 0.4	N. Pacific	0 - 4000	Gill and Fitzgerald, 1985
Hg-R	?	0.5	+- 0.2	Hawai-Tahiti	0	Fitzgerald _et al._, 1983
Hg-R	52	5	3.9 - 5.6	Japan Sea	0 - 1200	Matsunaga _et al._, 1975
Hg-P	2		1.2 - 1.5	Japan Sea	0	Fujita and Iwashima, 1981
MeHg	5	0.3 M	0.1 - 0.9	Japan Sea	0	Fujita and Iwashima, 1981
MeHg-P	2		0.2 - 0.2	Japan Sea	0	Fujita and Iwashima, 1981
coastal areas						
Hg-T	?	7.9	3.4 - 22	"UK seas"	0	Baker, 1977
Hg-T	15		0.07- 0.8	Puget Sound	0 - 5	Bloom and Creselius, 1983
Hg-T	4	5.1	3.2 - 7.4	Suruga B.Jap	0	Fujita and Iwashima, 1981
Hg-T	3	12.4 M	6.3 - 16	Japan coast	0	Yamamoto _et al._, 1983
Hg-R	27		0.1 - 0.3	Puget Sound	0 - 5	Bloom and Creselius, 1983
Hg-P	5	2.3 M	1.8 - 11.4	Suruga B.Jap	0	Fujita and Iwashima, 1981
MeHg	5	0.2 M	0.2 - 0.4	Suruga B.Jap	0	Fujita and Iwashima, 1981
MeHg-P	5	0.3 M	0.2 - 0.3	Suruga B.Jap	0	Fujita and Iwashima, 1981
MeHg	3	0.1 M	0.04- 0.16	Japan coast	0	Yamamoto _et al._, 1983

Hg-T: total Hg
Hg-Td: total dissolved Hg (membrane filtered)
Hg-A: ASV, unfiltered at pH 2
Hg-E: ammonium pyrholidine dithiocarbomate extracted with methyl-isotbutyl-ketone
Hg-R: reactive Hg (in acidified sample ?)
Hg-P: particulate Hg (membrane filtered)
MeHg: methyl mercury
M: median
n: geometric mean
(*) levels too high (Stroeppler 1984, pers. comm.)
?: data unknown
: range of means
+-: standard deviation.

Table 16

Selected mercury concentrations (mg kg^{-1} DW) in "open-sea" sediments.

depth	n	mean	range	location	reference
2720	1	0.26		Alboran	Robertson *et al.*, 1972
?	51	0.23	0.01 - 0.64	E. Gulf Lion	Arnoux *et al.*, 1983
?	43	0.11	0.01 - 0.27	W. Gulf Lion	Arnoux *et al.*, 1983
?	14	0.38	0.07 - 0.23	NW.Mediterranean	Arnoux *et al.*, 1983
?	17	0.13	0.16 - 0.57	NW.Mediterranean	Arnoux *et al.*, 1983
93 - 1715	9	0.1 M	0.05 - 0.24	Tyrrhenian	Selli *et al.*, 1973
390 - 3520	4	0.1 M	0.05 - 0.16	Tyrrhenian	Selli *et al.*, 1973
5 - 1195	20	0.1 M	0.07 - 0.97	Adriatic	Selli *et al.*, 1973
64 + 888	2		0.05 - 0.1	Adriatic	Selli *et al.*, 1973
12 - 1200	38	0.05	0.01 - 0.16	Adriatic	Kosta *et al.*, 1978
2360	1	0.3		S. of Crete	Robertson *et al.*, 1972

Table 17

Mercury concentrations in sediments of the Mediterranean (UNEP/FAO/WHO, 1983).

	Region	Extraction method	Concentration ug g^{-1} dry weight	Reference
I	Alboran Sea	Total	0.26 (mean)	Robertson et al., 1972
II	Ligurian coasts	HNO_3, HCI	0.16-5.4	Breder et al., 1981
	Ebro delta	conc. HNO_3	0.065-1.1	Obiols and Peiro, 1980
	Area of Marseille	HNO_3	0.07-21	Arnoux et al., 1980a, 1980b, 1980c
	Bay of Cannes	HNO_3,HPO_4 fraction 63 u	0.1-0.4	Ringot, 1982
	Gulf of Nice	HNO_3,$HClO_4$	0.01-0.16	Flatau et al., 1982
	Catalan coasts	conc. HNO_3	0.2-1.0	Peiro et al., 1980
III	Santa Gilla lagoon, Cagliari	HSO_4,HNO_3	0.7-37	Sarritzu et al., 1982
IV	Tyrrhenian Sea	-	0.05-0.24	Selli et al., 1973
	Tuscany Coast	-		
	near Solvay plant		1.1-1.3	Renzoni et al., 1973
	4 km S and N		0.1-0.8	
	10 km S and N		0.04-0.1	
V	Gulf of Trieste	-	1.4-14.8	Majori et al., 1978
	(close to cinnabar mine)	19.4		
	Gulf of Venice	H_2SO_4	0.14-3.0	Donazzolo et al., 1978 Angela et al., 1980
	Kastela Bay Dalmatia (chlor-alkali plant)	Total	8.5	Stegnar et al., 1980
	Adriatic Sea	Total	0.07-0.97	Robertson et al., 1972
VIII	Evoikos Gulf	0.5 HCl	0.3-0.8	Angelidis et al., 1980
	Aegean Sea	fraction 55 u		
	Saronikos Gulf, Athens	Total	0.5-1	Grimanis et al., 1976
	Athens outfall	Total	0.5-3	Papakostidis et al., 1975
IX	Coasts of Turkey	HNO_3	0.019-0.48	Tuncel et al., 1980
X	Region of Alexandria (close to chlor-alkali plant)	conc. HNO_3	0.8 9 - 15	Elsokkary, 1978 El Sayed & Halim, 1978
	Haifa Bay	HNO_3 fraction 250 u	0.008-073	Krumgalz & Hornung, 1982
	Hanigra to Hafifa		0.01-0.57	Roth & Hornung, 1977

Table 18

Mercury (ug kg^{-1}FW) in some fish (muscle) and shellfish species (whole body). (UNEP/FAO/WHO, 1987; UNEP, 1980)

	Median of means and range of means			
	median	range	location	references
plankton feeder				
herring	40	20-240	N.Sea	ICES, 1974
herring	20	10-35	N.Atl.	ICES, 1977a
herring	40	10-23	Irish coast	ICES, 1980
"typical"	40			
sardine	60	6-80	N.Atl.	ICES, 1977a
sardine	250	150-390	Medit.	UNEP, 1980
sprat	65	60-140	Irish c.	ICES, 1980
capelin	10	10-30	N.Atl.	ICES, 1977a
anchovy	160	145-180	Medit.	UNEP, 1980
feed on invertebrates				
brown shrimp	110?	50-230	N.Sea	ICES, 1974
brown shrimp	140	70-390	N.Sea	ICES, 1977b
brown shrimp	80	30-300	N.Sea	ICES, 1977c
"typical"	110			
deep sea prawn	25	20-30	W.Greenl.	ICES, 1977a
Norway lobster	960	290-970	Medit.	UNEP, 1980
cod	100	30-480	N.Sea	ICES, 1974
cod	100	60-300	N.Sea	ICES, 1977a
cod	40	40-50	N.Atlantic	ICES, 1977a
cod	260		Irish Sea	ICES, 1980
cod	140	70-370	Irish Coast	ICES, 1980
cod	70	50-140	NW.Atlantic	ICES, 1977a
cod	80	70-90	NW.Atlantic	ICES, 1980
"typical"	100			
feed on crustaceans and fish				
hake	90	30-130	N.Atlantic	ICES, 1977a
hake		30-850	Mediterr.	UNEP, 1980
haddock	50	20-60	Irish coast	ICES, 1980
haddock	50		NW.Atlantic	ICES, 1980
whiting	80	30-90	Irish coast	ICES, 1980
bluefin tuna	715	300-1485	Mediterr.	UNEP, 1980
mullet	190	55-1300	Mediterr.	UNEP, 1980
Greenl.halibut	40	30-50	N.Atlantic	ICES, 1977a
plaice	90	20-260	N.Sea	ICES, 1974
plaice	120	20-500	N.Atlantic	ICES, 1977a
plaice	25	10-80	Irish coast	ICES, 1980
"typical"	90			
sole	150	50-320	N.Atlantic	ICES, 1977a

? = values selected from source data.

Table 19

Overall averages of mercury concentrations according to UNEP sampling area (Nauen *et al.*, 1980, modified).

Area	Species	n	ug kg^{-1} FW mean	min	max
II	*Engraulis encrasicolus*	37	140	20	300
	Mullus barbatus	262	590	15	5600
	M. surmuletus	5	260	70	510
	Mytilus galloprovincialis	37	70	15	400
	Nephrops norvegicus	129	1080	350	3000
	Sarda sarda	14	1000	290	2300
	Thunnus thynnus	176	1100	20	6290
	Xiphias gladius	1	150		
III	*M. surmuletus*	204	90	30	230
	Perna perna	192	76	20	370
IV	*E. encrasicolus*	44	157	65	380
	M. barbatus	195	1440	60	7050
	M. galloprovincialis	59	240	25	1260
	N. norvegicus	86	1110	60	2900
	Thunnus alalunga	8	215	90	336
V	*M. barbatus*	6	190	100	390
	M. galloprovincialis	26	870	25	7000
VI	*E. encrasicolus*	11	145	55	270
	M. barbatus	13	190	45	330
	M. galloprovincialis	12	75	35	145
	N. norvegicus	7	290	190	360
	T. alalunga	8	275	60	400
VII	*Lithophaga lithophaga*	5	165	80	290
	M. barbatus	11	165	30	280
	Trachurus mediterraneus	5	345	80	955
VIII	*Carcinus mediterraneus*	13	215	115	345
	Merluccius merluccius	10	315	60	840
	Mugil auratus	16	350	85	2500
	Mugil cephalus	3	165	70	300
	M. barbatus	127	175	15	1400
	M. galloprovincialis	175	105	5	920
	Penaeus kerathurus	10	175	75	475
	T. thynnus	7	370	70	890
	T. mediterraneus	3	340	320	365
	X. gladius	8	280	85	755

Table 19 (Cont'd)

Overall averages of mercury concentrations according to UNEP sampling area (Nauen *et al.*,1980, modified).

Area	Species	n	ug kg^{-1} FW mean	min	max
IX	*Boops salpa*	3	10	5	15
	M. auratus	39	170	1	5600
	M. barbatus	6	55	2	90
	M. surmuletus	13	35	1	80
	M. galloprovincialis	4	37	20	50
	P. kerathurus	7	20	10	50
	Upenaeus moluccensis	7	200	110	430
	Boops boops	5	135	40	430
	Dentex dentex	6	385	220	480
	D. gibbosus	12	140	100	180
	Donax trunculus	42	210	35	910
	Epinephelus aenus	4	250	100	400
	Merluccius merluccius	6	150	31	260
	M. barbatus	168	140	30	475
	Pagellus acarne	7	190	70	340
	P. erythrinus	112	205	55	805
X	*Surida undosquamis*	143	135	40	650
	Sphyraena sphyraena	7	165	80	245
	T. mediterraneus	48	95	10	415
	U. moluccensis	120	440	40	1120
XI	*M. surmuletus*	5	150	15	380
	M. galloprovincialis	3	190	20	290
	T. thynnus	1	550		
XII	*M. merluccius*	3	815	780	850
	M. barbatus	3	215	210	230
	M. galloprovincialis	3	160	140	170
	P. erythrinus	3	220	210	225
	Parapenaeus longirostris	3	300	270	350
	T. mediterraneus	3	345	340	350

Table 20

Selected mercury concentrations (ug Hg-T kg^{-1} FW) in mixed plankton samples.

pore size (in um)	n	fresh weight mean	min	max	dry weight mean	min	max	location	ref.
Mediterranean:									
60	19				100	30	260	Aegean-Gibraltar	a
132	13				130	60	265	Aegean-Gibraltar	a
60	2					36	180	SE.Mediterranean	a
280	3				180 M	160	560	SE.Mediterranean	a
280	4				25	18	34	E.Mediterranean	a
80	2					63	115	Ionian	a
280	2					39	40	Ionian	a
60	2					50	65	Tyrrhenian	a
280	2					36	41	Tyrrhenian	a
500	5				33	15	78	NW.Mediterranean	a
220	38				205	20	130	Adriatic	b
250	7				290	160	440	Aegean, coasts	c
333	3				2860	1860	4230	Adriatic, open	d
Non-Mediterranean:									
400	57					70	910	N.Atlantic, shelf	e
153	3				140	110	190	W.Atlantic, estuar.	f
360	18				1100	70	3800	Caribbean	k
76	34	10	5	30	207	105	490	Monterey Canyon	f
76	7	20	10	52	410	115	705	Hawaii-Monterey	f
76	5	5.5M	4.7	15.2				Monterey Bay	f
76	5	2.0	Nct	4.5 Me				Monterey Bay	f
360	25	10	2	20	110	50	180	Monterey Canyon	i
360	14	10	4	35	130	40	4450	Hawaii-Monterey	i
360	2		65	170				Monterey Bay	i
360	3	28	5.3	50 Me				Monterey Bay	i
360	9	(8.5 +-3.5)			90 +-35			Monterey Bay	i
360	2					75	160	Off Pacific Grove	j
76	7				250	170	320	Pacific Gr. Calif.	g
95	3				12400M	6300	16800	Minamata Bay	h
95	2					150	750	Yatsushiro Sea	h
328	3				26400M	18500	47300	Minamata Bay	h
328	2					570	1770	Yatsushiro Sea	h

Note: M: median; Me: methyl mercury; +-: standard deviation;
nct: not detected.

Reference:

a: Fowler, 1985
b: Kosta et al., 1978
c: Zafiropoulos and Grimanis, 1977
d: Vucetic et al., 1974
e: Windom et al., 1973
f: Knauer and Martin, 1972
g: Robertson et al., 1972
h: Kumagai and Nishimura, 1978
i: Martin and Knauer, 1973
j: Robertson et al., 1972

Table 21

Mercury concentration in plankton species.

Species	length cm	sample n	ug Hg-T kg^{-1} DW mean	min	max	location	ref.
Arcatia clausi	?	8	290	30	240	Elefsis B. (Greece)	a
Euphausia spp.	?	8	140	30	240	Mediterranean	b
	1	3	80	55	100	East Ionian-Tyrrh.	c
	1.5-2	3	175	150	190	East Ionian-Tyrrh.	c
	2	1	240			East Ionian-Tyrrh.	c

a: Zafiropoulos and Grimanis, 1977
b: Fowler et al., 1976
c: Fowler, 1985

Table 22

Mercury concentrations in pelagic mammals from the Mediterranean and Atlantic (Bernhard and Renzoni, 1977).

