

State and pressures of the marine and coastal Mediterranean environment

Summary



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Foreword

When tackling the pressing issue of sustainable development in the Mediterranean Region – among which the challenging issues of rapid urbanisation rates; increasing tourism and coastal zone development and degradation; water scarcity; and trade – the need to establish a knowledge base and help come to grips with the problems is widely recognised, as is the current lack of timely and targeted information for action. To fulfil this need means also to contribute substantially to improving access to environmental data and information at the regional and national levels, both for governmental bodies and other institutions, as well as for the general public throughout the Mediterranean region.

Significant progress in building monitoring capacities (e.g. MEDPOL/MAP, environment/development observatories) and in framing, shaping and collecting data for commonly identified indicators (cf. the recent activities of the Mediterranean Commission for Sustainable Development) has been made. This is remarkable, but is it enough? We do not believe so. Is the best available information put to work for the right challenges, i.e. more stringent environmental political commitments and targets to improve in general environmental quality and the rational use of significant natural assets of the Mediterranean and, finally, to progress towards sustainable development? We must, indeed, consider the unique opportunity that a new generation of shared information could represent for an effective support to the national and regional decision-making processes and for stimulating the expected public participation.

What does this mean? For instance, the costs of environmental actions are often emphasised, but there are clearly also cost-effective opportunities for countries to develop eco-efficient economies, eg. increasing the share of renewable energies is realistic for many Mediterranean communities. Another example is given by the externalities of the tourism industry which, in many areas, offset the incomes and benefits it provides. If the right choices are to be made then new kinds of partnerships between all stakeholders are necessary as well as a new type of information that is relevant to the choices of development paths available.

This said, it is fair to state that expectations in the development of harmonised environmental data in the Mediterranean region through a joint information provision exercise have been often raised. To fulfil this objective the various actors ask the European Environment Agency (EEA) to contribute directly by bridging the European partners with the other Mediterranean actors. We have therefore initiated a partnership between EEA and UNEP/MAP. One of EEA's tasks, through the work of the Topic Centre on Marine and Coastal Environment, is to establish an Inter-Regional Forum to facilitate the exchange and integration of existing data and information among regional and international conventions and organisations active in marine and coastal environmental monitoring. Major regional and international organisations/conventions such as MAP, OSPAR, HELCOM have joined the Forum. From the first discussions between EEA and UNEP/MAP Secretariat, the need for an updated report on the state and trends for the Mediterranean Sea was emphasised.

The result of the cooperation on compiling and publishing such a report is presented here. It gives the best available information on the marine environment in the Mediterranean Sea and its coastal zone. It documents and describes the various interactions between human activities and the environment. It confirms and updates the major problems of the coastal zones. One of the major objectives of the report also includes the identification of possible gaps in current knowledge, especially in the field of marine environmental monitoring, following two decades of coordinated activities in the region under MEDPOL and complementary programmes. The final aim of the report is to identify objectives and recommend actions to improve the information, which can be achieved by encouraging better use of the scientific capacity in the region in order to focus more accurately on the existing problems and to propose suitable priorities and action.

It is worth stressing that the EEA and UNEP/MAP see this report both as a contribution to and a milestone towards an overall assessment of the environmental situation of the whole Mediterranean basin. It is necessary, however, to go beyond, in

support of the activities and political agenda dealing with environment/development issues. A status report on the current situation and prospects of the whole basin, including state of action, would address the specific needs of the European Union, UNEP, countries and international financial organisations to have an objective basis for decision-making. We should not wait too long before deciding about the making of this assessment report. In fact, such a report, which we might call 'The Mediterranean Basin. Situation and Prospects for the Next 20 Years' should be available for the Rio+10 Conference in 2002 in order to mark the place and ambitions of the Mediterranean within the world community.

In the meantime, we must dare to convey some strong messages, as demonstrated by the present report. Allow us to give you our perception of the issues:

- The Mediterranean sea and region is traditionally very rich in environmental data and specific, targeted information and scientific knowledge but extremely poor in consistent and integrated assessments. This difficulty to produce regular integrated assessments, linked to the political agenda, is a major handicap that has to be overcome;
- The Mediterranean is a fantastic asset: it is a strong and healthy sea that we submit, in spite of the reduction of some pollution, to excessive pressures; hot-spots identified by MAP are still numerous. Notwithstanding this, its natural conditions remain unique: its biodiversity, oligotrophic conditions, regular water renewal, rich coastal biotopes and landscapes, significant average depth (1,500 m), mild climatic conditions, etc. Properly used, the Mediterranean provides the basis for diversified economies in the basin while keeping a unique Mediterranean entity;
- We keep transforming all this potential and opportunities into threats for the future. If the sea, the water body, is still in favourable condition, we are doing much to degrade the landscapes by urbanising the coast beyond carrying capacities; we are also degrading the transition zone, the biotopes, the sealing of soils. In a way we are building a barrier of concrete that extends already over more than 25000 km of the 47000 total km of

Mediterranean coast, behind which the Mediterranean identity and its resources are gradually disappearing .

- We also discharge too much untreated waste water and toxic substances; and biodiversity is threatened by bringing invading fauna and flora species and scraping the sea beds.

The Mediterranean basin will only be what we make of the coasts. In line with the recommendations of the Mediterranean Commission for Sustainable development, the time has come to implement common policies for action aimed to improve the current situation and stop the degradation observed in this report. Otherwise, there is little hope of honouring our responsibility to take care of what is still a treasure; the Mediterranean Sea.

EEA and MAP will continue to develop their cooperation to provide more in-depth assessments; these should form the basis for the global action to reverse the present trends. It is not too late: it is a matter of understanding our collective interest as well as the rights of future generations.

Domingo Jiménez-Beltrán
Executive Director, European Environment Agency

Lucien Chabason
Coordinator, Mediterranean Action Plan

Introduction

Intense human activities in regions surrounding enclosed and semi-enclosed seas such as the Mediterranean Sea always produce, in the long term, a strong environmental impact in the form of coastal and marine degradation and a heightened risk of more serious damage.

In view of the above and in addition to the specific measures taken by individual countries, several regional and international organisations have, during the last decade in particular, shown great interest in the Mediterranean basin and have launched and implemented a number of environmental programmes. In particular, the United Nations Environment Programme (UNEP) has coordinated the Mediterranean Action Plan (MAP) since 1975 and implemented several programmes covering scientific, socio-economic, cultural and legal aspects of the protection of the Mediterranean environment.

Scope of the report

The report, prepared by the European Environment Agency (EEA) and its European Topic Centre on the Marine and Coastal Environment (ETC/MCE) in cooperation with the Mediterranean Action Plan (MAP), presents an overview of the Mediterranean marine and coastal environment. The report adopts the DPSIR assessment framework (Driving Forces/pressures/State/Impacts/Response) developed by EEA, and describes the various interactions between human activities and environment.

The report makes an attempt to give a picture of the region and reflect important and characteristic features of the Mediterranean marine environment and the impacts of human activities, based on the best available information in 1997-98.

In presenting and assessing the state and pressures of the marine and coastal environment based on the best available data, the report identifies possible gaps in current knowledge, especially in the field of marine environmental monitoring. The report does not attempt to describe in detail the activities

undertaken in the region by the various bodies. The report presents objectives and recommends actions to improve the quality and availability of information from the area. It describes the Mediterranean Sea and its coastal zone by reviewing:

- its natural characteristics including morphology, seismicity, climate and hydrographic conditions;
- the human activities (or driving forces), including urbanisation, tourism, loads and discharges through rivers and from coastal population, agriculture, maritime traffic, industry, oil industry and the influence of fisheries and aquaculture, which exert pressures (in the marine and coastal Mediterranean environment);
- its environmental state and the main threats, including the state of eutrophication, microbial pollution and chemical and radioactive contamination in the Mediterranean marine ecosystems;
- the ecosystem sensitivity and impacts from climate change, changes in biodiversity and a discussion of environmental-quality related health risks in the area; and
- the responses at the regional level, giving information about the international programmes that have been launched in the Mediterranean Sea.

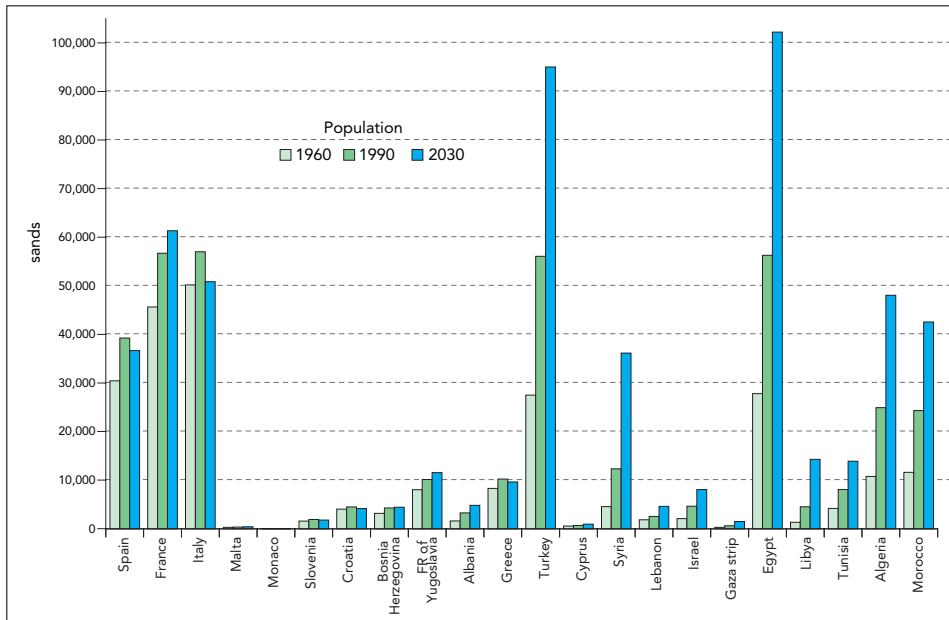
Data mainly from MEDPOL (Mediterranean Pollution Programme) and Blue Plan databases were used for assessment. Scientific literature, data and technical reports from other international organisations (e.g. FAO) and at national level have also been taken into consideration. The assessment has focused, where appropriate and available to the authors, on reliable and quality-assured data.

