STATE OF THE MEDITERRANEAN MARINE AND COASTAL ENVIRONMENT

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CONTENTS

Foreword 7
Preface 9
Summary for Policy Makers 11

PART 1
Introduction to the Mediterranean Basin 15

The Ecosystem Approach to the Management of Human Activities 17
The Mediterranean Basin and its Waters 19
The Human Mediterranean Basin 26

PART 2
Human Pressure, State and Impacts on Mediterranean Ecosystems 37

Coastal Ecosystems and Landscapes 39
Pollution 41
Eutrophication 51
Marine Litter 54
Marine Noise 55
Non-indigenous Species 56
Commercially Exploited Fish and Shellfish 58
Sea-floor Integrity 61
Hydrographic Conditions 62
Marine Food Webs 63
Biodiversity 64
Cumulative and Concurrent Impacts 68

PART 3
Regulatory Framework, Major Findings and Gaps and Next Steps in the Ecosystem Approach 71

Regional and Global Governance and Regulatory Instruments 73
Major Findings on the Pressures and State of the Mediterranean Sea Environment 84
Gap Analysis 85
Next Steps in the Application of the Ecosystem Approach 86

Annex: List of endangered or threatened species 88
References 90

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Foreword

The Mediterranean Action Plan (MAP) was established in 1975 as a coherent legal and institutional framework for cooperation through which all Mediterranean countries decided to jointly address common challenges of environmental degradation while linking sustainable resource management with development. It was soon followed by the Barcelona Convention and seven Protocols addressing issues relevant to the conservation and sustainable use of marine and coastal resources as well as to many policies and measures aiming to improve its management.

Information is key to the UNEP/MAP-Barcelona Convention which is first and foremost a governance framework. It acts as a catalyst facilitating cooperation and decision-making in the Mediterranean region. As it is well-known, availability and accessibility to relevant information is a precondition for sound policy-making and good governance.

Actions towards generating information on a more systematic basis followed the first Rio Conference 20 years ago. The Mediterranean countries decided to strengthen their reporting of information on environmental trends, a necessary feedback to improve the effectiveness of measures undertaken. In 2008 the Contracting parties to the Convention went one step further mandating the UNEP/MAP-Barcelona Convention to prepare periodic State of the Environment reports.

This State of the Mediterranean Environment report sets a new course while building on our previous thematic reports. It provides information on the overall nature of the Mediterranean ecosystems and defines recurrent and new pressures – such as aquaculture and desalination – that affect the state of its environment. It also assesses the availability and quality of information and identifies knowledge gaps so as to provide guidance for scientific research and monitoring efforts undertaken by the Contracting Parties to the Barcelona Convention. Lastly, an important insight on vital services provided by marine and coastal ecosystems to their inhabitants is offered.

For the first time, the report is organised around the 11 Ecological Objectives agreed by the Contracting parties to the Barcelona Convention as a common strategy for the application of the Ecosystem Approach to the management of human activities. Biodiversity conservation, coastal dynamics, fisheries management, pollution reduction, marine litter and hydrography are now agreed and presented as part of an integrated analytical and implementation framework which will be periodically monitored and reviewed through a rigorous six year cycle.

By doing so, this report initiates the post Rio+20 in the UNEP/MAP-Barcelona Convention. It launches a process that addresses two main lessons outlined in the Fifth Global Environment Outlook (GEO-5) of UNEP launched at the Rio+20 Summit on Sustainable Development earlier this year. Namely, that international agreements are most successful when they tackle goals with specific targets on a reduced number of priority issues; and, that evidence-based policy-making requires more reliable data. Indeed, a striking finding from the report is the significant information gaps that still exist.

The knowledge and management agenda ahead of us is huge. I am confident, however, that over time we will be able to fulfill our ambition of building the body of knowledge and management necessary for understanding and more effectively addressing cumulative risks and effects. A necessity if we are to reach the good environmental status of our battered sea and coastal ecosystems.

The report is a collaborative effort comprising UNEP/MAP-Barcelona Convention components, parties and partners. Its main source of information is the Initial Integrated Assessment on the Ecosystems Approach which was peer-reviewed by GESAMP. The report was compiled by GRID/ARENDAL and independently reviewed by experts on a pro bono basis. The Secretariat is grateful to all contributors to this report and looks forward to feedback and comments that could further enrich future reports.

Maria Luisa Silva Mejias
Executive Secretary and Coordinator,
UNEP/MAP-Barcelona Convention

Preface

The Mediterranean Action Plan (MAP) is a cooperative initiative undertaken by countries bordering the Mediterranean Sea and the European Union. It was launched in 1975 when sixteen Mediterranean countries and the European Community completed the first version of the plan. The MAP was the first plan to become a Regional Seas Programme under the United Nations Environment Programme (UNEP).

The "Convention for the Protection of the Mediterranean Sea against Pollution" (Barcelona Convention) was adopted in 1976 by the Mediterranean coastal states and the European Community and came into force in 1978. The main objectives of the MAP were to assist the Mediterranean countries 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 optimise the choices for allocation of resources. Although the initial focus of the MAP was on marine pollution control, experience confirmed that socio-economic trends, combined with inadequate development planning and management, are at the root of most environmental problems. Consequently, the focus of the MAP gradually shifted to include integrated coastal zone planning and management, biodiversity preservation and sustainable development dimensions as the key tools through which solutions are being sought.

Twenty years later, the "Action Plan for the Protection of the Marine Environment and the Sustainable Development of the Coastal Areas of the Mediterranean" (MAP Phase II) was designed, taking into account the results of the first United Nations Conference on Environment and Development (UNCED), Rio 1992, as well as the achievements and shortcomings of the first MAP in the context of previous developments. At the same time, the Contracting Parties adopted an amended version of the Barcelona Convention, renamed the "Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean" in order to reflect the wider mandate. The amended version of the Barcelona Convention came into force in 2004. Seven Protocols addressing specific aspects of Mediterranean environmental protection and conservation complete the MAP legal framework.

Today 21 countries that border the Mediterranean Sea: Albania, Algeria, Bosnia and Herzegovina, Croatia, Cyprus, Egypt, France, Greece, Israel, Italy, Lebanon, Libya, Malta, Monaco, Montenegro, Morocco, Slovenia, Spain, Syria, Tunisia, and Turkey, as well as the European Union are Contracting Parties to the Barcelona Convention. The countries participating in the Plan are determined to work together to meet the challenges of environmental degradation in the sea and coastal areas and to link sustainable resource management with development in order to protect the Mediterranean region and contribute to an improved Mediterranean quality of life.

The MAP Coordinating Unit is the Secretariat for the Mediterranean Action Plan – Barcelona Convention. It performs diplomatic, political, and communication roles, supervising the main MAP components (MED POL – the marine pollution assessment and control component of MAP – and the six Regional Activity Centres), as well as coordinating major programmes.

Under Article 26 of the Barcelona Convention, the Contracting Parties commit to transmit to the Secretariat reports on legal, administrative, and other measures undertaken to implement the Barcelona Convention and its Protocols. They also commit to transmit reports on the effectiveness of these measures and the problems encountered. Additionally, the Contracting Parties agree, under Article 15, to provide public access to information on the State of the Environment in the field of application of the Barcelona Convention and its Protocols. Publication of a report on the State and Evolution of the Mediterranean Environment at regular intervals has been reaffirmed as a priority objective by the Contracting Parties to the Barcelona Convention. In addition, in 2008 the Contracting Parties to the Barcelona Convention asked the Secretariat to report periodically on the state of the environment.

This State of the Mediterranean Marine and Coastal Environment Report (SoMMCER) synthesises available knowledge about major drivers and pressures affecting the sea and its coastal inhabitants, the Mediterranean environment's condition, the current and prospective impacts of collective human activity, and emerging issues in coastal and marine management. The SoMMCER is intended to meet the needs of decision-makers for a regionally integrated synthesis at this critical time in the application of the Ecosystem Approach to the management of human activities in the Mediterranean (see the 2008 Decision IG.17/6 and the 2012 Decision IG.20/4). The Contracting Parties have made substantive progress in implementing the Ecosystem Approach roadmap that was adopted in 2008. The latest milestone achieved is the agreement of the Ecological Objectives for the Ecosystem Approach, which were adopted by the Meeting of the Contracting Parties in February 2012. The Ecological Objectives describe, for each of the major environmental issue identified, the desired results pursued by the application of the Ecosystem Approach to the management of human activities. This report features information that will support future directions in the continued application of the Ecosystem Approach.

The geographical scope of this report is the whole Mediterranean Sea including its coastal zones. The framework used for the assessment of the state of the environment is the Driver-Pressure-State-Impact-Response (DPSIR) framework and this is reflected in the organisation of the report:

- Part I provides background information about the Mediterranean Basin, an overview of the major drivers in the Mediterranean region and an introduction on the interrelation between Mediterranean ecosystems and human drivers.

- Part II provides an analysis of the pressures, state and known impacts associated with each of the issues addressed by the Ecosystem Approach Ecological Objectives.

- Part III analyses the responses in terms of policy instruments to the issues analysed in Part II, highlights the major findings on the state of the marine and coastal environment as well as the major information gaps, and discusses future avenues for the continued application of the Ecosystem Approach.

While information exists on the environmental and socio-economic impacts of human activities in the Mediterranean Sea and a suite of responses to these have already been implemented, the report places its focus mostly on the drivers, pressures, state and known impacts in order to clearly lay out the ground for the discussion on the next steps of the Ecosystem Approach. These next steps are: defining Good Ecological Status, setting targets, and developing an integrated monitoring programme, all of which will require thorough consideration of the impacts from human activities. These forthcoming steps will ultimately lead to the revision and development of action plans and programmes of measures, which will require further analysis of previous responses. Overall, this process will allow complete implementation of the DPSIR framework in future iterations of the SoMMCER.

The guidance and recommendations provided in the discussion of avenues for furthering the Ecosystem Approach focus on policies that will establish a systematic, comprehensive, holistic, and efficient monitoring regime. The objective of this monitoring regime is to provide a rigorous scientific basis for periodically determining the state of the Mediterranean environment, as well as environmental trends, in order to support science-based decision-making. It is this monitoring regime that will move the region fully towards an Ecosystem Approach and allow future recommendations flowing from State of the Environment reports to be oriented towards management.

The main information source on which this report is based is the *Initial Integrated Assessment of the Mediterranean Sea* (UNEP/MAP 2012), prepared as part of the implementation of the roadmap for the application of the Ecosystem Approach. The report was produced following a participatory approach involving all the Mediterranean countries. It was revised by country-designated experts, commented on by country officials, and peer reviewed by GESAMP (the Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection). Where information contained in the *Initial Integrated Assessment* was insufficient to illustrate the subjects included in this report, it was complemented with information from the UNEP/MAP *State of the Environment and Development in the Mediterranean Report 2009* (UNEP/MAP/BP/RAC 2009), the EEA-UNEP/MAP 2006 report *Priority Issues in the Mediterranean Environment* (EEA and UNEP 2006), the UNEP/MAP 2005 report *Transboundary Diagnostic Analysis for the Mediterranean Sea* (UNEP/MAP/MED POL 2005), and the EEA-UNEP/MAP 1999 report *State and Pressures of the Marine and Coastal Mediterranean Environment* (EEA and UNEP 1999) and peer-reviewed research publications. Prior reports on the state of marine and coastal environment in the Mediterranean were produced within the MAP system in 1996 and 1989 (UNEP/MAP/MED POL 1996 and UNEP/MAP/MED POL/WHO/FAO 1989).

Some of the topics covered in the report, such as pollution and biodiversity, have been a focus of research and monitoring for many years and a wealth of information is readily available. Less information is available for other topics, such as noise, marine litter, sea-floor integrity, and trophic levels and food webs. This has resulted in some chapters of the SoMMCER being fully supported by robust evidence while other chapters are by necessity more qualitative. This dichotomy provides clear evidence of the need for a more robust approach to deriving information to support the major issues outlined in the Ecosystem Approach Ecological Objectives. For some issues, the existing information base is adequate to support decisions for the next steps of the development of the Ecosystem Approach. For other identified major issues, information will need to be gathered through targeted monitoring programs to provide a scientific basis for decision-making.

The strategic approach followed in the preparation of the SoMMCER was to aim to bridge the reporting requirements of the Barcelona Convention and the intrinsic need for systematic compilation of information for the application of the Ecosystem Approach. The report aims to avoid duplication in reporting by the MAP Contracting Parties and to provide a robust template for future reports on the state of the Mediterranean marine and coastal environment.

Upon request by UNEP/MAP, the SoMMCER was produced by UNEP/GRID-Arendal in collaboration with Sound Seas. The authors received input, guidance, and review throughout the process from the UNEP/MAP Coordinating Unit and all of the components of the UNEP/MAP system, MED POL (The Mediterranean Pollution Assessment and Control Programme), REMPEC (Regional Marine Pollution Response Centre for the Mediterranean Sea), BP/RAC (Blue Plan Regional Activity Centre), PAP/RAC (Priority Actions Programme Regional Activity Centre), SPA/RAC (Specially Protected Areas Regional Activity Centre), INFO-RAC (Regional Activity Centre for Information and Communication), CP/RAC (Regional Activity Centre for Cleaner Production). The report was finally reviewed by several independent experts on a pro bono basis.

Summary for Policy Makers

Introduction

The Mediterranean Basin is one of the most highly valued seas in the world. The region comprises a vast set of coastal and marine ecosystems that deliver valuable benefits to all its coastal inhabitants, including brackish water lagoons, estuaries, or transitional areas; coastal plains; wetlands; rocky shores and nearshore coastal areas; sea grass meadows; coralligenous communities; frontal systems and upwellings; seamounts; and pelagic systems.

The Mediterranean is not only complex in ecology, but also sociopolitically – twenty-one countries border this heavily used sea. The Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean (Barcelona Convention) embodies international partnership to protect the sea, its coasts, and the uses and livelihoods that it supports. The Barcelona Convention provides a critical framework for setting environmental standards and targets that are agreed to by all the Contracting Parties, as well as for sharing important information for management. The Barcelona Convention's main objectives – to assess and control marine pollution; to ensure sustainable management of natural marine and coastal resources; to integrate the environment in social and economic development; to protect the marine environment and coastal zones through prevention and reduction of pollution, and, as far as possible, elimination of pollution, whether land or sea-based; to protect the natural and cultural heritage; to strengthen solidarity among Mediterranean Coastal States; and to contribute to the improvement of the quality of life – have spurred much progress. As Contracting Parties to the Barcelona Convention, the Mediterranean countries, together with the European Union, are determined to meet the continuing and emerging challenges of protecting the marine and coastal environment of the Mediterranean while boosting regional and national plans to achieve sustainable development.

Human impacts on the Mediterranean marine and coastal environment

In addition to being heavily used and highly valued, the Mediterranean Sea is one of the most thoroughly monitored and best studied ocean areas. The Barcelona Convention framework allows the coordinated collection of information on levels of key contaminants, through MED POL, while the Regional Activity Centre (RAC/SPA) in Tunis coordinates the collection of information on biodiversity. Other Regional Activity Centres track coastal development, and coastal and maritime industries. This information is disseminated in a variety of ways. State of the Environment Reports are prepared periodically by MAP. While earlier reports have touched upon the most critical issues affecting the Mediterranean environment, including fisheries, pollution, and coastal habitat loss, this State of the Environment report differs from its predecessors by attempting to systematically look at the full array of pressures that human activities have on the coastal and marine environment of the Mediterranean, and the attendant loss in ecosystem services that those impacts cause.

The state of the Mediterranean coastal and marine environment varies from place to place, but all parts of the Mediterranean are subject to multiple pressures acting simultaneously and in many cases chronically. The State of the Mediterranean Marine and Coastal Environment Report 2012 highlights the following as the major issues requiring coordinated policy and management responses in the coming years in order to stem the tide of degradation of the Mediterranean ecosystems.

- **Coastal development and sprawl**, driven by urban and touristic development, leading to fragmentation, degradation and loss of habitats and landscapes, including the destabilisation and erosion of the shoreline. Special attention should be paid to the degradation of transitional areas, including deltas, estuaries, and coastal lagoons, which serve as critical nursery areas for commercial fisheries and support unique assemblages of species but also to the broader coastal zone.

- **Chemical contamination** of sediments and biota caused by pollution from urbanisation, industry, anti-foulants, and atmospheric transport. Although environmental conditions are improving in regard to certain pollutants in many Mediterranean areas, thanks to improved control of land based pollution releases, contamination linked to hazardous substances remains a problem in many areas.

- **Eutrophication** caused by human-mediated input of nutrients into marine waters is a source of concern, especially in coastal areas near large rivers and/or cities. Impacts of eutrophication include algal blooms, some of them harmful, and hypoxia. The direct socioeconomic impacts are related to toxicity or mortality of harvested fish and shellfish, loss of aesthetic value of coastal ecosystems, and reduced water quality impacting tourism.

- The impact of **marine litter**, concentrated especially in bays and shallow areas, is increasingly regarded as a matter of concern across the Mediterranean.

- The impact of **marine noise** on biota, especially marine mammals and fish, requires targeted research. Intense maritime traffic, particularly in the Western Mediterranean, and intense offshore exploration and military activities in specific locations, suggest potentially serious impacts.

- **Invasive non-indigenous species** have increased in recent years, particularly in the easternmost reaches of the Mediterranean. Documented impacts on natural diversity include predation, alteration of the food web, niche competition, and modification of habitats, leading to a variety of impacts on fishing, aquaculture, shipping, human health, and tourism.

