SoED 2020

State of the Environment and Development in the Mediterranean

UN environment programme | Mediterranean Action Plan Barcelona Convention | Plan Bleu

www.planbleu.org/soed
Enquiries: planbleu@planbleu.org

ISBN 978-92-807-3796-7

SoED State of the Environment and Development in the Mediterranean

SoED

State of the Environment and Development in the Mediterranean

UN environment programme | Mediterranean Action Plan Barcelona Convention | Plan Bleu

Copyright © United Nations Environment Programme, 2020
ISBN 978-92-807-3796-7 - Job No DEP/2294/NA

This publication may be reproduced in whole or in part and in any form for educational or non-profit services without special permission from the copyright holder, provided acknowledgement of the source is made. UNEP and Plan Bleu would appreciate receiving a copy of any publication that uses this publication as a source. An online version of this work is published at www.planbleu.org/soed which permits re-use, distribution and reproduction in any medium for non-commercial purposes providing appropriate credit to the original work is given. No use of this publication may be made for resale or any other commercial purpose whatsoever without prior permission in writing from UNEP. Applications for such permission, with a statement of the purpose and extent of the reproduction, should be addressed to the Director, Communication Division, UN Environment Programme, P. O. Box 30552, Nairobi 00100, Kenya. All versions of this work may contain content reproduced under license from third parties. Permission to reproduce this third-party content must be obtained from these third-parties directly.

The Key Messages and Summary for Decision Makers of the State of the Environment and Development in the Mediterranean have been adopted by the Contracting Parties to the Barcelona Convention at their 21st Conference of Parties in Naples, Italy (2-5 December 2019), (Decision IG.24/4). More information on the UNEP/MAP – Barcelona Convention system is available at https://web.unep.org/unepmap/.

This publication has been made possible through the collaboration of more than 150 contributors, who are listed in the full report.
In the framework of the UNEP/MAP – Barcelona Convention, this publication has been edited by:
Plan Bleu Regional Activity Centre
Tour la Marseillaise, 16e étage
2 bis, Boulevard Euroméditerranée - Quai d'Arenc
13002 Marseille, France
www.planbleu.org
Editors: Elen Lemaitre-Curri and Lina Tode

This publication has been funded by the Mediterranean Trust Fund of the UNEP/MAP- Barcelona Convention, the French Ministry of Ecological and Solidarity Transition, the French Environment and Energy Management Agency (ADEME), and the French Rhone Mediterranean Corsica Water Agency (AERMC).

Preferred citation: United Nations Environment Programme/Mediterranean Action Plan and Plan Bleu (2020). State of the Environment and Development in the Mediterranean. Nairobi.
Preferred in-text citation: UNEP/MAP and Plan Bleu, 2020.

Cover design and layout by Zen design studio (Marseille)
Copy-editing by Connected Language Services
This publication is printed according to high environmental standards.
Paper: chlorine-free, FSC recycled
Printed by Marseille Imprimerie

Disclaimer:
The designations employed and the presentation of material in this publication do not imply the expression of any opinion whatsoever on the part of UNEP, UNEP/MAP, Plan Bleu or contributory organizations, concerning the legal status of any country, territory, city area or its authorities, or concerning delimitation of its frontiers or boundaries. The views expressed in this publication do not necessarily reflect the views of UNEP, UNEP/MAP, Plan Bleu or contributory organizations..

SoED2020

State of the Environment and Development in the Mediterranean

Foreword

Since its inception in 1975, the Mediterranean Action Plan of the United Nations Environment Programme (UNEP/MAP) has equipped Contracting Parties with a solid understanding—distilled by the Plan Bleu Regional Activity Centre— of the state, dynamics and interactions of environment and development in the Mediterranean. In the last four decades, a growing wealth of knowledge generated by Plan Bleu has benefited stakeholders in the region in an inclusive manner, and many have used it for evidence-based decision-making. The present State of the Environment and Development in the Mediterranean (SoED) report continues in this tradition, providing recent information on a broad range of interconnected topics and insight for priority action. Prepared in collaboration with over 150 contributors and reviewers, it is a major milestone in our constant effort to strengthen dialogue between science, policy and practice.

This report comes at a historical turning point for the region and the world. In the first half of 2020, COVID-19 has spiraled into a pandemic, compounding a set of intersecting crises already affecting the Mediterranean region. The pandemic is taking a hefty toll through loss of life, human suffering and massive economic disruptions in our region, with much of its medium- and long-term impacts yet to be fully apprehended. As we launch the SoED and in response to the socio-economic crisis caused by COVID-19, Mediterranean countries are in the process of introducing policies, measures and stimulus packages to support recovery. Millions of jobs are on the line and according to initial estimates, the crisis has knocked several percentage points off national income. There is no silver lining to be found in the COVID-19 pandemic, but we believe that our region must seize a historic opportunity to recover in a smart, evidence-based green fashion.

The SoED brings to the decision-makers' fingertips a timely compilation and analysis of the most comprehensive and up-to-date knowledge available on the environment and development in the Mediterranean. This will be crucial for informed decision-making in this period of high uncertainty. If Mediterranean countries are to seize the historical opportunity to build back greener in the recovery from COVID-19, the SoED offers the possibility of drawing lessons from the mistakes of the past and evidence of the toll they have taken on the health of the environment and human wellbeing. Such lessons would be crucial in turning the tide on the unsustainable business-as usual and in scaling up adequate sustainable consumption and production models.

Building back better entails revisiting our relationship with nature. It calls for prioritizing green jobs, renewable energy, integrated water resource management, organic agriculture, sustainable fisheries and aquaculture, alternative tourism, low carbon shipping, solutions with limited resource intensity; and recognizing the potential of all generations and genders, to shape our collective future in the Mediterranean region.

At their 21st Ordinary Meeting (COP 21 - Naples, December 2019), the 21 countries bordering the Mediterranean Sea and the European Union – as Contracting Parties to the Barcelona Convention - approved the SoED Summary for Decision Makers and Key Messages, as important inputs for the definition of the UNEP/MAP Medium-Term Strategy 2022-2027 and other relevant policy and strategy developments of the system. The COP 21 Decision IG.24/4 invited Contracting Parties to take concrete steps to incorporate the concerns raised in their policies; encouraged all possible efforts to overcome the knowledge gaps identified in the SoED; and requested the UNEP/MAP-Barcelona Convention Secretariat to undertake an extensive dissemination and communication campaign on the report findings.

By highlighting the gaps between the objectives that Contracting Parties have collectively set and committed to and current trajectories, the SoED makes the case for renewed ambition towards environmental sustainability and inclusive socio-economic development. The report's findings warrant radical policy changes in production and consumption patterns, as well as land and sea use.

The UNEP/MAP-Barcelona Convention system continues to offer the enabling legal and implementation framework to enact the required changes. In fact, much remains to be done on compliance with the Barcelona Convention and its Protocols, notably to ensure that all commitments are translated into action with stakeholders on the ground, including local authorities, civil society organizations, the private sector; maintained over time; and effectively enforced. While ambitious environmental measures are discussed and often approved within specialized communities of individuals and institutions, integration of environmental objectives and actions into all sectoral policies and private decisions falls far behind what would be needed for a sustainable and inclusive future. The SoED has the potential to help initiatives, projects, institutions, and resources in and for our region to work together towards reversing unsustainable trends.

Priority actions identified in the report can help regional and national institutions draw blueprints for post COVID-19 recovery, based on partnerships and coordination among countries, with the continued support of all UNEP/MAP Components, the Mediterranean Commission on Sustainable Development, sister United Nations agencies and Multilateral Environmental Agreements, and Partners, including representatives of the vibrant Mediterranean civil society.

In the spirit of the 2030 Agenda for Sustainable Development, it is our collective responsibility to respond without any further delay to the new generations' call for action - action to end poverty, protect the planet and improve the lives and prospects of everyone, everywhere. The SoED is our contribution to the knowledge needed to do so in this magnificent region that we call home.

Gaetano LEONE
Coordinator, UNEP/MAP - Barcelona Convention Secretariat

Preface

The Mediterranean Sea and its region are very complex; reporting on the Mediterranean environment and development is therefore a challenge. However, this report rises up to this challenge by being:

• **evidence-based,** with data and facts on major and lasting features of the regional environment. The report stresses the overall unsatisfactory state of the regional environment regarding air pollution, quality and quantity of water resources, waste management and nature protection;

• **action-oriented,** identifying - out of the Mediterranean complexity - the actions required for transitioning towards a sustainable and inclusive future, with particular focus on relieving key sectors' pressures on the environment. Such actions are sought from individual governments or private companies, or based on international environmental agreements.

The report recognizes differences among riparian countries and sub-regions (e.g. north, south, east Mediterranean). Since Plan Bleu's 2005 report, *"A sustainable future for the Mediterranean: the Blue Plan's environment and development outlook"*, differences remain in human development, demographic trends, access to natural resources, and environmental protection. Riparian countries and the Mediterranean Sea itself benefit and are affected by major flows of people (e.g. from migration and tourism), as well as intense flows of goods and services (e.g. fossil fuels, agricultural products, manufactured goods). The Mediterranean is linked with the rest of the world through major straits or canals (Gibraltar, Turkish straits, Suez Canal). The region is also subject to important environmental risks. Differences among the Mediterranean countries further induce inequalities in resilience, as well as adaptation or prevention capacities to deal with ongoing or future challenges.

EIGHT SELECTED MAJOR THREATS FOR THE MEDITERRANEAN ENVIRONMENT

1. Climate change affects the Mediterranean significantly more than the world average, particularly with warmer air and sea surface temperatures all year round. While the average air temperature is worldwide about 1.1°C higher than pre-industrial times, the Mediterranean temperatures are above to 1.5°C higher. The Intergovernmental Panel on Climate Change (IPCC) further expects temperature increases in the region of 2 to 3°C by 2050, and 3 to 5°C by 2100.

2. Population densities in coastal areas have continued to increase at unsustainable rates over the last decade. Over 1965-2015, urban pressures increased in 75% of Mediterranean countries; particularly, built areas doubled or more than doubled within one kilometre from the sea. Consequently, biodiversity and especially natural coastal ecosystems and their services (e.g. carbon capture, flood control) decreased in contradiction with the Barcelona Convention Integrated Coastal Zone Management Protocol. Urbanization also resulted in the loss of agricultural land.

3. Health impacts from atmospheric pollution are most severe in urban and port areas, with pollution measured well beyond WHO recommended standards. The low quality of fuels in some countries, emissions from ships, and high shares of aged vehicles in motor vehicle stocks contribute to explain the annual 228,000 early deaths from air pollution in Mediterranean countries.

4. Health impacts from lack of water supply and wastewater treatment facilities, particularly on the southern and eastern rims of the region, contribute to a range of diseases, undermining population well-being and labour productivity.

5. Waste and its management remains a challenge in many countries. Around 730 tonnes of plastic waste end up daily in the Mediterranean Sea. Plastic waste represents 95 to 100% of marine floating waste and 50% of litter on sea beds. In tonnage, plastic could outweigh fish stocks in the near future. Many coastal uncontrolled landfill sites are found, particularly on eastern and southern shores.

6. Fisheries practices threaten fish resources: 78% of assessed stocks are over-fished, while 18% of the catches are discarded. Fisheries represent the number one threat to fish populations in the Mediterranean Sea. Aquaculture is growing fast with high dependency on fish meal from sea catches, large nitrate and phosphorus effluents, as well as genetic modification of natural fish stocks.

7. Fossil fuels overall dominate energy supply in the Mediterranean region, with heavy environmental and health impacts (e.g. CO_2, water acidification, particulate matters). An energy transition is imperative, focusing on energy efficiency and larger shares of renewable sources in the energy mix, in line with international agreements.