Driving forces and pressures

Concentration of populations (resident and non-resident) and human activities around the Mediterranean basin present considerable threats to coastal ecosystems and resources in four major areas:

- on the structure and function of natural ecosystems as a result of the construction and operation of facilities for human activities and the associated urbanisation and activities development;
- on the quality and quantity of natural resources (forests, soils, water, fisheries, beaches, etc.) as a result of increasing concentrations of people and activities adding to the demand for their use and exploitation and subsequent disposal of wastes;

Population increase in the different Mediterranean countries



Source: Blue Plan databases, United Nations, World Population Prospect, The 1994 Revision

- the coastal zones as a consequence of the development of different human activities and associated facilities as well as on the competition among conflicting users;
- the natural and man-made landscape as a result of the changes of activities, and of size and scale of related facilities and associated development.

In the future, coastal areas are likely to face increasing pressures, particularly on habitats, natural resources (land, fresh/marine waters and energy) and growth of demand for infrastructures (ports/marinas, transport, wastewater treatment facilities, etc). Urbanisation, tourism, agriculture, fishing, transport and industry are the major forces of change.

Urbanisation

The resident population of the riparian states of the Mediterranean was 246 million in 1960, 380 million in 1990 and is currently 450 million. 'Blue Plan' estimates that depending on the development scenarios applied, this figure will rise to 520-570 million in the year 2030, is expected to reach approximately 600 million in the year 2050 and possibly as much as 700 million at the end of the 21st century. Population density is greater in coastal regions, especially near the big cities.

The distribution of population between the northern and southern countries has changed dramatically: in 1950, countries of the northern Mediterranean represented two thirds of the total population, while today it is only 50 % and may be one third in the year 2025, and one fourth in 2050.

In general, the mass migration towards the major urban centres in the basin has overstrained the labour and housing markets and the associated public services (water supply, roads, sanitation and transport).

Population density in coastal regions



Source: Blue Plan databases

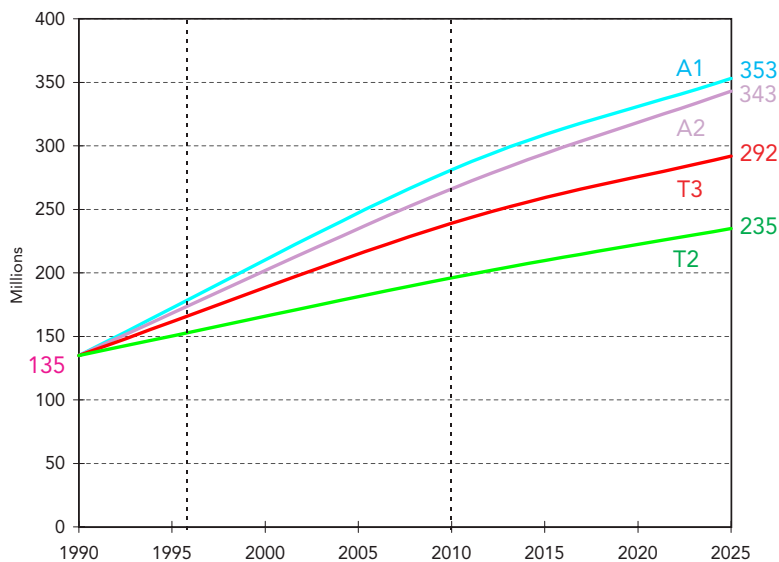
Tourism

The Mediterranean is the world's leading tourist destination, accounting for 30% of international tourism and one third of international tourism. Coastal tourism is strongly seasonal and increases annually. Pressures on the coastal zone are likely to continue to increase in the future, with an estimated doubling of tourism fluxes over the next twenty years from 135 million arrivals in 1990 to 235-350 million in 2025. Tourism is currently the first foreign currency source in the Mediterranean region and its contribution to GNP (Gross National Product) can average up to 22 %, as is the case for Cyprus, or 24 % for Malta.

The interactions between tourism and the environment in the Mediterranean region are seen in the following issues: land use; consumption of water resources; pollution and waste and physical and socio-cultural pressures. Coastal tourism causes reduction of natural sites and open spaces, substantial alteration of coastal landscapes and conflicts on the use of land, water and other resources. Pressures on the coastal zone are likely to increase in the future, with an estimation of a

doubling of tourism related development in the Mediterranean in the next twenty years. However, in recent years, tourism itself has produced a strong incentive for the protection of the landscape and the improvement of the quality of the environment (e.g. bathing waters, beaches, etc).

Alternative estimates of the distribution of the tourist frequency during the peak period (May-September) in the Mediterranean region (according to different Blue Plan scenarios)



Source: Blue Plan databases

Agriculture

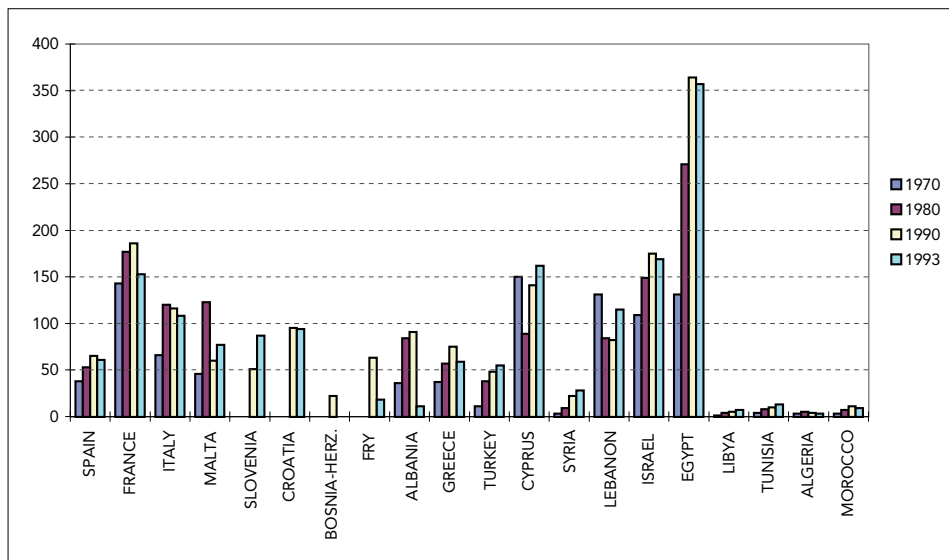
Due to the specific morphology of the Mediterranean basin, intense agricultural activity is carried out in the limited coastal plains, often as a result of reclamation of wetlands.

The role of agriculture in changing coastal environments of the Mediterranean basin is more indirect than direct and primarily affects the dynamics of wider areas. In most countries, all types of agricultural practices and land use lead to diffuse pollution of water and, hence, are difficult to quantify. Agricultural land is one of the resources on which the

pressures of development are the strongest, particularly on the narrow coastal strip bordered by desert regions on the southern coast.

The main pressures from agriculture are soil erosion and nutrient surplus when excessive fertilisers are applied. Large river basins like the Rhône and the Po Basins are subjected to agricultural pressures. The first six drainage regions, following a tentative ranking of the risk of soil erosion and nutrient

Fertiliser consumption in the Mediterranean countries from 1970 to 1993 (kg/ha)



Source : The World Bank, Social Indicator of Development, 1996

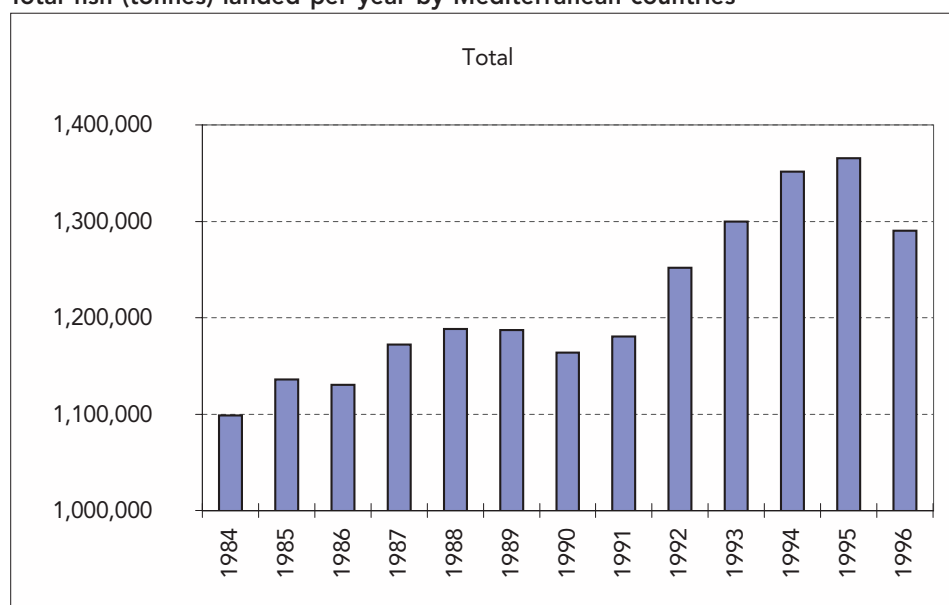
losses, are found in peninsular Italy, Sicily, Sardinia, Greece, Turkey and Spain.