- **Over-exploitation** beyond sustainable limits affects many of the commercially exploited fish stocks of the Mediterranean. The result is changes in species diversity, with some species regarded as Endangered, Vulnerable or Near-Threatened. Over-exploitation also leads to changes in community structure, the food web, and, ultimately, ecological processes and the delivery of ecosystem services. Other pressures brought by the intense fishing activity in the Mediterranean include by

catch, non-selective fishing methods, and destructive fishing. Understanding how multiple pressures reduce sustainable limits of harvest is necessary for effective fisheries management, which is crucial in a part of the world where seafood is both culturally and economically vital. While touted as a means of reducing pressure on wild stocks, aquaculture has increased noticeably since the 1990s, adding new pressures. These include nutrient and organic matter pollution leading to eutrophication and eventual benthic anoxia, pollution through the release of antibiotics and biocides, and the introduction of non-indigenous species.

- **Sea-floor integrity** is affected mainly by bottom fishing, but also by dredging and offshore installations. Bottom fishing and dredging lead to the resuspension of sediment and organisms and to changes in the structure of benthic communities. The impact of offshore installations is not well researched.

- Changed **hydrographic conditions** caused by local disruption of circulation patterns by human-made structures, changes in freshwater fluxes to the sea, brine release from desalination plants, or climate change influence both nearshore and offshore areas. Changes in freshwater flows also affect sediment delivery to the coastal zone near river mouths, with impacts on coastline stability on key systems, such as dune-beach complexes.

- **Marine food webs** have been affected by fisheries pressures that led to the estimated reduction on average of one trophic level in the fisheries catches during the last half-century, increased jellyfish numbers, and reduced abundance of large predator species.

- Finally the state of **biodiversity** reflects the cumulative effects of the pressures affecting the Mediterranean coastal and marine environment. Although there is still high diversity in the Mediterranean, some species of reptiles, marine mammals, birds, and fish are reaching dangerously low abundance levels. The Mediterranean also hosts a diverse array of habitats of commercial, ecological, and cultural importance. Many are under a variety of pressures. Complicating the issue, many offshore areas, where upwellings develop and seamounts provide important habitat, are located beyond national jurisdiction.

This picture of multiple pressures acting simultaneously, and affecting different components of the Mediterranean marine and coastal environment, to undermine ecosystem health and resilience, and put certain species and habitats at high risk, is certainly complex. Future monitoring will allow for more robust and systematic analyses of precisely how these pressures and their impacts affect the Mediterranean as a whole, and the economies and well-being of coastal countries and communities. This information is more urgently needed than ever, as countries define top priorities for management with limited time and resources with which to implement plans. The Mediterranean continues to be a valuable, treasured region, yet one clearly under threat; the commitment of countries that border it remains the only hope that these coastal and marine ecosystems will thrive despite these growing pressures.

Response analysis and recommendations

As use of Mediterranean coastal and marine resources and space grows, the ability of these interconnected ecosystems to deliver goods and services is compromised. Yet there is every reason for hope, as individual countries have tackled marine issues admirably, and the region as a whole is moving towards a more effective and efficient Ecosystem Approach. Such an Ecosystem Approach recognizes the linkages between various habitats, and between the environment and the biota it supports, and the economies and human well-being of coastal communities. The Ecosystem Approach allows priorities for management to emerge, and at the same time, creates efficiency in addressing management and conservation needs.

Contracting Parties to the Barcelona Convention have committed to this Ecosystem Approach; they have dedicated time and resources, as well as data, to the effort to more systematically address threats, and the drivers behind those threats. Understanding of the myriad values that natural infrastructure and the Sea as a whole provide has helped raise awareness, and has made the push for more effective management ever more urgent.

At the moment the information on the human pressures and their impacts in the Mediterranean is unevenly distributed depending on the subject and also in terms of space and time. Yet it is indisputable that a regionally shared understanding of how human activities impact the Mediterranean coastal and marine environment, and how those impacts in turn affect industries, local livelihoods, and human well-being, is developing. More effective management responses at both the country level and through international cooperation can be expected to flow from coordinated monitoring and systematic understanding of these pressures, allowing for prioritisation of the many complicated management issues that require management responses. With this systematic and coordinated framework for prioritisation, the sectorial management responses will mitigate the most harmful impacts, leading to fulfilment of an effective Ecosystem Approach that safeguards the vital biodiversity and ecosystem services upon which Mediterranean countries depend.

The net cumulative impact of the myriad of pressures affecting different locations within the Mediterranean is difficult to accurately determine beyond modelling efforts based on expert judgement due to previous non-integrated monitoring that focuses on single species, sites, or sectors. This drives home the need for a systematic monitoring regime that will allow accurate assessments of the state of the Mediterranean coastal and marine environment. In addition to establishing a systematic monitoring regime to derive needed information on condition and trends, future research will have to elucidate cause-effect relationships, in order to support the establishment of management measures that lead to the desired outcomes.

The Ecosystem Approach provides an integrated and holistic framework to give a much-needed look at, for example, the influence that freshwater use in watersheds and land use in coastal areas, in relation to urbanisation, industrialisation, and increasing coastal tourism, has on coastal and marine ecosystem health, productivity, and the delivery of valuable ecosystem services.

The commitment of the Contracting Parties to an Ecosystem Approach signals the extent to which countries value the coastal and marine resources and environments of the Mediterranean. Tangible progress towards the vision of "A healthy Mediterranean with marine and coastal ecosystems that are productive and biologically diverse for the benefit of present and future

generations" is in evidence after the extensive work undertaken four decades in the framework of the Barcelona Convention, its Protocols and the Mediterranean Strategy for Sustainable Development. The major issues described above are the base for the Ecological Objectives of the Ecosystem Approach that were endorsed by the Contracting Parties in February 2012.

Strong signals suggest steps towards better management have already been taken, for instance, the entry into force in 2011 of the 2008 Protocol on Integrated Coastal Zone Management (ICZM). Under this Protocol, Contracting Parties are committed to establish a common framework for the integrated management of the Mediterranean coastal zone and to take the necessary measures to strengthen regional cooperation for this purpose. Additional milestones in coastal and marine management include the ratification of the 1995 Dumping Protocol so it enters into force, the identification of Ecologically and Biologically Significant Areas (EBSAs) proposed by MAP and its RAC/SPA; the 2005 Decision by the GFCM to restrict bottom trawling in all waters below 1.000 meters; and the many bilateral and subregional agreements fostering improved understanding and harmonised management. The most important of all developments may well be the dedication shown to fostering the Ecosystem Approach. Under this available technology and tools can now be harnessed to better assess what changes are taking place, why, and how to craft effective management responses. This move towards a more ecosystem-based approach is timely, coming at a time when ecosystems, though facing multiple threats, are still healthy and productive enough to be able to respond positively to improved management.

PART 1

Introduction to the Mediterranean Basin

The Ecosystem Approach to the Management of Human Activities

The Mediterranean Basin and its Waters

The Human Mediterranean Basin

The region enclosing the Mediterranean Sea encompasses portions of three continents: Europe and its southern peninsulas to the north, southwestern Asia to the east, and the Maghreb region of northern Africa to the south. Overall, it is a densely populated region with an intricate political history involving many different ethnic groups. This has led to a complex and patchy political map. Today 21 countries, with surface areas from 2 km^2 to 2,4 million km^2, have coastlines on the Mediterranean Sea. They are Albania, Algeria, Bosnia and Herzegovina, Croatia, Cyprus, Egypt, France, Greece, Israel, Italy, Lebanon, Libya, Malta, Monaco, Montenegro, Morocco, Slovenia, Spain, Syria, Tunisia, and Turkey.

The Mediterranean region has historically been the scene of intense human activity. The Mediterranean Sea and its coasts are the source of many of the resources harvested in the region, but also the conveyor belt for trade, and often the sink for the cumulative impacts of these activities. The Mediterranean is a relatively small, enclosed sea with limited exchange with the oceanic basins, intense internal mesoscale circulation, and high diversity of sensitive ecosystems. These characteristics, combined with the political complexity of the region, mean the management and protection of the coastal and marine environment will require multilateral environmental agreements and regulations, abided by at a supranational level. This approach is essential to sustainable development in all nations bordering on bodies of water that extend beyond their boundaries.

In order to be able to analyse the different environmental problems and issues that affect the Mediterranean marine and coastal ecosystems it is important to be aware of the natural characteristics of the Mediterranean Basin and have an overview of the major drivers in the Mediterranean region, including all economic sectors within the Mediterranean basin and specially those devoted to the exploitation of the coastal and marine natural resources. This allows increased understanding of the overall interrelation between Mediterranean ecosystems and the human drivers.

The Ecosystem Approach to the Management of Human Activities

The Mediterranean coastal and marine ecosystems: productivity, diversity and services

In many ways, the Mediterranean Sea and its coastal fringes are unique. While the level of biological productivity is low, the Mediterranean Sea and surrounding lands are characterised by a relatively high degree of biological diversity. The fauna includes many endemic species and is considered richer than that of Atlantic coastal areas (Bianchi and Morri 2000). The continental shelf is generally very narrow, but the coastal marine area of the Mediterranean, which stretches from the shore to the outer extent of this continental shelf, shelters rich ecosystems and the sea's few areas of high productivity. Central zones of the Mediterranean are low in nutrients, but coastal zones benefit from nutrient inputs that support higher levels of productivity. Among the reasons for the high habitat diversity are the steep depth gradient in the basin and the latitudinal range causing climatic conditions to range from sub-tropical to temperate.

Both coastal and marine ecosystems in the Mediterranean deliver extremely valuable ecosystem services that benefit all of the region's inhabitants. They include fisheries resources and tourism values, for which economic values can be ascertained relatively easily, as well as waste assimilation, a transport medium, buffering from storms, and the means to maintain the ecological balances that make life on Earth possible.

Mediterranean countries recognise the value of these ecosystem services, but are only now beginning to quantify them. In 2010, the UNEP/MAP Blue Plan Regional Activity Centre produced a preliminary Mediterranean marine ecosystem services valuation report (UNEP/MAP/BP, 2010). The study concluded that, across the Mediterranean region, ecosystem service benefits may exceed 26.128 million Euros annually. More than two-thirds of the estimated economic benefits come from tourism and the value of nature supporting tourism. Other valuable ecosystem services include provisioning of seafood, waste assimilation, coastal stabilisation and erosion prevention, and carbon sequestration. While the findings of the study are under review, the magnitude of the estimates for the ecosystem services suggests the importance of certain types of habitats and resources in supporting human well-being throughout the basin. As countries discuss how to move forward together toward a more ecosystem-based approach to marine management, priorities may centre on those habitats that provide the bulk of these economically, ecologically, and culturally valuable services.

Coastal and marine ecosystems of the Mediterranean include:

- rocky shores and nearshore coastal areas (including karstic systems);
- coastal plains;
- brackish water lagoons, estuaries, or transitional areas;
- wetlands;
- sea grass meadows;
- coralligenous areas (calcareous formations produced by encrusting algae);
- frontal systems and upwellings;
- deep water benthic systems including seamounts and cold-water coral reefs; and,
- pelagic systems.

Understanding the economic and social value of Mediterranean ecosystem services helps in assessing the costs of inaction or of continuing sector-by-sector management. The current management regime generally does not take into account how multiple uses of the marine and coastal environment act in synergy to undermine the health and productivity of entire regions. The loss of ecosystem services can be very costly and the effects can linger over long time periods. Small investments in taking an ecosystem approach to management could prevent further degradation.

The Approach to the Management of Human Activities

The Mediterranean Sea and coasts are the lifeblood of the region, providing not only sustenance and space in which to live and practice commerce, but also a key cultural backdrop against which Mediterranean civilisations have flourished and continue to flourish. This is one of the most used and highly cherished marine areas in the world. The long history of settlement and use has undeniably altered the coastal and marine ecosystems of the Mediterranean Basin, yet they continue to support the countries and communities that line the sea's margins.

Previous reports on the Mediterranean marine and coastal environment (EEA and UNEP 1999; UNEP/MAP/MED POL 2005; EEA and UNEP 2006; UNEP/MAP/BP/RAC 2009) have highlighted the ways that development of coastal and marine areas has impacted the Mediterranean as a whole. The issues of the past remain relevant today:

- poorly planned coastal development with fragmentation and loss of the integrity of coastal habitats and landscapes;
- loss of marine habitats;
- pollution;
- unsustainable fisheries;
- spread of invasive species; and,
- climate change.

Past changes have ramifications for human well-being in the present. The loss of biodiversity, declines in productivity, and contamination by pollutants do not affect only the marine systems and how well they function. They also affect human health, human economies, and the very fabric of these coastal societies.

Today Mediterranean countries are taking a holistic look at the condition of the Mediterranean environment, with the goal of understanding how multiple and cumulative impacts affect the environment and how, in turn, continued degradation of the en-

vironment affects human well-being. This holistic approach will certainly build on the steps already covered by previous integrated management approaches as the Integrated Coastal Zone Management (ICZM), recently strengthened by the entry into force of its Protocol. The commitment by the Contracting Parties of the Barcelona Convention to an Ecosystem Approach signals recognition of the immense value of the region's seas and coasts, and the singular importance of promoting management that allows for sustainable use.

Growing coastal populations, urbanisation, ever-increasing maritime commerce, exploitation of natural resources, and coastal tourism are the drivers behind the chronic pressures that continue to degrade Mediterranean seas and coasts. However, these drivers and pressures are not uniform throughout the basin. Tailoring a management response that effectively ensures continued sustainable use requires solid understanding of the levels of pressure, the underlying condition of the ecosystems, how the ecology is affected, and how institutions are responding. The state of the Mediterranean environment is really the story of multiple states of the environment, varying from place to place, and of how this range of conditions affects the sea as a whole and the ability of its marine and coastal ecosystems to continue providing the goods and services people need.

Since the 2006 EEA-UNEP/MAP report on priority issues in the Mediterranean environment, some changes are apparent. Improvements in water quality are discernible in specific places, thanks to strategic efforts to reduce pollutant loading. Quantities of hazardous substances such as DDT and heavy metals are declining in some areas (UNEP/MAP/MED POL 2011). New issues, however, are emerging. Desalination and its effects, particularly with respect to brine release, needs further in depth investigation. The increasing use of coastal and ocean space for aquaculture, including grow-out operations for bluefin tuna, brings with it the threat of increased pollution, eutrophication, release of invasive species and pathogens, and growing conflict over reduced access and availability of space for other uses. And impacts on the region's ecology and economy from invasive species continue to grow, warranting more serious attempts to prevent new invasions and to control, where possible, damage caused by these species.

One reason that Mediterranean ecosystems continue to be threatened, despite ever-increasing recognition of their value, is the historic inability to conduct a uniform assessment of pressures and states in order to formulate responses. With the exceptions of localised pollutants and nutrient and organic matter enrichment, data for some countries are limited. Some countries though have begun to assess climate-change impacts and to study emerging issues, such as noise pollution and cumulative impacts assessment. Other countries, with more limited human and financial resources, are focusing on their obligations under the various Barcelona Convention Protocols. A future, rationalised monitoring programme, based on the selection of ecological and operational objectives, already underway by Contracting Parties to the Barcelona Convention, will overcome these barriers to understanding the Driver-Pressure-State-Impact-Response sequence across a wide span of impacts from human activity.

The Contracting Parties of the Barcelona Convention agreed during the meeting of Contracting Parties in February 2012 (Decision IG.20/4) to strive to meet a series of ecological and operational objectives (see Part 3) aimed at guaranteeing that the Mediterranean ecosystems keep providing valuable services and profitable resources for Mediterranean countries. These objectives can be summarised as follows:

- Coastal processes are not disrupted by urbanisation, coastal development, and inadequate protection of the integrity of coastal habitats, ecosystems and landscapes, with the result that shorelines remain stable, sea-level rise is accommodated as much as possible by natural adaptation, and habitat fragmentation is minimised.
- Pollution caused by contaminants is minimised so as to prevent disruption of ecology, loss of biodiversity, and negative human health impacts.
- Human-induced eutrophication and increasing hypoxia and anoxia are prevented or minimised through controls on nutrient inputs into coastal waters.
- Marine litter does not adversely affect the coastal and marine environment, including marine life.
- Marine noise from human activities causes no significant impact on marine and coastal ecosystems.
- Non-indigenous species introduced by humans are kept, to the maximum extent possible, from becoming invasive and disrupting natural productivity and balances.
- Fisheries exploitation (and harvesting of fish to support agricultural and aquaculture industries) does not exceed sustainable limits, leaving resources to support the complex of ecosystems and allowing for replenishment.
- Anthropogenic damage to the sea floor is avoided or minimised, such that the integrity of benthic systems is maintained and benthic/pelagic coupling can continue, as is necessary for healthy marine ecosystems.
- Hydrographic conditions are not unduly altered through poorly planned coastal construction, changes to river flows leading to estuaries, or other physical alterations to the coasts and seas.
- Where possible, food webs are not altered by resource exploitation and environmental change, so that balances and productivity are maintained.
- Marine and coastal biodiversity at all levels (genetic, species, and ecosystem) is kept from being irreversibly lost, so that the ecological roles of species can be supported and ecosystems can provide both cultural and amenity values to the maximum potential possible.

Until these conditions are met, the environment of the Mediterranean marine and coastal systems will continue to be threatened, and the delivery of important and valuable ecosystem services will be at risk. As a result, so will be the communities and countries that border the basin.

The Mediterranean Basin and its Waters

Geography, physiography and landscapes

A general overview of the Mediterranean region's physical geography reveals an irregular, deeply indented coastline, especially in the north, where the Iberian, Italian, and Balkan peninsulas jut southward from the main body of Europe. Numerous islands correspond to isolated tectonic blocks, the summits of submarine ridges, or the tips of undersea volcanoes. The largest islands are Sicily, Sardinia, Corsica, Cyprus, and Crete, and the major island groups include the Balearics off the coast of Spain and the Ionian, Cyclades, and Dodecanese islands off Greece. Apart from the coastal plains and the deltaic zones of large rivers (Ebro, Rhone, Po and Nile), the coastlines are mostly rimmed by mountain ranges. Only the coastal plains from eastern Tunisia to the Sinai Peninsula, bordered mainly by low-lying desert, are free of mountains. In fact, the highest reaches of the main mountain ranges generally mark the limit of the hydrographic basin that drains towards the Mediterranean Sea. These mountain ranges include the Atlas, the Rif, the Baetic Cordillera, the Iberian Cordillera, the Pyrenees, the Alps, the Dinaric Alps, the Hellenides, the Balkan, and the Taurus (Amblas *et al.* 2004).