8. Excessive use of chemical and pharmaceutical products generate increasing concerns, particularly in northern Mediterranean countries. Only about 700 out of 70,000 chemical substances on the market have been studied for their risk impacts, with focus on those used with 'high tonnage'. Endocrine disruptors penetrate the environment directly (e.g. herbicides, insecticides and fungicides) or indirectly (e.g. metabolic degradation of pharmaceuticals through treated wastewater). They have effects on fish and amphibians, as well as on children and human reproductive health.

EIGHT AREAS FOR ACTIONS AND TRANSITIONS

1. Major changes in production and consumption patterns are urgently needed in the Mediterranean region to progress decisively towards inclusive sustainable development, with focus on climate change concerns, biodiversity protection and restoration, circular economy, and transition towards blue/green economy. These goals are consistent with the UN 2030 Agenda for Sustainable Development and its Sustainable Development Goals (SDGs), as well as the Mediterranean Strategy for Sustainable Development 2016-2025.

2. Inclusive development must address inequalities and involve civil society in decision and action. Women can play a major role: i) in promoting sustainable household consumption and investment (e.g. in food/agriculture, energy), and ii) in entrepreneurship and economic development. Younger generations and their demands and potential for action are central to short-and long-term progress, including in countries with strong population increases.

3. Moving towards food and water security is key for inclusive sustainable development and requires: integrated water resources management, the use of new non-conventional water resources, water demand management with proper pricing (e.g. in agriculture), quantity and quality of food with attention to their health impacts.

4. Moving towards energy efficiency and reliance on low-carbon energy solutions is also key. The energy sector is too often supported by considerable fossil fuel subsidies, going well beyond those needed for social purpose. Its environmental impacts are to be addressed at energy facilities, including primary production, electricity production plants, and refineries.

5. Moving towards sustainable tourism requires the cooperation of the multiple actors in the sector. Their commitments to more sustainable models are required to capture economic, social and environmental benefits. This is particularly important in Mediterranean countries, which host about one third of world tourism.

6. Moving towards a sustainable transport sector requires attention to address the environmental impacts of infrastructure, vehicles and traffic management. This includes investment and maintenance in road, rail, port and airport facilities; pollution control of new and in use vehicles, transition to electric and/or hydrogen technologies; reduction of the environmental impacts of civilian and military maritime transport with riparian and non-riparian flags at port and at sea; urban traffic police, urban public transport, control of straights and canals; legal and illegal movements of maritime transport of freight and passengers, etc.

7. Industry and mining should improve: i) resource use in the context of a circular economy with reduction, reuse and recycling of waste, ii) attention to the production and use of chemicals and their impacts on humans and the environment.

8. The blue economy is sometimes considered a new frontier for economic development, to be managed in phase with the Sustainable Development Goal 14 which targets the conservation and sustainable use of oceans, seas and marine resources. Growth is expected in marine aquaculture, offshore energy, fish processing, shipbuilding repair and dismantling, maritime equipment and ports, maritime and coastal tourism. The economic benefits of the blue economy are accompanied by threats to the health of marine and coastal ecosystems through: i) sea water acidification, sea temperature and level increases, shifts in currents, biodiversity and habitat losses, ii) pollution (e.g. from agriculture and industry, chemicals, nutrients and plastics) and iii) overfishing, and other resource sustainability and efficiency issues. The implementation of Marine Spatial Planning and Integrated Coastal Zone Management needs to be rigorously strengthened to allow for a sustainable blue economy compatible with the restoration of the health of strained ecosystems and halting the relentless encroachment on the marine and coastal environment.

STRENGHTENING GOVERNANCE OF NATIONAL AND INTERNATIONAL FRAMEWORKS FOR TRANSFORMATIVE CHANGE

Mediterranean countries, individually and collectively, should capture potential economic, social and environmental benefits associated with progress not only in sectors such as agriculture and fisheries, energy, tourism, transport, industry and mining, but also in new sustainable development frontiers through aid, foreign direct investment, international trade and the blue economy. While capturing the related benefits, attention needs to be paid to the negative impacts of emerging and fast-growing sectors on the health of the sea and its coastal areas. Such sectors are strongly influenced in the Mediterranean by world trends and changes.

To ensure the necessary transition towards a sustainable and inclusive future, governments and enterprises in the Mediterranean region should build on: i) a mix of regulatory and economic instruments, with attention to proper prices, taxes and subsidies; ii) technological and social innovations; iii) multiple financing sources (in line with the 2015 Addis Ababa agreement) that target sustainable investments and walk-out on funding of polluting activities: national and international, public and private, conventional and non-conventional, micro-credit; and iv) monitoring factual progress, with tools such as indicators and data.

At this point in time, legislative and regulatory shortcomings, difficulties in controlling economic activities and budgetary restrictions explain the gaps between commitments and implementation of public policies in the Mediterranean region.

Countries need to strengthen active alliances of governments, enterprises and opinion leaders to:

- implement and enforce national environmental laws and regulations,
- implement and enforce international agreements and associated commitments, at transboundary level, at Mediterranean level (e.g. Barcelona Convention, Mediterranean Strategy for Sustainable Development 2016-2025), and at global level (e.g. Climate Convention and agreements, Biodiversity Convention and protocols, Law of the Sea, UN 2030 development agenda).

In particular, the Barcelona Convention and its Protocols need to be better translated into national laws and fully implemented and made operational.

Christian AVEROUS
Vice-president of Plan Bleu

Thierry LAVOUX
President of Plan Bleu

Acknowledgements

This report has been edited by Plan Bleu – Regional Activity Centre of UNEP/MAP. It is the fruit of a collective effort based on the contributions of numerous experts from around the Mediterranean. Plan Bleu would like to thank all individuals and institutions that have contributed to the SoED.

Special thoughts are dedicated to two of our valued colleagues, who sadly passed away too soon during the implementation of the SoED: Christine Ton Nu (CIHEAM-IAMM) in acknowledgement of her outstanding contribution to leading the preparation of chapter 6 of the SoED, and Jean-Roger Mercier, co-author of section 8.1.2.

REPORT ELABORATION

Editors: Elen Lemaitre-Curri *(Director of Plan Bleu)* and Lina Tode *(Programme officer, Plan Bleu).*
Introduction: Elen Lemaitre-Curri.

Chapter 1: Socioeconomic drivers and trends

Chapter lead: Janette Uhlmann *(CMI),* Jean-Pierre Giraud *(Plan Bleu)* and Lina Tode *(Plan Bleu).*
Expert contributions: Elvan Arik *(LabexMed)*, Lise Barbotte *(CMI)*, Gilda Borriello *(CMI)*, Vera Danilina *(Aix-Marseille Université / FEMISE)*, Kelly Fouchy *(Plan Bleu)*, Jean-Pierre Giraud *(Plan Bleu)*, Hend Hassassi *(CMI)*, Elen Lemaitre-Curri *(Plan Bleu)*, Lina Tode *(Plan Bleu)*, Clément Torres *(CMI)*, Constantin Tsakas *(FEMISE)*, Jocelyn Ventura *(Institut de la Méditerranée / FEMISE).*

Chapter 2: Climate change

Chapter lead: Wolfgang Cramer *(MedECC)*, Joël Guiot *(MedECC)*, Lina Tode *(Plan Bleu).*
Expert contributions: Wolfgang Cramer *(MedECC; IMBE, CNRS)*, Kelly Fouchy *(Plan Bleu)*, Gabino Gonzalez *(REMPEC)*, Joël Guiot *(MedECC; CEREGE, CNRS)*, Lilia Khodjet, Elen Lemaitre-Curri *(Plan Bleu)*, Katarzyna Marini *(MedECC)*, Josep Peñuelas *(CREAF-CSIC-UAB)*, Stéphane Pouffary *(ENERGIES 2050)*, Alessio Satta *(MEDSEA Foundation)*, Lina Tode *(Plan Bleu)*, Constantin Tsakas *(FEMISE).*
National reviewers: Roberto Giangreco *(Italy)*, Samia Grimida *(Libya)*, Omer Ozturk *(Turkey).*

Chapter 3: Biodiversity and ecosystem services

Chapter lead: Daniel Cebrian *(SPA/RAC)* and Nelly Bourlion *(Plan Bleu).*
Expert contributions: Dania Abdul Malak *(ETC-UMA)*, Katia Aikas *(IUCN Centre for Mediterranean Cooperation), Elisa Alcázar (consultant, IUCN Centre for Mediterranean Cooperation)*, Julie Belmont *(ACCOBAMS Permanent Secretariat)*, Nelly Bourlion *(Plan Bleu)*, Daniel Cebrian *(SPA/RAC)*, Florence Descroix-Comanducci *(ACCOBAMS)*, Maria del Mar Otero *(IUCN Centre for Mediterranean Cooperation)*, Kelly Fouchy *(Plan Bleu)*, Élie Gaget *(Tour du Valat)*, Thomas Galewski *(Tour du Valat)*, Susan Gallon *(MedPAN)*, Valentina Garavaglia *(FAO)*, Ilse Geijzendorffer *(Tour du Valat)*, Samir Grimes *(École Nationale Supérieure des Sciences de la Mer et de l'Aménagement du Littoral, Algérie)*, Anis Guelmami *(Tour du Valat)*, Yves Hénocque *(Ifremer)*, Lilia Khodjet, Lourdes Lázaro *(IUCN Centre for Mediterranean Cooperation)*, Ana Marín Guerrero *(ETC-UMA)*, Célia Le Ravallec *(ACCOBAMS)*, Tassos Krommydas *(GWP-Med)*, Catherine Numa *(IUCN Centre for Mediterranean Cooperation)*, Christian Perennou *(Tour du Valat)*, Nadège Popoff *(Tour du Valat)*, Nicolas Picard *(FAO)*, Marie Romani *(MedPAN)*, Maylis Salivas *(ACCOBAMS).*
National reviewers: Milena Batakovic *(Montenegro)*, Leonardo Tunesi *(Italy).*

Chapter 4: Economic activities and linked pressures

Chapter lead: Magali Outters *(SCP/RAC)* and Lina Tode *(Plan Bleu).*
Expert contributions: Nadia Benalouache, Miguel Bernal *(GFCM)*, Omar Bessaoud *(CIHEAM)*, Mohammed Blinda, Maria Caparis, Anna Carlson *(GFCM)*, Jérémie Fosse *(eco-union)*, Linda Fourlain *(GFCM)*, François Galgani, Alejandro Gonzalez *(eco-union)*, Gabino Gonzalez *(REMPEC)*, Housam Hamza (*GFCM)*, Lilia Khodjet, Salvador Klarwein *(eco-union)*, Josep Lloret *(University of Girona)*, Raffaele Mancini *(Plan Bleu)*, Fabio Massa *(GFCM)*, Karine Moukaddem *(eco-union)*, Magali Outters *(SCP/RAC)*, Federico de Rossi *(GFCM)*, Christoph Schröder *(ETC-UMA)*, Abdellah Srour *(GFCM)*, Lina Tode *(Plan Bleu).*
National reviewers: Lorenza Babbini *(Italy)*, Klara Jarni *(Slovenia)*, Menekșe Keski *(Turkey).*

Chapter 5: Coastal zone dynamics and related impacts

Chapter lead: Daria Povh Škugor *(PAP/RAC)* and Antoine Lafitte *(Plan Bleu).*
Expert contributions: Katia Aikas *(IUCN Centre for Mediterranean Cooperation)*, Marie Baduel *(AVITEM)*, Fabrice Bernard *(Conservatoire du littoral)*, Omar Bessaoud *(CIHEAM-IAMM)*, Giuseppina Cassalia *(Mediterranea University of Reggio Calabria)*, Heloïse Chaumier *(Codatu)*, Céline Damery *(Conservatoire du Littoral)*, Elodie Doze *(Aix Marseille Université)*, Kelly Fouchy

(Plan Bleu), Samir Grimes *(Ecole Nationale Supérieure des Sciences de la Mer et de l'Aménagement du Littoral, Algérie)*, Yves Hénocque *(Ifremer)*, Heba Hussein *(La Sapienza Università di Roma)*, Tassos Krommydas *(GWP-Med)*, Antoine Lafitte *(Plan Bleu)*, Pietro Laureano *(IPOGEA)*, Lourdes Lázaro *(IUCN Centre for Mediterranean Cooperation)*, Domitille le Huédé *(SMILO)*, Christophe Le Visage *(Stratégies Mer et Littoral SAS)*, Ivan Luque *(MedCities)*, Gonzalo Malvarez *(University Pablo Olavide)*, Jure Margeta *(Faculty of Civil Engineering Architecture and Geodesy in Split, Croatia)*, Marina Marković *(PAP/RAC Programme officer)*, Inel Massali *(UNESCO)*, Athina Mourmouris *(Environmental Engineer - Planner, Honorary Director General for the Environment, Greece)*, Fatima Navas *(University Pablo Olavide)*, Konstantia Nikopoulou *(MedCities)*, Daria Povh Škugor *(PAP/RAC)*, Enzo Pranzini *(University of Florencia)*, Margot Reyes *(Conservatoire du littoral)*, Brian Shipman *(PAP/RAC)*, Maria Snoussi *(Mohammed V University)*, Eva Tankovic *(Initiative PIM)*, Tabet, Youmna *(UNESCO)*.
National reviewers: Matteo Braida *(Italy)*, Emrah Söylemez *(Turkey)*, Seda Nal *(Turkey)*, Tutku Gökalp *(Turkey)*, Aleksandra Ivanovic *(Montenegro)*.