Species	sex	age	size cm	-- ug kg-T kg^{-1} FW -- muscle	fat	liver	sample location and date
Atlantic:							
Phocoena phocoena	M	adult	172	6750	770	61000	La Rochelle (May 1972)
Delphinus delphis	F	young	125	890	710	900	Ile de Ré (July 1972)
	F	adult	140	600	20	980	Pyrénées Atl. (July 1973)
	F	adult	165	910	27	1430	Pyrénées Atl. (April 1973)
	M	adult	185	1840	220	220	Landes (July 1973)
	F	adult	210	6250	2650	4850	Gironde (May 1972)
	M	15 y	220	2180	2780	66700	Tropic Atl. 1975
Mediterranean:							
D. delphis	M	12 y	205	1450	3900	604000	Mediterranean 1973
Stenella coeruleo.	F	adult	168	1950	1800	39850	Iles d'Hyères (Feb. 1973)
	M	adult	210	23800	6000	344900	Lavandou (Var) (April 1973)
Grapus priseus	F	adult	300	16000	1700	905000	Cacalastre (Var) (July 1973)
Tursiops truncata	?		140*	41000	-	-	Pescara (1971)
	M	6-18m	160	2200	310	14600	Mediterranean (1973)
	M	25 y	330	24000	4400	293000	Mediterranean (1973)
Atlantic:							
Globicephala melaena	F	young	300	640	50	900	Gironde (April 1972)
	M	adult	490	5300	860	860	Charente (August 1972)
Mediterranean:							
G. melaena	F	adult	390	13100	1290	670000	Cros de Cagne (Alp. Mar.) (July 1973)
Physeter catodan	M	?	800	4050	3150	-	Bonifacio (Cors.) (Dec.1972)

*) size in kg
M = male; F = female; y = year; m = month
(Data compiled from Thibaud and Dugay, 1973, Martoja and Viale, 1977 and Caracciolo *et al.*, 1972.

Table 23

PCB in marine samples from the Mediterranean Sea during 1974-1976 (Fowler, 1986).

Sample type	Date	Region	No. of samples	PCB (range)	PCB (X)
				ng l^{-1}	
Sea water	10.74	North-west Mediterranean	11	1.5-38	13
	2.75	Ligurian	17	1.3-8.6	3.2
	2.75	Aegean	7	0.2-1.3	0.36
	5.75	Ionian	10	0.2-2.0	1.0
		Tyrrhenian and Algero-Provençal Basin	34	0.2-5.9	2.0
	9.75	Algero-Provençal basin	8	0.6-19	4.6
			7	0.6-4.8	2.5
		Tyrrhenian	6	1.5-11.6	4.5
				ng $m3^{-1}$	
Marine air	8.75 to 1.76	Monaco coast	13	0.1-1.0	0.4
	1.76 to 2.76	Monaco coast	12	0.03-0.08	0.06
	9.75	Algero-Provençal basin	4	0.2-0.3	0.25
		Tyrrhenian	2	0.1-0.3	0.2
				ug kg^{-1}	
Sediments	5.75	Ionian	3	0.8-5.1	2.8
		Algero-Provençal basin	5	0.8-9.0	4.0
		Gibraltar sill and Siculo-Tunisian sill	2	0.8	0.8
		Algerian marin	1	9.0	9.0

Table 24

Chlorinated hydrocarbons (ug Kg^{-1} FW) in Mediterranean marine organisms (UNEP, 1985).

Region	Chlorinated Hydrocarbon	Species	No.of Samples	Mean concen.	Standard deviation	Range
II	PCB	Mytilus galloprovincialis	17	307	266	22 - 1200
IV	"	" "	13	95	114	5 - 420
V	"	" "	159	84	221	5 - 2622
VIII	"	" "	12	62	12	40 - 80
II	PCB	Mullus barbatus	33	813	1496	30 - 8000
IV	"	"	33	417	770	50 - 3950
V	"	"	86	234	473	1 - 3117
VIII	"	"	51	113	204	0 - 1110
IX	"	"	6	9.3	19	0,4 - 52
X	"	"	42	69	75	0 284
VIII	PCB	Parapenaeus longirostris	30	12.3	12,2	0 - 51
IX	"	" "	3	1.5	-	0 - 2,5
X	"	" "	11	31	57	0 - 157
II	"	Carcinus mediterraneus	10	12.3	12,2	0 - 51
V	"	" "	3	1.5	-	0 - 2,5
X	"	" "	11	31	57	0 - 157
IV	"	Mullus surmuletus	6	87	17	60 - 110
V	"	"	9	101	130	5 - 441
IV	"	Nephrops norvegicus	28	25	17	8 - 90
II	pp DDT	Mullus barbatus	27	28	35	8 - 170
IV	"	"	33	23	17	6 - 89
V	"	"	102	17	26	0,2 - 205
VIII	"	"	51	23	25	4 - 110
IX	"	"	17	38	29	0,5 - 92
X	"	"	44	8	9	0 - 37
II	"	Mytilus galloprovincialis	113	22	23	3 - 150
IV	"	" "	12	7	5	1.2 - 17
VIII	"	" "	180	15	77	0 - 1014
II	"	Thunnus thynnus thynnus	21	343	362	25 - 1401
IV	"	Mullus surmuletus	6	6	3	4 - 13
V	"	"	11	9	11	0,5 - 40
V	"	Carcinus mediterraneus	31	1.7	1.4	0.2 - 5
IX	"	"	6	1.6	0.7	0.4 - 2.6
VIII	"	Parapenaeus longirostris	29	0.9	1.4	0 - 6
II	"	" "	4	4.2	3.5	0.3 - 9
X	"	" "	10	0.1	0.2	0 - 0.8

Table 24 (Cont'd)
Chlorinated hydrocarbons (ug Kg^{-1} FW) in Mediterranean marine organisms (UNEP, 1985).

Region	Chlorinated Hydrocarbon	Species	No.of Samples	Mean concentr.	Standard deviation	Range
II	Dieldrin	Mullus barbatus	11	6.2	5.3	0.5 - 19
IV	"	"	9	6	3.6	0.5 - 12
V	"	"	67	1.7	4.1	0.1 - 17
X	"	"	35	0.4	1.1	0 - 35
II	"	Mytilus galloprovincialis	2	3.5	-	1 - 6
IV	"	" "	6	2.8	2.6	0.5 - 6
V	"	" "	145	0.8	4.4	0.1 - 56
V	"	Mullus surmuletus	8	0.4	0.2	0 - 0.7
IV	"	Nephrops norvegicus	7	0.9	0.5	0.5 - 1.8
V	"	Carcinus mediterraneus	31	0.5	0.6	0 - 2.4
X	"	" "	4	3.1	4.5	0.4 - 10
II	Aldrin	Mullus barbatus	9	0.5	-	0.5 - 0.5
IV	"	"	9	1.5	1.9	0.5 - 5
IX	"	"	5	0.5	0.4	0 - 1
X	"	"	44	1.5	4.7	0 - 28
IV	"	Mytilus galloprovincialis	6	2	2.1	0.5 - 5
IV	"	Nephrops norvegicus	7	0.6	0.2	0.5 - 1
X	"	Carcinus mediterraneus	5	1.6	2.8	0 - 6.5
IX	"	Parapenaeus longirostris	4	1.4	1	0 - 2.8
X	"	" "	11	0.2	0.6	0 - 2.2
II	Hexachloro-cyclohexane	Mullus barbatus	63	2.6	2.8	0.2 - 12
VIII	"	"	4	5	8	0.8 - 50
IX	"	"	5	3.9	3.9	1 - 11
V	"	Mytilus galloprovincialis	43	1.1	1	0 - 5
VIII	"	" "	55	1.9	1.5	0.4 - 5
V	"	Mullus surmuletus	4	1.2	1.7	0 - 4
V	"	Carcinus mediterraneus	27	0.9	-	0 - 8
IX	"	" "	6	20	-	12 - 34
VIII	"	Parapenaeus longirostris	7	0.7	0.3	0.2 - 1.1
II	Lindane	Mullus barbatus	17	19	14	2 - 36
IV	"	"	9	1.5	1.4	0.5 - 5
V	"	"	62	0.7	0.9	0 - 3.8
II	"	Mytilus galloprovincialis	7	4.8	6	0.5 - 20
IV	"	" "	6	1.7	0.9	0.5 - 3
V	"	" "	36	0.4	0.4	0 - 2
II	Lindane	Carcinus mediterraneus	4	19	14	2 - 36
V	"	" "	27	0.2	-	-
IV	"	Nephrops norvegicus	7	0.5	-	-

Table 24 (Cont'd)
Chlorinated hydrocarbons (ug Kg^{-1} FW) in Mediterranean marine organisms (UNEP, 1985).

Region	Chlorinated Hydrocarbon	Species	No.of Samples	Mean concentr.	Standard deviation	Range
II	pp DDD-1	*Mullus barbatus*	12	38	52	0 - 180
V	"	"	5	28	40	2.2 - 107
VIII	"	"	78	14	25	0 - 140
IX	"	"	17	18	14	0 - 44
X	"	"	44	1.6	3.8	0 - 21
II	"	*Mytilus galloprovincialis*	108	15	13	5 - 125
V	"	" "	11	49	124	0 - 440
VIII	"	" "	90	7	7	0 - 45
II	"	*Thunnus thynnus thynnus*	21	107	98	5 - 117
VIII	"	" "	4	323	422	26 - 1052
V	"	*Mullus surmuletus*	3	7	6	2 - 15
II	"	*Carcinus mediterraneus*	10	10	9	1.2 - 26
IX	"	" "	6	4.2	3.7	0 - 10
VIII	"	*Parapenaeus longirostris*	29	0.8	1.4	0 - 7
IX	"	" "	4	2.2	1.3	0.5 - 4.2
X	"	" "	11	0.4	0.8	0 - 2.7
II	pp DDE-1	*Mullus barbatus*	34	29	14	11 - 70
IV	"	"	33	33	18	7 - 93
V	"	"	43	8	12	0.1 - 75
VIII	"	"	88	33	39	1 - 255
IX	"	"	16	53	42	0,9 - 117
X	"	"	44	15	12	2 - 67
II	"	*Mytilus galloprovincialis*	114	13	9	2.2 - 42
IV	"	" "	13	6	4	2 - 17
V	"	" "	145	5	13	0.1 - 110
VIII	"	" "	99	10	12	1 - 75
II	"	*Thunnus thynnus thynnus*	21	352	415	23 - 1582
VIII	"	" "	4	601	659	161 - 1737
IV	"	*Mullus surmuletus*	6	11	3	6 - 15
V	"	"	10	12	12	0.1 - 33
II	"	*Carcinus mediterraneus*	10	36	24	14 - 72
V	"	" "	4	2.5	30	0.1 - 6.2
VIII	"	" "	3	23	3	20 - 26
IX	"	" "	7	22	15	0.3 - 45
X	"	" "	4	3.1	3.5	0.7 - 8
IV	"	*Nephrops norvegicus*	28	3.8	1.8	1.1 - 8
VIII	"	*Parapenaeus longirostris*	31	1.6	5	0 - 25
IX	"	" "	4	3.1	1.6	1 - 5.4
X	"	" "	11	1.5	2.6	0 - 9

Table 25

Dissolved/dispersed petroleum hydrocarbons (ug l^{-1}) (UNEP/IMO/IOC, 1987).

Area	Year	Concentrations	Technique	Reference
Western Mediterranean (offshore)				
Northern part	1973	10-2200 (surface) (av. 450)	Fluorescence	Monaghan et al., 1974
		3-37 (10 m) (av. 15)	"	"
	1975-77	2-6 (surface) (av. 3.3)	"	Faraco and Ros, 1978
	1981	1.5-21.1 (surface)	GC-n-alkanes	Ho et al., 1982
		3.5-4.6 (surface)	-UCM	"
		0.5-0.8 (chr. eq.)	Fluorescence	"
	1983	1.9 (surface)	GC-n-alkanes	Sicre et al., 1984
		1.3 (surface	-UCM	"
Central part	1981	0.33 (chr. eq.)	Fluorescence	Ho et al., 1982
	1983	0.68 (surface)	GC-n-alkanes	Sicre et al., 1984
		1.37 (surface)	-UCM	"

Table 25 (Cont'd)

Dissolved/dispersed petroleum hydrocarbons (ug l^{-1}) (UNEP/IMO/IOC, 1987).

Area	Year	Concentrations	Technique	Reference
Western Mediterranean (offshore)				
Southern part	1973	2-17 (surface) (av. 8.5) 2.7 (10 m)	Fluorescence	Monaghan *et al.*, 1974
	1974-75	av. 6.9 (surface)	"	Zsolnay, 1979
	1975-77	1-123.5 (surface (av. 17.5)	"	Faraco and Ros, 1978
	1981	0.23 (surface) 0.81 (surface) 0.078-0.2 (chr. eq.)	GC-n-alkanes -UCM Fluorescence	Ho *et al.*, 1982 " "
	1983	0.31 (surface) 1.15 (surface)	GC-n-alkanes -UCM	Sicre *et al.*, 1984 "
Alboran Sea	1975-77	4.3-14.6 (surface) (av. 7.9)	Fluorescence	Faraco and Ros, 1978
	1981	0.2 (chr. eq.)	"	Ho *et al.*, 1982

Table 25 (Cont'd)
Dissolved/dispersed petroleum hydrocarbons (ug l^{-1}) (UNEP/IMO/IOC, 1987).

Area	Year	Concentrations	Technique	Reference
Western Mediterranean (nearshore)				
Spanish coast				
Castellon	1983	1.36-2.40		De Leon, 1984
Sagunto	"	0.06-3.40		"
Valencia	"	0.63-4.35		"
Cullera	"	0.06-3.10		De Leon, pers. comm.
Benidorm	"	0.60-0.26		"
Alicante	"	0.85-8.26		"
Guardamar	"	1.15-3.15		"
Portman	"	0.26-6.50		"
Cartagena	"	0.26.3.22		"
French coast	1975-78	50-5000 (av. 580)	IR	UNEP, 1980
Banyuls-sur-Mer				
Var Estuary	1981	0.4-1.0	GC-UCM	Burns and Villeneuve, 1982
Gulf of Fos	1983-84	30-200		MEDPOL Phase II
Gulf of Ajaccio	1983-84	0-100		MEDPOL Phase II

Table 25 (Cont'd)
Dissolved/dispersed petroleum hydrocarbons (ug l^{-1}) (UNEP/IMO/IOC, 1987).

Area	Year	Concentrations	Technique	Reference
Italian coast				
Tyrrhenian Sea	1973	8-614 (surface) (av. 180) 3-19 (10 m) (av. 7)	Fluorescence	Monaghan et al., 1974
	1974-75	av. 4.8 (surface)	"	Zsolnay, 1979
	1975-77	1.9-20.5 (av. 7.4)	"	Faraco and Ros, 1978
Taranto, Mar Piccolo	1983	0.2-11.6 (av. 3.26)	GC	Strusi, pers. comm.
"	"	0.5-23.0 (av. 7.42)	"	"
"	"	0.1-36.0 (av. 7.98)	"	"

<u>Table 25</u> (Cont'd)
Dissolved/dispersed petroleum hydrocarbons (ug l^{-1}) (UNEP/IMO/IOC, 1987).

Area	Year	Concentrations	Technique	Reference
Central Mediterranean				
South Ionian Sea	1973	3-423 (surface) (av. 58)	Fluorescence	Monaghan *et al.*, 1974
		2-120 (10 m) (av. 16)	″	″
	1974-75	av. 14.9 (surface)	″	Zsolnay, 1979
Malta, coastal waters	1977-78	0.02-0.29	″	UNEP, 1980
	1984	0.03-1.70 (av. 0.51)	″	UNEP, 1985 (MED POL Phase II)
Libyan coast	1974-75	av. 24.9 (surface)	″	Zsolnay, 1979
W Sedra, Tripoli harbour Zawia	1980	20-28	″	Gerges and Durgham, 1982
Janzur, W&E Brega, Zawia W Khoms	″	12.5-19	″	″
Zlitan, Zwetina, Benghazi, E Sirte, Tajura		4.6-5.3	″	″
Sabratha, Derma, Sidi Blal		0.6-2.9	″	″
Libyan coast 171 samples from coastal areas	″	0.0-27.6 (av. 3.6)	″	MFRC, Tripoli 1981

Table 25 (Cont'd)
Dissolved/dispersed petroleum hydrocarbons (ug l^{-1}) (UNEP/IMO/IOC, 1987).