The Mediterranean Sea occupies a basin of almost 2,6 million km^2. The coastline is 46.000 km long, and the basin itself about 3.800 km from east to west and 900 km from north to south at its maximum between France and Algeria. The average water depth is approximately 1.500 m with a maximum depth of 5.121 m off southwestern Greece. The shallowest part of the Mediterranean Sea is the northern Adriatic, where the average depth does not exceed 50 m. The Mediterranean Sea can be divided into two sub-basins, the Western and the Eastern Mediterranean, which in turn are composed of a series of varied small basins (Amblas *et al.* 2004).

The Western Mediterranean has an area of approximately 0,9 million km^2 and includes the Alboran Sea, the Algerian-Balearic Basin, the Catalano-Balearic Sea, the Gulf of Lions, the Ligurian Sea, and the Tyrrhenian Basin. The Straits of Gibraltar, located at the western end of the Western Mediterranean, provide the only natural connection between the Mediterranean Sea and the global ocean. This passage, only 14 km wide and 290 metres deep at its sill, exerts crucial control on water circulation with an inflow of ca. 35.000 km^3 per year. The continental shelves tend to be narrow off the southern and northern Iberian Peninsula, the Balearic Islands, Corsica, Sardinia, the western Italian coast, northern Africa, and the Maritime Alps, where mountain slopes drop almost straight into the sea. Larger continental shelves, more than 50 km wide, are present off the mouths of the Ebro and Rhone rivers, mainly due to the seaward extension of deltaic systems. The continental shelf off the north coast of Tunisia is also wide. Bathyal plains, the flat deepest areas of the basin, occupy the central portions of the Algerian-Balearic Basin, with depths reaching 2.800 m, and the Tyrrhenian Basin, with depths up to 3.430 m.

In contrast, the much-larger Eastern Mediterranean, with an area of approximately 1,7 million km^2, has a highly varied physiographic character. It includes the Strait of Sicily, the Adriatic Sea, the Ionian Sea, the Levantine Basin, and the Aegean Sea. The major structures in the bathymetry of the Eastern Mediterranean are the Hellenic Trench and the Mediterranean Ridge. The Hellenic Trench is a subduction zone (an area where the Earth's tectonic plates meet, with one plate sliding beneath another), reaching a maximum depth of 5.267 m off the Peloponnese, the deepest point in the Mediterranean. This trench confines the Aegean Sea to the north, arching from the western Peloponnese to southeast of the island of Rhodes. The Mediterranean Ridge runs parallel to this structure, from the Ionian Basin in the west to the Cyprus arch in the east (Amblas *et al.* 2004).

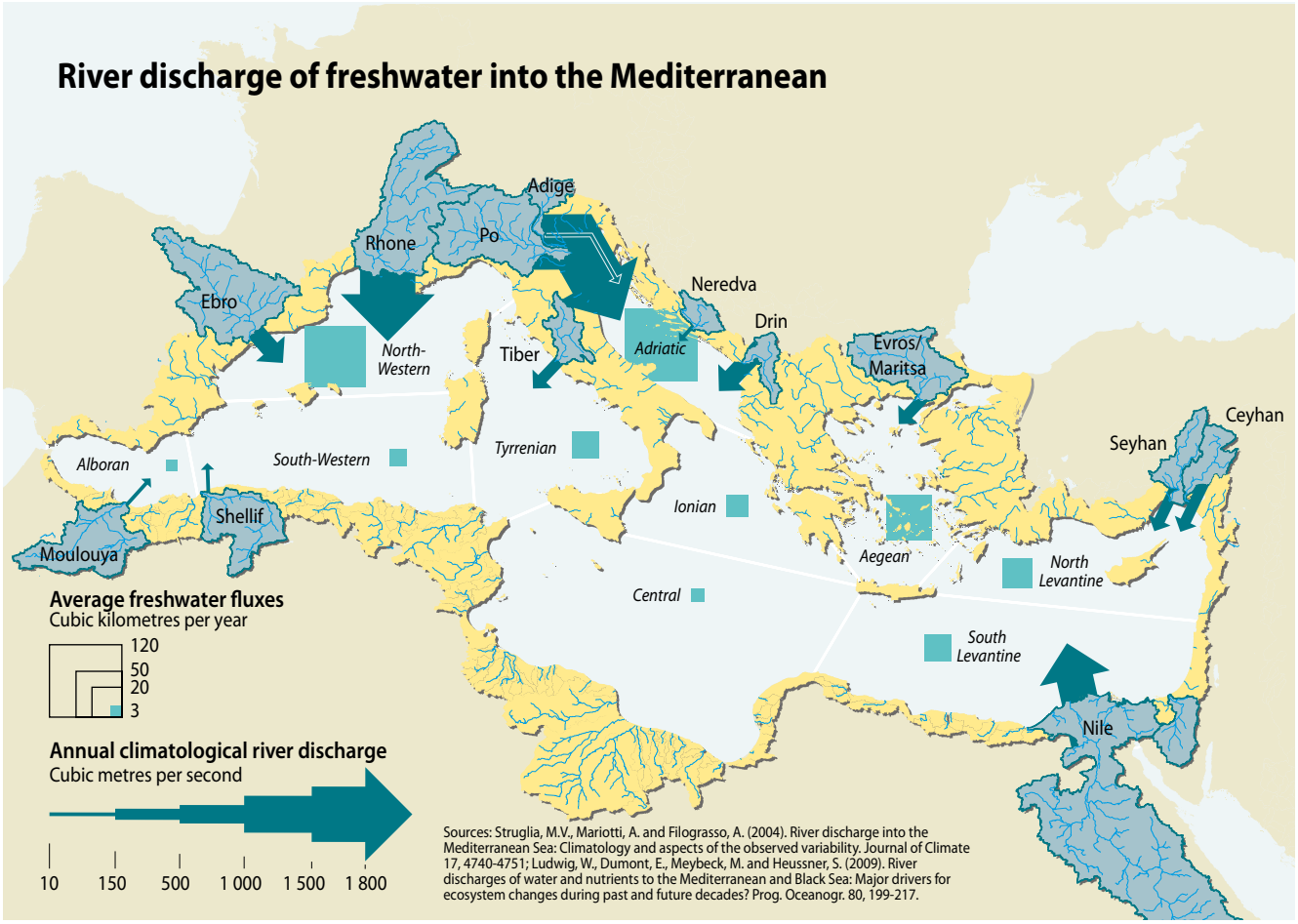
River	Drainage region	Outflow sub-basin	Drainage area
Ebro	Southern flanks of the Pyrenees and northern flanks of the Iberian Cordillera	Catalano-Balearic Sea	84.000 km^2
Rhone	Central Alps and flows through Lake Geneva and southeastern France	Gulf of Lion	96.000 km^2
Po	Southern flanks of the Alps and the northern part of the Apennine mountain range	Adriatic Sea	75.000 km^2
Nile	Northeastern part of the African craton	Levantine Sea	3.300.000 km^2

The Eastern Basin is connected to the Western Basin through the Strait of Sicily, with a maximum depth of about 400 m, and to the Black Sea by the Straits of the Dardanelles, with a maximum width of only 7 km and an average depth of 55 m. The inflow from the Black Sea is two orders of magnitude smaller than that from the Atlantic reaching ca. 200–300 km^3 per year. The connection on the southeastern end with the Red Sea occurs through the man-made Suez Canal. The continental shelves in the Eastern Basin are narrow off Peloponnesus, Crete, and southern and northern Turkey. However, they are particularly well developed east of Libya, in the area influenced by deposits from the Nile River delta, and in the Adriatic, where large areas are shallower than 100 m due to Po delta deposits. The Aegean Sea is also fairly shallow, a consequence of its relatively young crust rather than high sediment input. In the Eastern Basin, bathyal plains are deeper and smaller than those in the west. Maximum depths are up to 4.200 m in the Ionian Abyssal Plain and 3.200 m in the Herodotus Abyssal Plain (Amblas *et al.* 2004).

The Mediterranean drainage basin extends over an area of more than 5 million km^2. This includes the Nile and the Libyan coastal zone, neither of which are active parts of the drainage basin. Most of the water that drains to the Nile evaporates, particularly following construction of the Aswan High Dam, which increased the amount of water drawn from the system for agriculture. The drainage basin of the southern Eastern Mediterranean (including much of the Libyan coastal zone) is mostly desert with only small seasonal watercourses. Excluding these areas that have little riverine input, the drainage basin of the Mediterranean Sea measures less than 1,5 million km^2 (Ludwig *et al.* 2009). The major perennial rivers (Ebro, Rhone, Po, and Nile) are supplied by very large drainage basins that, in most cases, collect water beyond the boundaries of the Mediterranean climatic belt.

Smaller rivers, with drainage basins less than 10.000 km^2, cover nearly 60 % of the Mediterranean catchment area and play an important role. However, they are either ephemeral or carry small volumes of water due to relatively low annual rainfall (below 500 mm), high evaporation and infiltration, and the seasonal and sporadic nature of rainfall.

Sedimentary systems associated with the larger rivers have created large coastal plains, defining the characteristics of the



coastal zone and continental margin. Under the influence of the micro-tidal regime, these coastal plains have grown to form large deltaic systems, broad shelves formed by deltaic processes, and continental slopes incised by deep canyons hundreds of kilometres long (Canals *et al.* 2004). The Nile system is fed by sediments originating as far as 6.650 km from the coastline, creating an impressive onshore delta plain (formed before construction of the Aswan Dam) on the northeastern coast of Egypt. The offshore end of this sedimentary system is the Nile deep-sea fan, covering about 140.000 km^2, one of the largest submarine fan-shaped terrigenous deposits in the world.

The unique and recognizable Mediterranean coastal landscapes are the result of centuries of interplay among the diverse natural characteristics of the Mediterranean region and the equally diverse human activities, both past and present. The Mediterranean countryside is characterised by terraced slopes built for the mixed cultivation of vegetables, herbs, grains, grapes, olives, and fruit trees. Forests or small patches of forest also play an important visual, biological, and climatic role in the landscapes, even though forest is relatively scarce. Increasingly, mixed cultivation crops are being replaced by intensive plantations, and the traditional terrace pattern on the slopes is being displaced by the modern arrangement of large, dense farmlands in the flat areas. The terrace pattern remains, however, until natural vegetation gradually overgrows the terraces.

In the low-lying sectors of the coastal zone, large coastal plains occupy the areas near river mouths. Extensive saltpans were once located there. Nowadays, agricultural uses are taking over in some places, with salt produced in more restricted areas. In other places, the saltpans are abandoned and decaying.

Mediterranean cultural landscapes are also shaped by human activity, above all by architecture and urbanisation. The locations of traditional settlements were influenced mainly by climate and were largely contiguous along large parts of the Mediterranean coast. Currently, the settlement pattern is shifting from contiguous settlements to dispersed sprawl around major towns, resulting in landscape degradation.

Besides the characteristic landscapes described above, there is a multitude of other landscapes in the Mediterranean. So far, no Mediterranean-wide landscape classification system allows detailed mapping of landscapes for the entire basin. Nevertheless, the increased availability of spatial data in digital format and advances in Geographical Information Systems and related disciplines provide the opportunity for a more comprehensive, integrated and systematic assessment of the coastal environment (Vogiatzakis and Cassar 2007).

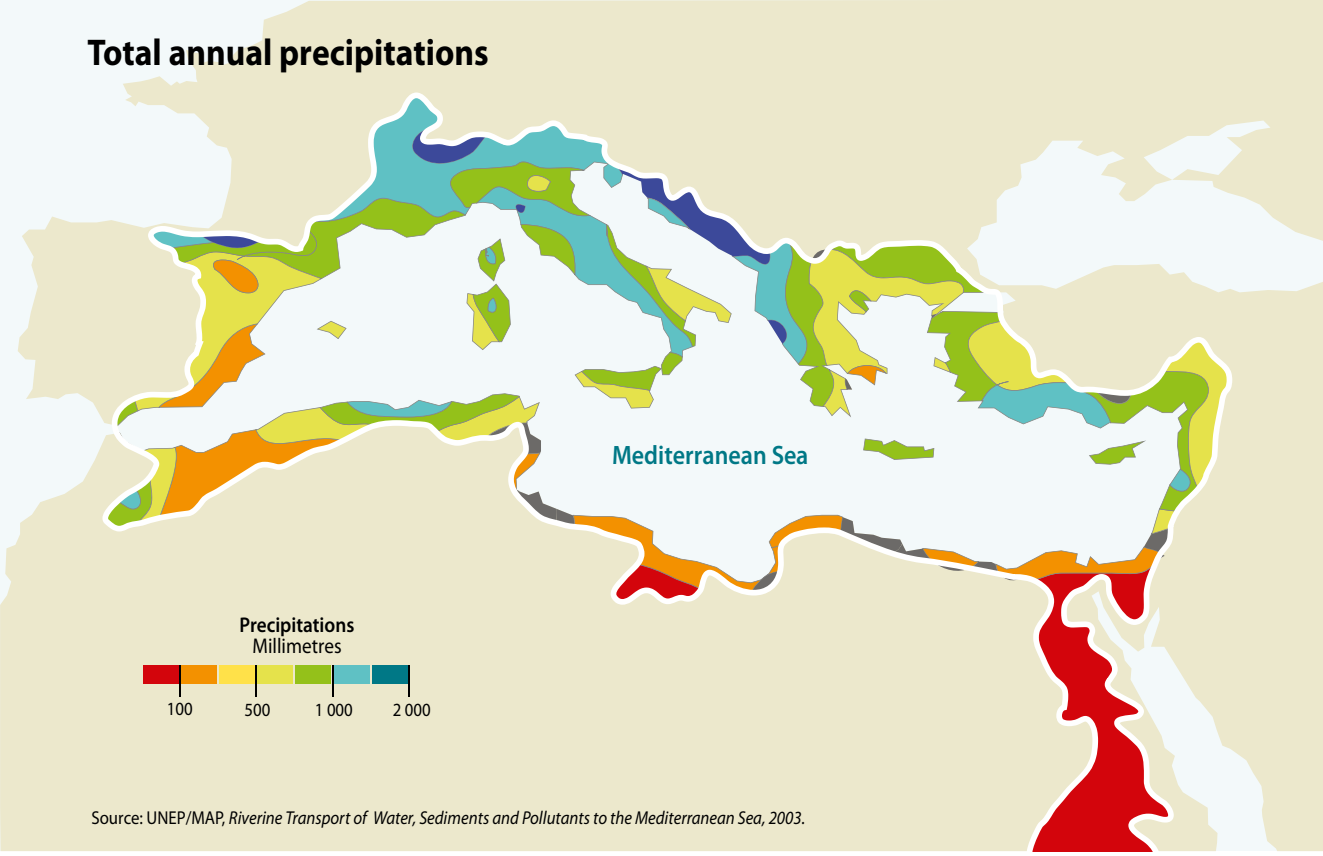
Hydrological and climatic setting

Rivers play a key role in the Mediterranean region's water circulation and geochemistry. Because the Mediterranean Sea is a semi-enclosed ocean basin receiving relatively large amounts of drainage, they also play a role in sustaining marine productivity. Changes in freshwater input due to natural variability or major river regulation lead to changes in the Mediterranean's surface-water salinity. These changes can have a basin-wide impact on the vertical circulation and mixing of water masses, with resulting impacts on surface water productivity and the characteristics and ventilation of deep-water masses (Rohling and Bryden 1992). The release of contaminants through the network of rivers will unavoidably have an impact on the levels of these contaminants in the marine basin. Finally, due to the oligotrophic – low in nutrients – character of the Mediterranean, changes in riverine nutrient inputs, whether natural or human-induced, are potential drivers for long-term changes in coastal and open-water marine productivity and in marine ecosystems (Ludwig *et al.* 2009).

The estimated mean annual river discharge into the Mediterranean for recent years is about 10.000 m^3/s, with a dry season in midsummer and a peak flow in early spring (Struglia *et al.* 2004). Ranked according to annual discharge, the ten largest rivers contributing to the Mediterranean Sea are the Rhone, Po, Drin-Bojana, Nile, Neretva, Ebro, Tiber, Adige, Seyhan, and Ceyhan. These rivers account for half of the mean annual discharge, with the Rhone and the Po alone accounting for already one-third of it (Ludwig *et al.* 2009). Of the three continents that discharge into the Mediterranean Sea, Europe dominates, with a climatological mean annual discharge that accounts for half of the total. The European discharge clearly determines the seasonal cycle for the Mediterranean. Discharge from Asia and Africa is considerably smaller. Discharge into the Adriatic Sea, the Northwestern Basin, and the Aegean Sea, combined, accounts for 76 % of the whole. About one-third of the total basin discharge flows into the Adriatic (3.700 m^3/s) (data from Ludwig *et al.* 2009). The Nile, with a catchment area an order of magnitude greater than any other Mediterranean river, has a mean annual discharge of 2.800 m^3/s to the Aswan Dam. The discharge is reduced to about 5 % of that amount (150 m^3/s) by the time it reaches the Mediterranean Sea.

Mediterranean river discharge patterns depend on properties of the atmospheric water budget as well as on the geographical characteristics of the Mediterranean catchment. A substantial latitudinal gradient characterises Mediterranean precipitation year-round, with dry areas along the African coast and significantly wetter ones north of the Mediterranean Sea (Struglia *et al.* 2004). Winter is the main rainy season for the European land regions, which contribute most of the discharge, while summers south of 40 degrees N are basically dry. Most of the water discharge in the northern region occurs during short floods associated with maximum river flow after heavy rainfall, which generally occurs between February and May. The strong summer-winter rainfall contrast, which increases from north to south and from west to east, is the major characteristic of the Mediterranean climate (UNEP/MAP/MED POL, 2003). In the large and medium-sized river basins in north and central Europe, wide-ranging and continuous precipitation is the most common cause of flooding. Floods also occur in association with snow melt in late spring and early summer. Intense short-lasting rainfall during spring and fall affecting small coastal catchments is the main cause of coastal floods in arid and semi-arid parts of the Mediterranean area.