Chapter 6: Food and water security
Chapter lead: Christine Ton Nu *(CIHEAM-IAMM)*, Pascal Bergeret *(CIHEAM-IAMM)*, Céline Dubreuil *(Plan Bleu)* and Kelly Fouchy *(Plan Bleu)*.
Expert contributions: Dania Abdul Malak *(ETC-UMA)*, Virginia Belsanti *(CIHEAM-IAMB)*, Guillaume Benoit *(CGAAER)*, Pascal Bergeret *(CIHEAM-IAMM)*, Omar Bessaoud *(CIHEAM-IAMM)*, Mohammed Blinda *(VOSPro)*, Claudio Bogliotti *(CIHEAM-IAMB)*, Henri Boyé, Carolina Cardete *(Universitat Politecnica de Valencia)*, Victor Castillo *(CEBAS-CSIC)*, Laurent Chazee *(Tour du Valat)*, Talal Darwish *(CNRS)*, Julien Demenois *(CIRAD)*, Céline Dubreuil *(Plan Bleu)*, Kelly Fouchy *(Plan Bleu)*, Abdelouahid Fouial *(CIHEAM-IAMB)*, Thierry Gauquelin *(IMBE)*, Tsafrir Gidron *(Israeli Ministry of Environmental Protection)*, Raphael Gros *(IMBE)*, Anis Guelmami *(Tour du Valat)*, Joël Guiot *(MedECC)*, Atef Hamdy *(CIHEAM-IAMB)*, Tassos Krommydas *(GWP-Med)*, Michael Karner *(CMI)*, Gaetano Ladisa *(CIHEAM-IAMB)*, Nicola Lamaddalena *(CIHEAM-IAMB)*, Ana Marín Guerrero (*ETC-UMA)*, Francisco Martinez Capel *(Universitat Politecnica de Valencia)*, Marianne Milano *(University of Lausanne)*, Thomas Pelte *(AERMC)*, Mélanie Requier *(CIHEAM-IAMM)*, Roberto Roson *(Ca' Foscari University, Bocconi University)*, José Luis Rubio *(WASWAC)*, Lina Tode *(Plan Bleu)*, Christine Ton Nu *(CIHEAM-IAMM)*, Rémi Touron *(AERMC)*, Constantin Tsakas *(FEMISE)*.

Chapter 7: Health and environment
Chapter lead: Mohamad Kayyal *(MED POL)* and Lina Tode *(Plan Bleu)*.
Expert contributions: Wolfgang Cramer *(MedECC)*, Gabino Gonzalez *(REMPEC)*, Lilia Khodjet, Salvador Klarwein *(eco-union)*, Josep Lloret *(University of Girona)*, Mazen Malkawi *(WHO-EMRO)*, Laurence Rouil *(INERIS)*, Lina Tode *(Plan Bleu)*.

Chapter 8: Governance
Chapter lead: Ilias Mavroeidis *(UNEP/MAP)* and Elen Lemaitre-Curri *(Plan Bleu)*.
Expert contributions: Abdou M. Bekhechi, Simone Cresti *(SDSN-Med)*, Kelly Fouchy *(Plan Bleu)*, Gabino Gonzalez *(REMPEC)*, Antoine Lafitte *(Plan Bleu)*, Elen Lemaitre-Curri *(Plan Bleu)*, Julien Le Tellier *(UNEP/MAP)*, Christophe Le Visage *(Stratégies Mer et Littoral SAS)*, Vicky Malotidi *(MIO-ECSDE)*, Ilias Mavroeidis *(UNEP/MAP)*, Jean-Roger Mercier, Irini Papanicolopulu, Moh Rejdali *(COMPSUD)*, Mélanie Requier *(CIHEAM-IAMM)*, Luisa Rodriguez Lucas *(UNEP/MAP)*, Michael Scoullos *(MIO-ECSDE)*, Lina Tode *(Plan Bleu)*.
National reviewer: Valentina Mauriello *(Italy)*.

Special thanks go to Kelly Fouchy, who has contributed to the overall editing of the report and to Arnaud Comolet, who supported the SoED in its early stage. Milan Nublat and Jean-Pierre Giraud have contributed to the creation of a number of maps contained in the SoED. Figures 17, 30, 40, 68, 74, 104, 131, 133, 140, 148, 171, 183 and 195 have been developed by ETC-UMA.

Steering Committee
Khalil Attia *(SPA/RAC Tunisia)*, Pascal Bergeret *(CIHEAM)*, Wolfgang Cramer *(MedECC)*, Gabino Gonzalez *(REMPEC)*, Joël Guiot *(MedECC)*, Samira Hamidi *(Algeria)*, Tatjana Hema *(UNEP/MAP Coordinating Unit)*, Mohamad Kayyal *(MEDPOL)*, Giuseppina Monacelli *(Info/RAC)*, Oliviero Montanaro *(Italy)*, Amal Mouffareh *(Morocco)*, Magali Outters *(SCP/RAC)*, Daria Povh Skugor *(PAP/RAC)*, Benoit Rodrigues *(France)*, Ivana Stojanovic *(Montenegro)*, Ronan Uhel *(EEA)*, Janette Uhlmann *(CMI)*.

Review
Scientific Committee: Amina Boumaour *(Algeria)*, Lucien Chabason *(France)*, Abed El Rahman Hassoun *(Lebanon)*, Suzan Kholeif *(Egypt)*, Mazen Malkawi *(Jordan)*, Samir Meddeb *(Tunisia)*, Najib Saab *(Lebanon)*.
Review by the Bureau of Plan Bleu: Christian Averous, Lucien Chabason, Yves Henocque, Thierry Lavoux, Jean de Montgolfier, Mauricette Steinfelder, Jacques Theys.

The SoED Summary for Decision Makers and Key Messages have been approved by COP21 of the Barcelona Convention (Decision IG.24/4). The draft full report has been shared with COP21 as an information document.

The SoED including its Summary for Decision Makers and Key Messages have been reviewed by the UNEP Publishing Secretariat.

Funding
This publication has been funded by the Mediterranean Trust Fund of the UNEP/MAP- Barcelona Convention, the French Ministry of Ecological and Solidarity Transition, the French Environment and Energy Management Agency (ADEME), and the French Rhone Mediterranean Corsica Water Agency (AERMC).

Disclaimer: The presentation of the material in this publication does not necessarily imply full endorsement or acceptance by the contributors.

Table of Contents

Table of Figures

Table of Tables

Table of Boxes

List of Acronyms

3S	Sea, Sand, Sun
ABNJ	Areas Beyond National Jurisdiction
ACCOBAMS	Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic Area
AERMC	Rhône-Mediterranean-Corsica Water Agency
AEWA	African-Eurasian Migratory Waterbird Agreement
AF	Adaptation Fund
AFD	*Agence Française de Développement* (French Development Agency)
ALDFG	Abandoned, lost or otherwise discarded fishing gear
AMU	Arab Maghreb Union
ANME	National Agency for Energy Efficiency (Tunisia)
ARLEM	Euro-Mediterranean Regional and Local Assembly
ASAP	Adaptation for Smallholder Agriculture Programme
ASEAN	Association of Southeast Asian Nations
ASI	ACCOBAMS Survey Initiative
ATBA	Area to be Avoided
AVITEM	Agency for Sustainable Mediterranean Cities and Territories
BAC	Background Assessment Concentrations
BAT	Best Available Technology
BBNJ	Biodiversity Beyond National Jurisdiction
BEP	Best Environmental Practices
BOD	Biochemical Oxygen Demand
BPZ	Biological Protection Zone
BRI	Belt and Road Initiative
BRT	Bus Rapid Transit
BSC PS	Permanent Secretariat of the Commission on the Protection of the Black Sea Against Pollution
BWM Convention	International Convention for the Control and Management of Ships' Ballast Water and Sediments
CAMP	Coastal Area Management Programme
CAP	Common Agricultural Policy
CBD	Convention on Biological Diversity
CCH	Cetacean Critical Habitats
CEBAS-CSIC	*Consejo Superior de Investigaciones Científicas - Centro de Edafología y Biología Aplicada del Segura*
CEREGE	Centre for Research and Teaching in Environmental Geoscience
CFP	Common Fisheries Policy
CGAAER	*Conseil général de l'alimentation, de l'agriculture et des espaces ruraux* (French High Council for Food, Agriculture and Rural Areas)
CHEC	China Harbour Engineering Company
CIESM	The Mediterranean Science Commission
CIHEAM	*Centre international des hautes études agronomiques méditerranéennes* (International Center for Advanced Mediterranean Agronomic Studies)
CIHEAM-IAMB	International Center for Advanced Mediterranean Agronomic Studies - Mediterranean Agronomic Institute of Bari
CIHEAM-IAMM	International Center for Advanced Mediterranean Agronomic Studies - Mediterranean Agronomic Institute of Montpellier
CIRAD	*Centre de coopération internationale en recherche agronomique pour le développement* (The French agricultural research and international cooperation organization)
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CKIS	Common Knowledge and Innovation Space
CLC Convention	International Convention on Civil Liability for Oil Pollution Damage
CMI	Center for Mediterranean Integration
CMPA	Coastal and Marine Protected Area
CMS	Bonn Convention on the Conservation of Migratory Species of Wild Animals
CNRS	National Council for Scientific Research
Codatu	Cooperation for urban mobility in the developing world
COP 21	21st Meeting of the Contracting Parties to the Barcelona Convention
CoR	European Committee of the Regions
CP	Coastal Plan
CREAF-CSIC-UAB	Ecological and Forestry Applications Research Centre, Spanish National Research Council, Autonomous University of Barcelona
CRF	Common Regional Framework
CSCEC	China State Construction Engineering Corporation
CTF	Clean Technology Fund
DALY	Disability-Adjusted Life Year
DCFTA	Deep and Comprehensive Free Trade Area
DII	Desertec Industry Initiative
DIVA	Dynamic Interactive Vulnerability Assessment
DPL	*Domaine Public Littoral* (Coastal Public Domain)
DPSIR	Drivers, Pressures, State, Impacts, Responses
DRR	Disaster Risk Reduction
DWT	Deadweight tonnage
E-PRTR	European Pollutant Release and Transfer Register
EAC	Environmental Assessment Criteria
EBRD	European Bank for Reconstruction and Development
EBSA	Ecologically or Biologically Significant Marine Areas
EC ENVI	European Parliament Committee on the Environment, Public Health and Food Safety
ECA	Emission Control Area
ECA	Economic Commission for Africa
EcAp	Ecosystem Approach
EDCs	Endocrine Disrupting Chemicals
EEA	European Environment Agency
EEZ	Exclusive Economic Zone
EF	Environmental flows
EIA	Environmental Impact Assessment
EIB	European Investment Bank
EMCAA	Euro-Mediterranean Common Aviation Area
EMEG	Euro-Mediterranean Expert Group
EMODnet	European Marine Observation and Data Network
ENI	European Neighbourhood Instrument
ENI MED	European Neighbourhood Instrument in the Mediterranean
ENP	European Neighbourhood Policy