Fisheries

Mediterranean fisheries exert pressure on the environment as well as on the fish stocks. The overall value of the landings is still high in comparison to the relatively modest tonnage (approximately 1.3 million tonnes) landed. There have been relatively small changes in fishing techniques in the

Mediterranean area during recent years. The number of fishing vessels increased from 1980 to 1992 by 19.8 %. Fleet technology in the industrialised EU countries is very high and there has been a shift from labour-intensive to more capital-intensive vessels, such as larger trawlers and multi-purpose vessels. The amount of 'passive' fishing by lost fishing nets has generally increased but the number of trawlers has remained steady since 1982.

Total fish (tonnes) landed per year by Mediterranean countries



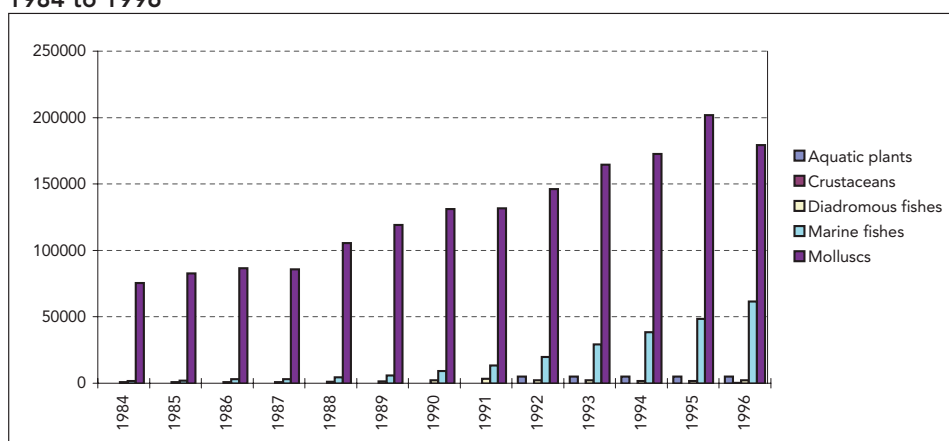
Source: FAO GFCM-PC release 1997 and FAO Fishstat-PC, release 1998

Aquaculture

Marine aquaculture has shown a large expansion in production in a number of Mediterranean countries over recent decades and increased from 78 000 tonnes in 1984 to 248 500 tonnes in 1996 (freshwater aquaculture not considered). Its future development will have to be considered in relation to all other existing and planned activities. The careful selection of sites where aquaculture could be done, with precise definition of their environmental carrying

capacity, will contribute to minimisation of nutrient loads on the ecosystem and to reduction of the effects of negative feedback which may eventually affect the production potential of fish-farming activities.

Aquaculture production (in tonnes) by major group in Mediterranean Sea from 1984 to 1996



Source: FAO Aquacult-PC, release 1998.

Since marine intensive aquaculture is a relatively new sector in the Mediterranean and concerns mainly shellfish and some fish species (mainly sea-bream and sea-bass), the impact of its relatively small productions (in comparison with Asia or South America) is still rather limited and very localised.

Industry

There is a large range of different industrial activities (from mining to manufactured products) scattered all around the Mediterranean basin, and a number of hot-spots are concentrated mainly in the north-west, generated by heavy industry complexes and big commercial harbours. Discharges and emissions of contaminants from this industry pose an environmental threat especially in the area of the hot-spots. Pressures from industry in the basin include mainly the chemical/petrochemical and metallurgy sectors. Other main industrial sectors in the coastal region are: treatment of wastes and solvent regeneration, surface treatment of metals, production of paper, paints and plastics, dyeing and printing and tanneries.

The export specialisation in each country provides a fairly precise image of the industrial activity which is most important in that country and could primarily cause environmental threats. Three groups of countries can be distinguished:

1. Countries highly specialised in exporting only few products, the rest being imported. This is typical of oil producing countries such as Algeria, Syria, Egypt and Libya;
2. a less specialised group, exporting goods even in a situation of comparative disadvantage with other countries, are Tunisia, Morocco, Turkey, FR Yugoslavia, Cyprus and Malta, exporting goods such as clothes, textiles, and leather. Each one also has more specific productions (chemistry, oils and lubricants in Tunisia; chemistry and fertilisers in Morocco; textile fibres, wool, cotton, paper and cement in Turkey and FR Yugoslavia);
3. a strongly diversified and thus much less specialised group comprises the European Union Member states which account also for the biggest part of the petrochemical industry in the Mediterranean basin.

The impacts of industry on coastal areas can be direct or indirect. Direct impacts deriving from effluents from industry, involve pollution problems at the site level (large commercial harbours, heavy industry complexes) that contribute to the creation of hot spots. Indirect impacts are related to the location of industries, ultimately leading to concentration of activities and urban development on the coast. Industry is also a major contributor to air pollution. However there is a lack of information on the impacts of industry on the coastal environment.

Maritime transport

There are three major passage ways to and from the Mediterranean Sea: the Strait of Çanakkale/Sea of Marmara/Istanbul Straits, the Strait of Gibraltar and the Suez Canal. The major axis (90 % of the total oil traffic) is from east to west (Egypt-Gibraltar), passing between Sicily and Malta and following closely the coasts of Tunisia, Algeria and Morocco. On average, there are about 60 maritime accidents in the

Activities of the oil industry in the Mediterranean Sea



Source: RAC/REMPEC

Mediterranean annually, of which about 15 involve ships causing oil and chemical spills. The most accident-prone areas, because of the intense maritime traffic, are: the Strait of Gibraltar and Messina, the Sicilian Channel and the approaches to the Straits of Çanakkale, as well as several ports and their approaches, particularly Genoa, Livorno, Civitavecchia, Venice, Trieste, Piraeus, Limassol/Larnaka, Beirut and Alexandria. The geographical distribution of pollution 'hot spots' is related also to the density of shipping traffic on the various Mediterranean routes.

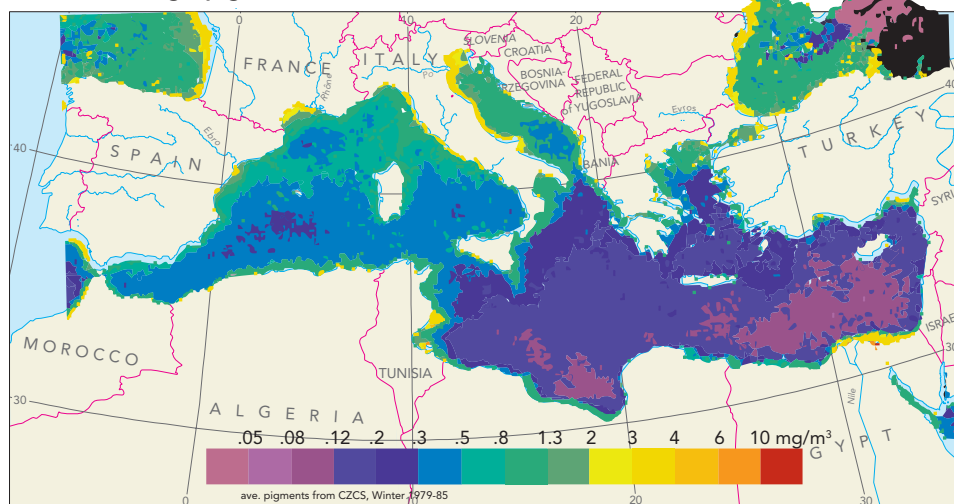
State and impact

Eutrophication

Eutrophication results from high nutrient loads from rivers and/or urban and industrial effluents. In the Mediterranean it appears to be limited mainly to specific coastal and adjacent offshore areas. Several, sometimes severe, cases of eutrophication are evident, especially in enclosed coastal bays which receive elevated nutrient loads from rivers, together with direct discharges of untreated domestic and industrial waste. Mediterranean surface waters in the open sea are classified among the poorest in nutrients (oligotrophic) of the world's oceans. The absence of significant up-welling keeps nutrients like nitrogen and phosphorus out of the biological recycling process.