Overall, freshwater discharge into the Mediterranean decreased by an estimated 20 % between 1960 and 2000, with no major differences between the Eastern and Western basins. This reduction results from large-scale changes in precipitation and temperature. It therefore reflects the potential impact of climate change on river freshwater discharge and represents a minimum estimate. In the drier parts of the Mediterranean drainage basin, anthropogenic water use can also reduce the long-term water



discharge, particularly to sub-basins such as the South Levantine, Alboran, Southwestern Basin, Aegean, Central, and North Levantine. Given the importance of water resources to local economies in this part of the world, a 20 % reduction in only 40 years is significant. Climate monitoring and modelling studies reveal a general trend toward drier and warmer conditions, which started in the last century and is expected to worsen in the future. The trend could have serious repercussions for riverine water discharges (Ludwig *et al.* 2009).

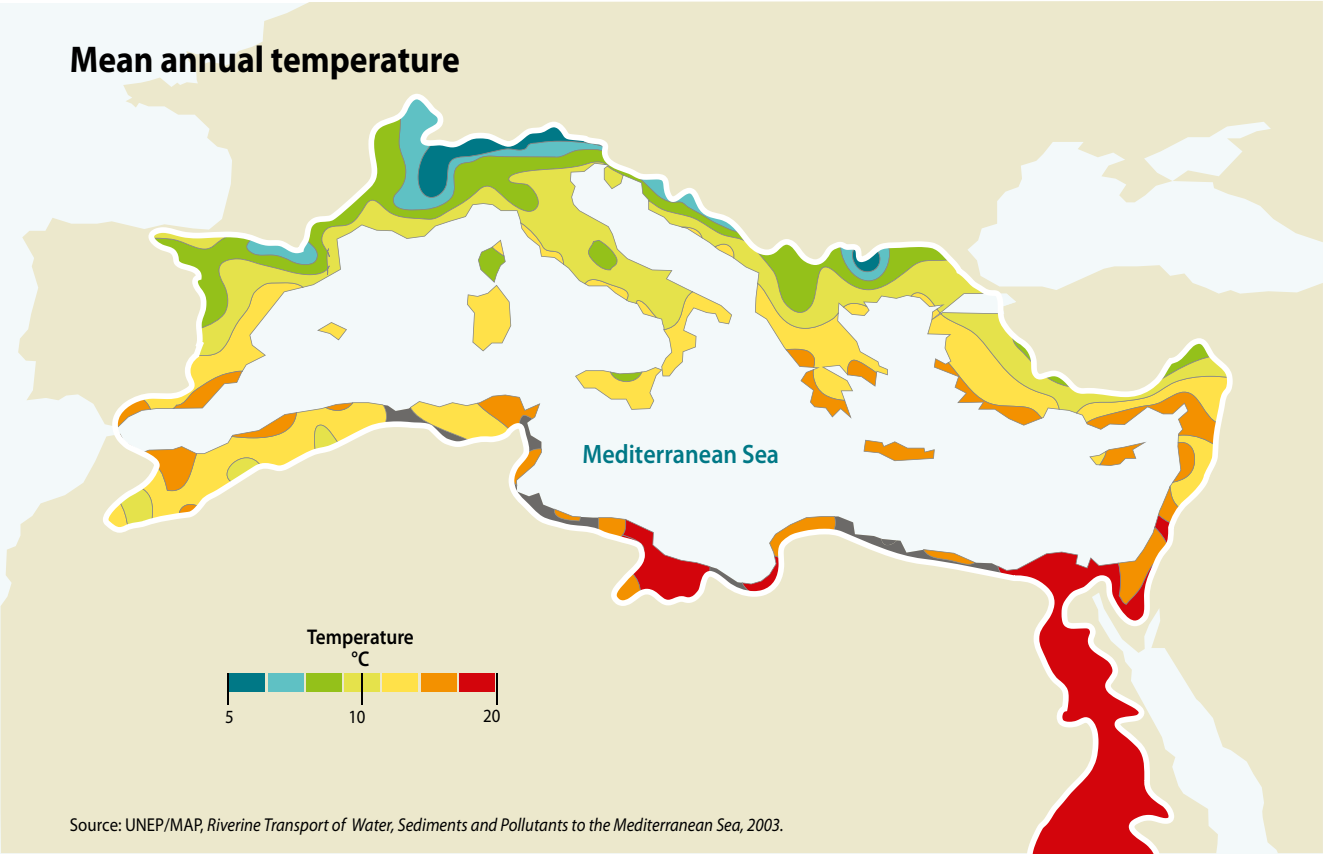
Due to damming, several major Mediterranean rivers, such as the Rhone and Ebro, have seen a reduction in freshwater discharge. River flow regulation for irrigation purposes is estimated to have caused a further reduction of up to 40 % in freshwater discharge to the Mediterranean Sea (Poulos 2011). In the case of the Ebro River in Spain, trend analysis shows a reduction of the river's discharge of about 50 % since the 1950s. This change is attributed to increased human water use (urban demand, agriculture, industry, and tourism) and regulation, but also to an increase in shrub and afforestation-related vegetation cover where grazing and traditional agriculture have disappeared (Lopez-Moreno *et al.* 2011). Similarly, Zahar and Albergel (1999) reported that the closure of the Sidi Salem Dam in Tunisia led to a reduction of the mean annual discharge of the Medjerdah River by 65 % due to diversion for irrigation and evaporative losses.

Coastal aquifers provide another source of freshwater discharge to the Mediterranean. The submarine groundwater discharge from the coastal aquifers, estimated at 2.200 m^3/s, accounts for almost one-fifth of the total freshwater inflow into the Mediterranean, with more than one-third of this discharge entering from the sea's European shores (Zektser *et al.* 2006). Seepage inflows are prevalent on the eastern coast of the Adriatic, dominated by karstic aquifer systems, as well as on the eastern and southern Mediterranean coast with semi-arid and arid conditions, limited precipitation and runoff, and limited surface watercourses and discharge points. Coastal seepage and submarine discharges are critical to the water balance and seawater quality in the marine sub-basins. They also support wetlands and brackish water habitats, important to biodiversity, and fishery nursery areas. The coastal aquifers are threatened by over-exploitation and consequent seawater intrusion and water and land salinisation, which will add to the deficit in recharge of the Mediterranean (UNEP/MAP/MED POL 2005). Submarine groundwater discharge is also a significant source of nutrient input in some regions and could provide pathways for pollutants to disperse into the sea (Lobkovsky *et al.* 2003).

Climatically, the Mediterranean is characterised by warm temperatures, winter-dominated rainfall, dry summers, and a profusion of microclimates (UNEP/MAP/MED POL 2003). Mean annual temperature follows a marked north-to-south gradient, with local variations superimposed by geography.

Mediterranean circulation and water masses

A large thermohaline cell (affected by both temperature and salinity) characterises the general circulation in the Mediterranean Sea. Circulation is driven by the water balance deficit and by the heat fluxes between the sea and the atmosphere. The water deficit, caused by greater evaporation than precipitation and river run-off, is mainly compensated for by the inflow of Atlantic water through the Straits of Gibraltar and by the water contribution from the Black Sea through the Straits of the Dardanelles. The exchange of heat with the atmosphere, leading to the cooling and subsequent sinking of surface waters, also contributes to the thermohaline circulation.



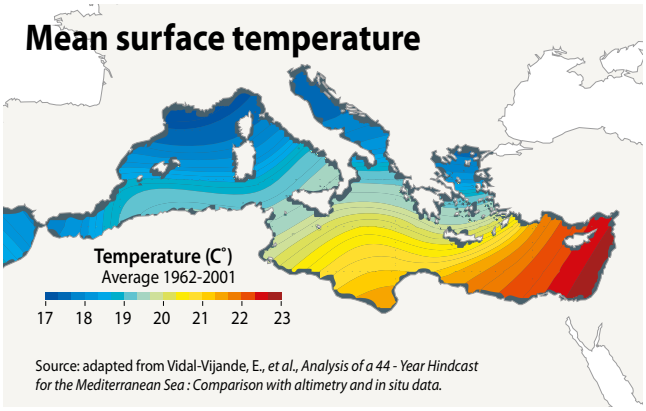
Source: UNEP/MAP, *Riverine Transport of Water, Sediments and Pollutants to the Mediterranean Sea, 2003.*

Schematically, the Mediterranean Sea comprises three main water masses (EEA and UNEP 1999):

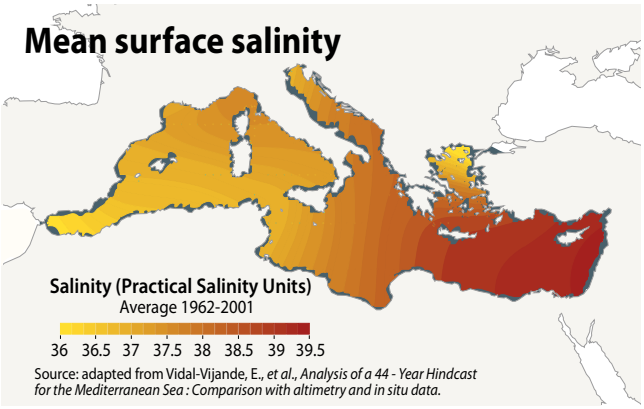
- the Modified Atlantic Water (MAW), found in the surface layer, with a thickness of 50–200 m and characterised by a salinity of 36,2 psu (practical salinity units) near Gibraltar to 38,6 psu in the Levantine basin;
- the Levantine Intermediate Water (LIW), formed in the Levantine basin, lying in depth between 200 and 800 m, and characterised by temperatures of 13–15,5°C and salinity of 38,4–39,1 psu;
- the Mediterranean Deep Water (MDW), formed in both the Western and Eastern basins. The Western Mediterranean Deep Water (WMDW) is characterised by a temperature of 12,7°C and a salinity of 38,4 psu, while the Eastern Mediterranean Deep Water (EMDW) is characterised by a temperature of 13,6°C and a salinity of 38,7 psu.

Within the sea, the incoming Atlantic water is continuously modified by interactions with the atmosphere and mixing with older surface waters and with the waters underneath. All along its course, MAW is seasonally warmed or cooled, but overall its salt content increases and it becomes denser. In autumn, in the northern parts of both basins, MAW remains at the surface. In winter, cold and dry air masses induce marked evaporation and direct cooling of MAW, resulting in a dramatic increase in its density, which makes it sink. This sinking occurs in a series of specific zones, generally located in the northern parts of the basins, and is responsible for the formation of the deeper waters in the Mediterranean.

Besides some secondary formation of deeper waters related to overcooling of shelf waters, the major deep water formation process occurs offshore in some sub-basins. Fundamentally, densified MAW sinks and mixes with the denser waters underneath. The mixture continues to increase in density. The resulting water masses will be either intermediate or deep. Deep vertical convection in the northern part of the Western Basin forms the WMDW.

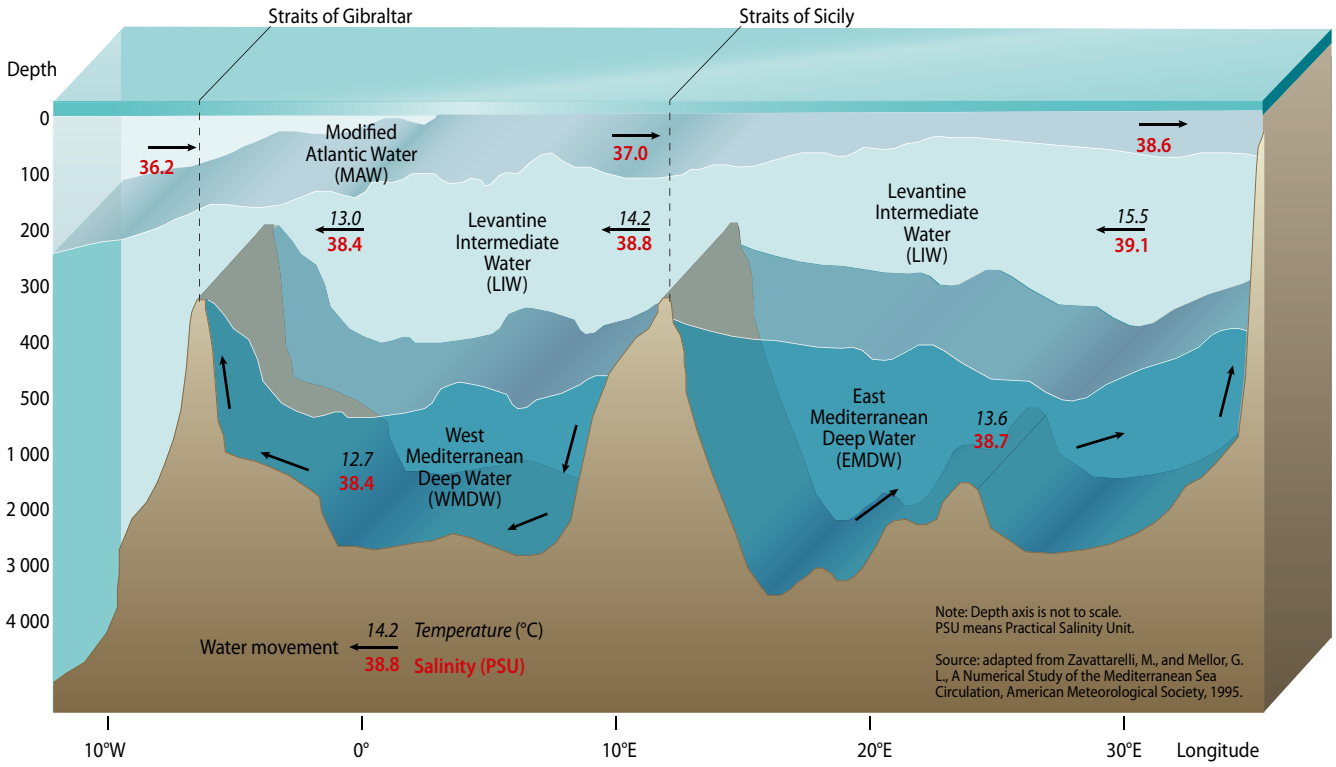


Source: adapted from Vidal-Vijande, E., *et al., Analysis of a 44 - Year Hindcast for the Mediterranean Sea : Comparison with altimetry and in situ data.*



Source: adapted from Vidal-Vijande, E., *et al., Analysis of a 44 - Year Hindcast for the Mediterranean Sea : Comparison with altimetry and in situ data.*

Mediterranean Sea water masses: vertical distribution



Cold winter winds between Rhodes and Cyprus and on the northern and central Adriatic Sea are responsible for the formation of LIW. LIW is the warmest and saltiest intermediate water, and the largest in volume. Because of its characteristics and amount, LIW is recognizable more or less everywhere in the sea. Due to its relatively low density, it is found just below MAW, and it mixes with MAW as soon as MAW starts sinking.

The overall formation rate of intermediate and deep Mediterranean waters is estimated to be approximately 90 % of the Atlantic water inflow at Gibraltar (10 % being evaporated). About three-quarters of intermediate and deep waters are formed in the Eastern Basin. The estimated residence time of Mediterranean waters is quite high, around 50–100 years (Millot and Taupier-Letage 2005), which has important implications for the cycling and eventually export of contaminants.

The large-scale circulation of the Mediterranean Sea has been described as sub-basin-scale and mesoscale gyres interconnected and bounded by currents and jets with strong seasonal and inter-annual variability (Millot and Taupier-Letage 2005). This general circulation flow impinges on the coastal regions and strongly influences the local dynamics of currents. Shelf areas in the Mediterranean are comparatively small and are separated from the deepest regions by steep continental shelf breaks. This configuration makes possible the intrusion of the large-scale flow field on the coastal/shelf areas and the direct influence of the large-scale currents on coastal flow. Transport of material from the coastal areas to the open ocean is enhanced by this mechanism, with important consequences for the maintenance of the ecological cycles in the basin (EEA and UNEP 1999) and for the potential for redistribution of pollution from land-based sources.