ENPI	European Neighbourhood and Partnership Instrument
ENSSMAL	*Ecole Nationale Supérieure des Sciences de la Mer et de l'Aménagement du Littoral*
EO	Ecological Objective
EPR	Extended Producer Responsibility
ERDF	European Regional Development Fund
ERWR	External Renewable Water Resources
ESCWA	Economic and Social Commission for Western Asia
ESD	Education for Sustainable Development
ESDP	European Spatial Development Perspective
ESIA	Environmental and Social Impact Assessment
ETC-UMA	European Topic Centre, University of Malaga
EU	European Union
EU ETS	European Union Emissions Trading System
EU MS	European Union Member State
EUWI	European Union Water Initiative
EVSE	Electric Vehicle Supply Equipment
FAO	Food and Agriculture Organization of the United Nations
FDI	Foreign Direct Investment
FEMISE	*Forum Euroméditerranéen des Instituts de Sciences Économiques* (Euro-Mediterranean Forum of Institutes of Economic Sciences)
FFEM	*Fonds Français pour l'Environnement Mondial* (French Facility for Global Environment)
FIP	Forest Investment Partnership
FRA	Fisheries Restricted Area
FWI	Fire Weather Index
FYROM	Former Yugoslav Republic of Macedonia
GAFTA	Greater Arab Free Trade Area
GCF	Green Climate Fund
GDE	Groundwater-Dependant Ecosystem
GDP	Gross Domestic Product
GEC	Global Environment Centre
GEF	Global Environment Facility
GES	Good Environmental Status
GFCM	General Fisheries Commission for the Mediterranean
GHSL	Global Human Settlement Layer
GIS	Geographic Information System
GloMEEP	Global Maritime Energy Efficiency Partnerships
GPA	Global Programme of Action for the Protection of the Marine Environment from Land-based Activities
GRanD	Global Reservoir and Dam Database
GSO	Group of Senior Officials
GVA	Gross Value Added
GWP-Med	Global Water Partnership - Mediterranean
HAB	Harmful algal bloom
HDI	Human Development Index
HLPF	High-level Political Forum
HNS	Hazardous and noxious substances
IAS	Invasive Alien Species
IBA	Important Bird and Biodiversity Area
IBRD	International Bank for Reconstruction and Development
ICARM	Integrated Coastal Areas and River Basins Management
ICCAT	International Commission for the Conservation of Atlantic Tunas
ICCT	International Council on Clean Transportation
ICOM	Integrated Coastal and Ocean Management
ICRI	International Coral Reef Initiative
ICT	Information and communication technologies
ICZM	Integrated Coastal Zone Management
IDDRI	*Institut du Développement Durable et des Relations Internationales* (Institute for Sustainable Development and International Relations)
IEA	International Energy Agency
IFAD	International Fund for Agricultural Development
Ifremer	*Institut français de recherche pour l'exploitation de la mer* (French National Institute for Ocean Science)
IGO	Intergovernmental Organization
IGRAC	International Groundwater Resources Assessment Centre
IHME	Institute for Health Metrics and Evaluation
IHP	Intergovernmental Hydrological Programme
ILO	International Labour Organization
IMAP	Integrated Monitoring and Assessment Programme
IMBE	Mediterranean Institute of marine and terrestrial Biodiversity and Ecology
IMMA	Important Marine Mammal Area
IMO	International Maritime Organization
IMTA	Integrated Multi-Trophic Aquaculture
INDCs	Intended Nationally Determined Contributions
INFO/RAC	Regional Activity Centre for Information and Communication
Interreg MED	Interregional cooperation programme in the Mediterranean
IPA	Instrument for Pre-Accession Assistance
IPBES	Intergovernmental Science policy Platform on Biodiversity and Ecosystem Services
IPCC	Intergovernmental Panel on Climate Change
IPEMED	*Institut de prospective économique du monde méditerranéen* (Mediterranean world Economic Foresight Institute)
IRWR	Internal Renewable Water Resources
ITAs	International Tourist Arrivals
ITF	International Transport Forum
ITPGRFA	International Treaty on Plant Genetic Resources for Food and Agriculture
ITPS	Intergovernmental Technical Panel on Soils
IUCN	International Union for Conservation of Nature
IUCN RLTS	IUCN Red List of Threatened Species
IUU	Illegal, Unreported, and Unregulated Fishing
IWRM	Integrated Water Resources Management
JRC	Joint Research Centre
KJWA	Koronivia Joint Work on Agriculture
LAS	League of Arab States
LDC	Least Developed Countries
LME	Large Marine Ecosystem
LNG	Liquefied Natural Gas
LSI	Land-sea interactions
M2PA	Association for the sustainable financing of Mediterranean Marine Protected Areas
MAF	Mean Annual Flow
MAP	Mediterranean Action Plan
MAPAMED	Marine Protected Areas in the Mediterranean
MARPOL	International Convention for the Prevention of Pollution from Ships
MCPA	Marine and Coastal Protected Area
MCSD	Mediterranean Commission on Sustainable Development
MDGs	Millennium Development Goals
MEA	Multilateral Environmental Agreement
MED POL	Programme for the Assessment and Control of Marine Pollution in the Mediterranean
MED-Amin	Mediterranean Agricultural Market Information Network
Med-TSO	Mediterranean Transmission System Operators
MedECC	Network of Mediterranean Experts on Climate and Environmental Change

MEdIES	Mediterranean Education Initiative for Environment and Sustainability
MedPAN	Network of Marine Protected Areas managers in the Mediterranean
MedWet	Mediterranean Wetlands Initiative
MENA	Middle East and North Africa
MENELAS	Mediterranean Network of Law Enforcement Officials
MIDAS	Managing Impacts of Deep-seA reSource exploitation
MINOUW	Science, Technology and Society Initiative to Minimize Unwanted Catches in European Fisheries
MIO-ECSDE	Mediterranean Information Office for Environment, Culture and Sustainable Development
MLRP	Regional Plan on Marine Litter Management in the Mediterranean
MOOC	Massive Open Online Course
MPA	Marine Protected Area
MSESD	Mediterranean Strategy on Education for Sustainable Development
MSFD	Marine Strategy Framework Directive
MSP	Marine Spatial Planning
MSSD	Mediterranean Strategy for Sustainable Development
MSST	Mediterranean Strategy for Sustainable Tourism
MSY	Maximum Sustainable Yield
Mtoe	Million tonnes of oil equivalent
MTS	Mid-Term Strategy
MWO	Mediterranean Wetlands Observatory
MWO2	Mediterranean Wetlands Outlook 2
NALAS	Network of Associations of Local Authorities of South-East Europe
NAMA	Nationally Appropriate Mitigation Actions
NAP	National Action Plan
NAZCA	Non-state Actor Zone for Climate Action
NBB	National Baseline Budget
NbS	Nature-based Solution
NBSAP	National Biodiversity Strategy and Action Plan
NCD	Non-communicable disease
NDCs	Nationally Determined Contributions
NGO	Non-governmental Organization
NIS	Non-Indigenous Species
NMCs	Northern Mediterranean Countries
NOx	Nitrogen Oxides
NS	National Strategy
NSSD	National Strategy for Sustainable Development
ODA	Official Development Assistance
OECD	Organisation for Economic Cooperation and Development
OECM	Other Effective Area-Based Conservation Measure
OHH	Oceans and Human Health
OIF/IFDD	*Institut de la francophonie pour le développement durable de l'Organisation internationale de la francophonie* (Francophone institute for sustainable development of the International Organisation of La Francophonie)
OME	*Observatoire Méditerranéen de l'énergie* (Mediterranean Observatory for Energy)
ONML	*Observatoire National de la Mer et du Littoral* (National Observatory of the Sea and Coast)
PAH	Polycyclic aromatic hydrocarbon
PAP/RAC	Priority Actions Programme Regional Activity Centre
PB/RAC	Plan Bleu/Regional Activity Centre
PCB	Polychlorinated biphenyl
PCL	*Patrimoine commun littoral* (Coastal Common Heritage)
PFCs	Perfluorocarbons
PM	Particulate matter
POI	Prima Observatory on Innovation
POPs	Persistent organic pollutants
PPA	Power Purchase Agreement
PPI	Private Participation in Infrastructure
PPP	Purchasing power parity
PPPP	Projects, Plans, Programmes and Policies
PRF	Port Reception Facilities
PRIMA	Partnership for Research and Innovation in the Mediterranean Area
PSP	Paralytic Shellfish Poisoning
PSSA	Particularly Sensitive Sea Area
QSR	Quality Status Report
RBMP	River Basin Management Plan
RCP	Representative Concentration Pathway
REALM	Resource Allocation Model
REDD+	Reducing Emissions from Deforestation and Forest Degradation
REMPEC	Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea
RES	Renewable Energy Systems
RFMO	Regional Fisheries Management Organization
RLTS	Red List of Threatened Species
RSP	Regional Seas Programme
RUSLE	Revised Universal Soil Loss Equation
SAP BIO	Strategic Action Programme for the Conservation of Biological Diversity in the Mediterranean Region
SCP	Sustainable Consumption and Production
SCP/RAC	Regional Activity Centre for Sustainable Consumption and Protection
SDAGE	*Schémas directeurs de la gestion des eaux* (water management guidelines)
SDGs	Sustainable Development Goals
SDSN	Sustainable Development Solutions Network
SEA	Strategic Environmental Assessment
SEIS	Shared Environmental Information System
SEMCs	Southern and Eastern Mediterranean Countries
SESA	Strategic Environmental and Social Assessment
SIMPEER	Simplified Peer Review Mechanism
SIPAM	*Système d'information pour la promotion de l'aquaculture en Méditerranée* (Information System for the Promotion of Aquaculture in the Mediterranean)
SMCs	Southern Mediterranean Countries
SMILO	Small Islands Organisation
SoED	Report on the State of the Environment and Development in the Mediterranean
SoMFi	State of Mediterranean and Black Sea Fisheries
SONEDE	National Water Distribution Utility (Tunisia)
SOx	Sulphur Oxides
SPA/BD Protocol	Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean
SPA/RAC	Regional Activity Centre for Specially Protected Areas
SPAMI	Specially Protected Area of Mediterranean Importance
SPAs	Specially Protected Areas
SPI	Science policy interface
SSFs	Small-scale fisheries
SUMP	Sustainable Urban Mobility Plan
TANAP	Trans-Anatolian Pipeline
TAP	Trans-Adriatic Pipeline