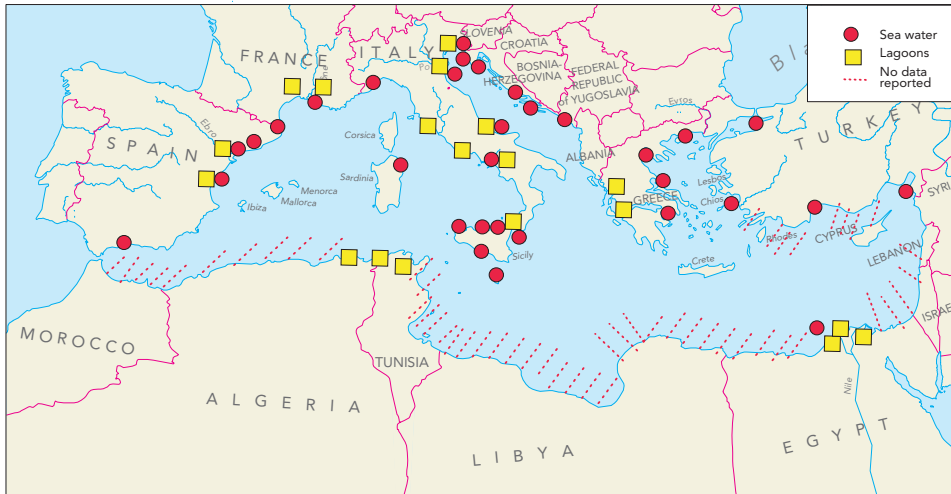
Algal blooms, diversity reduction of marine species and depletion of oxygen as well as potential human health risks related to the ingestion of seafood contaminated by pathogens or toxic algal blooms are some of the problems associated with eutrophication. Side effects (e.g. hypoxia/anoxia, algal blooms) have been reported in several places in the

Winter average pigments distribution in the Mediterranean Sea



Source: JRC, Ispra

Mediterranean areas where eutrophication phenomena were reported



Source: UNEP/FAO/WHO, 1996 (Modified)

Mediterranean Sea but they are confined to limited areas rather than widespread phenomena .

The Adriatic, the Gulf of the Lion and the northern Aegean are areas with relatively higher mean nutrient concentrations, higher primary and secondary production and, sometimes, local algal blooms related sporadically to hypoxic or anoxic conditions and rarely to toxic algal blooms.

Microbial contamination and human health risks

Microbial pollution is related to urban wastewaters. The most important eutrophication hot spots in the Mediterranean often coincide with coliform bacterial hot spots. Pathogenic and other micro-organisms enter the marine environment mainly through municipal waste water discharges. As is the case in other regions, microbiological pollution of the Mediterranean Sea is principally the direct result of the discharge of untreated or partially treated sewage into the immediate coastal zone. Microbial pollution and its effects have been mitigated along the EU Mediterranean coast since the installation of urban wastewater treatment plants in most of the European urban areas. However, the problem elsewhere remains as severe as before.

Rivers also add a considerable amount of microbiological pollution, mainly from upstream waste water discharges, but their relative contribution to the pollution of the Mediterranean by micro-organisms (pathogenic and otherwise) has not been assessed in this report.

One current area of concern is that of viruses. Those so far isolated in the various matrices of the Mediterranean marine environment are listed in the table. The geographical imbalance in the occurrence of viruses is caused by the difficulty in isolation and quantification.

The favourable climatic conditions which lure to the Mediterranean coast one third of the global tourism also provide conditions for relatively long and frequent bathing exposure and beach overcrowding, and thus the area is potentially more conducive to disease transmission and contraction than would be expected in more temperate regions, such as northern Europe.

The main risks to human health arise from: intake of pathogenic micro-organisms from infected sea water; direct contact with polluted sea water and beach sand and consumption of seafood contaminated by pathogens; and, in a minor way, heavy metals and chemicals, especially in bioaccumulating organisms such as filter feeders and carnivorous fish.

The extent of damage to health on a Mediterranean-wide basis still has to be determined, and the same applies to pathogen incidence. Available records have a chronological span of one and a half decades, making it difficult to arrive at an accurate

Viruses isolated in the Mediterranean marine environment

VIRUS	LOCALISATION
Enteroviruses	
Poliovirus	Greece, Italy
Echovirus	France, Greece, Italy
Coxsackie virus A	France, Italy
Coxsackie virus B	France, Greece
Hepatitis A virus	France, Greece, Spain
Unspecified, non-polio	France
Other viruses	
Adenovirus	France, Greece, Italy
Rotavirus	Spain

Source: WHO, 1991

assessment of the overall situation. Furthermore, there are still large stretches of the Mediterranean coastal zone, mainly in the southern and eastern parts, from which records are sparse.

Land use and coastal erosion

Information, at basin scale, about the coastal zones and their use does not exist for the Mediterranean area. Aside from urban population concentrations, competing land use along the coast comes from tourism, agriculture, fisheries and aquaculture, transport, energy and industry infrastructure, causing acceleration of the modification of the morphology of the coastal system.

Coastal erosion is an environmental threat, related to a combination of human activities such as damming and coastal development, the abandonment of agriculture, and global climate change. Habitat erosion has also occurred mainly due to the competitive use of the coastal zone. Erosion data showed that the 1500 km of artificial coasts can be found in the EU marine area (Balearic Islands, Gulf of the Lion, Sardinia, Adriatic, Ionian and Aegean) with harbours and ports contributing the major part (1250 km) (EC, 1998). Based on the CORINE coastal erosion data, about 25 % of the Italian

Evolutionary trends of some coasts of the European part of the Mediterranean Sea for both rocky coasts and beaches as % of coasts

Maritime regions	No information	Stability	Erosion	Sedimentation	Not applicable	Total (km)
Balearic Islands	0.5	68.8	19.6	2.4	8.7	2861
Gulf of Lion	4.1	46.0	14.4	7.8	27.8	1366
Sardinia	16.0	57.0	18.4	3.6	5.0	5521
Adriatic Sea	3.9	51.7	25.6	7.6	11.1	970
Ionian Sea	19.7	52.3	22.5	1.2	4.3	3890
Aegean Sea	37.5	49.5	7.4	2.9	2.6	3408

Source: EC, 1998

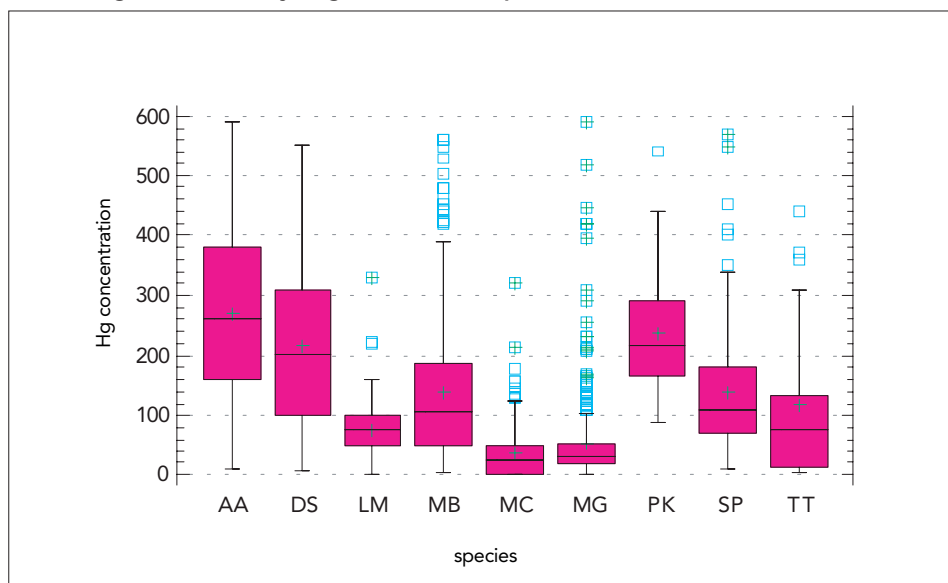
Adriatic coast and 7.4 % of the Aegean Sea show evolutionary trends of erosion while about 50 % of the total coastline of the Euro-Mediterranean area considered to be stable.

Heavy metals and organochlorine compounds

In the Mediterranean Sea, heavy metals are considered to arise mainly from natural processes, while anthropogenic sources, such as discharges from chemical industries, sewage and agriculture, are deemed to have a limited and spatially restricted effect. The relative importance of the various sources is, however, difficult to estimate due to the limited data available.

Total mercury values in Mediterranean species were generally higher than those found in the Atlantic. With the exception of

Box-and-Whisker plots showing the distribution of data for concentrations (in ng/g fresh weight) of mercury (Hg) in selected species from the Mediterranean Sea



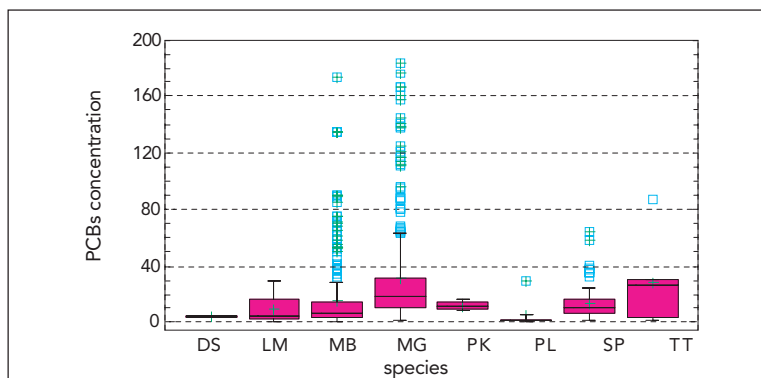
(AA=Aristeus antennatus, DS=Diplodus sargus, LM=Lithognathus mormyrus, MB=Mullus barbatus, MC=Mactra corallina, MG=Mytilus galloprovincialis, PK=Penaeus kerathurus, SP=Sardina pilchardus, TT=Thunnus thynnus)

Source: MED POL database

mercury in biota and sediments, heavy metal concentrations are generally low. The higher mercury levels are deemed to be the result of the region being in the Mediterranean - Himalayan mercuriferous belt (Bryan, 1976; Bernhard, 1988). In the early 1970s, very high mercury concentrations were observed in some coastal areas, in 'hot spots', near harbours and industrial areas. As a result of dramatic reductions, starting in the late 1970s, in mercury releases from chlor-alkali plants there have been quick recoveries (2-5 years for half-life of mercury) in biota and indications of slower (6-33 years) reductions of concentrations in sediments (Heirut et al., 1996).