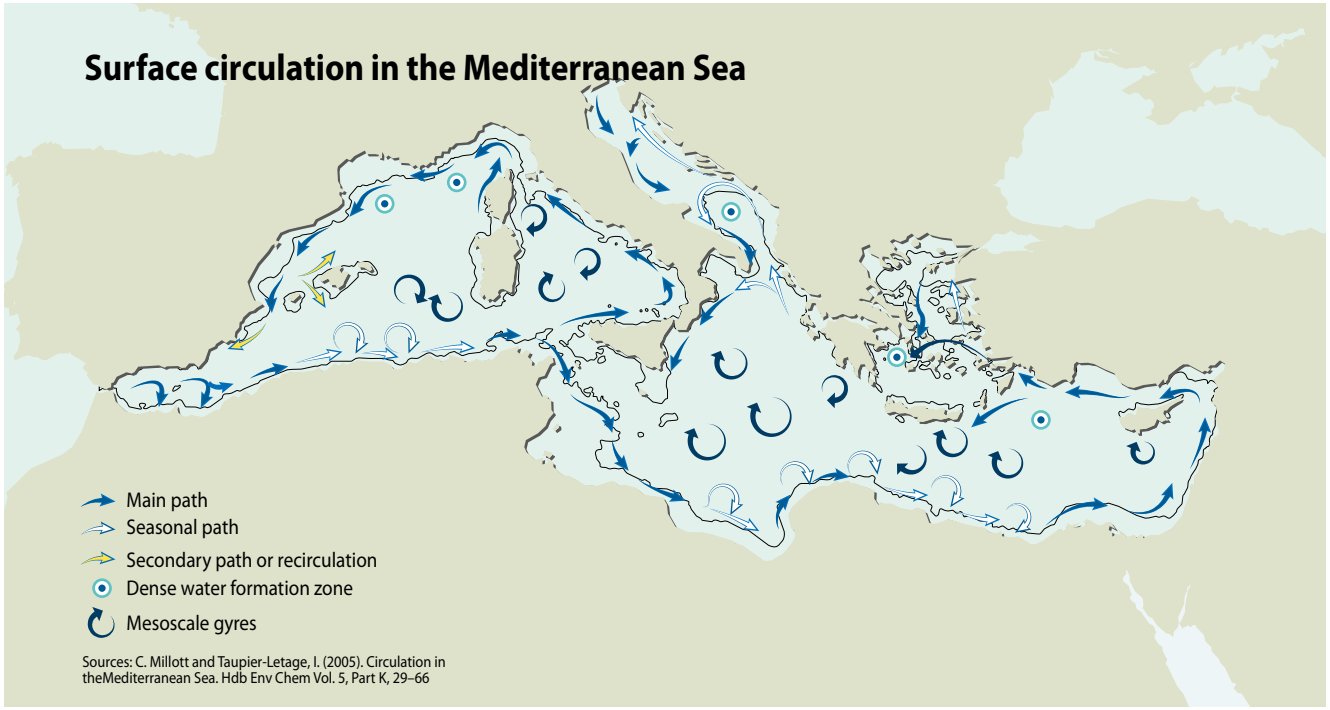
Chemical characteristics of the Mediterranean waters

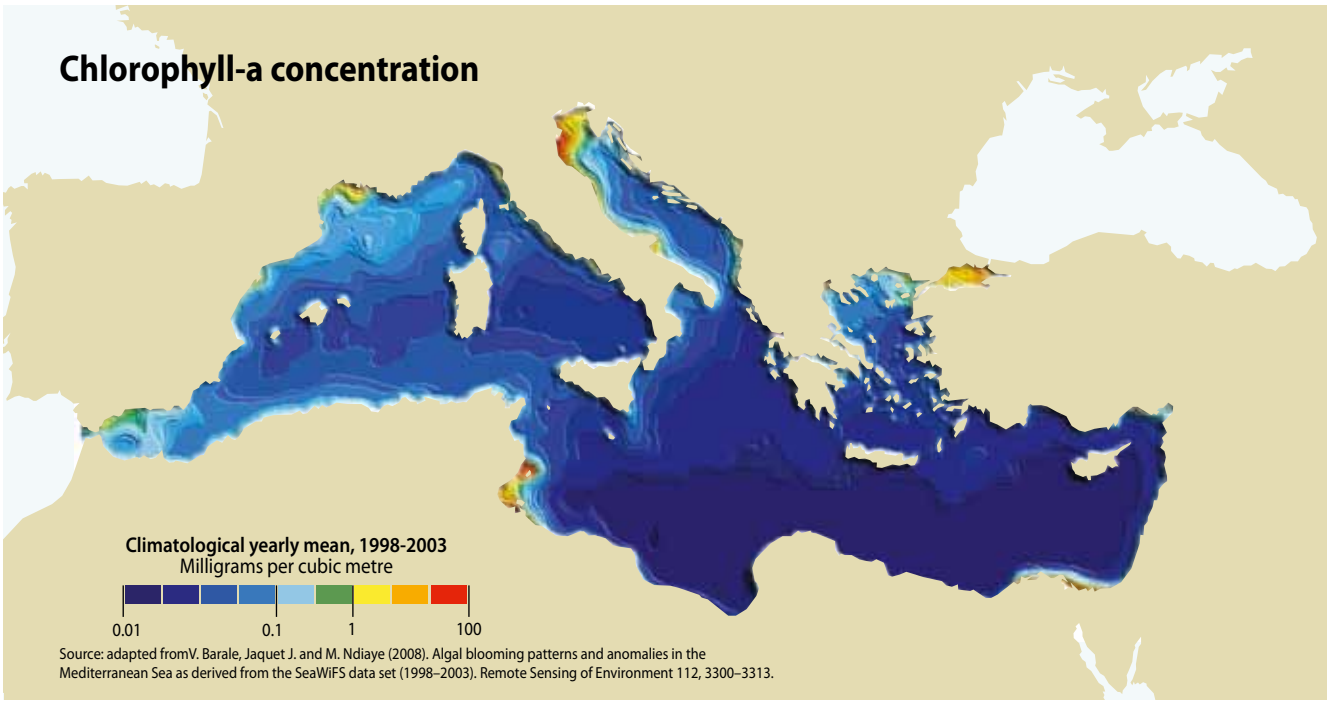
The Mediterranean Sea is an impoverished area with surface nutrient concentrations too low to support a large biomass (McGill 1961). Because of its negative water balance and the resulting water circulation, Mediterranean deep waters export large amounts of nutrients to the Atlantic Ocean (Hopkins 1985), where they are lost to the basin for internal primary production. The limited supply of nutrients to the surface waters of the Mediterranean Sea, both from its lower layers and from external sources, does not compensate for the export at depth. Zones of high productivity are therefore mainly restricted to areas in the vicinity of major freshwater inputs and/or with intensified mesoscale circulation.

Phosphorus is the most important limiting nutrient in the Mediterranean (Margalef 1963; Berland *et al.* 1980), closely followed by nitrogen. Inflowing Atlantic water carries nutrients needed for photosynthesis, but overall this water is low in nutrients. Estimates of inorganic forms of nutrients in the inflowing waters range from 0,05 to 0,20 µM (µmol/L) for phosphate-phosphorus, 1 to 4 µM for nitrate-nitrogen and nearly 1,2 µM for silicate-silicon (Coste *et al.* 1988). Density gradients develop in the lower part of the inflowing Atlantic waters, preventing the exchange with deeper, nutrient-rich basin waters. The nutrient content of the surface water is reduced as it moves through the Mediterranean Sea and encounters nutrient-poor basin water and biological activity. The nutrient concentration in the Aegean Sea is twelve times lower than in the Atlantic Ocean and eight times lower than in the Alboran Sea (McGill 1969), explaining the lower production in the Eastern Mediterranean. Coste *et al.* (1988) calculated a nutrient deficit of about 10 % for the total nitrogen and phosphorus outflow and about 50 % for the total

silicon outflow. Bethoux *et al.* (1992) proposed that, at a basin scale, the phosphorus deficit would be balanced by runoff from land and atmospheric deposition, while nitrogen losses might be balanced by additional fixation by sea grass epiphytes and pelagic bacterioplankton.

Mean annual gross primary production (PP) in the Mediterranean Sea is estimated at about 110–120 g C/m^2 for the Eastern Basin and about 120–160 g C/m^2 for the Western Basin (Bethoux *et al.* 1998; Crispi *et al.* 2002; Bosc *et al.* 2004). According to recent estimates by Ludwig *et al.* (2009) the maximum primary production that can be supported by the riverine nutrient inputs is only about 1–2 % of the total primary production in the Mediterranean. In coastal areas with large rivers, however, this contribution can be much more important. Changing river nutrient loads may therefore have a substantial impact on biological productivity in the more productive river-dominated coastal systems, such as the Adriatic Sea.





The Human Mediterranean Basin

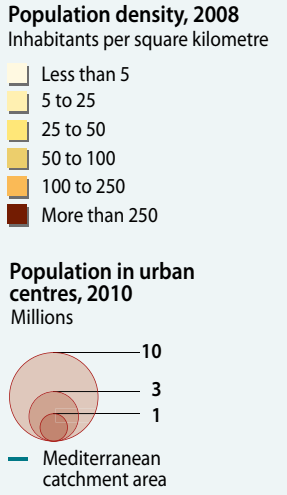
Human population and development

The total population of the Mediterranean countries grew from 276 million in 1970 to 412 million in 2000 (a 1,35 % increase per year) and to 466 million in 2010. The population is predicted to reach 529 million by 2025. Four countries account for about 60 % of the total population: Turkey (81 million), Egypt (72 million), France (62 million), and Italy (60 million) (Plan Bleu computations based on UNDESA 2011). Overall, more than half the population lives in countries on the southern shores of the Mediterranean, and this proportion is expected to grow to three-quarters by 2025 (UNEP/MAP/MED POL 2005).

The Mediterranean region's population is concentrated near the coasts. More than a third live in coastal administrative entities totalling less than 12 % of the surface area of the Mediterranean countries. The population of the coastal regions grew from 95 million in 1979 to 143 million in 2000. It could reach 174 million by 2025 (UN/MAP/BP/RAC 2005). The concentration of population in coastal zones is heaviest in the western Mediterranean, the western shore of the Adriatic Sea, the eastern shore of the Aegean-Levantine region, and the Nile Delta. Overall, the concentration of population in the coastal zone is higher in the southern Mediterranean countries. This is also where the variability of the population density in the coastal zone is highest, ranging from more than 1000 people/km^2 in the Nile Delta to fewer than 20 people/km^2 along parts of coastal Libya.

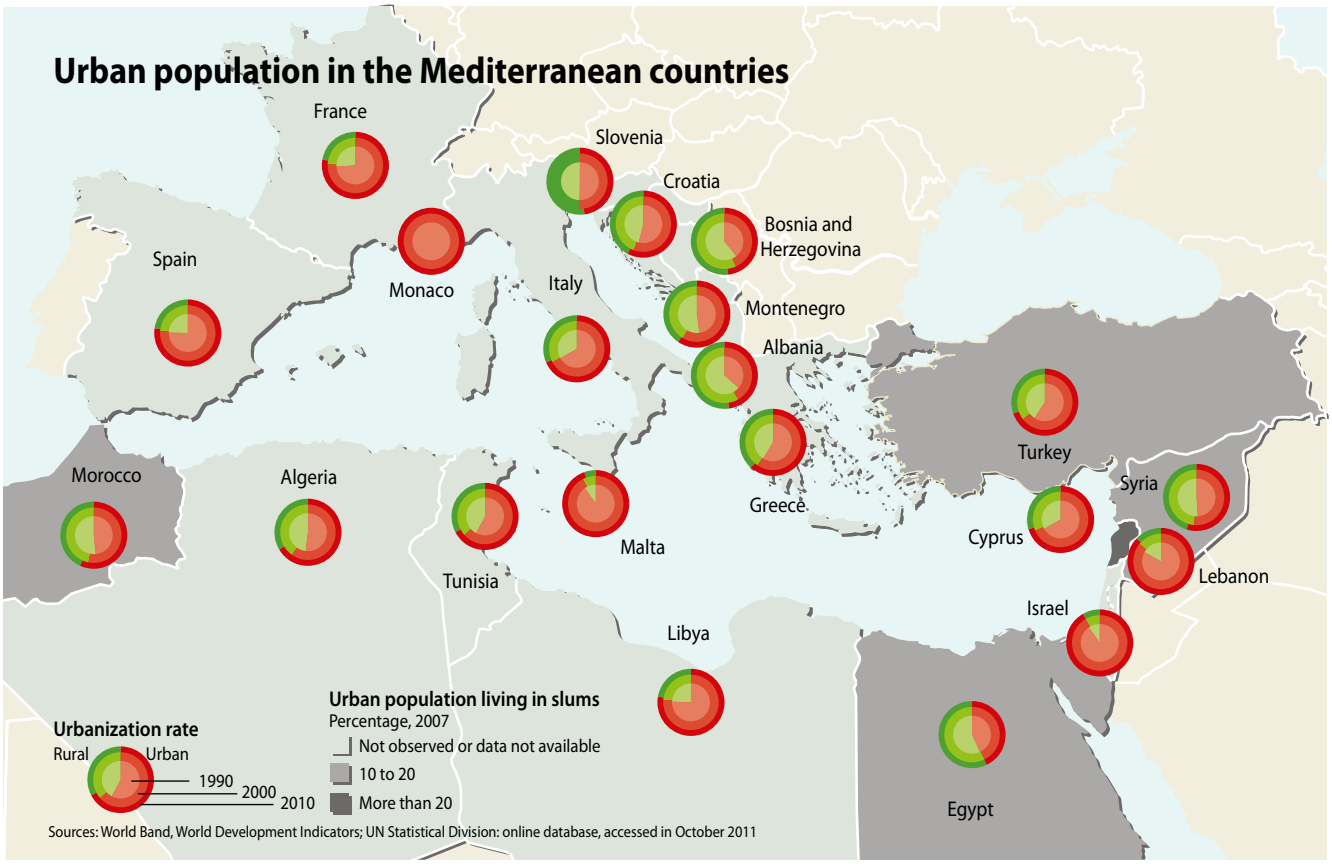
Urban development in the Mediterranean has been very rapid. Of the 190 million people added to the population between 1970 and 2010, 163 million live in towns. Urban population (towns with more than 10.000 inhabitants) increased 1,9 % per year during that period, from 152 million to 315 million. The total could reach 385 million by 2025. More than 74 % of this growth

Population density and urban centres in the Mediterranean basin

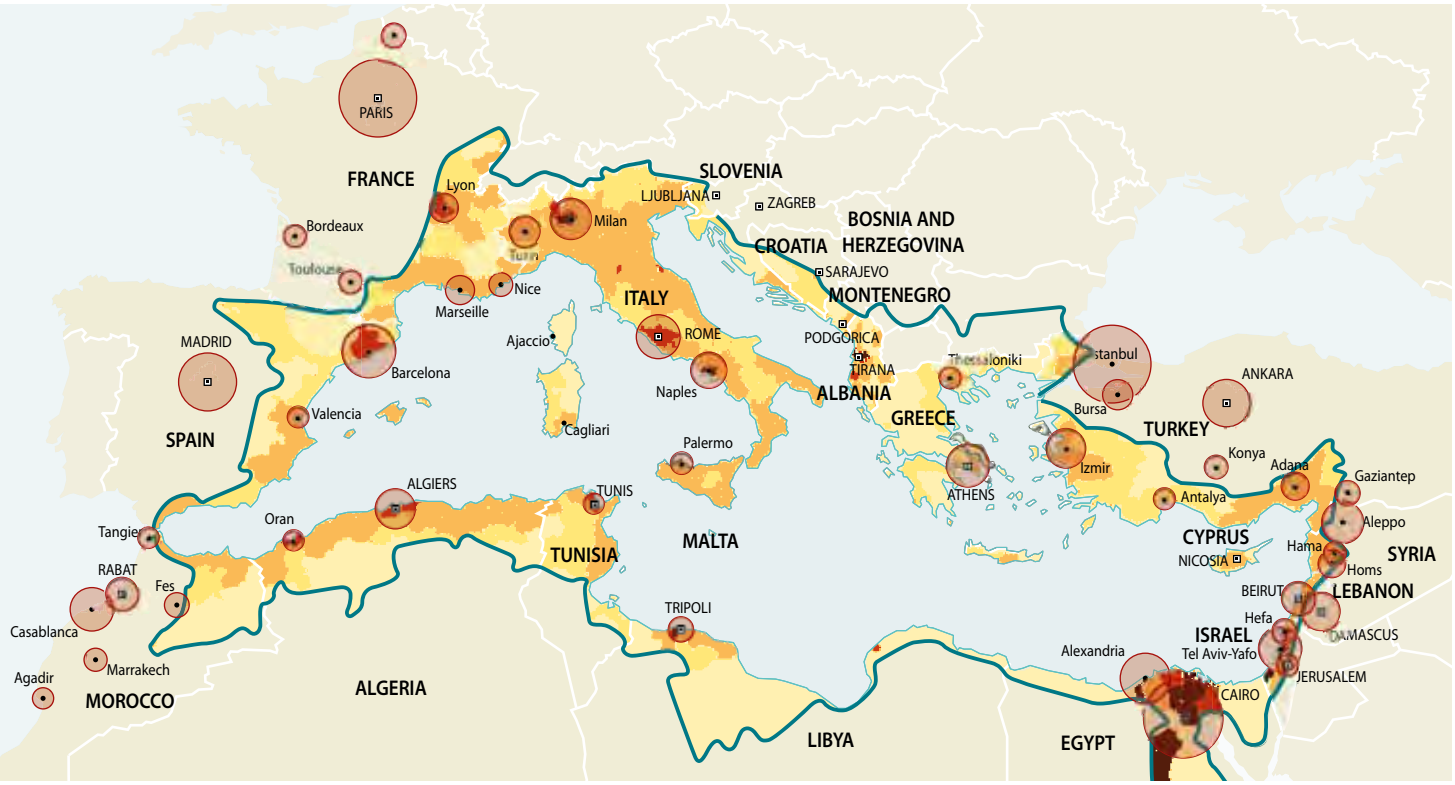


Sources: personal communication with Blue Plan, data collected from national sources, 2011; UNDESA, Population Division, online database, accessed in August 2011.