TEU	Twenty-foot equivalent unit
toe	Tonnes of oil equivalent
TRWR	Total Renewable Water Resources
TSS	Traffic Separation Scheme
UCLG	United Cities and Local Governments
UfM	Union for the Mediterranean
UMF	Urban Mobility Forum
UN DESA	United Nations Department of Economic and Social Affairs
UN Environment	United Nations Environment Programme (See also UNEP)
UNCCD	United Nations Convention to Combat Desertification
UNCLOS	United Nations Convention on the Law of the Sea
UNCTAD	United Nations Conference on Trade and Development
UNDP	United Nations Development Programme
UNDRR	United Nations Office for Disaster Risk Reduction
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environment Programme (See also UN Environment)
UNEP-GRID	United Nations Environment Programme Global Resource Information Database
UNEP-WCMC	UN Environment Programme World Conservation Monitoring Centre
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNESCO-IHP	UNESCO Intergovernmental Hydrological Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNFSA	Fish Stocks Agreement
UNGA	United Nations General Assembly
UNHCR	United Nations Refugee Agency
UNRWA	United Nations Relief and Works Agency for Palestine Refugees in the Near East
UNWTO	United Nations World Tourism Organization
UPFI	Urban Projects Finance Initiative
VME	Vulnerable Marine Ecosystem
VNR	Voluntary National Review
VOOPS	Venice Offshore-Onshore Port Systems
VTS	Vessel Traffic Service
WASH	Water, sanitation and hygiene
WASWAC	World Association of Soil and Water Conservation
WBCSD	World Business Council for Sustainable Development
WCDRR	World Conference on Disaster Risk Reduction
WCMC	World Conservation Monitoring Centre
WDM	Water Demand Management
WEAP	Water Evaluation and Planning
WEF	World Economic Forum
WFD	Water Framework Directive
WHC	World Heritage Convention
WHO	World Health Organization
WHO-EMRO	World Health Organization - Regional Office for the Eastern Mediterranean
WTO	World Trade Organization
WTTC	World Travel and Tourism Council
WWF	World Wide Fund for Nature
WWTP	Wastewater treatment plant

Country codes

ISO2 Code	COUNTRY OR ENTITY	REGION
AL	Albania	NMC
BA	Bosnia and Herzegovina	NMC
CY	Cyprus	NMC
DZ	Algeria	SEMC
EG	Egypt	SEMC
ES	Spain	NMC
FR	France	NMC
GR	Greece	NMC
HR	Croatia	NMC
IL	Israel	SEMC
IT	Italy	NMC
LB	Lebanon	SEMC
LY	Libya	SEMC
MA	Morocco	SEMC
MC	Monaco	NMC
ME	Montenegro	NMC
MT	Malta	NMC
PS	State of Palestine	SEMC
SI	Slovenia	NMC
SY	Syrian Arab Republic	SEMC
TN	Tunisia	SEMC
TR	Turkey	SEMC

NMC: Northern Mediterranean Country
SEMC: Southern and Eastern Mediterranean Country

Introduction - SoED Preparation Process

The Report on the State of the Environment and Development in the Mediterranean (SoED) is the fulfilment of long-standing common goals among Mediterranean countries

Since the late 1970s, Mediterranean countries have set the common objectives to put *"at the disposal of political leaders and decision makers all information that will enable them to develop plans likely to ensure sustained optimal socioeconomic development without degrading the environment"* and help *"governments of coastal states in the Mediterranean region to increase their knowledge of the joint problems they have to face, both in the Mediterranean Sea and in their coastal areas"* (Inter-governmental Meeting, UNEP/IG.5/7, 1977).

This goal resulted in the publication of two reference reports by Plan Bleu, a United Nations Environment Programme/Mediterranean Action Plan (UNEP/MAP) Regional Activity Centre, in 1989[1] and 2005[2], and a shorter update in 2009[3].

Since then, Mediterranean countries have published reports on the state of their environment, often analysing the interactions between environment and development issues. National reports[4] demonstrate progress associated with specific policy measures (e.g. on health, education and habitat in Morocco; air pollution in France, Greece, Spain, etc.), and identify continuing national challenges, including ones relevant for the Mediterranean environment (e.g. waste management in Lebanon, Greece, etc.; waste generation in Malta; coastal zone management in Morocco; haphazard and rampant urbanization in Lebanon; ground water quality in France; loss of common bird population on agricultural lands in France and Spain; land degradation in most reports; ongoing air pollution challenges, including in countries where there is progress, etc.). The impacts of climate change - which are of increasing concern - have started to be explicitly documented in national reports (e.g. on water resources in Morocco; river systems in Spain; marine resources affected by acidification in France, etc.).

Mediterranean countries and stakeholders have demonstrated a constant need for and interest in updated information and analyses on the environment and development, including maps, graphs and data, recent policies, and lessons learned. But no such report had been produced at the Mediterranean level in the past 10 years.

The Report on the State of the Environment and Development (SoED) fills this gap. It has been prepared within the framework of the UNEP/MAP - Barcelona Convention system, at the request of the 21 countries bordering the Mediterranean Sea and the European Union, as Contracting Parties to the Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean (Barcelona Convention).

The SoED presents a comprehensive and updated assessment of the interactions between the environment and development in the Mediterranean region. It intends to increase awareness and understanding of the environmental status and trends in the Mediterranean, their driving forces and impacts, as well as current and potential responses. It facilitates the measurement of progress made towards sustainable development, providing an up-to-date foundation for enhancing the implementation of the MAP, 2030 Agenda for Sustainable Development, Sustainable Development Goals (SDGs) and the Mediterranean Strategy for Sustainable Development 2016-2025 (MSSD).

The report builds on other UNEP/MAP reports, in particular the Mediterranean 2017 Quality Status Report (QSR 2017), which addresses the quality status of the marine and coastal environment. The SoED also lays the groundwork for the MED 2050 foresight study on the future of the Mediterranean in 2050, which is currently under preparation. These three exercises will jointly inform regional and national decision makers by identifying key areas requiring further joint or coordinated action, and drawing out elements for the next UNEP/MAP Medium-Term Strategy (MTS) 2022-2027 and the forthcoming Mediterranean 2023 Quality Status Report (QSR 2023).

While important data gaps are acknowledged, the report seeks to demonstrate our capacity to monitor and analyse the state of our environment, the impact of human activities on the environment, and the impact or potential impact of environmental

[1] Batisse, M., Grenon M. (1989). Futures for the Mediterranean Basin: the Blue Plan.
[2] Benoit, G., Comeau, A. (2005). A sustainable future for the Mediterranean: the Blue Plan's environment and development outlook.
[3] UNEP/MAP-Plan Bleu (2009). State of the Environment and Development in the Mediterranean, UNEP/MAP-Plan Bleu, Athens.
[4] Detailed references can be found at the end of the report.

degradations on our well-being and activities. Besides informing public and private decision makers, the report will help inform and communicate with the general public. As stated by the Spanish Minister for Ecological Transition in the recent Environmental Profile of Spain, 2017: *"transparency as regards what is being done and, equally, what has yet to be done but which is considered important to do, generates trust, and public trust in politicians provides the stimulus needed to keep working on the commitments made"*.

PREPARATION OF THE SOED WAS A LARGE COLLABORATIVE PROCESS

While Plan Bleu led the preparation of the SoED, its contents are the result of a large collaborative process. Other UNEP/MAP components co-led the preparation of thematic chapters or sections, including the UNEP/MAP Coordinating Unit (Chapter 8 on governance), the Programme for the Assessment and Control of Marine Pollution in the Mediterranean - MED POL (Chapter 7 on health and environment), the Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea - REMPEC (sections on maritime transport), the Priority Actions Programme Regional Activity Centre - PAP/RAC (Chapter 5 on coastal zone management), the Regional Activity Centre for Specially Protected Areas - SPA/RAC (Chapter 3 on biodiversity and ecosystem services), the Regional Activity Centre for Sustainable Consumption and Production - SCP/RAC (Chapter 4 on economic activities and linked pressures).

Regional organizations and networks co-led other chapters: the International Center for Advanced Mediterranean Agronomic Studies - CIHEAM (Chapter 6 on food and water security), the Center for Mediterranean Integration (CMI) through its World Bank component (Chapter 1 on socioeconomic drivers and trends); the network of Mediterranean Experts on Climate and Environmental Change (MedECC), bringing together 600 scientists (Chapter 2 on climate change).

In total, around 150 technical organizations and scientists co-authored the report, or reviewed specific sections, participating in chapter working groups, including several national experts recommended by their countries. National and thematic Focal Points in the UNEP/MAP - Barcelona Convention system and members of the Mediterranean Commission on Sustainable Development (MCSD) were consulted at several stages of the report preparation process.

Finally, a Steering Committee supported the preparation of the report, in particular its most strategic components: the Key Messages and Summary for Decision Makers. The committee included representatives of five volunteer Contracting Parties (Algeria, France, Italy, Montenegro and Morocco), the MCSD, the UNEP/MAP Secretariat (MAP Coordinating Unit and Components), and four technical partners: the European Environment Agency (EEA), CIHEAM, CMI, and MedECC.

DATA SOURCES ALIGN WITH INTERNATIONAL BEST PRACTICES

The report draws upon several available sources of information[5], giving priority to UN system data. When not available in the UN system, data was drawn from other recognized international and regional organizations, including the World Bank, the Organisation for Economic Cooperation and Development (OECD), the Intergovernmental Panel on Climate Change (IPCC), International Union for Conservation of Nature (IUCN), European Environment Agency (EEA), and at the regional level, the *Observatoire Méditerranéen de l'énergie* (OME), the Mediterranean Wetlands Initiative (MedWet), etc. On specific subjects and case studies, the report also draws data from national statistics offices/observatories, national thematic agencies, and national and local governments. Official data sources were supplemented, where required, by peer-reviewed scientific articles, reports from research institutions, doctoral theses, and scientific books. Some industry data from recognized industry organizations was used to describe specific sectors (e.g. MedCruise on the cruise sector). Finally, case studies were derived from project reports and interviews with project managers.

These data sources are in line with international best practices, the 2014 United Nations Secretary's call for a Data Revolution for Sustainable Development[6], and the UNEP methodological recommendations in the context of the Global Environmental Outlook 6 (UNEP, 2019).

THE FULL REPORT IS SUPPLEMENTED BY TWO SUMMARY DOCUMENTS

The full report is composed of eight thematic chapters. It is supplemented by two summary documents:

1. **The Summary for Decision Makers** provides a comprehensive overview of the state of the environment and development in the Mediterranean, along the same structure as the main report. It is intended for a large audience.
2. **The Key Messages** compile evidence from the various chapters most closely connected to marine and coastal environmental issues. They highlight interactions and combined impacts according to the Drivers-Pressures-State-Impacts-Responses analytical framework (DPSIR). The Key Messages expand on the larger significance of the findings, conveying policy-relevant but not policy-prescriptive suggestions in the context of the UNEP/MAP - Barcelona Convention system, and identify priority areas for further policy-oriented research.

[5] Sources exclude, among others: newspapers and magazines, blogs, social networking sites, broadcast media, and popular books.
[6] http://www.undatarevolution.org/wp-content/uploads/2014/11/execsum.pdf

BOX 1 General principles for the use of data and other information in this report

The following types of data sources are used for the purpose of providing information relevant for the policy debate within this report:

- UN system data
- Data from international organizations (EU agencies, IPCC, IUCN, OECD, United Nations and related agencies and organisations, World Bank, ...)
- Data from national statistics offices/observatories, national thematic agencies, national and local governments
- Data from Mediterranean regional observatories and initiatives (MedWet, OME, ...)
- Scientific articles, reports from research institutions, PhD theses, scientific books
- Reports from industry in their relevant fields (MedCruise...)
- Relevant conference proceedings, project reports for case studies

The following types of information sources are not accepted:

- Newspapers and magazines
- Blogs, social networking sites
- Broadcast media
- Popular books

Emphasis is placed on the reliability of all cited literature. Use of this literature brings with it the responsibility to assess the validity of cited information. This responsibility has been shared between authors, reviewers and editors.