Chlorinated hydrocarbons are released entirely from anthropogenic sources, since no natural chlorinated

Box-and-Whiskers plots showing the distribution of data for concentrations (in ng/g fresh weight) of PCBs in selected species from the Mediterranean Sea



(DS=Diplodus sargus, LM=Lithognathus mormyrus, MB=Mullus barbatus, MG=Mytilus galloprovincialis, PK=Penaeus kerathurus, PL=Parapenaeus longirostris, SP=Sardina pilchardus, TT=Thunnus thynnus)

Source: MED POL database

hydrocarbons exist. Generally DDT concentrations are low in open sea sediments but high values were reported from the Rhône delta. These were considered extremely high and are comparable to values obtained in heavily polluted locations.

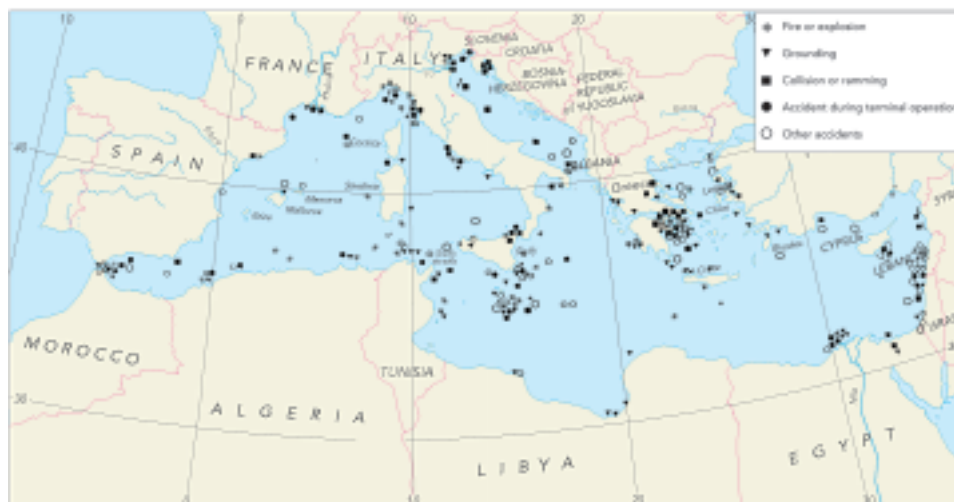
Maximum values reported for DDT and PCB concentrations are generally much lower than the permissible limits for seafood consumption (WHO/UNEP, 1995). Most of these chemicals are no longer used in Mediterranean countries.

Oil pollution

Oil spills float and drift. Up to now, accidental oil spills have caused localised damage to the Mediterranean marine and coastal environment. Out of 268 accidents listed by REMPEC for the 1977-1995 period, more than three-quarters involved oil. The number of accidents is increasing in the Mediterranean Sea, with 81 events in recent five years (1991-1995) compared to 99 events in the previous ten years (1981-1990) (MAP/REMPEC, 1996). It should be stressed that a major oil spill could occur at any time in any part of the Mediterranean, particularly along the major sea routes and in or around the more important oil loading and unloading terminals, particularly as several ageing tankers are operating in the Mediterranean waters.

Between 1987 and the end of 1996 an estimated 22 223 tonnes of oil entered the Mediterranean Sea as the result of shipping incidents. The figures for individual years vary between 12 tonnes reported in 1995 and approximately 13 000 tonnes in 1991. Taking into consideration that an estimated amount of more than 360 million tonnes of oil are transported annually in the Mediterranean (in transboundary trade), the quantities spilled as a result of accidents appear to be low.

Locations of 268 reported alerts and oil pollution accidents in the Mediterranean region between 1977 and 1995



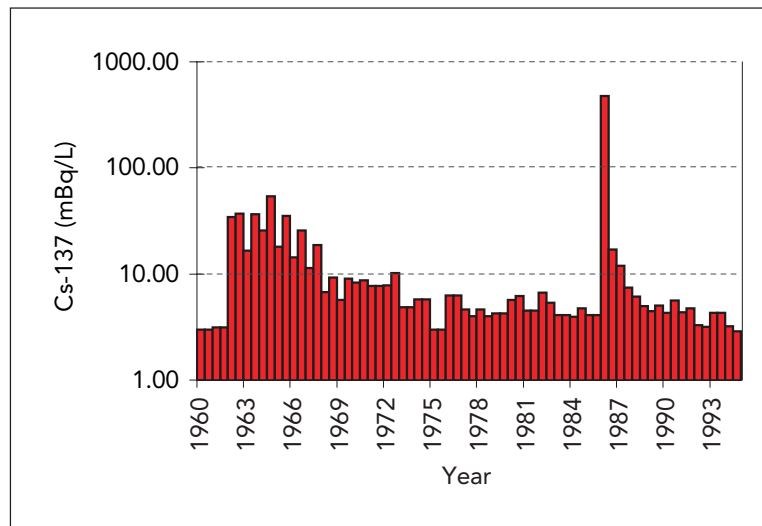
Source: RAC/REMPEC, 1996

Generally, marine life at basin scale has not been affected by oil pollution. Of course localised incidents have sometimes had adverse effects on the benthic communities. In addition clean-up procedures such as the use of chemical dispersants can also damage the marine environment. In the open sea, the response of the authorities to an oil spill has to be very rapid to prevent the oil from reaching the coastline. It is practically impossible to avoid oil pollution of the coast. The time taken for oil-damaged populations of marine life to recover is highly variable and the extent to which the biological recovery of a habitat can be accelerated is severely limited.

Radioactive contamination

LRadioactive contamination appears not to be a problem in the Mediterranean Sea. The major source of anthropogenic radionuclides is fallout from past nuclear weapon testing and from the Chernobyl accident.

¹³⁷Cs concentration in surface sea water of the Tyrrhenian Sea (1960-1995)



Sources: Giorelli & Cigna, 1975; ENEA, 1975-1992; ANPA, 1992-1995; ENEA, 1978-95

Overall, the total inventory of radionuclides in the Mediterranean Sea is declining. In surface waters the levels

of ^{137}Cs (Caesium) and $^{239,240}\text{Pu}$ (Plutonium) show decreasing trends. In marine organisms used for human consumption, ^{137}Cs concentration is very low (less than 1 Bq/kg), far below the limit (600 Bq/kg) fixed by the EU as the maximum permitted level in food

Nuclear facilities in the Mediterranean basin are mainly located along rivers and their effluents are subjected to riverine geochemical processes that delay, to a considerable extent, output to the sea. The contribution from these installations into the sea is low and limited to confined areas which are regularly monitored by national authorities.

Climate change

Assessment of potential impacts of climate changes in the Mediterranean region, based on several case studies were carried out by UNEP/MAP and include drought, floods, changed soil erosion and desertification processes, storms, coastal erosion, seawater temperature and salinity currents together with sealevel rise and biodiversity reduction. Recent paleoclimatic data collected in geologically stable areas, combined with archaeological or historical evidence, indicate that sea level increase for the next century (2100) could be limited within 30 cm, taking into account the pace of anthropogenic enhancement of sealevel rise. This scenario is compatible with the lower limits range indicated by IPCC.

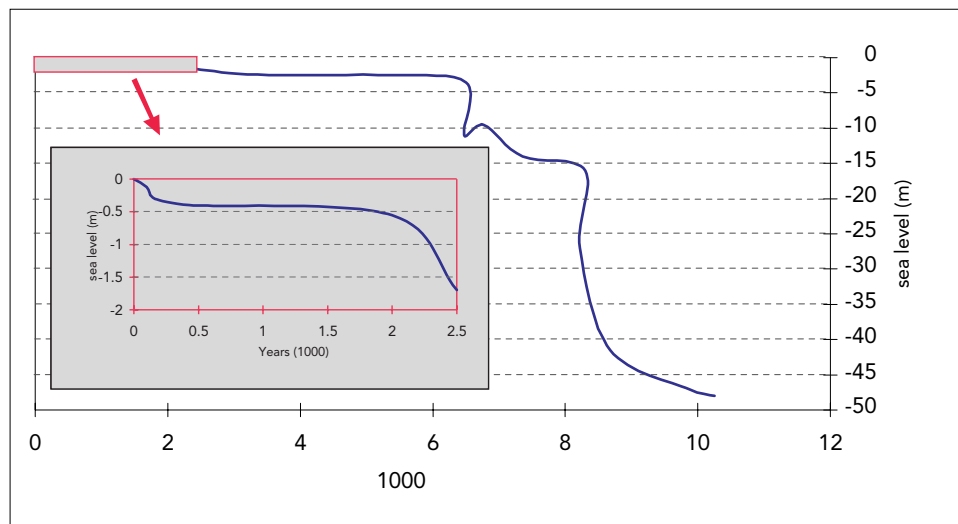
Although the physical impact of climate changes can be better predicted, with the constant improvement of the accuracy of models, data obtained on the Mediterranean spatial scale are still somewhat unreliable for the assessment and solution of practical problems. It is also more difficult to estimate the impact of such physical changes on the future socio-economic framework of the threatened areas and countries, especially if considered in conjunction with other threats posed by human activity.