Urban population in the Mediterranean countries

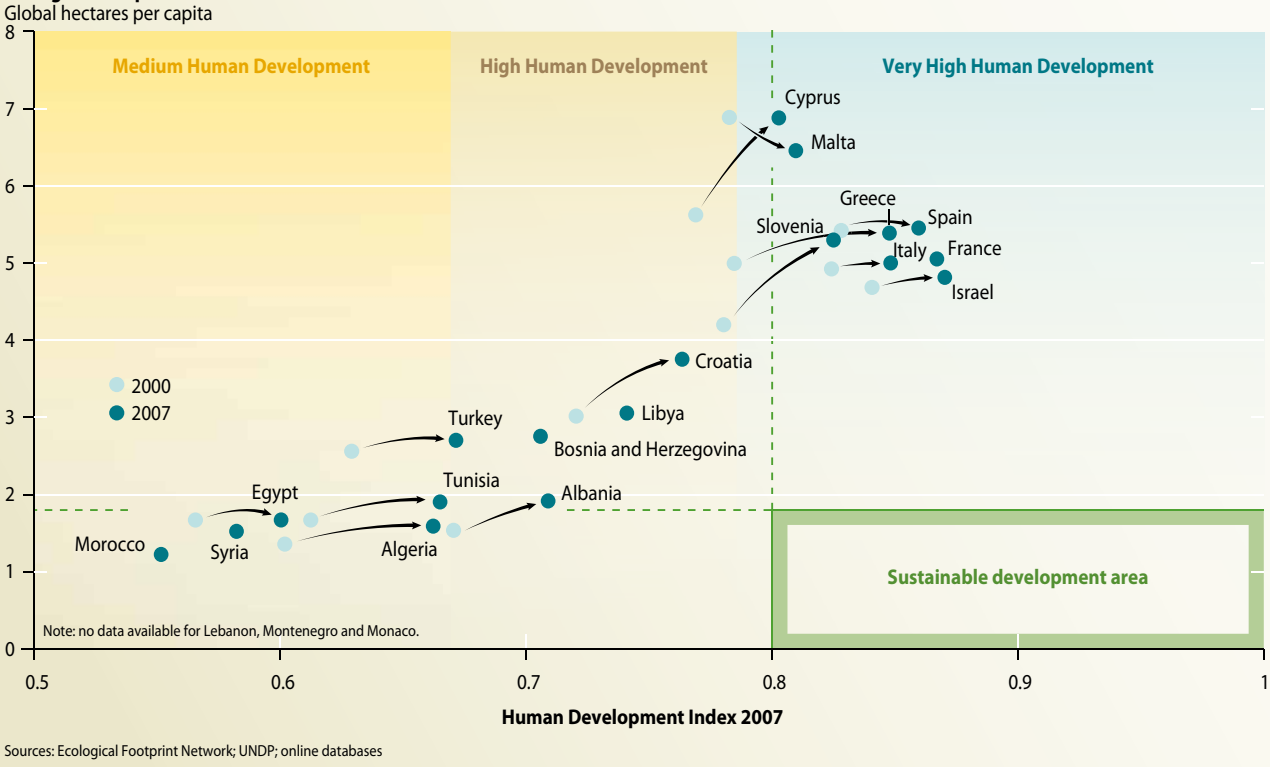


Sources: World Band, World Development Indicators; UN Statistical Division: online database, accessed in October 2011



took place in the south and east, where urban growth from 1970 to 2010 averaged 3,1 % a year, and about 4 % a year in Libya, Syria and Turkey. Urbanisation around the Mediterranean increased from 54 to 66 % over the same period. The south and east Mediterranean is urbanising more rapidly than the rest of the world. Projections indicate a drastic shift in the south and east Mediterranean. What were essentially rural countries, with an average urbanisation of 41 % in 1970, will become urban countries with

Human development and ecological footprint in Mediterranean countries



Sources: Ecological Footprint Network; UNDP; online databases

66 % urbanisation by 2025. (Plan Bleu computations based on UNDESA 2010). In coastal regions, where the urbanisation process results in over-development, the urban population could increase by 33 million (30 million of that increase in the south and east) between 2000 and 2025.

As for the overall distribution of population the number of coastal cities with more than one million inhabitants is largest in the western Mediterranean on the eastern coast of the Levantine basin, and in the Nile Delta region. In absolute terms, population growth remains high, and its impacts on the environment are likely to increase because of the greater number of people in cities and on the coasts.

The long history of the Mediterranean has led to a diversification of political and governance approaches, a broad range in economic development, and a diversity of social systems, all of which is reflected in the levels of development and the ecological footprints of the Mediterranean states. The ecological footprint is a measure of human demand on the Earth's ecosystems and it represents the amount of biologically productive land and sea area necessary to supply the resources a human population consumes, and to assimilate associated waste.

Mediterranean countries can be separated into two groups:

1. middle-income countries, with low Human Development Indices (HDIs) and small ecological footprints plus substantial progress in HDI, concentrated in the southern and eastern Mediterranean and on the eastern shore of the Adriatic Sea; and
2. high-income countries, with high HDIs and large ecological footprints. These are the EU Mediterranean countries and Israel.

Between 2000 and 2007, all Mediterranean countries both improved their HDIs and increased the size of their ecological footprints, with the exception of Malta, which managed to decrease its ecological footprint (UNEP/MAP/BP 2011).

Human economic activities have an impact on the structure and function of natural ecosystems and on the many services provided by these ecosystems such as recreation, climate regulation and provision of natural resources, either living, such as fish and molluscs, or non-renewable, such as oil and gas and minerals. Coastal areas and their landscapes, in particular, face significant pressures from heavy concentrations of population and economic activities. As the coastal population grows and urbanises, natural coastal habitats and landscapes get further fragmented, the land use changes towards more anthropogenic with the corresponding change in the landscapes leading to decreasing integrity of coastal landscapes and ecosystems.

Economic sectors

Agriculture and forestry

Agriculture in the Mediterranean Basin, despite many different sub-climates, is mainly rain-fed. Cereals, vegetables, and citrus fruits account for over 85 % of the Mediterranean's total agricultural production (UNEP/MAP/BP/RAC 2009). Cultivation of other products, such as olives for olive oil and grapes for wine, also occupies a significant amount of agricultural land (Leff *et al.* 2004).

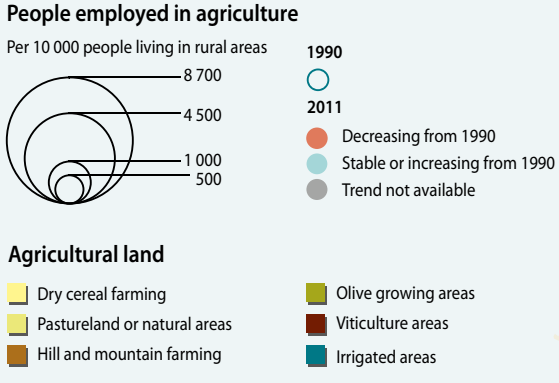
Production of vegetables, cereals, and citrus fruits has increased to between 2,5 and 5 times the production levels of the 1960s. The total surface area of cultivated land in the Mediterranean Basin, however, has remained approximately stable over this period. The increase results from intensified production through greater use of irrigation (approximately 20 million hectares in 1960, rising to 38 million hectares in 1999). Despite higher production, countries on the eastern and southern shores of the Mediterranean still depend on food imports to meet the requirements of an increasing population (UNEP/MAP/BP/RAC 2009).

Besides rain-fed or irrigated cultivation, other common agricultural land uses in the Mediterranean Basin are pasture, animal feedlots, dairy farming, and orchards. Aquaculture is also practised. All of these activities have environmental implications. Fertilising, tillage, application of pesticides, manure spreading, and cattle breeding feed nutrients (nitrates and phosphates), pesticides, and pathogens into the system (EEA and UNEP 1999). Surficial run-off, sediment transport, and leaching carry them into rivers, ground water, lakes, wetlands, and, ultimately, into the sea.

Especially in the drier parts of the Mediterranean Basin, agricultural production relies on the use, and sometimes over-use, of areas with good soil and adequate rainfall or irrigation water. The need to produce enough food drives over-extension of crops onto marginal land, easily degraded due to irregular rainfall and fragile soils on erosion-prone slopes. This leads to soil erosion, destruction of the woody and herbaceous cover, and a reduction in optimal grazing areas. Animal grazing is displaced, in turn, to poorer grazing areas and forests. The result is over-grazing, with the inevitable degradation of vegetation and soil, aggravating the process of desertification. According to the Intergovernmental Panel on Climate Change (IPCC), the southern shores of the Mediterranean will be strongly affected by climate change, placing an additional burden on agricultural production, which is already limited by constrained natural resources.

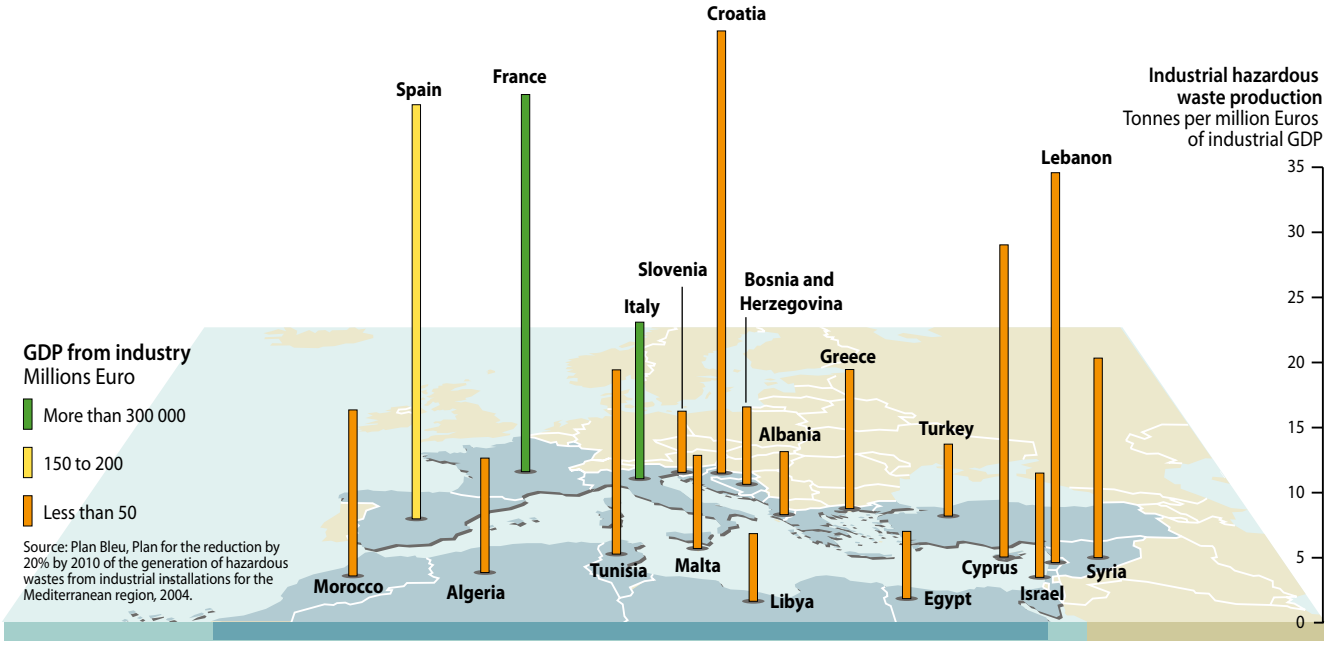
The Mediterranean forests even if characterised by low productivity provide several important ecosystem services (carbon sequestration, biodiversity, landscape quality, preservation of water

Agriculture and population in the Mediterranean basin



Sources: World Band, World Development Indicators, on line database, accessed October 2011; Beilstein, M;, Bournay, E., Environment and Security in the Mediterranean: Desertification, ENVSEC, 2009.

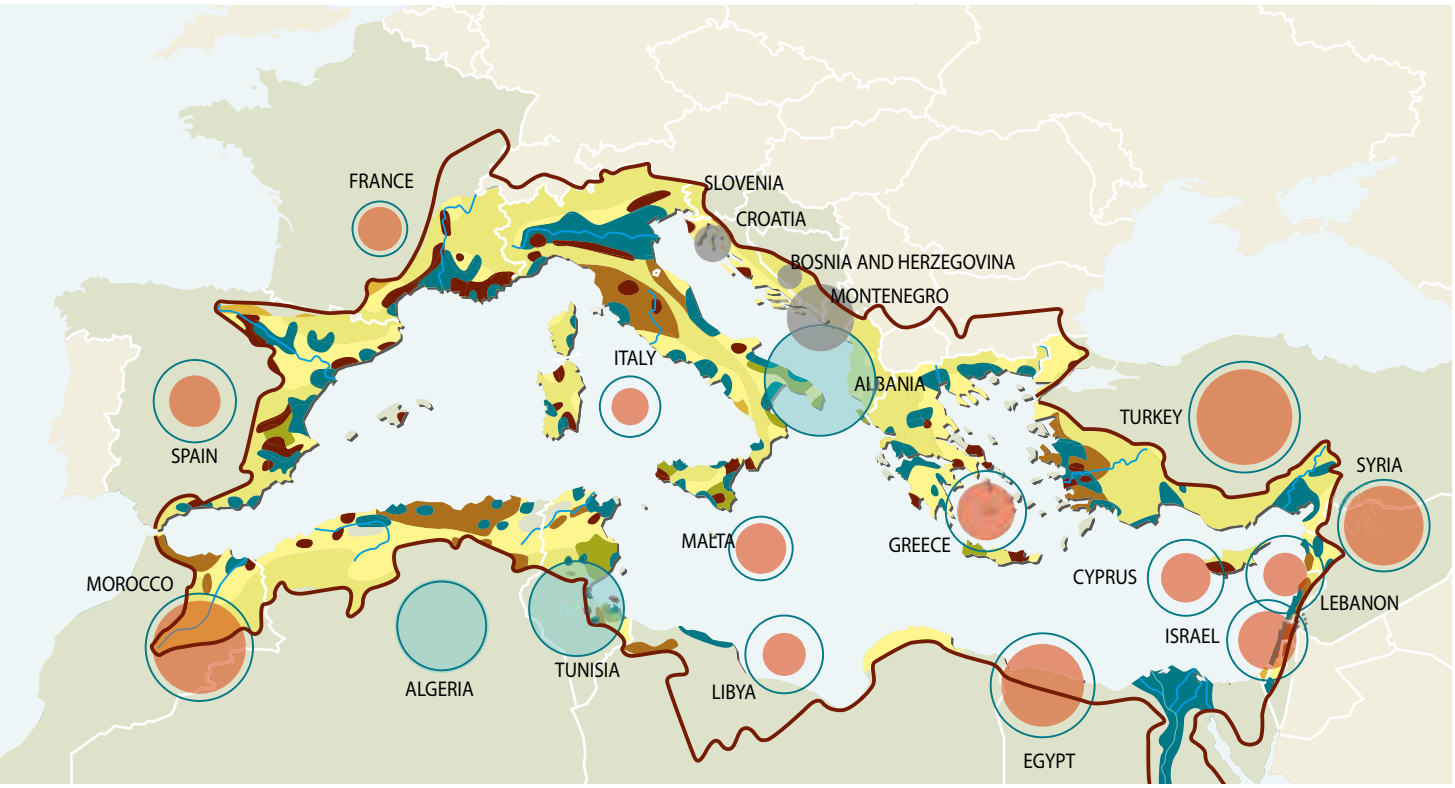
Industrial hazardous waste in the Mediterranean countries



resources and fight against land degradation). Despite their apparent fragility, Mediterranean forest landscapes have been shaped by human activities and have demonstrated for several centuries their strong resilience to changes of anthropogenic origins. However, today they are facing a threat of unprecedented magnitude dominated by climate change and the increase in population that they will have to adapt to in the coming decades. More than a third of the economic value of Mediterranean forests is linked to the production of wood forest products followed by recreation services, watershed regulation, grazing by cattle and the production of non-wood forest products altogether accounting in similar proportions for half of the remaining economic value (FAO/FD 2011).

Mining and manufacturing

The lack of major iron and, especially, coal reserves within the Mediterranean Basin influenced the industrial development path of the countries surrounding the Mediterranean Sea. Steel production has been concentrated in the north (Italy, France, Spain, Turkey and Greece), with a few producers in the south (Egypt, Algeria and Tunisia). Other mining activity in the Mediterranean has focused on mercury (Spain), phosphates (Morocco, and Tunisia), chromite (Albania and Turkey), lead, salt, bauxite (Bosnia and Herzegovina, Croatia, France, Greece, Slovenia and Montenegro) and zinc (Spain and Morocco) (EEA and UNEP 1999).



The existence of oil and gas reserves located in Algeria, Cyprus, Egypt, Israel, Italy, Lebanon, Libya and Syria motivate the presence of more than 40 refineries and petrochemical installations around the Mediterranean that produce ammonia, methanol, urea, ethylene, naphtha, propylene, butane, butadiene, aromatics, and other industrial chemicals. In addition to the mining, petrochemical, and metallurgy sectors, a highly diverse industrial manufacturing sector includes the manufacture of foods, textiles, leather, paper, cement, and chemicals, including fertilisers. However, the geographical distribution of industrial activities in the Mediterranean Basin is uneven, with most industry concentrated in the northwest, particularly in Italy, France, and Spain.

The study of the substances released by the different industrial sectors together with their hazardous nature allowed identifying the following as the most polluting types of industry (UNEP/MAP/MED POL 2012):

- Energy production
- Metal industry
- Manufacture of cement
- Oil refining
- Treatment of urban wastewater
- Chemical industry
- Manufacture of fertilizers

Industry is frequently located along the region's coasts in areas with high population density, sometimes within urban centres, and often in close proximity to other economic activities like agriculture and tourism. This means that pressures brought by industry to coastal and marine environments add to and interact with other types of pressures.

The environmental pressures on the Mediterranean coastal marine environment generated by this broad range of industrial activities are multiple and varied, including the use of territory and natural resources (both marine and non-marine), the generation of waste and the release of pollutants into the atmosphere and water bodies.