1.0 Socioeconomic drivers and trends

Countries along the Mediterranean Sea share a common heritage, analogies in lifestyle and values, exposure to climate and environmental risks and impacts, urbanization and coastal erosion, and an increasing tourism pressure. The contrasts are also significant: throughout the past decade, gaps have persisted between Northern Mediterranean Countries (NMCs) and Southern and Eastern Mediterranean Countries (SEMCs) in terms of demographic dynamics, human development, access to natural resources and environmental protection. These differences lead to large inequalities in resilience and adaptive capacity to deal with current and projected environmental and climate changes. Recent estimates of the cost of environmental degradation attest to the magnitude of these impacts, which are exacerbated in situations of conflict.

While facing contrasted situations, countries in the region remain connected by intense flows of people (migration and tourism), goods and energy products (especially via maritime transport), financial resources (foreign investment), information and social interaction (increase in mobile phone subscriptions and the number of people using the Internet and social media), as well as via environmental flows (river flows, marine currents, migratory species, etc.). Globalization and technological progress are accelerating connections between individuals and certain strategic locations (large cities, airports, industrial and logistics zones), and more remote locations such as local markets[7]. Among other recent trends, the emergence of regional and international powers, including China, repositions the Mediterranean at the centre of transnational influences and flows (Arrault, 2006). Such interconnections call for strengthened collaboration on sustainable development challenges.

The widespread urbanization and other shared phenomena occurring at varying levels of intensity (economic growth, centralization/decentralization and liberalization of public action, demographic transition, internal and transnational migrations, increased social mobilization at various levels, and the local empowerment of populations) have also profoundly changed the context and lifestyles of societies in the region. The environmental impacts of such changes in lifestyles vary. While current trends tend to scale up the negative environmental impacts of unsustainable production and consumption patterns, emerging alternative models and aspirations also open a window to potential transformative changes.

This introductory chapter seeks to provide updated information on some key drivers of environmental, social and economic changes in the Mediterranean region. It acknowledges both important interactions with continents beyond Mediterranean boundaries, and subregional contrasts or "complementary differences" among countries and subregions. Important developments in environmental preferences and consumption patterns are described in greater detail in Chapter 4.

1.1 Demographic contrasts: a young growing South and aging North

The population of the States bordering the Mediterranean Sea[8] amounted to approximately 512 million people in 2018 (UN DESA, 2019), representing 6.7% of the world population. While the population has been stabilizing in the north since 1980, the population in the south and east of the basin has more than doubled over the same period (from 153 million in 1980 to 314 million in 2018), and is expected to increase by an additional 182 million inhabitants by 2050. In 2018, 39% of the Mediterranean countries' population lived on the northern shore and 61% on the southern and eastern shores. In decreasing order, population growth rates in the past decades have been highest in the State of Palestine, Lebanon, Israel, Egypt, Algeria and the Syrian Arab Republic. The most populated country is Egypt with 98 million people in 2018, followed by Turkey (82 million) and France (67 million). 2018 population density was highest in Monaco, Malta and the State of Palestine, and lowest in Libya (ranging from 4 to almost 26,000 people per km^2) (UN DESA, 2019).

The demographic transition has been completed in two thirds of Mediterranean countries and is ongoing in the remaining ones. The demographic convergence with Northern Mediterranean Countries (NMCs) is striking in Lebanon, Tunisia and Turkey. In Morocco and Libya, where fertility continues to decline, this convergence is only a few years away. This trend is coherent with an increasing urbanization, as, in demographic transition, fertility rates generally decline fastest in urban areas and remain highest in the most remotely settled and rural zones. Contrary to earlier projections, the demographic transition seems to have come to either a halt or a new increase in Algeria and Egypt. All Southern and Eastern Mediterranean Countries (SEMCs) have a fertility rate at or above the replacement rate of 2.1, leading to population growth, except Lebanon (1.7). In Egypt, Israel and the State of Palestine, fertility rates exceed the symbolic threshold of three children per woman. Fertility is below the replacement rate in all NMCs, leading to population decrease and aging. Migration impacts these dynamics.

The current and historic differences in fertility have led to different age structures in Northern, Eastern and Southern countries, with a population in SEMCs on average 14 years younger than in the North. The average median age in SEMCs ranges from 20 to 31, and in NMCs from 34 to 45.

Around 70% of the Mediterranean population lives in urban areas. The urban population has continued to increase throughout the region in the past decade with more than half of the population living in urban areas in 2017 in all countries except for Egypt (57% rural population), and Bosnia and Herzegovina (52%). A new phenomenon is the decline in absolute numbers of the rural population

[7] For more information on the "inconspicuous spaces of globalization" and peripheral goods flows towards poor population categories in Southern and Northern countries, see Choplin & Pliez (2018).

[8] Including the State of Palestine.

Box 2

Stagnation or increase in fertility in Algeria, Egypt, Israel and Tunisia, and life expectancy in the Syrian Arab Republic

The fertility decline dynamics in the SEMCs have been visible since the 1960s and seemed sufficiently strong to scientifically support the thesis of an ongoing demographic transition. Data sources from various international institutions all agreed on 2020-2025 as the date for reaching a fertility rate similar to that of the NMCs, i.e. around the replacement threshold of two children per women. Until the mid-2000s, the forecasts proved generally in keeping with reality, with spectacular decreases in fertility recorded in Algeria, Egypt, Libya, Morocco, the Syrian Arab Republic and Tunisia. The disruption of these trajectories since 2005, which in some of these countries has led to a stabilization or even a significant increase in fertility, has come as a surprise for the community of demographers. Even if demographers seem to consider this inflection as temporary, they have put forward a number of potential arguments to understand this "counter-transition".

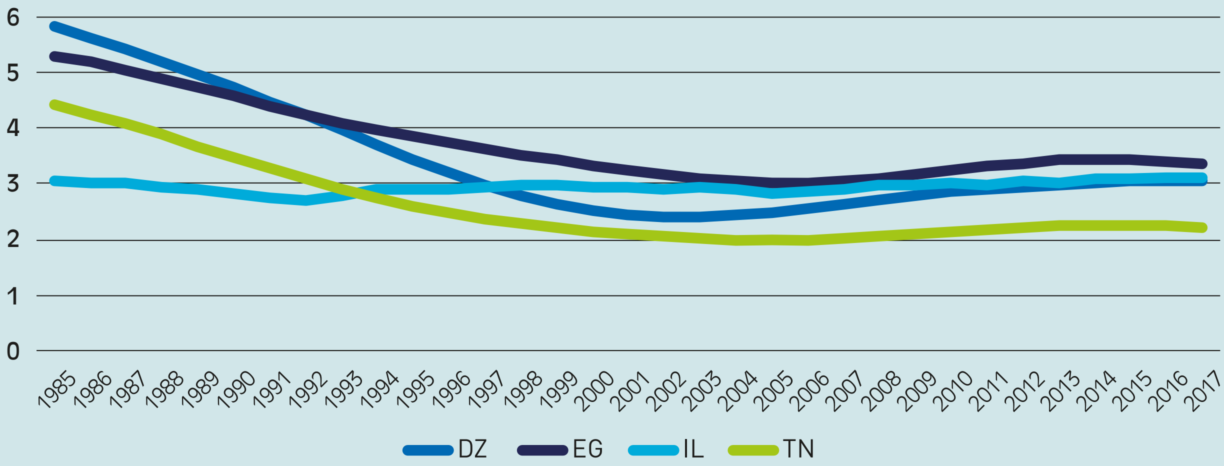


Figure 1- Fertility rates in Algeria, Egypt, Israel and Tunisia, 1985-2017
(Source: United Nations, 2019)

In Egypt, fertility rates rose from around 3.0 in 2006 to almost 3.4 in 2013 and 2014, in a country particularly affected by limited living space, accelerating natural resource depletion and a difficult labour market situation. Although there is currently no consensus among demographers on the explication of this fertility increase, hypotheses include: poverty leading to overinvestment in future generations, difficulties for the female workforce on the labour market leading to earlier motherhood (without necessarily having more children than older generations), economic support from expatriate Egyptians working in the Gulf countries, which makes it economically feasible to have a higher number of children, etc.

Potential reasons to explain the rise in fertility in Algeria and the stagnation in Tunisia after a previous period of spectacular decline include (i) a slowdown in the rise of the age of marriage, which has tended to stabilize at around 30 years old since 2000; and (ii) the stabilization, or decrease in Tunisia, of the proportion of women using contraception. This increase in fertility is more significant in urban than rural areas and affects all social categories of women, but especially educated women, including in rural areas, as fertility of the most highly-educated women in Algeria increased from 1.4 children per woman in 2001 to 2.8 in 2007. In Israel, fertility rates have stagnated at around 3 children per woman.
In the Syrian Arab Republic, the recent conflict has brought about an eight-year reduction in life expectancy for men compared to a reduction of just over one year for women (Loichinger, Goujon & Weber, 2016). This trend implies that women are increasingly likely to be widowed and have proportionally higher dependency levels among the older age categories than men (UNDESA, 2017).

in Albania (-2.4%), Croatia (-1%), Montenegro (-1%), Algeria (-0.4%), Slovenia (-0.5%), and Turkey (-0.5%), while Egypt still registers an annual growth of 2% of its rural population. Continuing urbanization is accompanied by an increase in the number of inhabitants in Mediterranean metropolises, which challenges urban planning, including transport and environmental infrastructure.
In Mediterranean countries, one out of three people live in a Mediterranean coastal region[9]. The share of the coastal population ranges from 5% in Slovenia to 100% in island countries (Cyprus, Malta) and Monaco. Coastal urbanization is partly driven by tourism, with Mediterranean countries hosting around 360 million international tourist arrivals (ITAs) per year, representing around 27% of world tourism in 2017 (UNWTO, 2019), largely concentrated in coastal zones and in the summer months.

[9] Plan Bleu calculations, national sources (referring to NUTS 3 or equivalent).

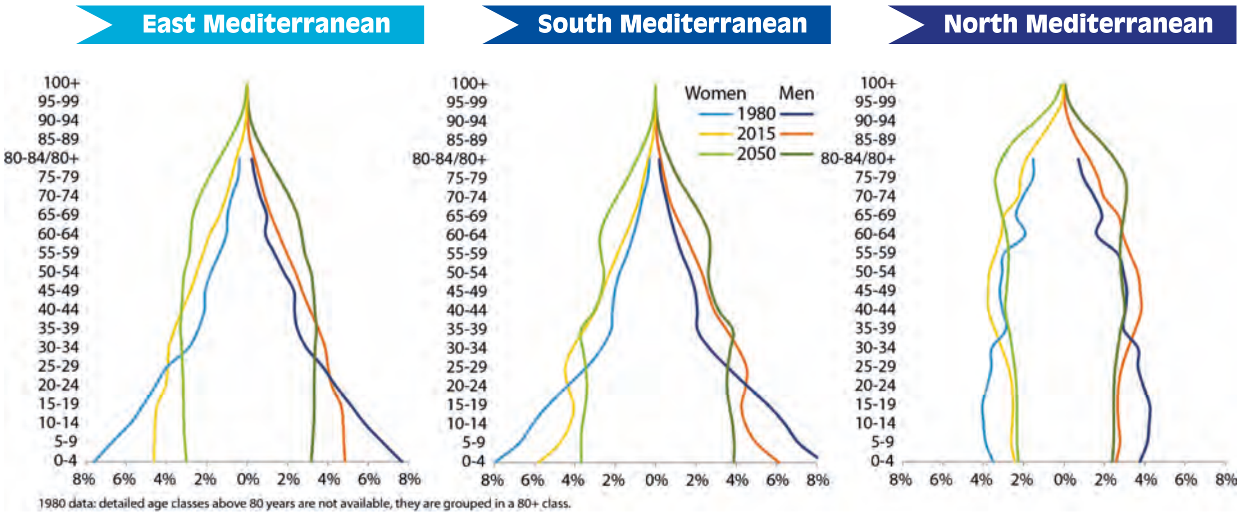


Figure 2 - Age distribution of population in the Mediterranean
In the East Mediterranean, South Mediterranean and North Mediterranean, 1980, 2015 and 2050 forecast.
(Source: UNDESA, World Population Prospects, 2017)