Major potential impacts identified in the UNEP/MAP studies

Delta of Ebro, Spain	increased coastal erosion; reshaping of coastline; loss and flooding of wetlands; reduced fisheries yield
Delta of Rhône, France	erosion of unstable or threatened parts of coastline; reduction of wetlands and agricultural land; increased impact of waves; increased salinisation of coastal lakes; destabilisation of dunes; intensified tourism
Delta of Po, Italy	increased flooding and high-water events; increased coastal erosion; retreat of dunes; damage to coastal infrastructure; salinisation of soils; alteration to seasonal water discharge regimes; reduced near-shore water mixing and primary production; increased bottom water anoxia
Delta of Nile, Egypt	increased coastal erosion; overtopping of coastal defences and increased flooding; damage to port and city infrastructure; retreat of barrier dunes; decreased soil moisture; increased soil and lagoon water salinity; decreased fisheries production
Ichkeul-Bizerte, Tunisia	increased evapotranspiration leading to decreased soil moisture, reduced lake fertility and enhanced salinity; increased salinity of the lakes and shift to marine fish fauna; reduced extent of wetlands and loss of waterfowl habitat
Thermaikos Gulf, Greece	inundation of coastal lowlands; saline water penetration in rivers; drowning of marshland; increased sea water stratification and bottom anoxia; decreased river run-off; salinization of ground water; decreased soil fertility; damage to coastal protective structures; extension of tourist season
Island of Rhodes, Greece	increased coastal erosion; salinisation of aquifers; increased soil erosion
Maltese Islands, Malta	salinisation of aquifers; increased soil erosion; loss of fresh-water habitats; increased risk for human health, livestock and crops from pathogens and pests
Kaštela Bay, Croatia	inundation of Pantana spring and Zrnovica estuary; increased salinization of estuaries and groundwater; negative impact on coastal services and infrastructure; accelerated deterioration of historic buildings; increase in domestic, industrial and agricultural water requirements
Syrian coast	increased soil erosion; modification of vegetation cover due to increased aridity; increased salinisation of aquifers; erosion of beaches and damage to coastal structures and human settlements due to exceptional storm surges
Cres-Lolinj, Croatia	increased salinisation of lake Vrana; extension of tourist season; increased risk from forest fires
Albanian coast, Albania	salinisation of coastal aquifers and shortage of adequate quality of drinking water; soil erosion (physical); extension of summer drought; extension of tourist season
Fuka-Matrouh, Egypt	increased evapotranspiration and decreased rainfall; extension of summer aridity; increased coastal erosion; flooding in eastern part; decreased soil fertility
Sfax coastal area, Tunisia	salinisation of ground water; increased rainfall; possible flooding

Source: UNEP/MAP

Sea-level rise in the Mediterranean region over the past 10 000 years



Source: Pirazzoli, 1991, Antonioli et al., in press

Biodiversity and ecosystem changes

Mediterranean marine fauna and flora provide a rich diversity of species which represent 8-9 % of world seas species richness (4-18 % according to the group of species considered e.g. mollusc, echinoderms, crustaceans etc).

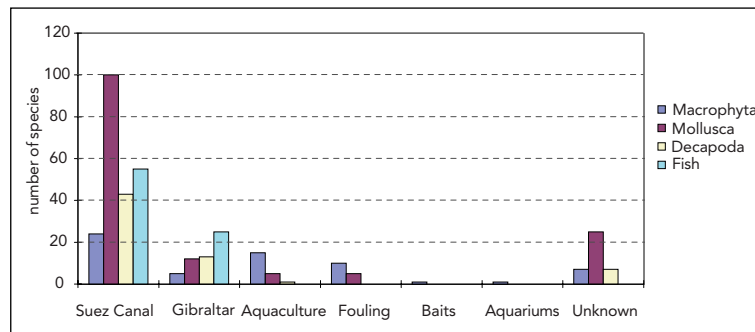
The Mediterranean marine ecosystem is a high-diversity ecosystem. As such, it is highly vulnerable to environmental perturbation and the impact of pressures is expected to be more significant. Such perturbations in marine and coastal environment include pollution, over-exploitation of marine living resources, habitat erosion, climatic changes (e.g. through the greenhouse effect), introduction of non-indigenous species and other human activities leading to environmental degradation.

Mediterranean fisheries resources are in a state of over-exploitation driven by rising prices and demand in the past decades. Over-fishing and fishing practices largely account for

the impact on natural stocks and habitats:

- demersal fish stocks (close to the sea bottom) are usually fully exploited, if not over-exploited, with a general trend towards smaller individual sizes;
- small pelagic fish stocks are highly variable in abundance (depending on environmental conditions) and probably not fully exploited except perhaps, for the anchovy resources;
- large pelagic fish stocks (tuna and swordfish) are overexploited also by international industrial fleets, especially the red tuna for which the Mediterranean is an important spawning area;
- habitats of high biological significance, such as the *Posidonia oceanica* meadows, are frequently destroyed by trawl-nets operating close to the shore.

Example of introduction routes for non-indigenous species in the Mediterranean Sea

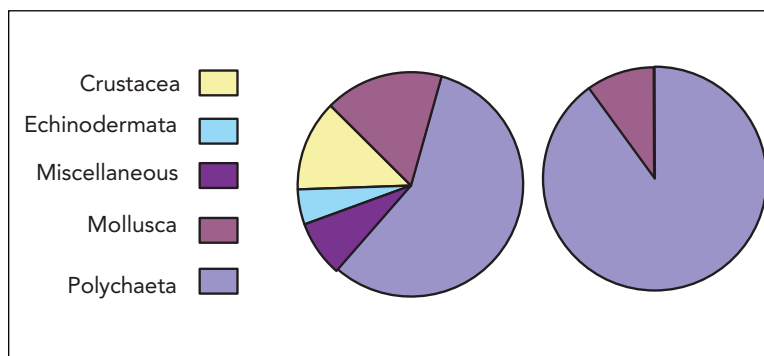


Sources: ETC/MCE compilation based on: Ribera & Boudouresque, 1995; National Centre for Marine Research, Greece data; CIESM 1999a; CIESM 1999b

Introduction of non-indigenous species is not a recent phenomenon in the Mediterranean Sea. A massive introduction of tropical species to the Red Sea was observed after the construction of the Suez Canal in 1869 (Lessepsian migration called after the famous Canal engineer Ferdinand de Lesseps). Other species are also being imported through transportation or intentionally through aquaculture practice.

Reduction of habitats caused by anthropogenic pressures, coastal land development and coastal eutrophication, impacting directly on productivity but also on nursery grounds, leads to a reduction in biodiversity and ecosystem changes. No general effects of species disappearance have been ascertained for the Mediterranean Sea. Nevertheless, changes in species composition and richness have been detected for some seas in the Mediterranean Sea. Habitat loss or reduction that potentially could lead to extinction has been reported for species which are considered endangered such as Monk seal and other marine mammals, red coral, sea turtles and colonial water birds.

Composition of Benthic communities in an undisturbed (left pie) and in a polluted area (right pie).



Source: Stergiou et al., 1997

List of endangered or threatened marine and freshwater species in the Mediterranean. (Annex II of the Protocol concerning Specially Protected areas and Biological Diversity in the Mediterranean Sea adopted in the Barcelona Convention in 1996; revised in the Bern Convention, 1998)

Magnolophyta	<i>Ophidiaster ophidianus</i>	<i>Mobula mobula</i>
<i>Posidonia oceanica</i>	Bryozoa	<i>Pomatoschistus canestrinii</i>
<i>Zostera marina</i>	<i>Hornera lichenoides</i>	<i>Pomatoschistus tortonesei</i>
<i>Zostera noltii</i>	Crustacea	<i>Valencia hispanica</i>
Chlorophyta	<i>Ocyrode cursor</i>	<i>Valencia letourneuxi</i>
<i>Caulerpa ollivieri</i>	<i>Pachylasma giganteum</i>	Reptiles
Phaeophyta	Mollusca	<i>Caretta caretta</i>
<i>Cystoseira amentacea</i>	<i>Charonia lampas lampas</i>	<i>Chelonia mydas</i>
<i>Cystoseira mediterranea</i>	<i>Charonia tritonis variegata</i>	<i>Dermochelys coriacea</i>
<i>Cystoseira sedoides</i>	<i>Dendropoma petraeum</i>	<i>Eretmochelys imbricata</i>
<i>Cystoseira spinosa</i>	<i>Erosaria spurca</i>	<i>Lepidochelys kempii</i>
<i>Cystoseira zosteroides</i>	<i>Gibbula nivosa</i>	<i>Trionyx triunguis</i>
<i>Laminaria rodriguezii</i>	<i>Lithophaga lithophaga</i>	Mammalia
Rhodophyta	<i>Luria lurida</i>	<i>Balaenoptera acutorostrata</i>
<i>Goniolithon byssoides</i>	<i>Mitra zonata</i>	<i>Balaenoptera borealis</i>
<i>Lithophyllum lichenoides</i>	<i>Patella ferruginea</i>	<i>Balaenoptera physalus</i>
<i>Ptilophora mediterranea</i>	<i>Patella nigra</i>	<i>Delphinus delphis</i>
<i>Schimmelmannia schoubsboei</i>	<i>Pholas dactylus</i>	<i>Eubalaena glacialis</i>
Porifera	<i>Pinna nobilis</i>	<i>Globicephala melas</i>
<i>Asbestopluma hypogea</i>	<i>Pinna rudis</i>	<i>Grampus griseus</i>
<i>Aplysina cavernicola</i>	<i>Ranella olearia</i>	<i>Kogia simus</i>
<i>Axinella cannabina</i>	<i>Schilderia achatidea</i>	<i>Megaptera novaeangliae</i>
<i>Axinella polypoides</i>	<i>Tonna galea</i>	<i>Mesoplodon densirostris</i>
<i>Geodia cydonium</i>	<i>Zonaria pyrum</i>	<i>Monachus monachus</i>
<i>Ircinia foetida</i>	Pisces	<i>Orcinus orca</i>
<i>Ircinia pipetta</i>	<i>Acipenser naccarii</i>	<i>Phocoena phocoena</i>
<i>Petrobiona massiliana</i>	<i>Acipenser sturio</i>	<i>Physeter macrocephalus</i>
<i>Tethya sp. plur.</i>	<i>Aphanius fasciatus</i>	<i>Pseudorca crassidens</i>
Cnidaria	<i>Aphanius iberus</i>	<i>Stenella coeruleoalba</i>
<i>Astroides calycularis</i>	<i>Carcharodon carcharias</i>	<i>Steno bredanensis</i>
<i>Errina aspera</i>	<i>Cetorhinus maximus</i>	<i>Tursiops truncatus</i>
<i>Gerardia savaglia</i>	<i>Hippocampus hippocampus</i>	<i>Ziphius cavirostris</i>
Echinodermata	<i>Hippocampus ramulosus</i>	
<i>Asterina pancerii</i>	<i>Huso huso</i>	
<i>Centrostephanus longispinus</i>	<i>Lethenteron zanandreae</i>	