Area	Year	Concentrations	Technique	Reference
Adriatic				
Yugoslavia, Rijeka Bay	1976-77	1-50	Fluorescence	UNEP, 1980
		100-1100	IR	
		below 0.1	GC	Ahel & Picer, 1978
" "	1976-78	1-7 ("polluted")	Fluorescence	Ahel, 1984
		0.2-0.5 ("unpolluted")	"	
Yugoslavia, Sibernik area	1984	0.2-16.4 (av. 1.4)	"	UNEP, 1985 (MED POL Phase II)
Yugoslavia, Split	1984	av. 24.9 (surface)	"	" "
Eastern Mediterranean				
Aegean Sea	1974-75	av. 20.5	Fluorescence	Zsolnay, 1979
Greece				
Coastal waters		below 3	"	Mimicos, 1980
Saronikos Gulf	1980-81	1.6-5.6	"	Gabrielides *et al.*, 1984
Aegean Sea	"	2.9-13.7	"	"
Thessaloniki harbour	1976-79	1500	IR	UNEP, 1980
Cavala harbour	"	2600	"	"
Strymonikos Bay	"	1100	"	"
Patraikos Gulf	1977-83	0.12-28.2	Fluorescence	Mimicos *et al.*, 1984
Acheloos River estuary	"	1.3-4.5	"	"

Table 25 (Cont'd)
Dissolved/dispersed petroleum hydrocarbons (ug l^{-1}) (UNEP/IMO/IOC, 1987).

Area	Year	Concentrations	Technique	Reference
Turkey				
Mersin-Akkuyu	1977-78	8.2-39.4	"	UNEP, 1980
Southern coast	1980-82	0.5-3.5 (av. 1.5)	"	Sunay *et al.*, 1982
Offshore between Turkey and Cyprus	1980-82	2.0-6.0	"	Sunay *et al.*, 1982
Iskenderun Bay	"	0.7-7.0	"	"
Sea of Marmara	1983	0.88 (max. 8.07)	"	Sakarya *et al.*, 1984
Izmit Bay	"	0.75-5.0	"	"
Aegean Sea	"	0.14-1.39	"	"
Mediterr. coastal waters	"	0.02-1.1	"	"
Iskenderun Bay	"	0.11-1.0	"	"
Candarli Bay	1983-84	1.20-80.0	"	Topcu & Muezzinoglu, 1984
Aliaga	"	0.53-7.30	"	"
Saros Bay	1983	0.77	"	"
Izmir Bay	"	9.40	"	"
Southern Aegean Coast	"	0.86	"	"

Table 25 (Cont'd)
Dissolved/dispersed petroleum hydrocarbons (ug l^{-1}) (UNEP/IMO/IOC, 1987).

Area	Year	Concentrations	Technique	Reference
Eastern Mediterranean				
Offshore South of Cyprus, Southeast of Crete	1975-76	10-40	Fluorescence	UNEP, 1980
Israel				
Ashkelon	1975-76	9.4-19.4	"	"
Haifa Bay	"	15.0-15.6	"	"
Plamachin	"	10.7-12.5	"	"
Bardawil Lagoon	"	20.6	"	"
Tel Shikmona	"	1.1-45.3	"	"
Egypt				
Alexandria	1978-79	0.7-35.2 (av. 3.7)	"	Aboul-Dahab & Halim, 1980b
Alexandria	1979-80	6.6-41.4 (nearshore)	"	Wahby and El Deeb, 1980
		0.7-3.9 (offshore)	"	"
Mouth of Suez Canal	1980-81	0.5-14	"	Samra _et al_., 1982
Cyprus, Limassol Bay	1983	2.6-8.1	"	MED POL - Phase II
	1984	1.15-1.48	"	"
Larnaca Bay	1983	4.2-13.6	"	"
	1984	1.74-2.53	"	"

Table 26

Summary assessment of the microbiological quality of shellfish and shellfish-growing waters in the Mediterranean, according to WHO/UNEP interim criteria (UNEP/WHO, 1986).

(MED POL VII sampling stations with at least 10 shellfish analyses per year).

Year	Stations surveyed	Stations with satisfactory		Stations with satisfactory water and shellfish
		water	shellfish	
1976	15	10 (67%)	0 (0%)	0 (0%)
1977	12	7 (58%)	0 (0%)	0 (0%)
1978	21	14 (67%)	2 (10%)	2 (10%)
1979	19	9 (47%)	4 (21%)	1 (5%)
1980	21	16	0 (0%)	0 (0%)
1981	-	-	-	-
Overall	88	56 (63%)	6	3 (3%)

Table 27

Summary assessment of the microbiological quality of recreational waters in the Mediterranean according to the WHO/UNEP interim criteria (UNEP/WHO, 1985).

(MED POL VII sampling stations with at least 10 samples per year).

Year	Number of stations			
	Surveyed	In accordance with FC50	FC90	Satisfactory by FC50 & FC90
1976	21	16 (76%)	14 (67%)	14 (67%)
1977	40	38 (95%)	34 (85%)	34 (85%)
1978	33	30 (91%)	30 (91%)	28 (85%)
1979	133	124 (93%)	104 (78%)	104 (78%)
1980	86	79 (92%)	72 (84%)	69 (80%)
1981	0	0	0	0
Overall	313	287 (92%)	254 (81%)	249 (80%)

Table 28

Treatment Facilities in Mediterranean Municipalities in 1978 (from UNEP, 1987b).

Country	Number of municipalities considered	Total population	Municipalities with treatment			Municipalities without treatment
			Functioning	Under construction	Planned	
Spain	29	6,275,687	13	3	18	10
France	16	1,955,300	10	4	7	5
Italy	17	1,176,775	11	10	7	2
Yougoslavia	1	65,000	0	1	0	0
Greece	5	3,932,484	0	0	3	5
Turkey	4	897,704	1	1	1	2
Cyprus	1	125,000	1	0	0	0
Tunisia	4	397,500	2	0	1	2
Morocco	1	90,000	-	-	-	-
TOTAL	78	14,906,450	38	20	37	28

Table 29

Percentage of access of urban and rural population to sanitation services (sewer connections, septic tanks, and adequate sanitation). Evolution 1975-1980. (UNEP, 1987b)
Percentage of access of total population, 1980s

	1970		1975			1980		TARGETS				TOTAL POPULATION	
			Urban					1985		1990			
	Urban	Rural	Total	with sewer connections (*)	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Year	%
SPAIN			..	90	..	81	79	81 (**)	85 (**)			1984	90
FRANCE			..	100	..							1980	85
ITALY			96	80	..							1981	99
MALTA	100	80	100	98	93	100	84					1983	100
YUGOSLAVIA			..	70	..							1981	58
ALBANIA			..	60	..							-	
GREECE			..	70	..	83	80					-	
TURKEY			13	5	5	56	..					1982	10
CYPRUS	100	92	100	10	95	100	100					1984	100
SYRIA			..	90	..	74	28	80	41	90	54	1984	..
LEBANON			..	70	..			94	18			1985	75
ISRAEL			..	70	..	90	..	100	..	100	..	1984	95
EGYPT			..	95	..	95	49	..	..	..	..	1981	70
LIBYA	100	54	100	90	69	100	72	100	88			1983	70
TUNISIA	100	34	..	29	..	100	..	..	77			1984	46
ALGERIA	8	..	100	57	..	95	70	100	70	100	..	1980	..
MOROCCO	75	4	..	60	..							1984	46

(*) Percentage of the urban population -1975 - connected to a municipal sewage system
(**) 1983

Source : Blue Plan (from WHO)

Table 30

Infrastructure facilities for the Population in the Turkish Mediterranean Area (Kavasogullari *et al.*, 1987).

Facilities	Population served				
	Existing	Under construction	Planned	Not existing	Total
1. Sewerage System					
- Coastal Zone	516,841	1,613,992	880,983	108,926	3,120,742
- Discharging to Rivers	1,690,976	147,497	62,915	272,992	2,174,380
Total	2,207,817	1,761,489	943,898	381,918	5,295,122
2. Marine Outfalls					
- Coastal Zone	342,853	172,128	122,012	1,488,004	3,120,742
- Discharging to Rivers	NA*	NA	NA	NA	
3. Treatment Plants					
- Coastal Zone	-	-	994,745	2,124,997	3,120,742
- Discharging to Rivers	-	310,723	184,452	1,679,215	2,174,380

NA* = Not Applicable

Table 31

Estimated annual pollution loads of the Mediterranean from land-based sources (from UNEP/ECE/UNIDO/FAO/UNESCO/WHO/IAEA, 1984).

Pollutant		Pollution loads originating in the coastal zone				Loads carried by rivers into the Mediterranean				Total Mediterranean Loads		
		Domestic t/a	Industrial t/a	Agricult. t/a	Sub-total t/a	Pollution t/a	Background t/a	Sub-total t/a	Sub-total range	Pollution	Total(incl.background) t/a	Total(incl.background) (range)
1. Volume:												
Total discharge	$x10^9$	2	6	-*	(8)	(-)	420	420	(400-500)	(-)	430	(400-500)
2. Organic matter:												
BOD	$x10^3$	500	900	100	1500	1000	(800)	1800	(1200-2300)	2500	3300	(2700-3800)
COD	$x10^3$	1100	2400	1600	5100	2700	800	3500	(2300-4700)	7800	8600	(7400-9800)
3. Nutrients:												
Phosphorus	$x10^3$	22	5	30	57	260	40	300	(200-400)	320	360	(260-460)
Nitrogen	$x10^3$	110	25	65	200	600	200	800	(600-1000)	800	1000	(800-1200)
4. Specific organics:												
Detergents	$x10^3$	18	-	-	18	42	0	42				
Phenols	$x10^3$	-	11	-	11	1	0	1	(0,5-1,8)	12	12	(6-18)
Mineral oil	$x10^3$	-	120	-	120	(-)	0	(-)		(120)	(-)	
5. Metals:												
Mercury		0,8	(7)	-	(8)	90	30	120	(40-200)	100	130	(50-200)
Lead		200	1400	-	1600	2200	1000	3200	(2700-3800)	3800	4800	(4300-5400)
Chromium		250	950	-	1200	1200	400	1600	(500-2700)	2400	2800	(1700-3900)
Zinc		1900	5000	-	6900	14000	4000	18000	(14000-22000)	21000	25000	(21000-29000)
6. Suspended matter:												
TSS	$x10^6$	0,6	2,8	50	53	-	300	300	(100-500)	-	350	(100-600)
7. Pesticides:												
Organochlorines		-	-	-*	-	90	0	90	(50-200)	90	90	50-200)
8. Radioactivity:												
Tritium	Ci/a	-	400	-	400	2100	(-)	2100	(1600-3100)	2500	(-)	
Other radio-nuclides	Ci/a	-	25	(-)	25	15	(-)	15	(10-25)	40	(-)	

Legend:
- \- contributions from this source negligible
- (-) insufficient data base for estimate
- -* included in river assessment

Table 32

Discharge of Pesticides into the Mediterranean Sea (from UNEP, 1987).

The most significant Compounds for the Mediterranean Sea	Polluting Loads Discharged (t/a)
- DDT and similar compounds	196
- HCH and Lindane	194
- Aldrin, Dieldrin, Endrin	29
- Other organochlorine compounds	148

Table 33

The Mediterranean coastline (UNEP, 1987b)

	TOTAL	MED. COAST	CONTINENT	ISLANDS	ROCKY COAST (%)
SPAIN	6 121	2 580	1 670	910 (Balearic)	52
FRANCE	5,533	1,703	901	802 (Corsica)	64
MONACO	4	4	4	---	75
ITALY	7 953	7 953	4 187	1 126 (Sicily) 1 387 1 253	40
MALTA	137	137	---	137	50
YUGOSLAVIA	6 116	6 116	2 092	4 024	80
ALBANIA	418	418	418	---	34
GREECE	15 000	15 000	7 300	7 700	70
TURKEY	7 100	5 191	4 382	809	70
CYPRUS	782	782	---	782	55
SYRIA	183	183	183	---	5
LEBANON	225	225	225	---	50
ISRAEL	190	190	190	---	5
EGYPT	2 400	950	950	---	0
LIBYA	1 770	1 770	1 770	---	10
TUNISIA	1 300	1 300	1 300	---	5
ALGERIA	1 200	1 200	1 200	---	80
MOROCCO	3 446	512	512	---	30
TOTAL	59 878	46 214	27 284	18 930	58

SOURCE: BLUE PLAN

Table 34

Area, population and density of Mediterranean countries [a] (UNEP, 1987a)

	AREA (1000 Km^2)	POPULATION (thousands)				DENSITY (inhab. Km^{-2})			
		1960	1985	2000	2025	1960	1985	2000	2025
SPAIN	504.8	30 303	38 542	42 237	45 983	60	76	84	91
FRANCE	547.0	45 684	54 621	57 162	58 431	84	100	104	107
ITALY	301.2	50 223	57 300	58 642	57 178	167	190	195	190
MALTA	.3	329	383	418	459	1,041	1,212	1,323	1,451
YUGOSLAVIA	255.8	18 402	23 153	25 206	26 756	72	91	99	105
ALBANIA	28.7	1 611	3 050	4 102	5 772	56	106	143	201
GREECE	131.9	8 327	9 878	10 437	10 789	63	75	79	82
TURKEY	780.6	27 509	49 289	65 351	91 925	35	63	84	118
CYPRUS	9.3	573	669	762	902	62	72	82	98
SYRIA	185.2	4 561	10 505	17 809	31 758	25	57	96	172
LEBANON	10.4	1 857	2 668	3 617	5 221	179	257	348	502
ISRAEL	20.8	2 114	4 252	5 302	6 865	102	205	255	331
EGYPT	1,001.4	25 922	46 909	63 941	90 399	26	47	64	90
LIBYA	1,759.5	1 349	3 605	6 082	11 090	1	2	3	6
TUNISIA	163.6	4 221	7 081	9 429	12 860	26	43	58	79
ALGERIA	2,381.7	10 800	21 718	33 444	50 611	5	9	14	21
MOROCCO	446.6	11 626	21 941	29 512	40 062	26	49	66	90
TOTAL	8,528.8	245 411	355 564	433 453	547 061	2,030	2,654	3,097	3,734

(a) The projections shown here are the medium variants of different projections.

SOURCE: UNITED NATIONS, WORLD POPULATION PROSPECTS AS ASSESSED IN 1984

Table 35

Population in the Mediterranean coastal regions in 1985 (a) (UNEP, 1987a)

	COUNTRY		MEDITERRANEAN REGIONS		SHARE OF MEDITERRANEAN REGIONS		COASTAL ADMINISTRATIVE ZONES
	POPULATION (1000)	AREA (Km^2)	POPULATION (1000)	AREA (Km^2)	POPULATION (%)	AREA (%)	NUMBER
SPAIN	38 542	504 782	13 860	95 504	36.0	18.9	12 PROVINCES
FRANCE	54 621	547 026	5 494	46 248	10.1	8.5	9 DEPARTEMENTS
ITALY	57 300	301 225	41 862	226 685	73.0	75.3	15 REGIONS
MALTA	383	316	383	316	100.0	100.0	COUNTRY AS A WHOLE
MONACO	27	2	27	2	100.0	100.0	COUNTRY AS A WHOLE
YUGOSLAVIA	23 153	255 804	2 582	42 448	11.2	16.6	33 COMMUNES + 3 AS. COM.
ALBANIA	3 050	28 748	3 050	28 748	100.0	100.0	COUNTRY AS A WHOLE
GREECE	9 878	131 944	8 862	100 278	89.7	76.0	41 NONES + GREATER ATHENS
TURKEY	49 289	780 576	10 000	122 612	20.3	15.7	10 PROVINCES
CYPRUS	669	9 251	669	9 251	100.0	100.0	COUNTRY AS A WHOLE
SYRIA	10 505	185 180	1 155	4 200	11.0	2.3	2 MOHAFAZATS
LEBANON	2 668	10 400	2 668	10 400	100.0	100.0	COUNTRY AS A WHOLE
ISRAEL	4 252	20 770	2 886	4 474	67.9	21.5	9 SUB-DISTRICTS
EGYPT	46 909	1 001 449	16 511	403 716	35.2	40.3	10 GOVERNORATS
LIBYA	3 605	1 759 540	2 284	251 360	63.4	14.3	15 BALADYATS
TUNISIA	7 081	163 610	4 965	45 712	70.1	27.9	13 GOVERNORATS
ALGERIA	21 718	2 381 741	11 500	68 294	53.0	2.9	13 WILAYAS
MOROCCO	21 941	446 550	3 390	41 950	15.5	9.4	6 PROVINCES
TOTAL	355 564	8 528 914	132 115	1 491 797	37.2	17.5	

(a) There are no clear criteria for defining the Mediterranean coastal regions. The Blue Plan decided to take in account the administrative units along the coast.