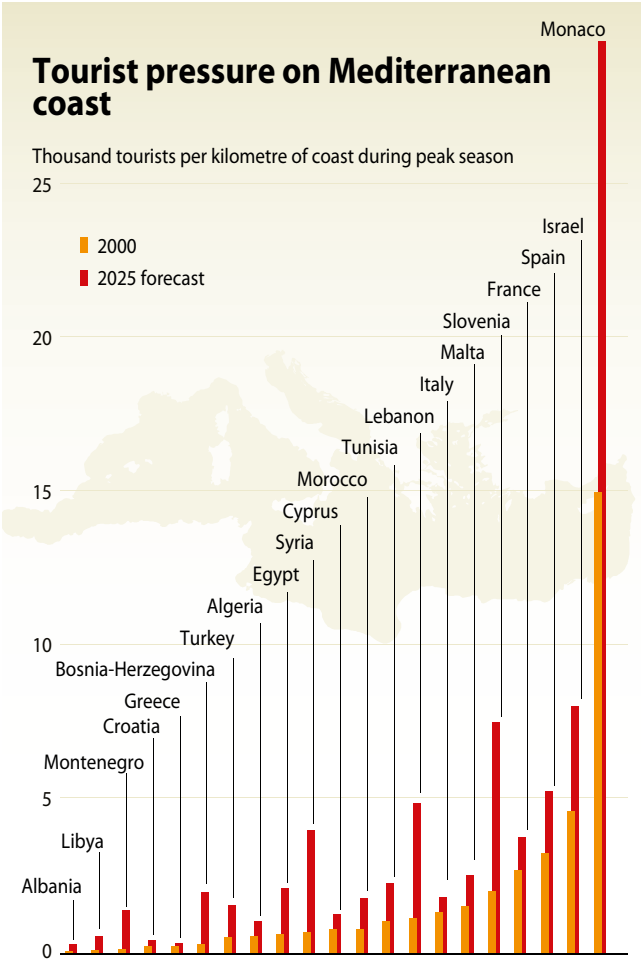
Tourism

The Mediterranean basin, if considered as a single area, is by far the largest global tourism destination, attracting almost a third of the world's international tourists (306 million out of 980 million worldwide) and generating more than a quarter of international tourism receipts (190 out of 738 billion Euro worldwide). It is forecasted that the Mediterranean region will reach 500 million of international tourist arrivals by 2030 (UNWTO 2012). The bulk of the tourists are of European origin (81,1 % in 2010) followed by Middle East tourists (6,4 %) that recently have outnumbered those coming from the Americas (5,7 %). Domestic tourism is also significant in the region. Of a total of 450 million visitors each year, including both domestic and international tourists, 100 million stay on the Mediterranean coast of their own host country, considerably increasing human concentration there (UNEP/MAP/MED POL 2005).

Mediterranean tourism includes emigrants returning to their homelands during the summer holiday period, which produces a noticeable flow of visitors over a short period of time. This kind of tourism is not always focused on the coast. In Israel, for example, tourism is mostly related to pilgrimage and family visits. Fewer than a quarter of such visitors stay on the Israeli coast. Still, tourism in the Mediterranean Basin is strongly coastal, with more than half of all visitors (and as high as 90 % of visitors to some countries) visiting coastal areas. Tourism is heavily seasonal, peaking in July and August.

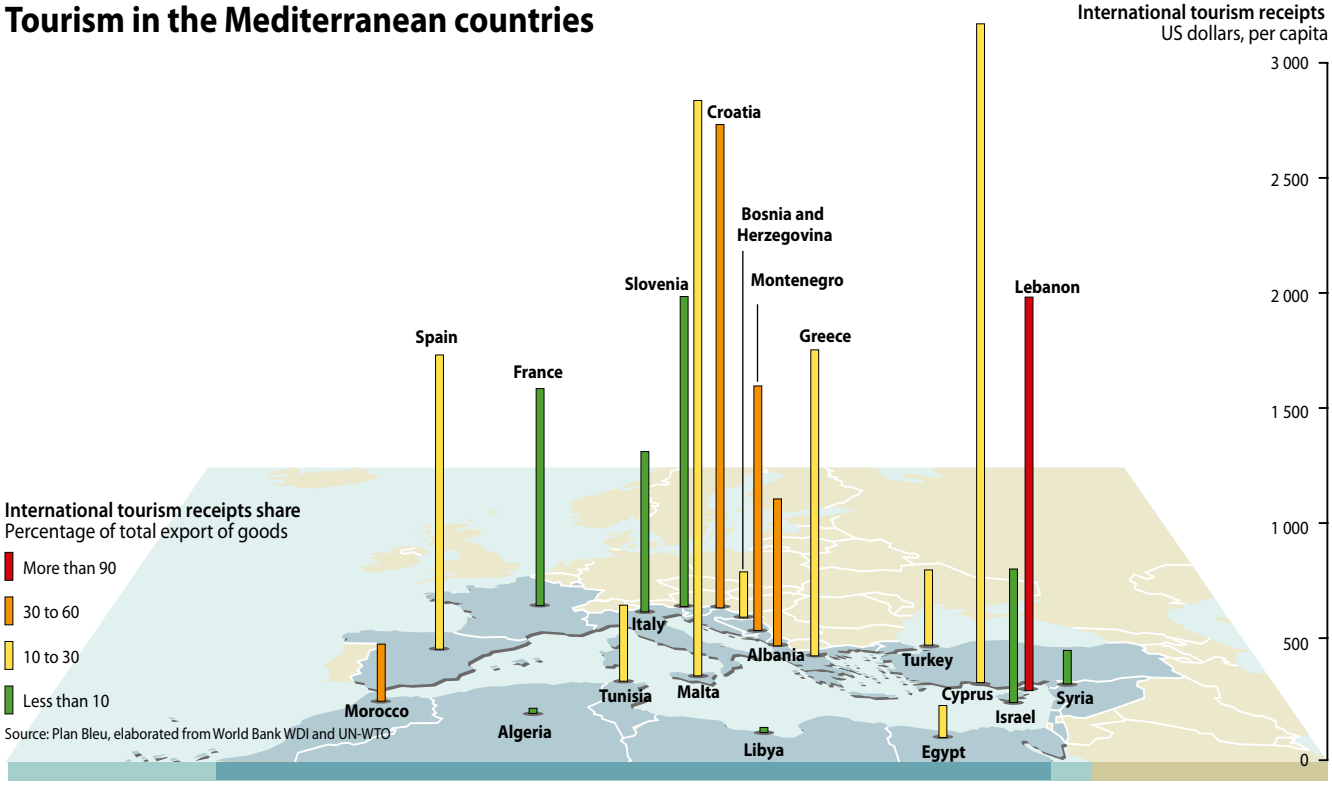
The tourism sector is more developed in the advanced economies of Europe, with more than two thirds of international tourism arrivals concentrated there. Still emerging economy destinations in the Eastern Mediterranean, North Africa and the Middle East experienced above average growth (9 % a year), with international arrivals more than tripling between 1995 and 2010. Average growth in this period was 12 % a year in the Middle East, 6 % in North Africa, and 9 % in emerging Europe. 2011-2012 were particularly challenging years for North Africa and the Middle East destinations in terms of international tourist arrivals with a drop of 31 % in the Middle East and 10 % in North Africa. Long-term forecasts still show that emerging country destinations are expected to grow faster than mature destinations. For the period 2010–2030, Mediterranean Africa (4,6 % a year), the Middle East (4,5 %) and the emerging economies of Europe (4,1 %) are expected to significantly outgrow the advanced economies of Europe (1,6 %) (UNWTO, 2012).

Tourism is a vital part of the Mediterranean economy and an extremely important source of employment and foreign currency for all the states bordering the Mediterranean Sea. The amenities and recreational opportunities for tourism provided by the Mediterranean's marine and coastal ecosystems form the foundation for more than 68 % of the total value of economic benefits provided by these ecosystems and about 17 % of total international tourist spending (UNEP/MAP/BP 2010).



Source: WTO; Plan Bleu, 2003; Attané and Courbage, 2001; Géopolis.

Tourism in the Mediterranean countries



Tourism contributes CO_2 emissions, mostly through increased use of air and road transportation. Beyond that, the major direct pressure from coastal tourism on the marine and coastal environment is the demand for space, both in the coastal zone, resulting mainly in urbanisation, and on the coastline itself, through construction of marinas and other infrastructure that leads to concretisation of the shores. The concentration of tourism within specific geographical areas and limited time periods increases pressure on natural resources such as fresh water and leads to higher rates of sewage and solid waste production. Coastal tourism is, by definition, located in sensitive habitats within the coastal zone, such as beaches, sand dunes, and wetlands. The unavoidable result is change in the state of these habitats and their associated ecosystems, as well as economic impacts on other activities that benefit from coastal ecosystem services. Unsustainable development of mass tourism will result in the rapid degradation of fragile natural habitats (EEA and UNEP 1999, UNEP/MAP/MED POL 2005).

Marine transport

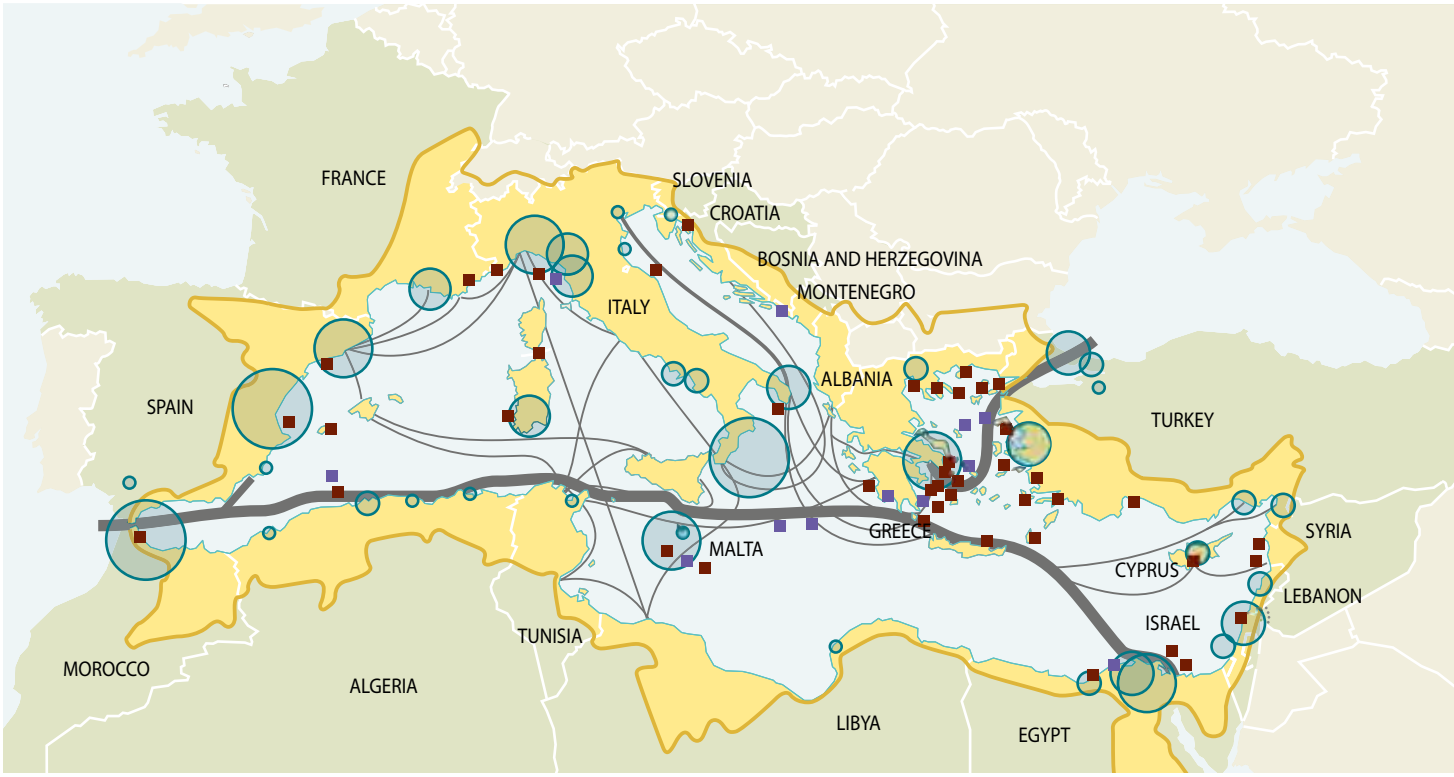
Another strong traditional economic sector in the Mediterranean is transport, specifically maritime transport. The Mediterranean Sea is among the world's busiest waterways, accounting for 15 % of global shipping activity by number of calls and 10 % by vessel deadweight tonnes (dwt). More than 325.000 voyages occurred in the Mediterranean Sea in 2007, representing a capacity of 3.800 million tonnes. Almost two-thirds of the traffic was internal (Mediterranean to Mediterranean), one-quarter was semi-transit voyages of ships mainly of small size, while the remainder was transit voyages, mainly by large vessels travelling between non-Mediterranean ports through the Mediterranean's various straits: the Straits of Gibraltar, the Straits of the Dardanelles, and the Suez Canal (data provided by REMPEC).

During the last ten years, merchant vessels operating within and through the Mediterranean have been getting larger and carrying more trade in larger parcels. Vessels transiting the Mediterranean average 50.000 dwt and are, on average, more than three times larger than those operating within the Mediterranean. Transit densities, measured in terms of ship voyages, are dominated by high-frequency, small-size intra-Mediterranean passenger traffic. However, the majority of trade, including petroleum oils and gases, is concentrated in larger vessels sailing less frequently (data provided by REMPEC).

The major axis, which sees 90 % of total oil traffic, is from east to west, connecting the eastern passages of the Straits of the Dardanelles and the Suez Canal with the Straits of Gibraltar. This axis passes between Sicily and Malta and closely follows the coasts of Tunisia, Algeria and Morocco. Traffic branches off as it moves westward to unloading terminals in Greece, the northern Adriatic, the Gulf of Genoa and near Marseilles. It is intersected by tanker routes connecting Algerian and Libyan loading terminals with the northern Mediterranean oil ports. From the eastern Mediterranean another important route links crude oil terminals in the Gulf of Iskenderun and on the Syrian coast with the main axis (EEA and UNEP 1999).

Passenger ships (34 % and concentrated in the western Mediterranean) and dry cargo ships (31 %) make up the majority of ships calling at Mediterranean ports. Ships transiting through the Mediterranean without stops are dominated by dry cargo ships, which account for nearly two-thirds (61 %) of the voyages. Other transiting ships are container ships (13 %), tankers (chemical tankers 8 %, product tankers 5 %, crude oil tankers 4 %), and passenger ships (4 %). Container ships and tanker ships, however, represent an important part of the tonnage.

The Mediterranean is a major load and discharge centre for crude oil. Approximately 18 % of global seaborne crude oil shipments take place within or through the Mediterranean, even if only 2 % of the ship calls are crude oil tankers. The major traffic lanes are dominated by crude oil shipments from Novorossiysk (in the Black Sea) through the Straits of the Dardanelles to Mediterranean destinations, as well as exports from the Persian Gulf



through the Suez Canal and the Sumed pipeline (ending at Sidi Kerir, close to Alexandria), both to Mediterranean destinations and to ports west of Gibraltar. Transit voyages in 2006 accounted for only 15 % of the crude oil voyages. The remainder of the voyages either originated from or ended at Mediterranean ports.

Liquefied natural gas (LNG) and liquefied petroleum gas (LPG) shipments also make up a considerable proportion of the energy-related shipments in the Mediterranean. The vast majority are intra-Mediterranean exports from North Africa to other ports in the Mediterranean, mostly in Europe.

The forecast for maritime transport in the Mediterranean points to an increase in traffic, linked in part to increased exports of crude oil from the Caspian region and the Black Sea. Another factor is improved infrastructure in Central and Eastern Europe, which could lead to an increase in bulk cargo through the Adriatic ports, rather than through Northern European ports, which is the current practice.

The major maritime-transport-related impacts that affect marine environment are pollution from marine accidents and from antifouling-paint biocides, the introduction of pathogens and invasive species, ship-strike mortality of cetaceans and sea turtles, and underwater noise. Despite the regulation and eventual banning of the discharge of waste at sea, the practice of dumping waste and other harmful substances continues to occur. Ongoing marine dumping, plus the legacy from past dumping, continues to subject the marine environment to considerable pressure.

With regards to the coastal zone the development of maritime transport is inherently linked to the development of coastal infrastructures such as ports and motorways and railways connecting inland areas to the ports. The development of large logistic coastal infrastructures brings, amongst others, fragmentation of coastal landscapes and habitats, changes in the land use and increased pollution loads.

Coastal and marine natural resources

Coastal and marine resources include both non-living resources, such as fertile soil, fresh water, and fossil fuels, and living resources, such as fish. The availability of these resources is a precondition for sustainable economic development in the region. The Mediterranean Basin faces growing problems with degradation of land resources and water scarcity as a result of human activity. Fisheries, also vital to Mediterranean economies, are threatened by over-exploitation and unsustainable practices (UNEP/MAP/MED POL 2005).

Water stress in the Mediterranean basin

Water Exploitation index[1]
Percentage, 2000-2010

- Less than 20
- 20 to 40
- 40 to 60
- 60 to 80
- more than 80

1. Ratio of annual volume extracted from natural esources/annual average volume of renewable natural sources

Existing and planned desalination plants
Capacity, thousand cubic metres

- More than 50
- 50 or less

Desertification

- Severe desertification area

Sources: Blue Plan, informations based on national sources; *Water, energy, desalination & climate change in the Mediterranean*, 2008; IDA Worldwide Desalting Plants Inventory; Beilstein, M;, Bournay, E., Environment and Security in the Mediterranean: Desertification, ENVSEC, 2009.

Maritime transportation routes in the Mediterranean

Maritime accidents
2000-2009
- Oil spill occurred
- Noxious substance spill occurred

Main shipping routes
- Very high intensity
- Lower intensity

(Line thickness indicates volume of traffic)

Container traffic, 2005
Thousands containers or equivalent
- 2 100 to 3 180
- 1 200 to 2 100
- 600 to 1 200
- 300 to 600
- 40 to 300

One container is equal to 39 cubic metres

Sources: REMPEC; ; Beilstein, M;, Bournay, E., Environment and Security in the Mediterranean: Desertification, ENVSEC, 2009.