Responses

The Mediterranean Action Plan

In 1975, the Mediterranean countries and the EEC adopted the Mediterranean Action Plan (MAP) and in 1976 the Convention for the Protection of the Mediterranean Sea against Pollution (Barcelona Convention). The Convention envisages the preparation of technical protocols.

The main objectives of MAP were to assist the Mediterranean governments to assess and control marine pollution, to formulate their national environment policies, to improve the ability of governments to identify better options for alternative patterns of development and to make better rational choices for allocation of resources. The MED POL programme, major component of MAP, played a leading role in upgrading the technical capabilities of most Mediterranean countries (1975-1981). In its second phase it developed and maintained national monitoring programmes in the region.

A large number of concrete actions were taken by several countries in conformity with the requirements and provisions of MAP, thus influencing the environmental policies and practices of the Mediterranean countries.

In 1995 a new phase of MAP was approved, and was renamed 'Action Plan for the Protection of the Marine Environment and the Sustainable Development of the Coastal Areas of the Mediterranean'. This second phase was designed taking into account the achievements and shortcomings of MAP's first twenty years of existence, as well as the results of recent developments such as the United Nations Conference on Environment and Development (Rio de Janeiro, 1992).

In the meantime, MED POL has entered its third phase shifting emphasis from pollution assessment to pollution control by means of action plans, programmes and measures for the prevention and control of pollution, for the mitigation of impacts and for the restoration of systems already damaged by pollution.

Barcelona Convention and its Protocols

Title into force	Adopted	Entered	Amended	New Title
Barcelona Convention				
Convention for the Protection of the Mediterranean Sea Against Pollution	Barcelona, Spain, 16.2.1976	12.2.1978	Barcelona, Spain, 9-10.6.1995	Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean
1 Dumping Protocol				
Protocol for the Prevention of Pollution of the Mediterranean Sea by Dumping from Ships and Aircraft	Barcelona, Spain, 16.2.1976	12.2.1978	Barcelona, Spain, 9-10.6.1995	Protocol for the Prevention and Elimination of Pollution of the Mediterranean Sea by Dumping from Ships and Aircraft or Incineration at Sea
2 Emergency Protocol				
Protocol Concerning Cooperation in Combating Pollution of the Mediterranean Sea by Oil and other Harmful Substances in Cases of Emergency	Barcelona, Spain, 16.2.1976	12.2.1978		
3 Land-Based Sources (LBS) Protocol				
Protocol for the Protection of the Mediterranean Sea against Pollution from Land-Based Sources	Athens, Greece, 17.5.1980	17.6.1983	Syracusa, Italy, 6-7.3.1996	Protocol for the Protection of the Mediterranean Sea against Pollution from Land-based Sources and Activities
4 Protocol Concerning Specially Protected Areas				
Protocol Concerning Mediterranean Specially Protected Areas	Geneva, Switzerland 3.4.1982	23.3.1986	Barcelona, Spain, 9 - 10.6.1995 The new Protocol includes Annexes which were adopted in Monaco, on 24.11.1996	Protocol Concerning Specially Protected Areas and Biological Diversity in the Mediterranean
5 Offshore Protocol				
Protocol for the Protection of the Mediterranean Sea against Pollution Resulting from Exploration and Exploitation of the Continental Shelf and the Seabed and its Subsoil	Madrid, Spain, 14.10.1994		in progress of ratification	
6 Hazardous Wastes Protocol				
	Izmir, Turkey, 1.10.1996		in progress of ratification	

Source: UNEP/MAP

EU programmes

There are several EU and international programmes and projects which deal with one or more aspects of the environment in the Mediterranean. Furthermore, a good share of other EU programmes which cannot be classified strictly as environmental programmes, falling under 'regional development' trans-national co-operation; telecommunication, etc, also have some important environmental component. These arise also from the incorporation of environmental concerns in sectoral policies and planning as requested by the consolidated EU treaty (The Amsterdam Treaty). However, information on environmental programmes, funding and projects within the EU is fragmented, the environment being a transversal issue which is dealt with by several Commission Directorates General (DGs).

The following list of the EU programmes is not complete but it is worth mentioning some of the projects that have an impact on the information, knowledge and actions of the Mediterranean marine and coastal environment:

1. The **MEDA** programme, is part of the creation of a Euro-Mediterranean free-trade zone and has stressed the need for continuing cooperation in the sectors of energy policy, environment, water policy, maritime transport, agriculture, reducing food dependency, developing regional infrastructure, and the transfer of technology.
2. The Short and Medium-term Priority Environmental Action Programme (**SMAP**) is a framework programme of action for the protection of the Mediterranean environment, within the context of the Euro-Mediterranean Partnership.
3. **LIFE Third Countries**, includes 15 Mediterranean countries and provides, inter alia, funds for technical assistance in the establishment of environmental administrative structures.
4. DG Marine Science and Technology (**MAST**) Programme, especially under the two Mediterranean Targeted Projects (MTP 1 and MTP 2-MATER) and **MEDATLAS**. MTP 1 and 2 represent a major effort in the understanding of the Mediterranean Sea today (both western and eastern basins).

5. Environment and Climate Programmes with major focus on European Land-Ocean Interaction Studies (**ELOISE**).
6. The **AVICENNE** programme, covering areas of action such as organic and inorganic pollutants and their effects on the environment (cooperation with the Maghreb and the countries of the Mediterranean basin).
7. The **FAIR** programme had the aims of promoting and harmonising research in the major European primary food and non-food sectors including agriculture, forestry, fisheries and aquaculture.
8. **RECITE** and **ECOS OUVERTURE** programmes, stimulating inter-regional cooperation among EU member states and third countries in the Mediterranean basin on topics which are relevant at regional level.
9. **INTERREG** funds actions and studies for transnational strategies, identification of environmentally sensitive areas, actions to improve the territorial management of the marine areas at the periphery of the European Union, based on both economic development and environmental protection and improvement (e.g. integrated coastal development, prevention and control of sea pollution, and environmental protection).
10. **TERRA** programme within the framework of Article 10 of the European Regional Development Fund (ERDF) Regulation.
11. A concurrent growing quest at local level for management tools capable of jointly tackling local environmental problems and social and economic growth, has spurred the launch by the EU Commission of a specific Demonstration Programme for Integrated Coastal Zone Management (**ICZM Demonstration Programme**) with the close co-operation of three Directorates: DG Environment, DG Fisheries and DG Regional policies, and with the participation of DG Research, the JRC (Joint Research Centre) and EEA.

Many regional programmes have also been launched in co-operation with other multilateral organisations or international NGOs which are active in the region.

In November 1997 a meeting of environmental ministers held in Helsinki identified desertification and integrated coastal zone management as environmental priorities in the Mediterranean, together with the conservation and sustainable use of biodiversity as a 'horizontal' environmental issue.

Conclusions and recommendations

State of the Mediterranean Sea

The state of the open waters in the Mediterranean Sea, based on the available information presented and assessed in this report, is considered to be generally good. In coastal areas, the presence of pollution hot spots, located generally in semi-enclosed gulfs and bays near important harbours, big cities and industrial areas, is probably the major problem of the Mediterranean Sea. Waters in the open sea are classified among the poorest in nutrients of the world ocean; marine ecosystems still seem to function well and the Mediterranean Sea is characterised by a high diversity of marine species. Nevertheless, in several cases, natural peculiarities (e.g. seawater movement and circulation patterns) determine the state of the Mediterranean Sea and, together with pressures deriving from coastal anthropogenic activities, create hot spots which pose adverse local environmental impacts and could be persistent.