Table 36

Life expectancy at birth [a] (UNEP, 1987a)

	MALES				FEMALES			
	1960-65	1980-85	2000-05	2020-25	1960-65	1980-85	2000-05	2020-25
SPAIN	67.9	71.3	73.2	74.4	72.7	77.5	80.1	80.9
FRANCE	67.6	70.6	72.9	74.1	74.5	78.7	80.5	81.3
ITALY	67.4	71.2	73.2	74.3	72.6	78.0	80.2	81.0
MALTA	67.0	69.4	72.4	73.7	70.8	74.2	78.2	80.4
YUGOSLAVIA	63.0	68.0	71.4	73.2	66.3	73.5	77.8	80.2
ALBANIA	63.7	69.0	72.1	73.6	66.0	73.0	77.5	80.1
GREECE	67.9	72.1	73.5	74.7	71.2	76.0	79.3	80.7
TURKEY	50.3	60.0	67.2	71.0	53.2	63.3	72.0	76.8
CYPRUS	67.5	72.3	73.7	74.9	71.0	75.7	79.1	80.6
SYRIA	49.7	60.8	68.0	71.4	52.4	64.4	72.7	77.2
LEBANON	58.9	63.1	69.1	72.2	62.6	67.0	74.6	78.1
ISRAEL	68.1	72.8	74.0	75.0	70.7	76.2	79.4	80.6
EGYPT	46.2	56.8	65.8	70.3	48.6	59.5	69.3	75.2
LIBYA	46.7	56.6	65.6	70.2	49.2	60.0	69.7	75.4
TUNISIA	49.1	60.1	67.7	71.2	50.1	61.1	70.6	75.9
ALGERIA	47.3	58.5	66.8	70.8	49.4	61.6	70.9	76.1
MOROCCO	46.7	56.6	65.6	70.2	49.2	60.0	69.7	75.4

(a) "Life expectancy at birth" is the average number of years of life for the considered cohort, if this one would continue to be subject to the same mortality experience in the birth interval to which the life expectancy refers.

SOURCE: UNITED NATIONS, WORLD POPULATION PROSPECTS AS ASSESSED IN 1984

Table 37

Urbanisation rate (UNEP, 1987a)
(percentage)

	1960	1970	1980	1985	1990	2000	2010	2020	2025
SPAIN	57	66	73	76	78	82	84	86	86
FRANCE	62	71	73	73	74	75	76	77	77
ITALY	59	64	66	67	68	70	72	75	76
MALTA	70	78	83	85	87	89	91	92	92
YUGOSLAVIA	28	35	42	46	50	58	64	70	72
ALBANIA	31	34	33	34	35	40	47	55	58
GREECE	43	53	58	60	63	68	73	77	79
TURKEY	30	38	44	46	48	54	61	67	70
CYPRUS	36	41	46	49	53	60	66	71	74
SYRIA	37	43	47	49	52	57	64	69	72
LEBANON	40	59	75	80	83	88	90	92	92
ISRAEL	77	84	89	90	91	93	95	95	96
EGYPT	43	44	45	46	49	56	62	68	71
LIBYA	23	36	57	64	70	76	80	83	85
TUNISIA	36	43	52	57	61	68	73	77	79
ALGERIA	30	39	41	43	45	51	58	64	67
MOROCCO	29	35	41	45	48	56	63	68	71

SOURCE: UNITED NATIONS, WORLD POPULATION PROSPECTS AS ASSESSED IN 1984

Table 38

Gross national product per capita [a] (UNEP, 1987a)
(US dollars)

	1978	1979	1980	1981	1982	1983	1984
SPAIN	3 470	4 380	5 400	5 640	5 430	4 780	4 440
FRANCE	8 260	9 950	11 730	12 190	11 680	10 500	9 760
ITALY	3 850	5 250	6 480	6 960	6 840	6 400	6 420
YUGOSLAVIA	2 380	2 430	2 620	2 790	2 800	2 570	2 120
GREECE	3 250	3 960	4 380	4 420	4 290	3 920	3 770
TURKEY	1 200	1 330	1 470	1 540	1 370	1 240	1 160
SYRIA	930	1 030	1 340	1 570	1 680	1 760	1 620
ISRAEL	3 500	4 150	4 500	5 160	5 090	5 370	5 060
EGYPT	390	480	580	650	690	700	720
LIBYA	6 910	8 170	8 640	8 450	8 510		8 520
TUNISIA	950	1 120	1 310	1 420	1 390	1 290	1 270
ALGERIA	1 260	1 590	1 870	2 140	2 350	2 320	2 410
MOROCCO	670	740	900	860	870	760	670

(a) The Gross National Product (G.N.P.) measures the total domestic and foreign output claimed by residents of a country.
The "G.N.P. per capita" figures were calculated according to the World Bank Atlas method; it uses primarily the average official exchange rate for three years.

SOURCE: WORLD BANK, WORLD DEVELOPMENT REPORTS

Table 39

Distribution of labour force [a] (UNEP, 1987a)
(percentage)

	AGRICULTURE			INDUSTRY			SERVICES		
	1960	1977	1980	1960	1977	1980	1960	1977	1980
SPAIN	42	19	14	31	42	40	27	39	45
FRANCE	22	10	8	39	41	39	39	49	53
ITALY	31	13	11	40	47	45	30	40	44
YUGOSLAVIA	63	42	29	18	34	35	19	24	36
GREECE	56	40	37	20	27	28	24	33	35
TURKEY	79	62	54	11	14	13	11	24	33
SYRIA	54	49	33	19	23	31	27	28	36
ISRAEL	14	8	7	35	37	36	51	55	57
EGYPT	58	51	50	12	26	30	30	23	20
LIBYA	53	22	19	17	27	28	30	51	53
TUNISIA	56	43	35	18	23	32	26	34	33
ALGERIA	67	35	25	12	18	25	21	47	50
MOROCCO	62	53	52	14	19	21	24	28	27

(a) The "labour force" comprises economically active persons aged 10 and over, including the armed forces and the unemployed.

SOURCE: WORLD BANK, WORLD DEVELOPMENT REPORTS

Table 40

Oil production (UNEP, 1987a)
(1000 barrels)

	1955	1960	1965	1970	1975	1980	1985
SPAIN			49	1 153	13 450	10 427	15 887
FRANCE	6 409	14 120	21 710	17 230	7 487	10 288	19 257
ITALY	2 536	846	803	10 260	7 235	12 434	16 240
MALTA							
YUGOSLAVIA	1 736	6 884	14 850	20 080	27 410	31 317	29 628
ALBANIA	1 871	4 024	5 692	8 760	17 970	25 550	25 020
GREECE							9 855
TURKEY	1 199	2 573	10 830	25 230	22 170	16 352	15 109
CYPRUS							
SYRIA					68 390	62 568	64 240
LEBANON	12						
ISRAEL		900	1 469	475	28 540	128	
EGYPT	12 740	22 560	44 790	119 200	84 350	212 345	326 770
LIBYA			445 300	1 211 000	540 100	666 709	383 250
TUNISIA				32 230	37 500	42 426	38 544
ALGERIA	434	67 230	201 300	373 100	344 600	416 465	357 700
MOROCCO	758	695	786	323	154	100	117

SOURCE: WORLD OIL, GULF PUBLISHING COMPANY

Table 41

Crude oil reserves (UNEP, 1987a)
(1000 barrels)

	1955	1960	1965	1970	1975	1980	1985
SPAIN			20 000	100 000	262 332	132 675	38 746
FRANCE	150 000	185 000	190 000	120 000	55 381	102 747	233 913
ITALY	125 000	346 000	10 000	305 000	328 190	361 898	779 339
MALTA							
YUGOSLAVIA		106 000	163 000	315 000	370 350	376 061	253 681
ALBANIA		75 000	70 000	90 000	142 115	306 600	201 750
GREECE					136 875	50 000	30 100
TURKEY	85 000	60 000	500 000	200 000	99 328	274 830	584 610
CYPRUS							
SYRIA		50 000	500 000	1 320 000	2 708 000	1 452 028	1 540 000
LEBANON							
ISRAEL	1 800	15 000	20 000	2 000	1 500	480	
EGYPT	250 000	500 000	600 000	990 100	1 429 000	2 916 450	3 800 000
LIBYA		3 000 000	13 000 000	30 000 000	24 000 000	25 787 622	22 400 000
TUNISIA			250 000	380 000	2 323 000	2 180 593	1 780 000
ALGERIA	2 000	4 600 000	6 300 000	8 098 000	10 000 000	7 293 900	5 020 000
MOROCCO	7 000	7 000	10 000	9 000	853	1 325	456

SOURCE: WORLD OIL, GULF PUBLISHING COMPANY

Table 42

Number of international tourists arrivals[a] (UNEP, 1987a)
(thousands)

	1970	1975	1980	1981	1982	1983	1984
SPAIN	15 320	19 800	22 500	23 800	25 300	25 583	27 100
FRANCE	18 130	25 710	30 100	31 340	33 467	34 018	34 812
ITALY	14 188	15 500	22 987	20 036	22 297	22 140	22 855[b]
MALTA	171	335	729	706	511	491	480
YUGOSLAVIA	4 749	5 834	6 410	6 616	5 955	5 947	7 224
GREECE	1 407	2 840	4 796	5 034	5 033	4 778	5 523
TURKEY	446	1 201	865	997	1 026	1 178	1 533
CYPRUS	127	47	353	421	547	621	737
SYRIA	409	678	1 204	1 043	831	836	976
LEBANON	900	1 555	118				
ISRAEL	419	559	1 116	1 090	949	1 043	1 095
EGYPT	348	730	1 253	1 376	1 423	1 498	1 560
LIBYA	77	241	126	126[b]	126[b]	126[b]	126[b]
TUNISIA	411	1 014	1 602	2 151	1 355	1 439	1 580
ALGERIA	236	296	290	320	280	285	410
MOROCCO	747	1 242	1 425	1 567	1 815	1 877	1 936
TOTAL	58 085	77 582	94 974	96 623	100 915	101 915	107 947

(a) "Number of tourist arrivals" refers to persons staying at least 24 hours in the country visited; are excluded immigrants, residents in a frontier zone and transit passengers.

(b) BLUE PLAN ASSESSMENT

SOURCE: WORLD TOURISM ORGANIZATION

Table 43

Tourism receipts [(a)] (UNEP, 1987a)
(millions U.S. dollars))

	1970	1975	1979	1980	1981	1982	1983
SPAIN	1 681	3 404	6 484	6 968	6 716	7 126	6 836
FRANCE	1 189	3 449	6 823	8 235	7 193	6 991	7 226
ITALY	1 639	2 579	8 218	8 914	7 554	8 339	9 034
MALTA	29	76	206	329	265	185	148
YUGOSLAVIA	274	768	825	1 115	1 350	844	929
GREECE	194	644	1 662	1 734	1 881	1 527	1 176
TURKEY	52	201	281	327	381	370	408
CYPRUS	21	15	141	200	243	292	332
SYRIA			136	156	175	150	110
ISRAEL	104	233	797	866	977	894	1 029
EGYPT	71	279	511	562	375	386	469
LIBYA	11	18	9	12	11	12	12
TUNISIA	61	280	521	605	581	545	573
ALGERIA		51	43	48	152	197	202
MOROCCO	136	434	388	397	440	354	417
TOTAL	5 462	12 431	27 045	30 468	28 294	28 212	28 901

(a) "Tourism receipts" are defined as the receipts of a country resulting from consumption expenditures made by visitors out of the foreign currency resources (excluding international fare receipts).

SOURCE: WORLD TOURISM ORGANIZATION

Table 44

Tourism expenditures [a] (UNEP, 1987a)
(millions U.S. dollars))

	1970	1975	1979	1980	1981	1982	1983
SPAIN	113	385	922	1 229	1 008	1 008	894
FRANCE	1 057	3 062	5 187	6 027	5 752	5 157	4 281
ITALY	727	1 050	1 509	1 907	1 664	1 731	1 822
MALTA		13	21	43	50	57	53
YUGOSLAVIA	129	150	155	132	127	107	107
GREECE	14	55	202	190	249	231	225
TURKEY	48	155	95	115	103	109	127
CYPRUS	13	14	45	56	57	67	68
SYRIA			108	177	208	188	181
ISRAEL	55	157	423	533	621	651	769
EGYPT	20	52	521	573	630	693	762
LIBYA		84	375	470	358	397	405
TUNISIA		55	58	55	59	63	65
ALGERIA			242	333	405	452	527
MOROCCO	62		103	98	94	83	83
TOTAL	2 238	5 332	9 966	11 938	11 385	10 994	10 369

(a) "Tourism expenditures" are defined as consumption expenditures made by residents of a country visiting abroad (excluding international fare payments).