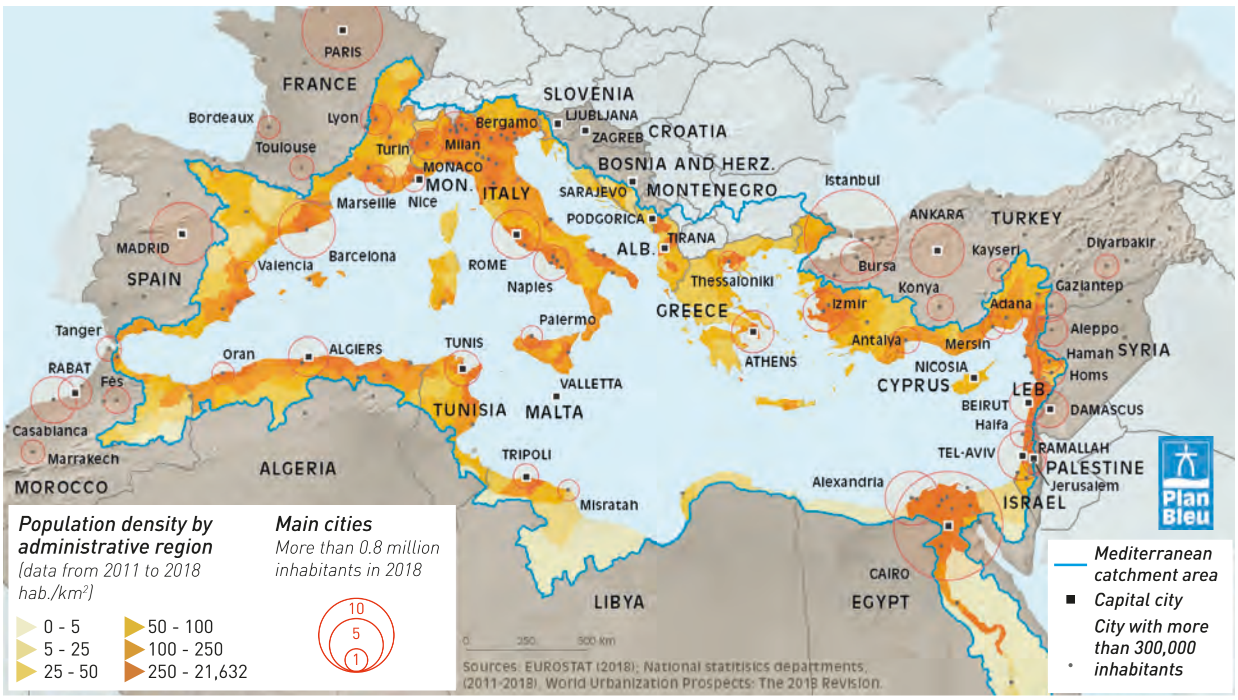


Figure 3 - Population settlement in the Mediterranean
Population density by administrative region and main cities in the Mediterranean catchment area.
(Source: EUROSTAT, 2018; National statistics departments, 2011-2018; UNDESA, World Urbanization Prospects: The 2018 Revision)

1.2 A region of socioeconomic inequalities

1.2.1 Disparities in human development are decreasing but remain, aggravated by conflicts

The levels of development in the region, as measured by the Human Development Index (HDI), reflect the geographic and economic divide between NMCs and SEMCs, with the exception of Israel. In European Union (EU) countries, higher income, coupled with social security systems and investment in education, have increased life expectancy at birth and the number of years of schooling. The EU candidates are in an intermediate position, even if Albania and Bosnia and Herzegovina have lower Gross Domestic Product (GDP) per capita than Algeria, Lebanon or Libya.

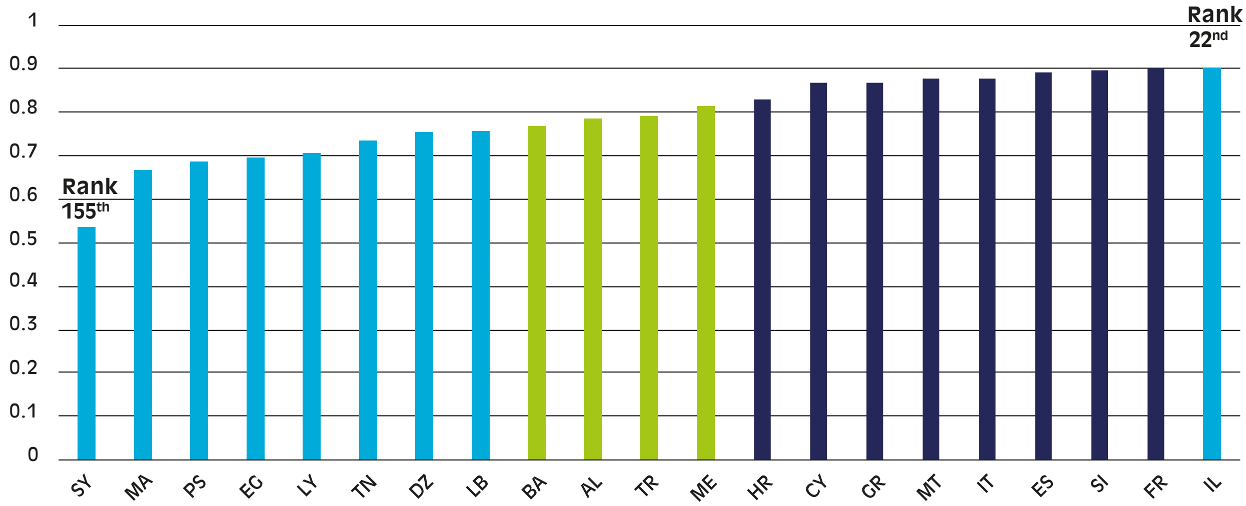


Figure 4 - Human Development Index scores of Mediterranean countries, 2018
(Source: UNDP, 2018)

Despite demographic growth, geopolitical difficulties and conflicts, human development, as measured by the HDI, has experienced an upward trend throughout the last decade, significantly increasing in almost all countries. Most SEMCs have conducted policies to provide widespread access to education in primary and secondary schools. The expected number of years of schooling for new generations are not far from European standards, with the exception of tertiary education to which access remains unequal. Girls' education has also improved with an increased gender parity index for the enrolment rate in primary and secondary schools in most Mediterranean countries.
The challenge lies in the quality of the education provided. The World Economic Forum (WEF) has produced a human capital index that measures "the knowledge and skills people possess that enable them to create value in the global economic system", for which most southern Mediterranean countries are lagging behind, as indicated in *Figure 5* below.

1.2.2 Unemployment is a core issue, particularly for women and young generations

In Mediterranean countries, 22.5 million people were unemployed in 2018, more than 11% of the total labour force. Unemployment rates vary from 4% in Malta to 26% in the State of Palestine. The number of unemployed has reached up to 3 million in Egypt, Turkey and Spain. Compared to 1995, the total rate of unemployment has decreased in 15 countries, mainly in Algeria and Montenegro (- 20% and - 15% respectively), and increased in 6 countries, mainly in the State of Palestine and Greece (+15% and 10% respectively).

Youth unemployment is a major issue in all Mediterranean countries. In most cases, the youth unemployment rate is double to triple the total rate. In 2018, the youth unemployment rate varied from 7% in Israel to 42% in the State of Palestine and close to 50% in Libya.

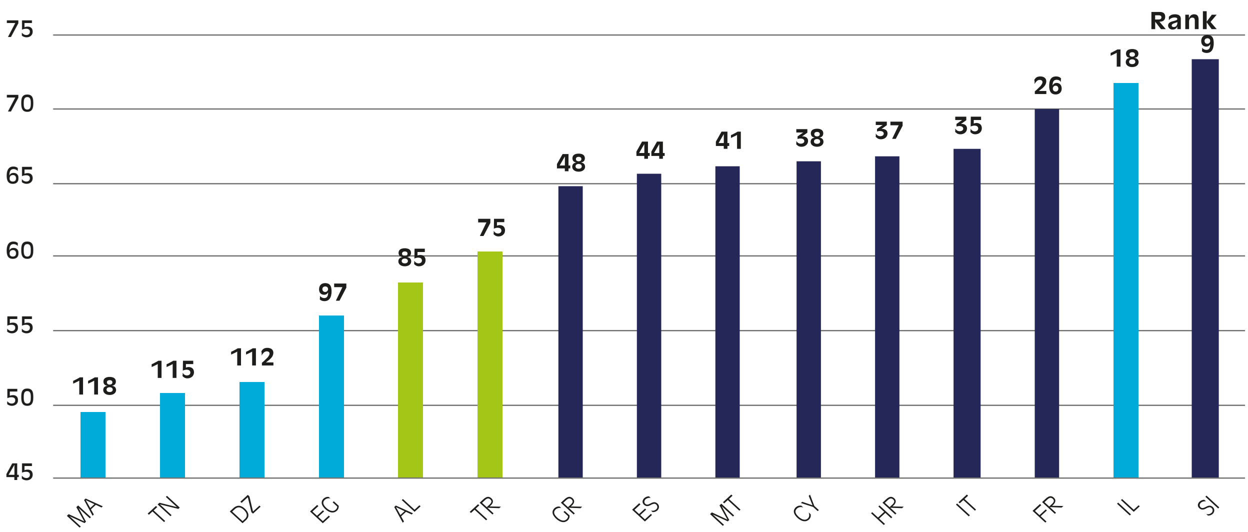


Figure 5 - Human Capital Index score and rank/130, 2017
(Source: World Economic Forum, 2017)

Another trend in unemployment is that advanced education does not seem to provide better protection against unemployment in some countries. According to the International Labour Organisation (ILO), unemployment rates among individuals with advanced education (tertiary level) is higher than the national averages and reached 42% in Tunisia in 2013, 30.8% in Egypt in 2016, and 54% in the State of Palestine in 2017.
The situation for women on the labour market varies between countries. In 2017, the female unemployment rate was higher than the male unemployment rate in most Mediterranean countries, except in France and Albania. The situation is very diverse, from less than 5% female unemployment in Malta and Israel (similar to the male rate) to 47% in the State of Palestine (more than double the male rate). The share of women in the labour force in NMCs and Israel is above 33% and below 33% in SEMCs, having slightly increased in almost all countries over the past decade.