In contrast to relatively favourable conditions of the Mediterranean Sea itself, only a small percentage of its coastal zone is still in pristine condition, of which an even smaller proportion is protected. This report shows that the current threats (e.g. localised eutrophication, heavy metals, organic and microbial pollution, oil spills, introduction of non-indigenous species) are mainly the results of pressures from anthropogenic activities and hence more attention to their management and control is needed.

Land-based activities (urbanisation, industry and agriculture) represent the main source of pollution into the Mediterranean Sea, although many uncertainties remain regarding their respective contribution, the different fluxes (rivers, atmosphere, non-point sources, etc.) and the fate of the contaminants they generate. In the case of urban and industrial pollution, the main problem is the rapid population growth along the southern coasts of the Mediterranean, where there are fewer legal instruments and lesser environmental infrastructure investments.

The pressure from tourism, especially in the northern

Mediterranean countries, is one of the problems that have to be managed effectively to avoid any further degradation of the marine and coastal environment.

Recommended measures

The report also identifies several major issues, which need to be addressed to ensure higher environmental quality and better integrated information from the region:

1. **Climate change:** Multi-disciplinary research is still needed to assess the major environmental and socio-economic problems that may follow from accelerated sea level rise, erosion and desertification, floods and other threats that originate from climate change, and to distinguish natural fluctuations from the effects of anthropogenic activities.
2. **Biodiversity:** The creation of marine parks and protected areas for conservation purposes is often not sufficient as an impact-control measure, since many of the impacts derive from pressures that are not locally originated. Mediterranean wilderness and important habitats need to be protected as the Mediterranean Sea is recognised as one of the richest biotopes in the world with about 6 % of the global total of higher species. Protection of the wilderness and habitats of the Mediterranean Sea requires integrated environmental management. As the coasts are heavily populated and co-ordinated action plans for environmental management are still lacking in most places, there is a threat that the number of important habitats will decline and impacts on biodiversity will become more evident.

The following actions should be considered in order to further protect the ecosystem balance:

- Develop national and Mediterranean-wide co-ordinated plans for environmental management and infrastructure development, with specific attention to the coastal zones;

- introduce effective measures for environmental protection from threats arising from sea transport, coastal works and sea exploitation activities;
 - promote the implementation of the provisions of the (CBD) Convention for Conservation of Biological Diversity and of the Mediterranean protocol on specially protected areas and biodiversity at national level in the Mediterranean, including the development of national strategies for the conservation of biodiversity, adopting the biogeographic regional approach suggested by technical bodies of the CBD;
 - promote the implementation of the existing action plans for the protection of the threatened species in the Mediterranean;
 - increase protection of the remnants of pristine areas.
3. **Sewage discharges:** Sewage treatment plants are still missing from urban areas along the coasts and about 60 % of urban waste disposed in the Mediterranean Sea is still untreated. Based on the existing information, sewage should be discharged after advanced treatment in adequately designed treatment plants. The technology is available and reasonably cheap. As analysed convincingly by several studies, the health costs and other economic losses, especially in tourist areas due to contamination of coastal waters, is much higher than the investment necessary for achieving an acceptable sewage effluent quality.
4. **Agriculture practices:** In most Mediterranean countries, all types of agricultural practices and land use are treated as non-point sources of water pollution. It is very difficult to estimate the input from these diffused sources into the Mediterranean Sea quantitatively. Countries should adopt a holistic approach to water resource management, based on the integrated assessment of water quality and ecosystem health, from the coastal waters to the entire catchment area.
5. **Fisheries:** Control of fishing effort is an urgent priority identified by the General Fisheries Council for the Mediterranean (GFCM); although one must not forget that coastal fisheries by small scale boats play an

important social and economic role along the Mediterranean coast.

6. **Marine aquaculture:** Careful selection of sites, with precise definition of their carrying capacity, needs to be regulated and enforced. Open sea practices should be further developed to avoid adverse coastal impacts.
7. **Oil pollution:** Oil reception facilities should be recommended for all big ports along the basin. The areas around straits and ports already appear to be top priorities for planning and protection.
8. **Coastal zones:** An integrated approach to coastal zone management and physical planning are still missing. Decisions and management of the coastal zones should be made at regional, national and local level, taking into account the driving forces and pressures of the human activities including tourism in order to integrate environmental protection into economic development. Integrated coastal zone management can be a success story only if the experience and expertise are maximised and the allocation of budgets to projects which take into account the holistic environmental dimension is enhanced. Organisational and legal instruments - including market-based instruments - should be developed to control and manage coastal development, land reclamation and groundwater exploitation.

Improvement of data availability

One of the major concerns identified in the report which emerges from the different issues dealt with in individual chapters is the scarcity or unavailability of comparable and, in some cases, reliable data for the Mediterranean basin as a whole. For the assessment of the state and pressures of the marine and coastal Mediterranean environment, the following missing elements in information have been identified:

1. **Coastal erosion:** Information – and access to existing information for its compilation at the regional level – is not available throughout the basin. Dispersal of the data among different administrative bodies, lack of knowledge

of the existing inventories, data contained in reports considered confidential (or accessible only through long and hard administrative procedures) make the problem worse. Uncertainties about the evolution of numerous coastal segments still exist in cartographic atlases. The coastal evolution trends are thus often considered on the basis of expert judgements in the absence of studies or preliminary measurements.

2. **Contaminants:** Although a large effort has been made through the MED POL programme, there is still a scarcity of data from some regions. The monitoring capabilities of some Mediterranean countries have to be improved.
3. **Oil pollution:** Attention should be given at the planning stage to identifying areas that need protection, their order of priority and the techniques to be used.
4. **Microbial pollution:** The problems of the effects of microbial pollution in the Mediterranean coastal zone persist and are mainly related to urban waste water. Further research and data on virus contamination is required on a basin scale. The geographical imbalance of data is more acute. Intake of pathogenic micro-organisms causing damage to health on a Mediterranean-wide basis still has to be determined. Furthermore, there are still large stretches of the Mediterranean coastal zone, mainly in the southern and eastern parts, for which records are very sparse.
5. **Sewage discharges:** There is a need for further data and information on water quality and the operation of sewage treatment plants to be available.
6. **Radionuclides:** Information on radionuclide distribution is missing from some areas of the Mediterranean Sea, particularly from the eastern and southern basins; background data should be established in these areas.
7. **Fisheries:** Knowledge of Mediterranean fisheries needs to be improved. This will to a large extent depend on the quality of statistics, which is still one of the main weaknesses in dealing with real amounts of catches for the different species, as well as the structure and capacity of the different types of fishing fleets.

8. **Biodiversity:** A specific inter-Mediterranean approach to the monitoring of marine biodiversity - and the identification of important risks threatening the present state - is still missing. In order to avoid biodiversity reduction special attention is essential in species introductions and habitat loss. Research on processes related to ecosystem changes and rehabilitation of degraded coastal ecosystems is also required.

The information collected by the countries around the Mediterranean Sea is not easily accessible as it is scattered in various departments and institutions and in many cases it is not available in electronic form. It is vital that this information is centrally gathered in electronic form in a national database, as for example the exercise with the National Oceanographic Data Centres (NODC), so that it can be utilised easily by decision makers in the administration and by other partners.

EEA, ETC/MCE and MAP could help establish the databases by giving guidance at the relevant technical level in the Mediterranean countries following the standard procedures that were adopted at basin level under the MEDPOL programme and making use of the experience and involvement in this field of the European Information and Observation Network (EIONET), co-ordinated by EEA.

Mediterranean monitoring

Development of an effective, common Mediterranean monitoring system of measurements of contaminants and their effects is still missing, although monitoring in the Mediterranean has been in place for a long time (for example, the MED POL programme initiated monitoring activities in 1975). Unfortunately, this monitoring has not been very effective and data is often unavailable. However, the plan of data gathering from Mediterranean Countries has not been consistent and large data gaps can be identified both temporally and geographically. Effective monitoring would include the following elements:

- Information useful for the protection of human health, e.g. levels of contaminants in seafood, microbial quality of bathing and shellfish growing waters, and algal toxins;

- information useful for the assessment of the effectiveness of pollution control and abatement measures taken (trends);
- support for implementation of the protocol of the Barcelona Convention in order to contribute to the reduction of pollution from land-based sources, especially the hot-spots;
- information useful for coastal zone management;
- an early warning system (bio-markers). Research would probably be needed in order to identify sources of pollution (e.g. non-point sources in agriculture) and biological effects of long-range pollutants.

Quality assurance and control procedures should be further developed and implemented to ensure data quality and reliability. Allocated resources should increase to enable a continuous flow of high quality data. An assistance component should be developed which could include training and establishment of contacts with more advanced laboratories (sister approach). The latter could be further developed through training and inter-calibration exercises between laboratories.

Future action could include the facilitation and coordination of responses to transboundary issues and problems. International cooperation between EU and non-EU countries, European Community bodies (CEC, EEA) and Mediterranean Institutions (MAP, CIESM, GFCM) should be further strengthened. Full implementation of the Barcelona Convention and its six protocols should be promoted at national level. Existing agreements, programmes and other cooperative efforts should be further developed to achieve maximum results and avoid duplication, while moves towards sustainable development should be reinforced at regional level. Action is needed at all policy levels; international cooperation, which should involve European Community bodies, should therefore play a fundamental role in the field of policy, research and information gathering through adequate resources directed to activities in the region.