SOURCE: WORLD TOURISM ORGANIZATION

Table 45

Merchant Shipping (UNEP, 1987a)
(thousands gross registered tons)

	MERCHANT FLEETS				OIL TANKER FLEETS			
	1970	1975	1980	1984	1970	1975	1980	1984
SPAIN	3 441	5 433	8 112	7 005	1 423	2 556	4 818	3 650
FRANCE	6 458	10 746	11 925	8 945	3 477	6 938	7 777	4 800
ITALY	7 448	10 137	11 096	9 158	2 721	4 061	4 818	3 650
MALTA	35	46	133	1 366				70
YUGOSLAVIA	1 516	1 873	2 467	2 682	255	250	213	231
GREECE	10 952	22 527	39 472	35 059	3 872	8 295	11 780	10 895
TURKEY	697	995	1 455	3 125	170	327	358	1 165
CYPRUS	1 138	3 221	2 091	6 728	121	526	112	3 180
SYRIA	1	8	39	56				
LEBANON	182	167	268	458				14
ISRAEL	714	451	450	563				1
EGYPT	238	301	556	779	79	106	129	104
LIBYA	4	242	890	855		221	796	745
TUNISIA	22	41	131	277				
ALGERIA	29	246	1 219	1 372		88	592	594
MOROCCO	55	80	360	434		3	113	62

SOURCE: UNITED NATIONS STATISTICAL YEARBOOKS

Table 46

Motor vehicles in use (passenger cars) (UNEP, 1987a)
(thousands)

	1960	1965	1970	1975	1980	1984
SPAIN	291	807	2 378	4 807	7 557	8 874
FRANCE	5 430	9 600	12 900	15 300	18 400	20 800
ITALY	1 976	5 469	10 181	15 061	17 686	20 389
MALTA		22	42	54	71	80
YUGOSLAVIA	54	188	721	1 537	2 417	2 874
GREECE	43	104	227	439	863	1 151
TURKEY	44	88	138	383	711	920
CYPRUS		31	56	66	94	118
SYRIA		27	30	50	52	127 (b)
LEBANON		99	136	220	220	
ISRAEL		83	151	284	415	598
EGYPT		98	131	216	432	890
LIBYA		42	100	263	443	485 (a)
TUNISIA		51	66	103	125	
ALGERIA		94	143	286	507	574
MOROCCO	125	163	223	320	425	491 (a)

(a): 1981
(b): 1983

SOURCE: UNITED NATIONS STATISTICAL YEARBOOKS

Table 47

Trend of the Mediterranean countries' automobile stock (UNEP, 1987)
(in thousands of vehicles)

	1970	1980	2000	2025
Spain, France Italy and Greece	29 360	51 402	73 966	83 077
Yugoslavia, Turkey Cyprus, Malta and Israel	1 527	4 478	19 992	35 801
Syria, Lebanon, Egypt	366	945	11 580	25 355
Libya, Tunisia Algeria and Morocco	783	2 250	14 945	30 430
TOTAL	32 036	59 075	120 483	174 663

Table 48

Agricultural land (by use) (1980-1985) (UNEP, 1987b)
(1000 ha)

	Year	Utilized Agricultural Land			Ranges and other grazing land	Unproductive agricultural land	Area used for agriculture (&stock-breeding)		Total area of country/region
		Total land used for agriculture	of which fallow	of which irrigated land			Total (1000ha)	% of country	
SPAIN Med. region	1984	39 898 6 882	4 744 769	2 755 (3) 1 527 (3)	7 233.1 1 868.6	3 344 800	47 131.2 8 750.2	93 92	50 475 9 550
FRANCE Med. region	1982 1984	31 649 1 711	201 ..	801 216	- -	2 747 827	34 396 2 538	63 54	54 703 4 688
ITALY Med. region	1982	17 252 13 787	.. ..	2 373 1 345	2 776 2 025	3 706 2 477	23 734 18 289	79 81	30 122 22 668
YUGOSLAVIA Med. region	1982	10 019 3 241	.. ..	.. ..	4 349 2 202	1 324 2 488	15 692 7 931	62 71	25 602 11 115
ALBANIA									
GREECE									
TURKEY Med. region	1983 ?	47 751 9 642	16 792 (1) 1 621 (1)	2 990 1 146	643 34	1 042 555	49 436 10 231	64 46	77 784 27 294
CYPRUS									
SYRIA Med. region	1984	5 655 215	1 920 -	618 50	8.317 4	514 16	14 486 235	78 56	18 518 420
LEBANON Med. region									
ISRAEL Med. region	1985 ?						555 140	27 31	2 077 447
EGYPT Med. region	1980								
LIBYA Med. region									
TUNISIA Med. region	1984	3 677 1 968 (2)	.. ..	175 93	3 358 1 627 (2)	3 260 545	10 295 4 140	63 91	16 361 4 571
ALGERIA Med. region	1981	7 510 2.740	3 320 883	320 143	31 661 700	346 174	39 517 3 615	17 53	238 174 6 829
MOROCCO Med. region		8 353 758	2 334 240	.. 96	28 449 1 846	- -	36 802 2 064	82 63	44 655 4 195
MED. TOTAL									

(1) These figures correspond to the definition: "arable land with fallows", and not to fallows alone

(2) Including partly the governate of Tataouine, counted in "major crops", "ranges", and "arboriculture"

(3) 1976; "irrigated areas" in the Spanish "Mediterranean region" corresponds to the Mediterranean drainage basin and not to the coastal provinces.

Table 49

Agricultural population [a] (UNEP, 1987a)

	TOTAL AGRICULTURAL POPULATION (thousands)				ECONOMICALLY ACTIVE AGRICULTURAL POPULATION (percentage)			
	1970	1975	1980	1985	1970	1975	1980	1985
SPAIN	8 475	7 294	6 200	5 065	36.0	36.1	36.3	36.9
FRANCE	6 961	5 755	4 641	3 722	41.3	42.2	42.7	45.1
ITALY	10 077	8 128	6 363	5 427	37.3	37.3	37.3	39.7
MALTA	22	19	17	17	36.4	36.8	35.3	35.3
YUGOSLAVIA	10 145	9 284	8 352	5 734	45.0	45.9	45.8	45.3
ALBANIA	1 415	1 535	1 649	1 542	42.5	42.6	42.9	45.8
GREECE	4 041	3 742	3 537	2 587	42.7	42.3	41.9	38.3
TURKEY	23 926	24 561	24 691	25 477	44.2	42.8	41.4	43.4
CYPRUS	237	232	222	140	41.8	43.1	43.7	46.4
SYRIA	3 200	3 627	4 106	2 599	26.6	26.0	25.6	24.7
LEBANON	487	395	312	322	26.1	25.8	26.0	28.9
ISRAEL	288	282	266	212	36.1	36.2	35.7	37.7
EGYPT	18 124	19 340	21 161	19 958	28.0	28.0	28.2	27.4
LIBYA	634	555	467	508	26.8	25.9	25.1	25.0
TUNISIA	2 553	2 531	2 582	2 239	23.7	23.7	24.0	31.4
ALGERIA	8 014	8 599	9 174	5 216	22.9	22.5	22.4	22.5
MOROCCO	8 601	9 346	10 381	8 712	26.4	26.1	26.4	30.4

(a) The "total agricultural population" includes all persons depending for their livelihood on agriculture: all persons actively engaged in agriculture and their non-working dependants.
"Economically active population in agriculture" includes all economically active persons engage principally in agriculture, forestry, hunting or fishing; it is given in percentage of total agricultural population.

SOURCE: F.A.O., PRODUCTION YEARBOOKS

Table 50

Fertilizers total consumption (UNEP, 1987a)
(N + P_2O_5 + K_2O)
(1000 tons)

	1967/68	1969/70	1974/75	1979/80	1984/85
SPAIN	932	1 112	1 493	1 685	1 637
FRANCE	3 797	4 204	4 656	5 905	5 780
ITALY	1 123	1 231	1 272	2 355	2 113
MALTA	1	1	1	1	1
YUGOSLAVIA	516	583	674	870	976
ALBANIA	16	36	64	98	94
GREECE	275	322	426	581	651
TURKEY	279	446	523	1 299	1 541
CYPRUS	16	21	14	17	20
SYRIA	24	29	52	125	219
LEBANON	23	33	42	45	51
ISRAEL	47	53	65	78	89
EGYPT	281	348	429	604	851
LIBYA	9	9	22	60	115
TUNISIA	23	39	50	60	87
ALGERIA	46	89	171	170	177
MOROCCO	77	95	150	223	249
TOTAL	7 485	8 651	10 104	14 176	14 651

SOURCE: F.A.O. FERTILIZER YEARBOOKS

Table 51

Withdrawals and uses of fresh water in the Mediterranean basin, updated June 1987 (*) (UNEP, 1987b)

		WITHDRAWALS (all uses)		SECTORAL USE of withdrawals (%)			
	Date of information	Total (km^3/year)	per cap. ($1000m^3$/year)	Public (drinking water)	Industry (self-supplied)	Electricity generation facilities (cooling)	Agriculture (irrigation)
SPAIN	1984	24.7	0.64	15			85
Med. region	1984	12.74	0.80	13			87
FRANCE	1981	32.5	0.60	17	16	52	14
Med. region	1981	12.7	1.03	14	9	53	24
ITALY	1980	56.2	0.99	14	14	12	57
Med. region							
MALTA	1977	0.02	0.07	100	-	-	-
YUGOSLAVIA	1980	8.77	0.40	17	43	32	8
Med. region		1.5	0.21	20	67	-	13
ALBANIA	1970	0.2	0.09	30	60	-	10
GREECE	1980	6.94	0.73	11	2	-	84
TURKEY	1980	29.9	0.67	12	10	-	78
Med. region	1980	7.5	0.68	11	9	-	80
CYPRUS	1975	0.55	0.86	5	2	-	93
SYRIA	1976	7.0	0.92	7	-	-	93
Med. region		2.5		4	-	-	96
LEBANON	1975	0.75	0.24	13	-	-	87
Med. region	1975	0.6		17	-	-	83
ISRAEL	1975	1.7	0.50	18	6	-	76
Med. region		1.6		18	4	-	78
EGYPT	1976	45.0	1.18	2	2	-	96
Med. region		..	..			-	
LIBYA	1977	1.47	0.54	17	-	-	83
Med. region	1977	1.0		25	-	-	75
TUNISIA	1977	1.07	0.18	19	5	-	76
Med. region		..	..			-	
ALGERIA	1980	3.4	0.18	21	4	-	75
Med. region	1980	2.8	..				
MOROCCO	1980	10.5	0.52	4	2	-	93
Med. region	1980	1.0	0.59	5	5	-	90
MED. TOTAL							

(*) In this table, "Mediterranean region" means land within the Mediterranean basin

Source: Blue Plan

Table 52

Balance of use of freshwater in the Mediterranean regions of coastal countries in 1980s (UNEP, 1987b)

MEDITERRANEAN WATERSHEDS	POTENTIAL SUPPLY (km3/year)	EQUIPMENT AND AVAILABILITY RATE (%)	ALLOCATED WATER (km3/year) (*)	UTILIZATION RATE (%)	EXPLOITATION INDEX (%)
SPAIN	28.3	60.0	12.7	85.0	51.0
FRANCE	75.0	23.0	12.7	40.0	9.2
ITALY	187.0	23.0	56.2	95.0	21.9
MALTA	.03	100.0	.02	100.0	100.0
YUGOSLAVIA	62.0	10.0	1.5	25.0	2.5
ALBANIA	21.3	..	.2	80.0	..
GREECE	62.9	7.0	6.9	85.0	6.0
TURKEY	77.0	5.0	7.5	75.0	3.8
CYPRUS	.95	73.0	0.54	85.0	62.1
SYRIA	4.4	60.0	2.5	20.0	12.0
LEBANON	4.0	25.0	.6	95.0	23.8
ISRAEL	1.0	170.0	1.8	100.0	170.0
EGYPT	57.3	100.0	43.0	85.0	85.0
LIBYA	.6	125.0	1.0	100.0	125.0
TUNISIA	3.0	45.0	1.0	80.0	36.0
ALGERIA	13.2	20.0	2.8	30.0	6.0
MOROCCO	4.0	26.0	1.0	80.0	20.8
MEDITERRANEAN		25.0	152.0	94.0	23.5

(*) = volume withdrawn

Source : BLUE PLAN 1983, 1986

Table 53

Domestic use of fresh water in the Mediterranean basin, estimates 1980 (UNEP, 1987b)
(km^3 yr^{-1})

	ALLOCATED	LOSSES	USE	CONSUMPTION	WASTE WATER
SPAIN	.800	.160	.640	.040	.600
FRANCE	.900	.180	.720	.045	.675
ITALY	7.000	1.400	5.600	.350	5.250
MALTA	.020	.004	.016	.001	.015
YUGOSLAVIA	.300	.060	.240	.015	.225
ALBANIA	.060	.012	.048	.003	.045
GREECE	.600	.120	.480	.030	.450
TURKEY	.150	.030	.120	.008	.113
CYPRUS	.030	.006	.024	.002	.023
SYRIA	.040	.008	.032	.002	.030
LEBANON	.100	.020	.080	.005	.075
ISRAEL	.300	.060	.240	.015	.225
EGYPT	.600	.120	.480	.030	.450
LYDIA	.120	.024	.096	.006	.090
TUNISIA	.200	.040	.160	.010	.150
ALGERIA	.300	.060	.240	.015	.225
MOROCCO	.030	.006	.024	.002	.023
MEDITERRANEAN	11.550	2.310	9.240	.580	8.660

Source : BLUE PLAN, Expert Report N° 2, "Water Resources", 1983

Table 54

Number of forest fires, 1961-1965 (UNEP, 1987b)

	1961	1965	1970	1975	1980	1981	1982	1983	1984	1985
SPAIN	1 264	1 686	3 203	4 242	7 193	10 882	6 443	4 880	7 224	11 523
Med. region									1 660	1 815
FRANCE	2 137	1 507	1 960	4 017	5 040	5 173	5 308	4 659	5 672	
Med. region					3 301	3 017	2 544	2 438	2 155	3 732
ITALY	3 936		6 579	6 092	5 660	8 150	6 134	5 555		
YUGOSLAVIA	1 650		770	676	908	759	1 063	1 080	729	
GREECE	855	1 187	558	768	1 207	1 159	1 045	908	1 284	1 442
TURKEY	620		790	811	1 094	982	951	968	1 434	1 793
Med. region					843	678	677	742	1 046	
CYPRUS	56				91	82	97	55		
ISRAEL	14				678	731	1 117	1 128	908	834
LIBYA								3	3	3
TUNISIA						91	73	145	121	77
ALGERIA						1 584	638	990	562	747
MOROCCO	185 fires per year on average									

Source : Blue Plan : (from FAO)

Table 55

Area of forest and other land burnt, 1961-1965 (UNEP, 1987b)
(hectares)

	1961	1965	1970	1975	1980	1981	1982	1983	1984	1985
SPAIN	34 507	38 018	87 324	187 314	265 954	298 436	151 644	117 599	164 546	412 426
FRANCE	43 986	59 694	61 230	25 849	22 176	27 711	55 145	53 729	27 203	57 400
Med. region				17 600	13 980	20 052	45 775	47 627	12 086	46 628
ITALY	43 000	–	91 176	71 425	144 302	242 218	130 239	223 728	75 272	190 640
YUGOSLAVIA	14 146	2 114	3 139	7 851	4 033	12 170	19 358	20 585	9 010	15 000
GREECE	10 646	27 030	3 189	30 955	32 965	81 417	27 372	19 613	33 655	105 450
TURKEY	8 989	3 954	15 019	17 515	10 546	5 470	4 018	3 554	7 358	26 007
Med. region					7 388	3 925	2 665	2 989	5 459	
CYPRUS	279	2 706 (1)			754	371	7 512	3 718		
SYRIA	1 500 ha/year on average									
LEBANON	1 200 ha/year on average									
ISRAEL	71	600	1 400	900	1 805	2 395	3 441	4 788	1 740	1 476
LIBYA								1	3	43
TUNISIA						376	1 613	4 139	1 287	396
ALGERIA					19 700	33 516	9 381	221 367	4 731	4 668
MOROCCO						1 707	1 818	17 730	1 423	1 888

(1) in 1964

Source : Blue Plan (from FAO)

Table 56

Soil erosion intensity in the Mediterranean (UNEP, 1987b)

Country	Importance of erosion	Eroded area (1000 ha)	as % of total area	Estimated deposit (1000 m^3)	Area of arable land lost through erosion, in ha/year (% of total land)
SPAIN (49 719 oo ha)	none	27 804	55.9		
	slight				
	moderate	13 744	27.6		
	severe	8 171	16.5		
MEDITERRANEAN SPAIN (1) (15 884 000 ha)	none	6 035	38.0		
	slight	1 250	7.9		
	moderate	3 356	21.1		
	severe	5 243	33.0		
YUGOSLAVIA (2) (20 415 000 ha)	slight	6 626	26.0	28 213	
	moderate	7 264	29.0	54 790	
	severe	4 585	18.0	50 568	
	excessive	1 938	7.0	37 510	
GREECE (13 144 400 ha)	severe and excessive	4 700 (3)	35.6		
TURKEY (4) (19 863 100 ha)	none or slight	5 884	28.5	8 750 000 t/year	54 237 ha/year (0.3 %)
	moderate to severe	6 461	31.5		
	very severe	7 445	36.3		
	excessive	114	0.6		
MEDITERRANEAN TURKEY (5)	none or slight	1 738	10.0		
	moderate to excessive	15 536	90.0		
TUNISIA					18 000 ha/year (1.1 %)
ALGERIA					..
MOROCCO					22 000 ha/year (0.5 %)

Source : Blue Plan

(1) Concerns the following regions: Andalusia, Murcia, Valencia and the Balearic islands. *Medio Ambiente en Espana*, 1984, 1985.