Soil and freshwater

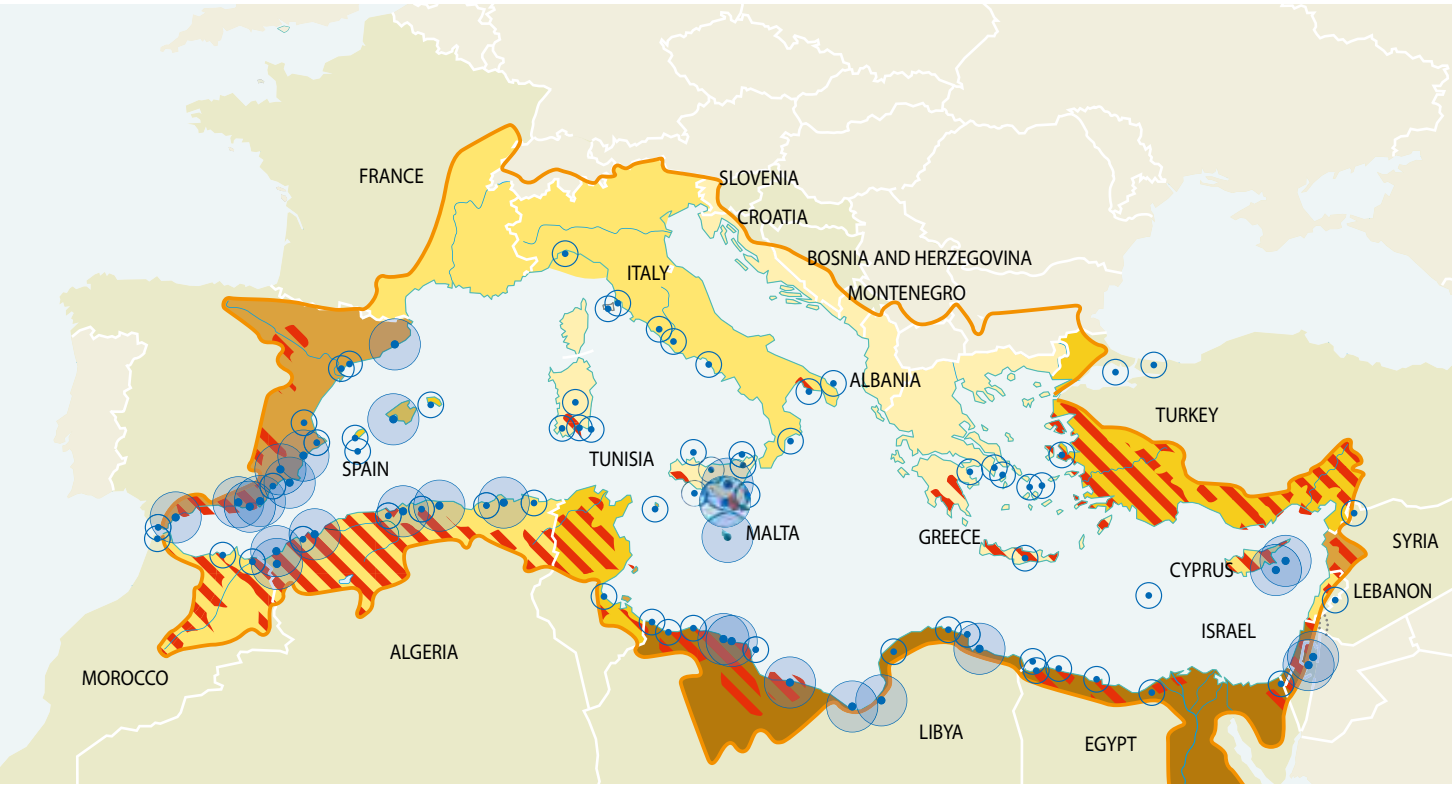
Around the Mediterranean Sea, alluvial and coastal plains are few and not extensive, the Nile Delta being by far the largest. The coastal lowlands are particularly vulnerable to climate change, which can affect hydrology, sea levels and ecosystems. They are also threatened by the results of human activity, such as pollution and sediment flow from intensive agriculture and industrial development, both local and upstream. The intensification of agriculture, in particular, has reinforced a long-term trend toward desertification in the region. About half of Mediterranean lands are subject to the risk of erosion (UNEP/MAP/MED POL 2005) and therefore of soil loss.

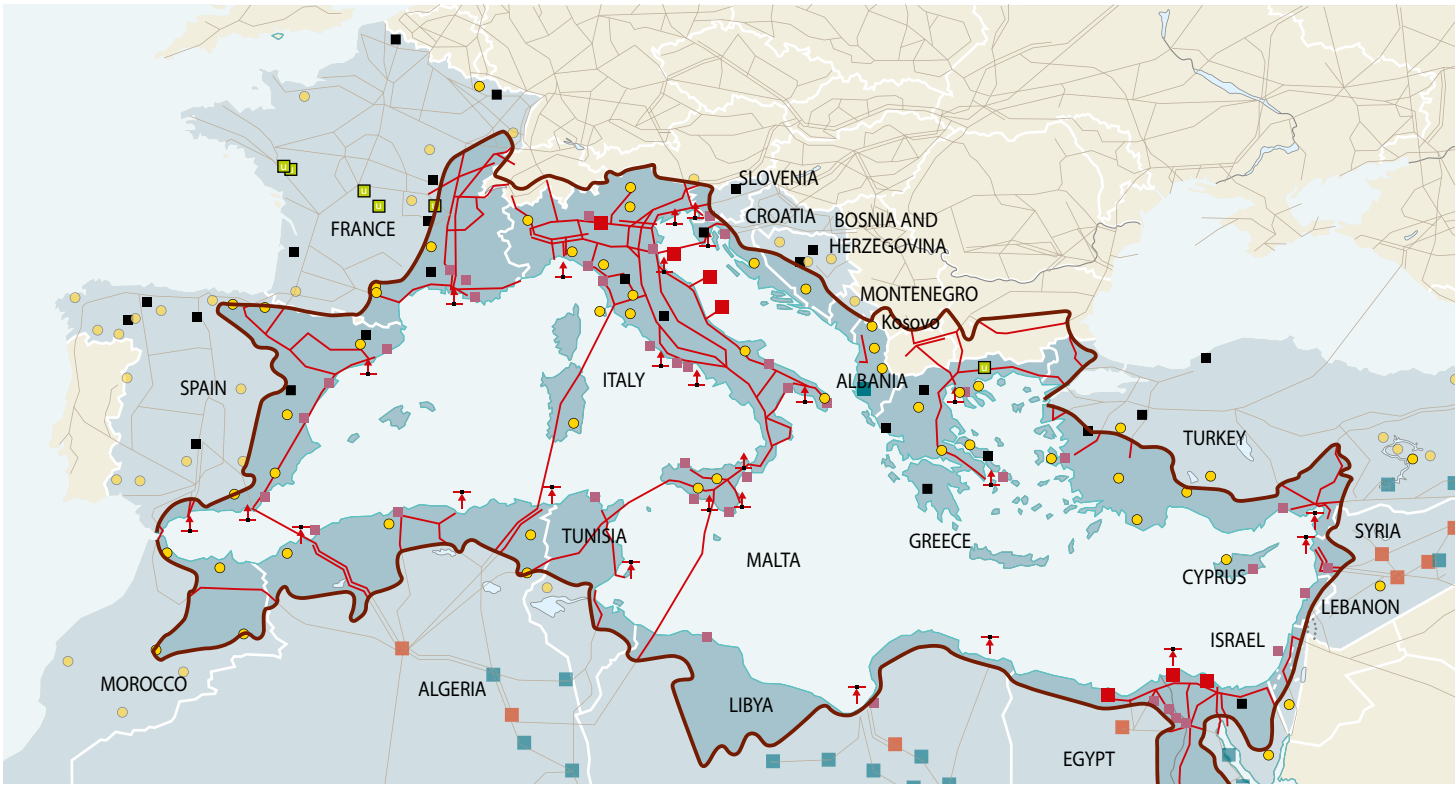
Agricultural irrigation and population growth are also reducing the flow of fresh water in the rivers that feed the Mediterranean's alluvial plains. In most Mediterranean countries with an erratic rainfall pattern, many of the available sources of water have already been developed or are currently being developed. Estimates by Blue Plan conclude that by the year 2025, eight of the twelve southern and eastern Mediterranean countries could be consuming more than the total of their renewable water sources (UNEP/MAP/MED POL 2005). Already, all major rivers flowing into the Mediterranean have had much of their flows diverted to agriculture and other uses over the past 40 years, resulting in a 20 % reduction in freshwater inflow into the Mediterranean (Ludwig *et al.* 2009).

Oil and gas

The oil industry is extremely active in the Mediterranean Basin, with Libya, Algeria and Egypt considered moderate-sized petroleum producers and refineries distributed all around the basin. In some countries, such as Greece, Italy, Cyprus, Israel, Lebanon and Turkey, domestic oil and gas production is relatively small, but exploration is very active especially since the recent vast discoveries and assessment of undiscovered reserves in the Levantine Basin Province in the eastern Mediterranean (EEA and UNEP 1999, Schenk *et al.* 2010). Complex geology and large, unexplored regions contribute to the uncertainty in determining the size of hydrocarbon resources in the Mediterranean region. The total known oil reserves are estimated at more than 45.000 million barrels. Exploration is the focus of most companies operating in the area and the most attractive exploration regions are located in both onshore and offshore areas.

Among the better prospects are four in Algeria (at Ghadamis and Illizi basins near the Algeria-Tunisia-Libyan borders), three in Libya (at Sirte, Ghadamis and Murzuq basins), six in Egypt (at Ashrafi in the Gulf of Suez, East Tanka offshore, Western Desert, Meleiha, Qarum and Abu Gharadiq), four in Greece (north-west Peloponnesus, Ioannina, Aitoloakrnania and the Gulf of Patraikos



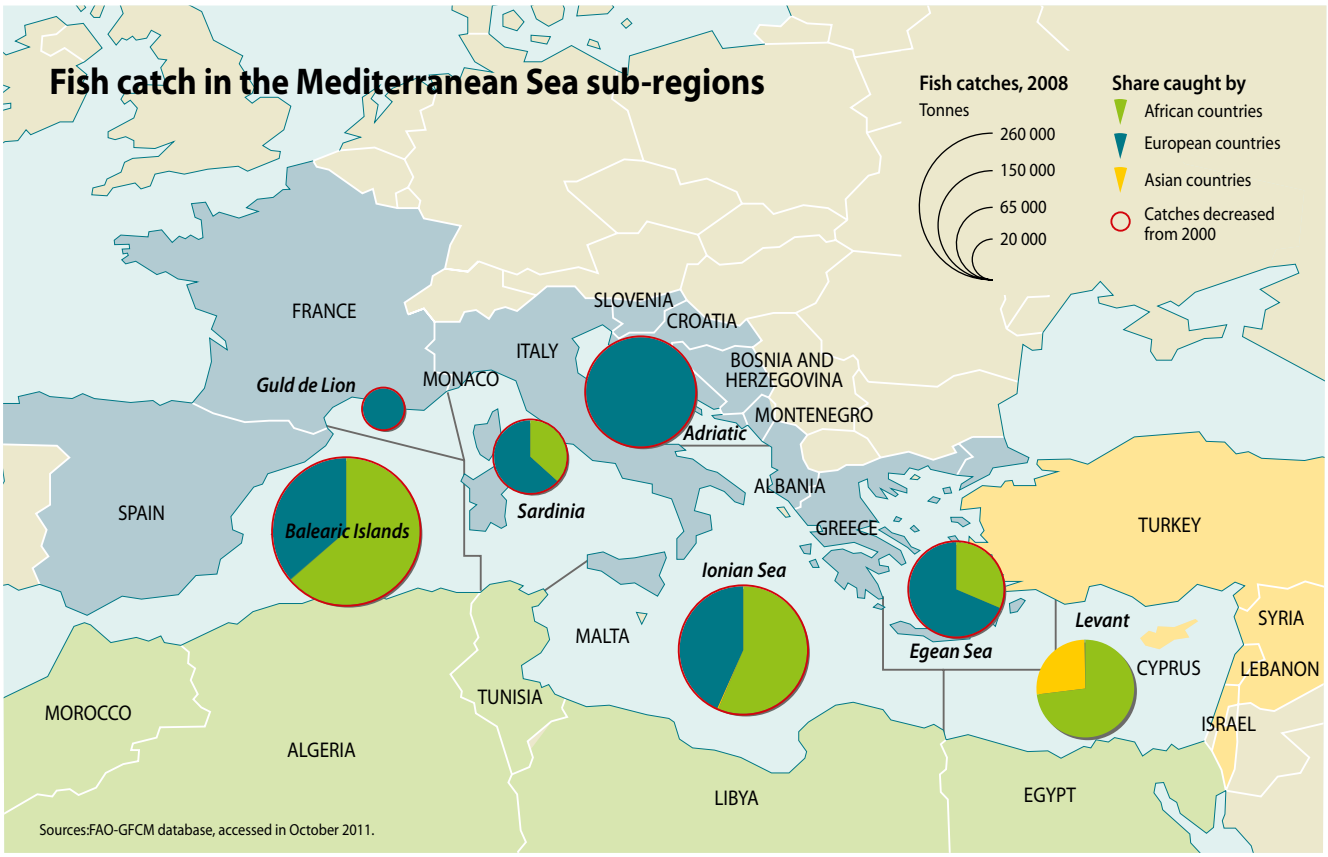


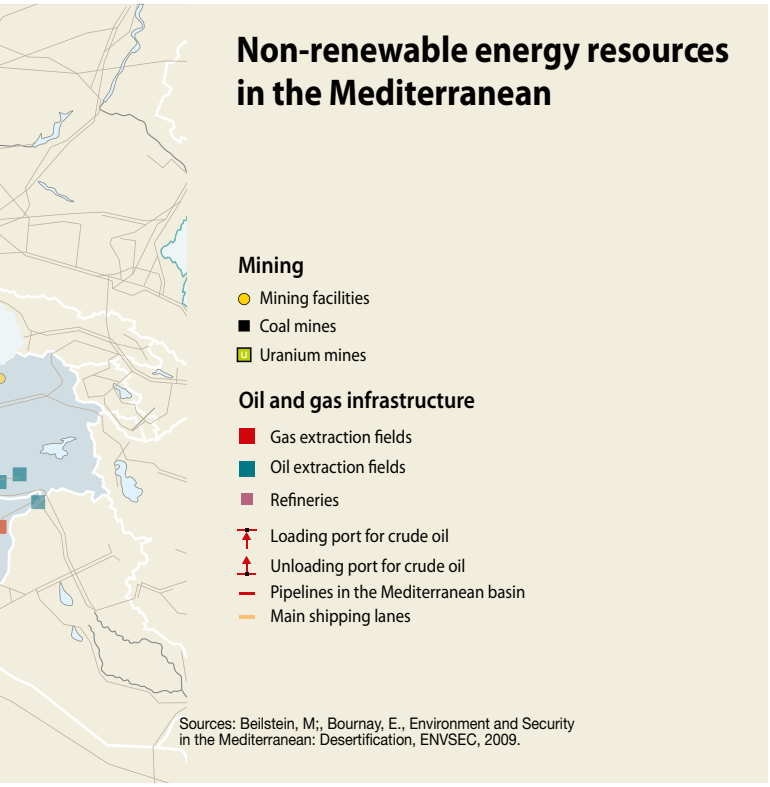
offshore), three in Italy (Val d'Agri in the southern region of Basilicata, Abruzzo, offshore, and in the lower Adriatic Sea off Brindisi) (EEA and UNEP 1999), and very considerable reserves in the Levantine Basin Province (Schenk *et al.* 2010).

The active trade and distribution of oil and gas in the Mediterranean Basin, both on land and at sea, involves an extensive network of crude oil pipelines and gas line systems, mainly in the countries of production, linking their oilfields to their refineries and port terminals or to other countries.

Fisheries

Fishing is an important issue for the Mediterranean. Although it puts only a relatively small quantity of produce on the market compared with the demand, it is a significant source of employment and an important component of the Mediterranean cultural identity. It ac-





counts for 420.000 jobs, 280.000 of which are fishermen, and the average prices of landed produce are much higher than world prices.

The sustainability of fish resources (and, consequently, of fishing) is favoured by the diversity of water depths and by the presence of many refuge zones for spawning, two factors that can increase the resilience of fish populations to pressures. The exceptionally high proportion of small-scale operators engaged in commercial fishing is also an advantage in terms of sustainability. Small-scale inshore fishing operations target commercially valuable fish, have a high ratio of jobs created to the quantity of fish landed and are much more selective in their catch than large-scale industrial fishing (trawl nets in particular). Over 85 % of the boats in the Mediterranean fishing fleet (71.800 out of a total of 84.100) are involved in small-scale fisheries. These boats are sometimes not motorised (for example, 4.000 of the 13.700 fishing boats in Tunisia are not motorised).

Many fishermen have several jobs (for example, 80 % of fishermen in Malta and 92 % in Syria). The percentage of the total catch that is from inshore fishing varies among countries (87 % for Syria, 58 % for Cyprus, 56 % for Greece, 44 % for Tunisia, 41 % for Italy, 39 % for Israel and 10 % for Slovenia). The industrial fleet is concentrated mainly in the EU-Mediterranean countries (57 % of the total fleet). Recreational fishing accounts for 10 % of the total catch, which is substantial (UNEP/MAP/BP 2005).

Mediterranean fish landings represent a small fraction of the worldwide total – just over 1 % of the total landings, by volume. This is a significant level of fishing pressure, however, given that the Mediterranean Sea represents less than 0,8 % of the global ocean surface. Moreover, fishing in the Mediterranean tends to be concentrated in the in-shore areas, with some boats fishing on the continental slope for prized species such as the pink shrimp (*Aristeus antermarus*), the deepwater rose shrimp (*Parapenaeus longirostris*), and hake (*Merluccius merluccius*). Deep-water areas are currently not exploited and are highly unlikely to be exploited in the short term. Mediterranean fish production currently ranges from 1,5 million t/year to 1,7 million t/year. 85 % of production is attributable to six countries (Italy, Turkey, Greece, Spain, Tunisia and Algeria). Mediterranean fishing no longer satisfies demand in the coastal nations, supplying, on average, one-third of the demand for fish (UNEP/MAP 2012).