(2) The State of the Environment and the Environmental Policy in Yugoslavia, 1983

(3) In addition, 300 million hectares threatened with salinization and alkalization (from Review of Environmental Policies in Greece, OECD, 1981)

(4) Environmental Profile of Turkey, 1981.
The areas studied at national level only represents part of total land surface (78 058 thousand ha)

(5) Figures refer to the three Mediterranean provinces: Marmara, Aegean, Mediterranean (whose total area is 22 294 thousand ha)

Table 57

Land use, 1984 (UNEP, 1987b)
(1000 ha)

	TOTAL LAND	ARABLE LAND	LAND UNDER PERMANENT CROPS	LAND UNDER PERMANENT MEADOWS AND PASTURES	FORESTS AND WOODLANDS	OTHER LAND
SPAIN	49 940	15 620	4 920	10 640	15 625	3 135
FRANCE	54 563	17 468	1 344	12 385	14 603	8 763
ITALY	29 402	9 100	3 133	4 930	6 410	5 829
MALTA	32	12	1			19
YUGOSLAVIA	25 540	7 018	740	6 379	9 294	2 109
ALBANIA	2 740	592	121	400	1 038	589
GREECE	13 080	2 948	1 026	5 255	2 620	1 231
TURKEY	77 076	24 500	2 911	9 000	20 199	20 466
CYPRUS	924	365	67	93	171	228
SYRIA	18 406	5 104	550	8 319	498	3 935
LEBANON	1 023	210	88	10	82	633
ISRAEL	2 033	345	92	818	116	662
EGYPT	99 545	2 310	164		2	97 069
LIBYA	175 954	1 780	335	13 300	640	159 899
TUNISIA	15 536	3 167	1 520	3 024	555	7 270
ALGERIA	238 174	6 800	640	32 100	4 384	194 250
MOROCCO	44 630	7 815	516	12 500	5 200	18 599

Source : Production Yearbook, FAO, 1985

Table 58

Protected areas, 1985 (UNEP, 1987b)

	Protected areas		% of territory protected	Protected area per 1000 hab	I		II		III		IV		V	
	Number	Total size (1000 ha)	%	(ha)	Number	Area (ha)	Number	Area (ha)	Number	Area (ha)	Number	Area (ha)	Number	Area (ha)
SPAIN Med. region (1983)	55 10	1697 288	3.4 0.6	44 7	- -	- -	10 -	148 500 -	- -	- -	25 10	760 940 228 845	20 2	786 523 59 191
FRANCE Med. region	37 7	1655 735	3.0 10.9	24 12	4 -	27 340 -	6 2	270 378 70 994	- -	- -	19 1	94 760 1 669	8 4	1.262 400 662 800
ITALY Med. region	34 18	517 148	1.8 0.7	9 1.2	- -	- -	3 2	127 000 57 000	- -	- -	18 11	70 967 44 735	13 5	318 737 46 147
MALTA	-	-	-	-	-	-	-	-	-	-	-	-	-	-
YUGOSLAVIA Med. region	20 11	336 160	1.3 3.8	14 6.6	- -	- -	8 5	58 652 18 630	- -	- -	4 3	48 700 47 200	8 3	228 738 94 515
ALBANIA	4	11	0.4	3	-	-	4	10 000	-	-	-	-	-	-
GREECE	14	63	0.5	6	3	4 200	2	8 848	-	-	1	22 100	8	27 957
TURKEY Med. region	15 6	287 65	0.4 0.5	6 6.5	- -	- -	15 6	286 850 65 343	- -	- -	- -	- -	- -	- -
CYPRUS	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SYRIA	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LEBANON	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ISRAEL	5	34	1.7	8	-	-	2	15 140	-	-	3	18 856	-	-
EGYPT	1	17	0.0	0	-	-	-	-	-	-	1	17 094	-	-
LIBYA	2	130	0.1	36	1	100 000	1	30 000	-	-	-	-	-	-
TUNISIA	3	33	0.2	5	-	-	3	33 033	-	-	-	-	-	-
ALGERIA Med. region	5 4	227 127	0.1 1.9	10 1.2	- -	- -	5 4	226 500 126 500	- -	- -	- -	- -	- -	- -
MOROCCO Med. region	2 -	41 -	0.1 -	2 -	- -	- -	1 -	36 000 -	- -	- -	1 -	5 000 -	- -	- -
MEDITERRANEAN TOTAL	85	1811	0.5	2.3	8	131.540	32	435 488	-	-	30	385 499	22	890 610

Source : IUCN (United Nations List of National Parks and Protected Areas, 1985) / Blue Plan

* I = Scientific Reserve/Strict Nature Reserve ; II = National Park ; III = Natural Monument/Natural Landmark ; IV = Nature Conservation Reserve/Managed Nature Reserve/Wildlife Sanctuary ; V = Protected Landscape or Seascape.

Table 5.9

National parks as recorded in recent national publications (UNEP, 1987b)

COUNTRY Med. region	NATIONAL PARKS		
	Date *	Number	Surface area (Ha)
SPAIN	1985	9	112,689
Med. region		-	-
FRANCE	1986	6	124,670
Med. region		4	75,678
ITALY	1984	5	273,400
Med. region		3	66,400
YUGOSLAVIA	1976/83	15	301,704
Med. region		10	82,756
GREECE	1983	10	350,000
TURKEY	1985	17	271,032
Med. region		8	170,390
CYPRUS		..	..
SYRIA	1980	-	-
LEBANON	1985	-	-
ISRAEL	1985	2	15,140
EGYPT	1980	-	-
LIBYA	1985	1	30,000
TUNISIA	1985	4	36,102
Med. region		4	36,102
ALGERIA	1985	7	170,000
Med. region		6	160,000
MOROCCO	1980	2	36,580
Med. region		1	580

* date of publication of document consulted

Table 60

Mediterranean watershed, area and flows (updated 1987) (UNEP, 1987b)

	Area (1000 km^2)		Theoretical resources (Gm^3/year)				Stable resources (Gm^3/year)	
	Country	Mediterranean region	Total: incl. neighbouring country inflows	Total: Internal	Surface runoff	Underground runoff	Low flow = low water mark	Underground flow of coastal watertables
SPAIN Med. region	505	180	109.9 28.3	109.9 28.2	89.4 19.8	20.4 8.4	17.0 6.3	3 - 4 1.6
FRANCE Med. region	550	130	185.0 74.0	170.0 62.0	70.0 31.0	100.0 31.0	85.0 35.0	1.1 0.2
ITALY Med. region	300	300	187.0	185.0	155.0	30.0	18.5	12.0
MALTA	0.3	0.3	0.03	0.03		0.03	0.007	0.023
YUGOSLAVIA Med. region	256	80	265.0 77.5	150.0 77.5	130.0 62.0	20 15.5	6.5	5.0
ALBANIA	29	29	21.3	10.0	..	..	6.5	
GREECE	132	132	62.9	49.4	37.4	12.0	7.0	2.5
TURKEY Med. region	780	195	181.0 77.0	166.0 70.0	156.4 ..	9.4 ..	.. 14.5	.. 1.1
CYPRUS	9.3	9.3	0.9	0.9	0.6	0.3	0.2	0.01
SYRIA Med. region	185	22	35.4 4.4	7.6 3.4	3.1 1.3	4.5 2.1	14.0 2.1	0.2 0.2
LEBANON Med. region	10.4	9.8	4.8 4.0	4.8 4.0	1.3 1.0	3.5 3.0	2.1 1.9	0.9 0.9
ISRAEL Med. region	21	12	1.0	1.0	0.2	0.8	0.2	0.08
EGYPT Med. region	1 000	144	57.5 (*) .3	1.0 0.8	0.5 0.3	0.5 0.5	55.5 55.5	0.3 0.3
LIBYA Med. region	1 760	250	0.6 0.6	0.6 0.6	0.1 0.1	0.5 0.5	0.1 0.1	0.1 0.1
TUNISIA Med. region	164	90	4.35 3.0	3.75 2.5	2.13 1.8	1.62 0.8	1.0 0.8	0.7 0.7
ALGERIA Med. region	2 380	133	16.0 13.2	15.7 13.2	13.6 12.0	3.3 1.2	.. 1.8	.. 0.7
MOROCCO Med. region	710	80	29.0 4.0	29.0 4.0	20.0 3.0	9.0 1.0	2.5 0.6	0.9 0.2
MED. TOTAL	8 792	1 796.4	..	497.0	427.4	..	157.5	25.4

(*) Regulated flow. Former natural flow = 86 Gm^3/year; former low-water flow = 24 Gm^3/year

Source : Blue Plan, 1987

Table 61

List of rivers draining into Mediterranean Sea
(UNEP/ECE/UNIDO/FAO/UNESCO/WHO/IAEA, 1984).

Sea area No	Sea area Name	Country	River	Flow m^3/s	Drainage area $10^3 km^2$
I	Alboran	Spain	Guadalhorce	8.5	2.85
		Morocco	Laou	28	0.94
			Riss	7.5	
			Nekor	2.2	0.63
			Moulouya	50	52
			Martel *et al.*,	24	
		Total		120	
II	North Western	Spain	Jucar	40	21.5
			Turia	14.6	6.3
			Mijares	11.3	2.5
			Ebro	550	84
			Llobregat	22	4.9
			Besos	1.3	1.0
			Todera	3.8	0.8
			Ter	14.5	1.8
			Fluvia	6.8	1.0
		France	Tedr		
			Tet	13.7	
			Aude	66	1.79
			Orb	31.9	1.15
			Hérault	53.4	2.55
			Rhône	1712	95.6
			Argens	16	2.53
			Var	65.4	1.83
		Italy	Arno	103	
		Total		2730	
III	South Western	Spain	Segura	7.3	14.9
		Algeria	Macta	2.7	4.0
			Cheliff	40	43.7
			Mazafran	13.8	1.9
			Soummam	24.9	8.4
			Seybouse	13.4	5.9
		Italy	Tirso	4.4	0.6
		Total		107	

Table 61 (cont'd)

List of rivers draining into Mediterranean Sea (UNEP/ECE/UNIDO/FAO/UNESCO/WHO/IAEA, 1984).

Sea area No	Sea area Name	Country	River	Flow m^3/s	Drainage area $10^3 km^2$
IV	Tyrrhenian	Italy	Ombrone	25	2.7
			Tevere	234	16.5
			Volturno	98	5.6
		Tunisia	Medjerdah	31	22.1
		Total		388	
V	Adriatic	Italy	Ofanto	11.6	2.7
			Biferno	21	1.29
			Pescara	54	3.12
			Tronto	17	0.91
			Metauro	13.6	1.04
			Reno	45	3.41
			Po	1550	70
			Adige	231	11.95
			Brenta	73	1.56
			Piave	88	3.33
			Tagliamento	89	1.88
		Yugoslavia	Zrmanja	40	0.78
			Krka	51	2.25
			Cetina	89	5.8
			Neretva	355	12.75
		Albania	Drini	342	12.48
			Semani	113	5.3
			Vjöse	182	5.2
		Total		3365	
VI	Ionian	Greece	Acheloos	167	
		Italy	Basento	13	1.4
		Total		180	
VII	Central		no rivers		

Table 61 (cont'd)

List of rivers draining into Mediterranean Sea
(UNEP/ECE/UNIDO/FAO/UNESCO/WHO/IAEA, 1984).

Sea area No	Sea area Name	Country	River	Flow m^3/s	Drainage area 10^3km^2
VIII	Agean	Greece	Pinios	102	
			Aliakmon	133	9.46
			Axios	163	24.66
			Strimon	111	16.55
			Nestos	100	6.18
			Evros	311	
		Turkey	Büyük Menderes	100	23.8
		Total		1020	
IX	North Levantin	Turkey	Manavgat	129	0.93
			Seyhan	188	20.45
			Ceyhan	230	19.8
		Cyprus	Vassilikos	0.12	0.15
		Total		547	
X	South Levantin	Israel	Kishon	0.46	0.68
			Hadera	0.56	0.52
		Egypt	Nile	500	2960
		Total		500	

Table 62

Sediment load in some rivers of the Mediterranean basin (UNEP, 1987b)
(sensitivity of watersheds to erosion due to runoff)

River	Localization of station	Watershed area	Turbidity (kg/m^3)	Mean annual load to the sea (1000t sediments)	Suspended sedimentary load (in t/km^2)
NILE (*)	150 km upstream of mouth, Egypt	3 031.0	4 à 468	25 107	8
RHONE	mouth, France	95.6	34	1 625	17
EBRO	mouth, Italy	84.2	26	456	5
PO	mouth, Italy	70.1	405	14 417	206
AXIOS	mouth, Greece	23.0	189	799	35
MEDJERDAH	mouth, Tunisia	22.0	400 à 4720	4 617	210
JUCAR	mouth, Spain	21.5	62	79	4
TEVERE	mouth, Italy	16.7	45	333	20
DRIN	mouth, Albania	12.4	1250	13 412	1 082
ADIGE	mouth, Italy	12.0	223	1 654	138
ARNO	mouth, Italy	8.2	681	2 213	270
SEMANI	mouth, Albania	5.3	6160	220	41
VAR	middle-course, France	1.8	323	437	243

(*) in 1976-1977

Source : Blue Plan (taken from the report of the meeting of National Committees for the International Hydrological Programme of Countries bordering the Mediterranean, Rome, 1978)

Table 63

Global classification of industrial solid waste and sludge (from Orhon 1986).

1 - Production-related waste	: By-products, side products, process residues, spent reaction media, contaminated plant of equipment from manufacturing operations, discarded manufactured products
2 - Waste from auxiliary services	: Municipal-type solid waste (canteens, cafeterias) power plant waste, packaging/shipping waste
3 - Waste aring from pollution control systems	: Wastewater/water treatment system sludges, incinerator residues

Table 64

Hazardous wastes identified in 297 major industrial plants in Istanbul.

Category	Amount (t/a)
Oily wastes	27.5
Flammable organic solvents	0.4
Non-flammable organic solvents	8.0
Organic sludges	143
Inorganic sludges	1506
Combustible solids	3730
Non-combustible solids	3262
Acid wastes	26.9
Alkaline wastes	1.5

Table 65

Industrial solid wastes in the Alexandria Metropolitan Area (from Hamza and Gallup, 1983).

Type	Nb of Plants	KKg/d	Major constituents	Disposition
I. Inorganics				
A. Water treatment	6	3300	precipitation and backwash sludges	slurry discharge to drainage canals
B. Glass	3	2.6	cullet	recycle or reuse
		0.2	fiber glass	incineration
C. Cement and Ceramics	2	22	dust	air emission
D. Iron and steel	1	30	slag	open dumping
E. Foundries	5	6	foundry dust	reclaim or dumping
F. Chemicals	1	420	salt refining and processing (CA Co_3,$Ca(OH)_2$,Ca SO_4)	direct discharge to the sea
Sub total	18	3810.8		
II. Organics				
A. Dyes and Chemicals	3	260	organic residues and Ca SO_4	controlled dumping
B. Tires	1	0.7	pastes and rejects scrap	reclaimation reclaim or dump
C. Textile	13	30.9	reject textile and waste fiber	reprocessing
D. Batteries	1	0.8	sludge (lead 6-9%)	dumping
E. Plastics	1	0.9	rejects	reprocessing
F. Paper	6	180	rejects and waste paper	reprocessing
G. Tanneries	6	4	fleshing and rejects	glue manufacture
Sub total	31	481.5		
III. Food				
A. Poultry	1	35	viscera and feathers	animal feed
B. Flour mills and bakeries	28	49	bread rejects and flour	animal feed
C. Beer	1	0.5	fermentation sludges	animal feed
D. Starch	2	10.4	processing residues	sewerage discharge
E. Yeast	1	3.6	germination residues	sewerage discharge
F. Canning	2	33	vegetable and fruit residues	animal feed
"		3	fish residues	animal feed
G. Dairy	1	5	whey	sewerage discharge
H. Edible Oils	8	6	spent belaching earth	dumping
		0.3	spent sludge (Ni catalyst)	
Sub total	44	145.8		
IV. Metal and Other Hazardous Wastes				
A. Iron	1	1.3	pickling wastes	neutralization and dumping
B. Metal cleaning	5	0.5	cleaning wastes, solvents	sewerage discharge
C. Pharmaceuticals	1	0		
D. Caustics	2	1.2		discharge to sea
E. Oil refining	2	3.6	tank bottoms (intermittent)	dumping
F. Municipal WWT	2	2	sludges	drying beds
G. Service stations	39	12	crank case oil	reclaimation
Sub total	52	18.6		
TOTAL	145	4456.7		

Table 66

Quantity and Treatment of Municipal Solid Waste
in a few Mediterranean Countries (from UNEP, 1987).

Country	Quantity (1000 t/a)	Treatment		
		Land Disposal (%)	Compost (%)	Incineration (%)
Spain	10.000	81	14	5
France	17.000	44	10	35
Italy	15.000	25	50	25
Israel	12.000		25	

Table 67

Composition of municipal solid wastes.

Component, %	Alexandria	Istanbul
Putrescible	78.1	46.5
Paper	12.6	12.0
Glass	0.7	3.0
Metals	0.7	1.5
Inert (Ash)	3.7	29.0
Others	0.9	9.0
	100	100

Table 68

Inputs of petroleum hydrocarbons in the marine environment
(million metric tonnes per annum)
(From IMCO, 1981; and Baker, 1983; US/NAS, 1985).

	Best estimate		Probable range		US.Nat.Acad. of Sci. 1985	
Transportation	1.49		1.00-2.60		1.47	
Tanker operation		0.71		0.44-1.45		0.7
Drydocking		0.03		0.02-0.05		0.03
Marine terminals		0.02		0.01-0.03		0.02
Bilge and fuel oil		0.32		0.16-0.60		0.3
Tanker accidents		0.39		0.35-0.43		0.4
Non-tanker accidents		0.02		0.02-0.04		0.02
Production platforms	0.05		0.04-0.07		0.05	
Atmospheric	0.30		0.05-0.50		0.3	
Municipal, industrial wastes, run-off	1.40		0.70-2.80		1.18	
Natural seeps/erosion	0.03		0.03-2.60		0.25	
Total	3.27		1.82-8.57		3.25	

Table 69

Quantities of oil movement at sea and the size of the world's merchant and tanker fleets in 1970 and 1980
(IMCO, 1981).

	1970	1980	Ratio 1980/70
Oil movement at sea (million tonnes)			
Crude oil	1,100	1,319.3	1.20
Product oil	255	268.9	1.05
Total	1,355	1,588.2	1.17
World's merchant fleet			
No of ships	55,041	73,832	1.34
Tons gross tonnage	247,202,634	419,910,651	1.70
World's tanker fleet			
No of ships	6,292	7,112	1.13
Total deadweight tonnes	169,354,743	339,801,719	2.0
Average deadweight tonnes	36,900	47,800	1.78

Table 70

Inputs of petroleum hydrocarbons in the Mediterranean (10^3 tonnes per year) (UNEP/IMO/IOC, 1987).

Source	Estimate
- Spilled oil from tankers, ballasting and loading operations, bilge and tank washings	330
- Land-based discharges, run-off	
- municipal	160
- industrial	110
- Atmospheric deposition	35
total	635

Table 71

Barcelona Convention States and MARPOL 73/78 Convention (UNEP/IMO/IOC, 1987).

	No of tankers over 10,000 dwt	Percentage of World Fleet at 31.12.83
States for which MARPOL 73/78 has entered into force		
Egypt	5	0.05
France	58	3.67
Greece	254	7.46
Israel	-	-
Italy	76	2.18
Lebanon	1	-
Spain	55	2.34
Tunisia	-	-
Yugoslavia	5	0.12
Sub-Total	454	15.82
States which have not ratified MARPOL 73/78		
Algeria	11	0.38
Cyprus	44	1.28
Libya	13	0.52
Malta	-	-
Monaco	-	-
Morocco	7	0.08
Syria	-	-
Turkey	19	0.55
Sub-Total	94	2.81
Grand-total	548	18.63

Table 72

Offshore oil and gas exploratory and development drilling
in the Mediterranean Sea (1985).

	Exploratory	Development	Total
Tunisia	22 600 m	2 250 m	25 150 m
Libya	9 500 m	0 m	9 500 m
Egypt	10 000 m	3 000 m	13 000 m
Turkey	4 700 m	0 m	4 700 m
Greece	3 000 m	6 100 m	9 100 m
Yugoslavia	2 600 m	0 m	2 600 m
Italy	50 600 m	80 000 m	130 000 m
Spain	15 000 m	12 000 m	27 000 m
			220 000 m

Table 73

Mediterranean Fish Production (Area 37).

Sector	Species Groups	Coastal countries	Estimated stocks	Potentials ('000 t)	Catches ('000 t) 1970 -74	1975 -79	1980	1981	1982	1983	1984
Balearic 37.1	Demersal	Algeria	Trawl only	80	32.4	37.0	46.7	38.2	42.5	44.1	41.9
	Coastal pel.	Morocco		unknown	93.2	132.4	133.6	152.7	163.3	161.8	165.8
	Miscel.	Spain			10.3	22.6	22.7	38.6	34.9	26.7	25.7
Gulf Lions 37.2	Demersal		Finfish(shelf)	10	9.1	7.2	8.0	8.7	10.0	9.7	7.9
	Coastal pel.	France	Sardine	20-25	19.7	18.5	22.4	29.9	29.3	24.8	21.2
	Miscel.				9.4	3.3	1.6	1.9	1.8	2.4	3.0
Sardinia 37.3	Demersal	France	Trawl only	60	43.6	22.8	19.2	22.1	22.3	26.5	27.6
	Coastal pel.	Italy (W)		100	58.8	39.1	28.5	43.2	35.9	43.5	33.4
	Miscel.	Tunisia (N)			15.1	12.4	12.5	11.9	11.7	14.1	15.3
Adriatic 37.4	Demersal	Italy (E)	Trawl only	80-100	32.6	18.4	18.0	15.8	27.1	16.2	16.0
	Coastal pel.	Yugoslavia		few 100s	80.2	91.7	121.6	138.6	124.5	21.4	105.7
	Miscel.				30.6	37.2	27.3	29.5	20.8	40.9	48.3
Ionian	Demersal	Albania	Trawl only	85	37.8	42.2	38.4	39.8	30.1	54.5	74.0
	Coastal pel.	Italy(S),Libya		Unknown	32.2	43.8	50.0	46.0	54.2	46.5	45.9
	Miscel.	Malta,Tunisia(E)			16.3	35.2	35.1	38.4	56.8	35.7	38.1
Aegean 37.6	Demersal			Unknown	17.5	22.2	26.2	25.1	27.6	28.3	28.9
	Coastal pel.	Greece (E)		Unknown	23.2	35.8	46.1	43.3	43.8	45.2	50.4
	Miscel.	Turkey (W)			7.5	10.2	12.9	12.3	14.4	7.9	8.0
Levant 37.7	Demersal	Cyprus,Egypt,	Finfish	25(?)	10.0	12.0	13.0	15.3	11.5	13.2	11.9
	Coastal pel.	Israel, Lebanon		Unknown	9.1	9.0	12.0	14.7	12.4	14.5	13.7
	Miscel.	Syria, Turkey			4.1	3.1	4.9	5.2	3.3	4.0	3.6
Whole Mediter-ranean	Demersal			400-500	183.0	161.8	169.5	165	171.1	192.7	208.4
	Coastal pel.			500(?)	316.4	370.3	414.2	468.4	463.4	457.9	436.2
	Miscel.				93.3	124.0	117.0	137.8	143.7	113.6	143.6
Total Mediterranean				1000	592.7	656.1	700.7	771.2	778.2	764.1	788.2

Source: FAO Fisheries Circular (710). Reviewed the state of World Fisheries Resources

Table 74

Red tides south of the river Po. The coast of Emilia-Romagna (Summarized from Marchetti et al., 1987).

Date	Organism	Biomass (10^6cell/l)	Observations
1969 May	Peridinium depressum, 95%	Very dense.	One week. 8 km. Fish and mollusc kills for lack of oxygen
1975 Sept.7	algal bloom	Very dense.	Massive fish and mollusc kills
1978 March	Skeletonema costatum	100	-- --
July-August	Gonyaulax polyedra, Gymnodinium coril		-- --
1979 end winter	S. costatum G. polyedra	30	-- --
1981 February	S. costatum	25	
	Glenodinium lenticula	30	
June	Massartia rotunda	10	
August	G. coril	25	Chlorophyll up to 1 mg l^{-1}
1982 March	S. costatum	--	
May	Glenodinium lenticula	--	O_2 less than 1mg l^{-1} over 900km^2
Summer	G. polyedra + unidentified dinof.	10	
1984 March-April	S. costatum		
June	Prorocentrum micans	--	Spreading 3 km from shore
Aug.Sep.	G. polyedra, G. coril, Massartia	--	
1985 February	S. costatum + other diatoms	Heavy growth	-- --
October	G. polyedra	Impressive bloom	
1986 January-May	S. costatum	Heavy growth	

Table 75

Red tides in the Mediterranean Sea
(Dino=Dinoflagellate, Chloro=Chloromonadina, Diato=Diatoms)
(Jacques and Sournia, 1980, updated).

Locality	Biomass 10^6 cell. l^{-1}	Sporadic (+) Recurrent (++)	Organism
Barcelona harbour	1-52	++	Chloro
Castellon	21	?	Dino
Coast of Catalonia	0.38	++	Dino
Banyuls/mer	2	++	Dino
Rhône outlet	-	++	Dino, Diato
Juan-les-Pins	80	++	Dino
Bay of Antibes	-	+	Chloro
Villefranche/mer	-	++	Chloro
Emilia-Romagna	10-100	++	Dino, Diato
Kastela Bay	18	?	Dino
Izmir Gulf	-	++	Dino
Alexandria, East Harbour	26	++	Dino
Algiers harbour	-	?	Chloro
Malta	0.4	++	Dino
Messina	-	?	Chloro

Table 76

Total mercury and methylmercury content of seafood and percentage of families consuming each of the listed species during the period of dietary surveys in Yugoslavia (WHO/FAO/UNEP, 1987)
(English names adjusted according to Fisher *et al* (1987)

Experimental area

Latin name	English name	Total mercury (mg kg^{-1})	Methyl mercury (mg kg^{-1})	Percent. of families
Boops boops	Bogue	0.391	0.130	12.7
Diplodus annularis	Annular seabream	0.628	0.321	15.2
Lithognathus mormyrus	Striped seabream	0.106	0.036	2.5
Diplodus vulgaris	Common seabream	0.326	0.098	2.5
Sarpa salpa	Salema	0.109	0.011	1.3
Pagellus erythrinus	Common pandora	0.155	0.138	8.9
Sparus aurata	Gilthead seabream	0.119	0.031	1.3
Puntazzo puntazzo	Sharpsnout seabream	0.110	0.028	1.3
Mullus spp.	Mullet	0.318	0.128	3.8
Mugilidae (FAM)	Mullet	0.093	0.064	26.6
Atherina hepsetus	Medit.sand smelt	0.135	0.086	6.3
Gobius spp.	Goby	0.111	0.048	5.1
Uranoscopus scaber	Stargazer	1.370	0.618	2.5
Scorpaena scrofa	Red scorpionfish	0.276	0.230	5.1
Belone gracilis	Garfish	-	-	1.3
Spicara smaris	Picarel	0.208	0.055	39.2
Spicara maena	Blotched picarel	0.326	0.098	1.3
Dicentrarchus labrax	European seabass	0.155	0.138	1.3
Serranus scriba	Painted comber	0.270	0.074	3.8
Conger conger	European conger	0.152	0.139	1.3
Anguilla anguilla	European eel	0.159	0.152	2.5
Merluccius merluccius	European hake	0.312	0.122	29.1
Solea vulgaris	Common sole	0.390	0.170	1.3
Trachurus spp.	Mackerel	0.215	0.103	21.5
Sardina pilchardus	European pilchard	0.198	0.055	39.2
Engraulis encrasicolus	European anchovy	0.405	0.128	1.3
Alosa fallax	Twaite shad	0.113	0.111	1.3
Scomber scombrus	Atlantic mackerel	0.070	0.016	3.8
Thunnus thynnus	Northern bluefin tuna	-	-	1.3
Scyliorhinus canicula	Smallspotted catshark	0.375	0.092	1.3
Mustelus mustelus	Smoothhound	0.810	0.477	3.8
Sepia officinalis	Common cuttlefish	0.483	0.179	10.1
Loligo vulgaris	European squid	0.322	0.194	53.2
Eledone spp.	Octopus	0.370	0.170	5.1
Nephrops norvegicus	Norway lobster	0.540	0.508	1.3
Crustacea natantia	Shrimp	0.207	0.124	1.3
Portunus corrugatus	Wrinkled swimcrab	0.361	0.122	3.8
Murex spp.	Murex	-	0.231	2.5

Table 77

Total mercury and methylmercury content of seafood and percentage of families consuming each of the listed species during the period of dietary surveys in Yugoslavia (WHO/FAO/UNEP, 1987)
(English names adjusted according to Fisher *et al* (1987)

Control area

Latin name	English name	Total mercury (mg kg^{-1})	Methyl mercury (mg kg^{-1})	Percent. of families
Boops boops	Bogue	0.096	0.018	69.8
Diplodus annularis	Annular seabream	0.077	0.021	11.6
Diplodus vulgaris	Common seabream	0.160	0.074	3.2
Sarpa salpa	Salema	0.054	-	17.5
Pagellus erythrinus	Common pandora	0.155	0.138	6.3
Oblada melanura	Saddled seabream	0.092	0.038	1.6
Spondyliosoma cantharus	Black seabream	0.063	0.054	3.2
Diplodus sargus sargus	White seabream	0.163	0.079	1.6
Dentex dentex	Common dentex	0.150	0.135	1.6
Mullus spp.	Mullet	0.166	0.180	17.5
Mullus spp.	Mullet	0.222	0.126	1.6
Mugilidae (FAM)	Mullet	0.067	0.023	1.6
Atherina spp.	Smelt	0.040	0.035	15.9
Belone gracilis	Garfish	0.092	0.063	3.2
Spicara spp.	Picarel	0.102	0.082	20.6
Spicara maena	Blotched picarel	0.110	0.056	3.2
Trigla lyra	Piper gurnard	0.079	0.085	3.2
Serranus scriba	Painted comber	0.060	0.063	1.6
Sciaena umbra	Brown meagre	0.067	0.059	1.6
Labrus merula	Brown wrasse	0.073	0.046	6.3
Scorpaena scrofa	Red scorpionfish	0.276	0.383	14.3
Raja spp.	Ray	0.268	0.200	4.8
Merluccius merluccius	European hake	0.210	0.211	20.6
Solea vulgaris	Common sole	0.222	0.220	4.8
Zeus faber	John dory	0.082	0.025	4.8
Lophius spp.	Angler	-	0.146	3.2
Trachurus spp.	Mackerel	0.091	0.063	20.6
Conger conger	Sea eel	0.152	0.159	14.2
Sardina pilchardus	European pilchard	0.078	0.026	42.9
Euthynnus alletteratus	Little tunny	0.077	0.016	6.3
Scomber japonicus	Chub mackerel	0.080	0.022	9.5
Seriola dumerili	Greater amberjack	0.065	0.052	4.8
Loligo vulgaris	European squid	0.255	0.160	54.0
Sepia officinalis	Common cuttlefish	0.236	0.285	4.8
Eledone moschata	Musky octopus	0.505	0.485	1.6
Octopus vulgaris	Common octopus	0.520	0.495	7.9
Nephrops norvegicus	Norway lobster	-	0.508	11.1

Table 78

Estimation of the "recovery time" (t_{rec})
(Bacci *et al.*, 1986).

Sample	Reference area level ug_{Hg} g^{-1} (wet weight) x	S.D.	n	t_{rec}(*) (years)
Pachygrapsus marmoratus				
whole body	0.033	0.013	11	15.2
Patella sp.				
visceral mass	0.208	0.051	30	13.4
foot	0.067	0.018	30	14.0
Scorpaena porcus				
(25-50 g body weight) muscle	0.124	0.039	17	23.2
Coris julis				
(60-90 g body weight) muscle	0.340	0.161	8	23.8

(*) from 1973

Table 79

Solid Phase contamination of the sediments from the Vaine lagoon and Carteau cove at the beginning of the experiment.

	Organic Carbon (%)	Total hydrocarbons (mg $100g^{-1}$)	Zn	Pb ($ug\ g^{-1}$)	Cu	Cd	Hg
Vaine	7.17	652	400	273	104	5.4	1.12
Carteau	0.90	14.1	207	33	20.7	1.7	0.26

Source A. Arnoux, G. Stora and C. Diana, 1985.

Table 80

Accidents reported at the Regional Oil Combating Centre, Malta (between August 1977 and June 1985)* (UNEP, 1987b)

Date	Location	Type	Flag	Quantity (t)	Type	Actions taken	Damage/impacts
13.08.77	SE Sicily, It.	Collision	Italy/Egypt	5 000	Lybian AmNA	Dispersant 54000 L	none
29.10.77	Genoa, It.	Damage	Kuwait	5 000-12 000	Crude oil	Dispersant BP	none
11.01.78	W Sicily, It.	Fire	Greece	500	Bunker fuel	Disp. 4T FINASOL	?
13.02.78	Malta	Slick	non identified	<1 000	?	Dispersant	none
04.06.78	Trieste, It.	Wrong manoeuvre	Liberian	?	?	?	?
20.10.78	Paphos, Cyprus	Slick	non identified	<1 000	?	Aerial survey	none
01.03.79	Suez Canal	Collision	Liberia	2 200	Crude oil	Dispersant	?
02.03.79	S. Kaloi Limenes, Crete	Grounding	Liberia	5 000-10 000	Lybian crude oil	Dispersant on shore and at sea	Beaches
04.03.79	Gibraltar, GB	Grounding	GB	722	Crude oil	Dispersant 2000 L; removal of sand	Beaches
26.06.79	W. Fiumicino	Collision	Italy/France	5 200	Gas oil and gasoline	Dispersants; fire fighting	none
15.02.80	Istanbul, Turkey	Collision	Romania/Greece	94 600	Lybian crude oil	Booms; fire fighting	Tar balls on shore
23.02.80	Navarino, Greece	Fire and Sinking	Greece	40 000	Iraki light crude	Disp., skimmers booms, aerial survey	Tourist beaches
27.05.80	Malta	Slick	-	<1 000	Crude oil	Disp., aerial survey	none
11.06.80	Larnaca, Cyprus	Sinking	Sweden	50-500	Bunker C	Dispersants, booms, skimmers, transfer of cargo	Pollution Larnaca harbour, tourist resorts
20.07.80	Sicilian Chan.	Slicks	-	<1 020	none	?	
08.11.80	Bosphorus, Turkey	Collision	GB/Greece	645	Kerosene	Straits closed (fire risk)	Pollution of Bosphorus; fire
20.12.60	Harzew Harbour, Algeria	Grounding	Uruguay	39 000	Condensate	Cargo transferred; anti-pollution eqpt.	Little damage
31.03.81	Tarragona, Spain	Explosion, fire	Greece	18 000	Naphta	Towing tried. Bombed by French Navy	None
31.06.81	W. Malta	Slick		miles long	oil?	None	-
12.07.81	Genoa, It.	Lightning; pipe rupture	Japan	31 000	?	Booms, dispersant, skimmer	Fire, five dead; harbour pollution
08.06.83	Ashqelon, Isr.	Rupture hose		54 000	Crude oil	-	-
03.11.83	Tripoli, Lebanon	Military attack/ explosion, fire: 12 tks, refinery		millions of gallons, burned, spilled	Crude oil	-	-
19.10.84	Izmir, Turkey	Grounded	Turkey	565	Crude oil	Skimmers (land, sea)	?
21.03.85	Messina, It.	Collision	Greece/Spain	900	Crude oil	Dispersants	?

Source : UNEP/IG.56/Inf.6, updated

*Only accidents causing spills equal or higher than 500 t have been listed

Table 81

IMPLEMENTATION WORKPLAN FOR LAND-BASED SOURCES PROTOCOL

1. USED LUBRICATING OILS	1986
2. SHELL-FISH AND SHELL-FISH GROWING WATERS	1986
3. CADMIUM AND CADMIUM COMPOUNDS	1987
4. MERCURY AND MERCURY COMPOUNDS	1987
5. ORGANOHALOGEN COMPOUNDS	1987
6. PERSISTENT SYNTHETIC MATERIALS WHICH MAY FLOAT, SINK OR REMAIN IN SUSPENSION	1988
7. ORGANOPHOSPHOROUS COMPOUNDS	1988
8. ORGANOTIN COMPOUNDS	1988
9. RADIOACTIVE SUBSTANCES	1989
10. CARCINOGENIC, TERATOGENIC OR MUTAGENIC SUBSTANCES	1989
11. PATHOGENIC MICROORGANISMS	1989
12. CRUDE OILS AND HYDROCARBONS OF ANY ORIGIN	1990
13. ZINC, COPPER AND LEAD	1990
14. NICKEL, CHROMIUM, SELENIUM AND ARSENIC	1990
15. INORGANIC COMPOUNDS OF PHOSPHOROUS AND ELEMENTAL PHOSPHORUS	1991
16. NON-BIODEGRADABLE DETERGENTS AND OTHER SURFACE-ACTIVE SUBSTANCES	1991
17. THERMAL DISCHARGES	1991
18. ACID OR ALKALINE COMPOUNDS	1992
19. SUBSTANCES HAVING ADVERSE EFFECT ON THE OXYGEN CONTENT	1992
20. BARIUM, URANIUM AND COBALT	1992
21. CYANIDES AND FLUORIDES	1993
22. SUBSTANCES, OF A NON-TOXIC NATURE, WHICH MAY BECOME HARMUL OWING TO THE QUANTITIES DISCHARGED	1993
23. ORGANOSILICON COMPOUNDS	1993
24. ANTIMONY, TIN AND VANADIUM	1994
25. SUBSTANCES WHICH HAVE A DELETERIOUS EFFECT ON THE TASTE AND/OR SMELL OF PRODUCTS FOR HUMAN CONSUMPTION	1994
26. BIOCIDES AND THEIR DERIVATIVES NOT COVERED IN ANNEX I	1994
27. TITANIUM, BORON AND SILVER	1995
28. MOLYBDENUM, BERYLLIUM, THALLIUM AND TELLURIUM	1995

Table 82

GENOA DECLARATION
ON THE SECOND MEDITERRANEAN DECADE

The Contracting Parties to the Convention for the Protection of the Mediterranean Sea against pollution and its related protocols, meeting in Genoa on 9-13 September 1985;

- Having reviewed their co-operation in the framework of the Mediterranean Action Plan over the past ten years and the role of the United Nations Environment Programme (UNEP) therein;

1. CONSIDER that the actions already taken and the progress achieved are positive developments, while noting that the state of the environmental quality of the Mediterranean Sea requires great acceleration of action to improve it;

2. FIRMLY BELIEVE that their co-operation in the protection of the Mediterranean is a good example of the contribution of environmental protection towards sustainable development, and better understanding among the people of the region;

3. CONSIDER that the health of the Mediterranean is of paramount importance to the well-being of the peoples of the Mediterranean in their totality;

4. FURTHER CONSIDER that the political will and solidarity of all countries concerned are already in place and that the foundation is already established for more concrete action to protect their common heritage;

5. REAFFIRM their commitment to the protection of the Mediterranean Sea through the implementation of the Mediterranean Action Plan which is a very useful mechanism to ensure their common action;

6. REAFFIRM their determination to co-operate for the protection of the Mediterranean environment and the rational use of its resources, especially through the harmonization of legislation and developing common standards; strengthening research and monitoring centres; the establishment of training programmes; the transfer of knowhow; and broadening the scope of technical co-operation with developing countries of the region to enable them to meet their obligations in the protection of the Mediterranean;

7. COMMIT THEMSELVES to accelerate the implementation of national and international programmes in order to achieve the objectives of the various components of the Action Plan;

8. COMMIT THEMSELVES to increase investment to combat pollution and to increase their vigilance on the application and adherence to the legislation on the protection of the environment;

Table 82 (Cont'd)

9. DECIDE to use the budget of the Action Plan in a catalytic way in projects with organizations willing to contribute their own resources;

10. DECIDE to increase efforts, through all appropriate information channels, to make the aims and achievements of the Mediterranean Action Plan more widely known;

11. RECOGNIZE that the provisions of the Action Plan should constitute an important framework for national development activities;

12. FURTHER RECOGNIZE that the support of the international, regional and non-governmental organizations is essential for the full achievement of the goals of the Mediterranean Action Plan;

13. CONSIDER that the protection of the Mediterranean requires major support of governments efforts through a much greater acceleration of the action-oriented activities of parliaments, local authorities, industries, non-governmental organizations, the scientific community, the media and the public at large to reverse the trend of deterioration of the sea and of its coastal areas;

14. APPEAL to the 350 million inhabitants of the Mediterranean Coastal States and to the 100 million tourists visiting the region, to become more aware of the exceptional natural, economic and cultural values of the Mediterranean and to commit themselves individually and collectively to its protection;

15. INVITE THE GOVERNMENTS to proclaim an annual Mediterranean Environment Week to serve as the rallying point for local, national and regional initiatives for its protection;

16. DECIDE to launch a new phase of their co-operative efforts to accelerate ongoing activities and to achieve concrete targets during the second decade of the Mediterranean Action Plan;

17. ADOPT the following ten targets to be achieved as a matter of priority during the second decade of the Mediterranean Action Plan:

(a) Establishment of reception facilities for dirty ballast waters and other oily residues received from tankers and ships in ports of the Mediterranean;

(b) Establishement as a matter of priority of sewage treatment plants in all cities around the Mediterranean with more than 100,000 inhabitants and appropriate outfalls and/or appropriate treatment plants for all towns with more than 10,000 inhabitants;

(c) Applying environmental impact assessment as an important tool to ensure proper development activities;

Table 82 (Cont'd)

(d) Co-operation to improve the safety of maritime navigation and to reduce substantially the risk of transport of dangerous toxic substances likely to affect the coastal areas or induce marine pollution;

(e) Protection of the endangered marine species (e.g. Monk Seal and Mediterranean sea turtle);

(f) Concrete measures to achieve substantial reduction in industrial pollution and disposal of solid waste;

(g) Identification and protection of at least 100 coastal historic sites of common interest;

(h) Identification and protection of at least 50 new marine and coastal sites or reserves of Mediterranean interest;

(i) Intensify effective measures to prevent and combat forest fires, soil loss and desertification;

(j) Substantial reduction in air pollution which adversely affects coastal areas and the marine environment with the potential danger of acid rains.

Table 83

Financial losses due to forest fires, 1979-1985 (UNEP, 1987b)

(US$1000)

	Wood and other tangible losses							Other				
	1979	1980	1981	1982	1983	1984	1985	1979	1980	1981	1982	1983
SPAIN	101 154	94 474	103 527	44 338	29 262	28 985	..	250 562	264 874	320 320	236 164	150 875
FRANCE	256 550	82 821	96 603	..	..	..	..	..	..	..	..	..
ITALY	14 055	24 770	29 032	24 838	41 260	..	..	11 025	10 659	10 426	14 188	12 050
MALTA												
YUGOSLAVIA	..	..	2 068	..	..	..	..	..	..	86	..	..
ALBANIA												
GREECE	49											
TURKEY	..	..	27 945	13 264	5 178	25 960	104 080					
CYPRUS	291	84	12	8	12	..	..	..	..	..	..	..
SYRIA												
LEBANON												
ISRAEL	15		13	260	173	100	114					
EGYPT												
LIBYA												
TUNISIA (*)	..	..	16	151	1 836	298	202					
ALGERIA												
MOROCCO												

(*) Value in 1000 dinars

Source : Blue Plan (from FAO, 1984 and 1985)

Table 84

Investment in fire-fighting, 1978-1985 (UNEP, 1987b)
(US$1000)

	1978	1979	1980	1981	1982	1983	1984	1985
SPAIN	8 844	35 755		52 061	51 147	40 591		
FRANCE	23 046	31 731		34 225	29 670	26 898		
ITALY	4 713	13 329		5 093	19 599	11 840		
MALTA								
YUGOSLAVIA				41				
ALBANIA								
GREECE	9 621	10 386		443 862 (*)			2 306 242 (*)	2 435 679 (*)
TURKEY				55 665	46 804	28 307	41 800	84 700
CYPRUS	327	380		469	424	336		
SYRIA								
LEBANON								
ISRAEL	1 329	1 425	1 096	925	674	708	489	1 300
EGYPT								
LIBYA								
TUNISIA(*)				200	220	215	1 175	340
ALGERIA								
MOROCCO								

(*) thousand local currency

Source : Blue Plan (from FAO, 1984 and 1986)

APPENDIX

LIST OF ACRONYMS AND SYMBOLS

BOD	Biological Oxygen Demand
COD	Chemical Oxygen Demand
DDD	Dichloro-Diphenyl Dichloroethane
DDE	Dichloro-Diphynyl Dichloro Etheme
DDPH	Dissolved Petroleum Hydrocarbons
DDT	Dichloro-Diphenyl Trichloroethane
DW	Dry Weight
dwt	Dead weight tonnage
ECE	Economic Commission for Europe
EEC	European Economic Community
FAO	Food and Agricultural Organization
FC	Faecal Coliforms
FW	Fresh Weight
GC	Gas Chromatography
GESAMP	Joint Group of Experts on the Scientific Aspects of Marine Pollution
GNPC	Gross National Product per Capita
HC	Hydrocarbons
HCH	Hexachlorohexane
IAEA	International Atomic Energy Agency
ICES	International Council for the Exploration of the Sea
ICSU	International Council of Scientific Unions
IMO	International Maritime Organization
IOC	Intergovernmental Oceanographic Commission
IR	Infra-Red
LBS	Land-based Sources
M	Mega (10^6); Median
MARPOL	International Convention for the Prevention of pollution from ships
MED POL	Co-ordinated Programme for Pollution Monitoring and Research in the Mediterranean
nct, ndc	not detected
ng	Nanogram (10^{-9}g)
OCA/PAC	Oceans and Coastal Areas/Programme Activity Centre
P	Peta (10^{15})
PAP	Priority Actions Programme
PCB	Polychlorinated biphenyls
PH	Petroleum Hydrocarbons
ppb	Parts per billion
ppm	Parts per million
ROCC	Regional Oil Combating Centre
SPA	Specially Protected Areas
T	Total
UN	United Nations
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNIDO	United Nations Industrial Development Organization
WHO	World Health Organization
WMO	World Meteorological Organization

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