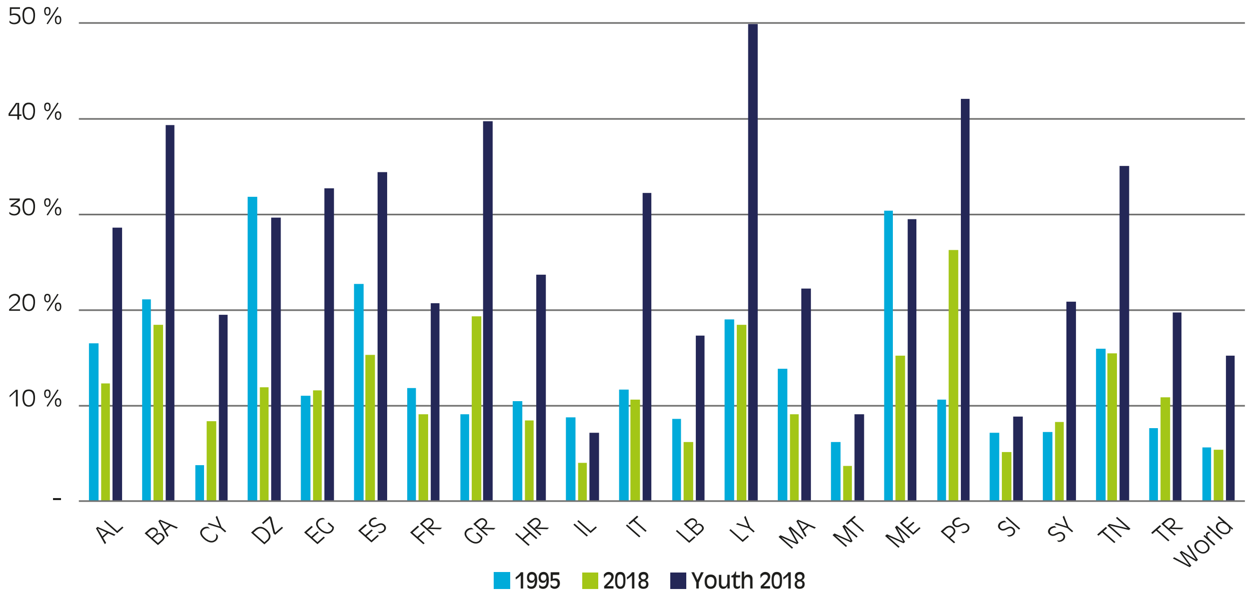
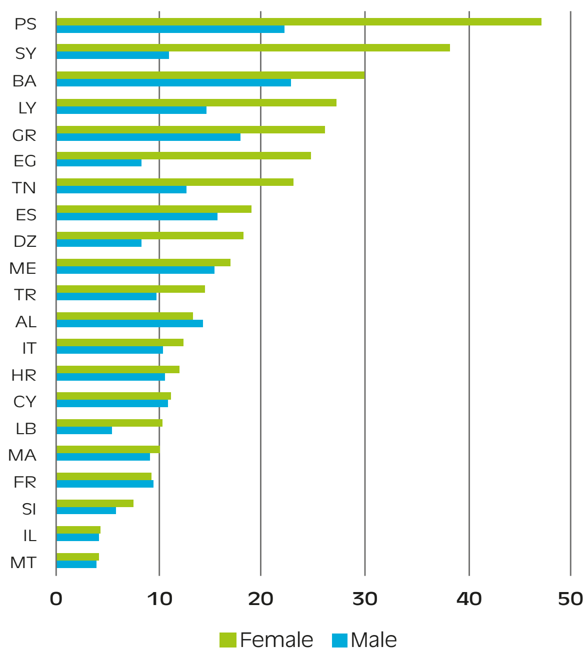


Figure 6 - Unemployment rates 1995-2018 and youth unemployment rates in 2018
(Source: World Bank, 2019a, based on ILOSTAT, 2019)



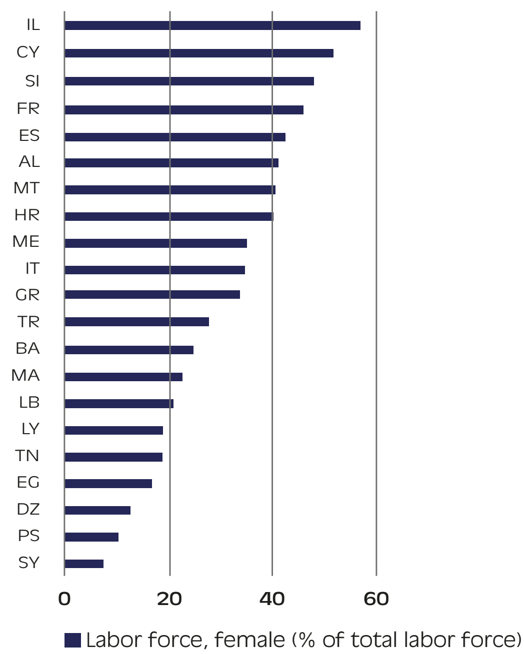


Figure 7 - Female and male unemployment, Female labour force
Left: Female and male unemployment rates in Mediterranean countries, 2017. (Source: ILOSTAT, 2019)
Right: Female labour force, as a percentage of total labour force. (Source: World Bank, 2019a)

1.2.3 A significant gender gap remains a barrier for inclusive environmental management

The gap between economic activity rates of men and women *(Figure 7)* cannot be explained by the (relatively small) differences in educational attainment alone. Even higher enrolment rates of women in tertiary education do not lead to higher female employment *(Sidło et al. 2017)*. Instead, the main reasons for the discrepancies in activity rates of men and women on the labour market include sociocultural norms regarding women and their place in family, society and work and the resulting discrimination in workplaces and lack of work-life balance, as well as more practical issues such as lack of safe, reliable and affordable ways to commute to work or access to financing to start a business *(Sidło et al. 2017)*. In addition, time spent on domestic work is much higher for women than for men in all Mediterranean countries *(Figure 9)*.

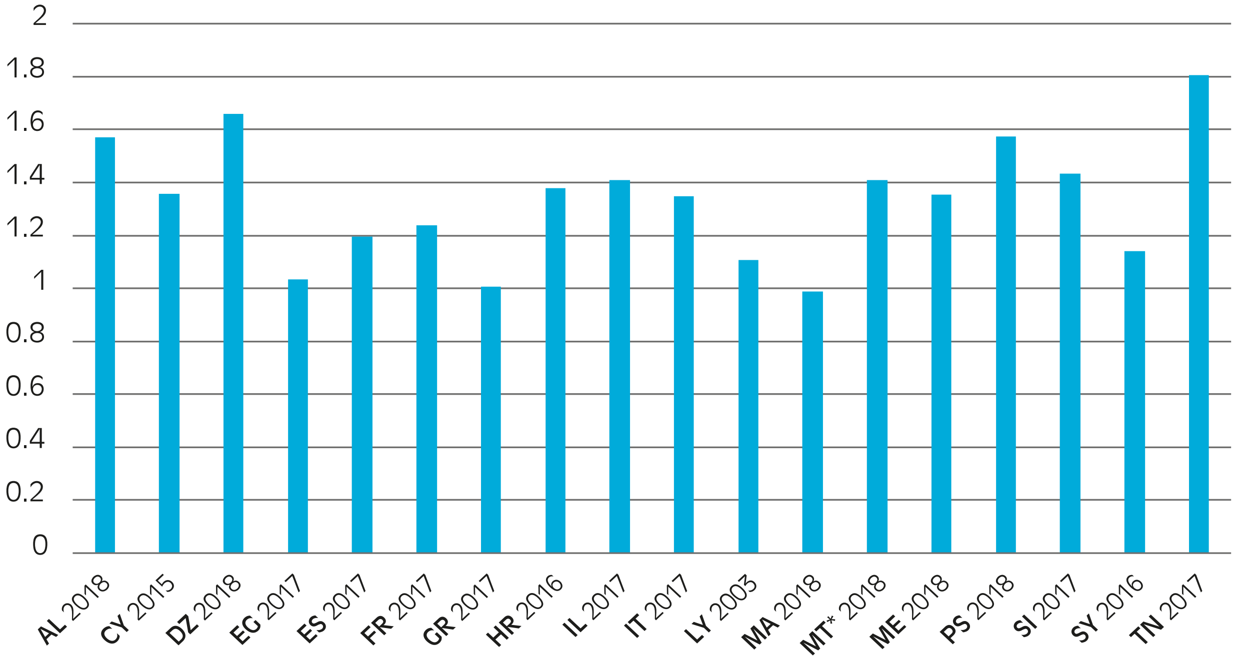


Figure 8 - Gross school enrollment in tertiary education, gender parity index
(Ratio of women to men enrolled at tertiary level in public and private schools) in Mediterranean countries.
(Source: World Bank, 2019a; *Malta National Statistics Office, 2020)

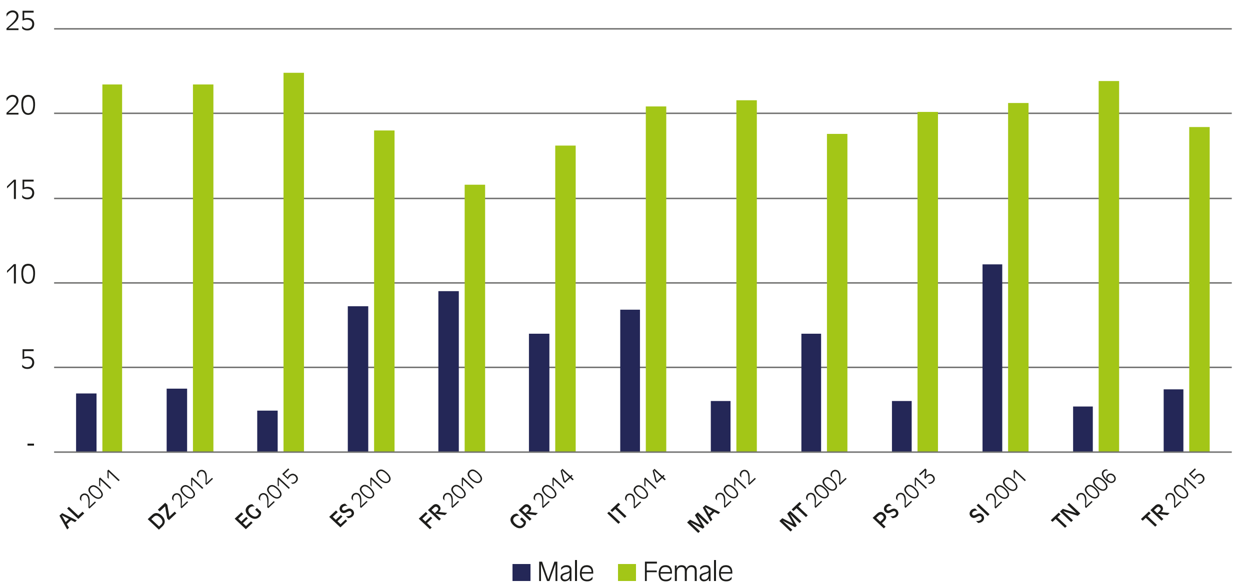


Figure 9 - Proportion of time spent on unpaid domestic and care work, male and female in % of 24-hour day
(Source: World Bank, 2019a)

The Global Gender Gap Index (World Economic Forum, 2020) has been conceived to capture the magnitude of gender-based disparities. It benchmarks national gender gaps on economic, education, health and political criteria to create global awareness of the challenges posed by gender gaps and the opportunities created by reducing them.

In all Mediterranean countries, just as at the global level, gender parity, as assessed by the Global Gender Gap Index, is far from being achieved *(Figure 10)*. The gender gap to be closed in Mediterranean countries ranges from 20 to 43%, compared to 31% at the global level. In all SEMCs except Israel, the gender parity gap is larger than at the global level, while all NMCs and Israel are closer to gender parity than the world average.

Mediterranean countries score particularly well in educational attainment, with only two countries (Morocco and Syrian Arab Republic) showing a larger gender gap than the global average and four countries (France, Israel, Malta, Slovenia) having achieved full gender parity for educational attainment. All Mediterranean countries are less than 4,5% away from closing the gender gap for this indicator.

When it comes to the survival and health parity index, the maximum gap to be closed in any of the Mediterranean countries is 4%, which is close to the global average of 3%. Economic participation and opportunity for women remains much lower than for men in all Mediterranean countries. The gender gap to be closed is between 20 and 75%, being larger in most SEMCs than the global average of 42% and around the world average or narrower in NMCs.

At the global level, the gender gap is by far highest when it comes to political empowerment of women: 75% of this gender gap still is to be closed. The situation is particularly difficult for women in Mediterranean countries, where the gap is between 47 and 91%. 75% of Mediterranean countries have a larger gender gap than the global average and only five countries (Albania, Bosnia and Herzegovina, France, Italy and Spain) score better than the global average.

These socially constructed gender roles result in different attitudes of women and men in relation to the environment and different possibilities to act as agents of environmental change. As illustrated by the United Nations Environment Programme (UNEP) Global Gender and Environment Outlook (UNEP, 2016) "[...] if many men drive to work in a private car and most women use public transportation, they will inevitably have different sets of environmental knowledge and experience. This different environmental positioning may mean women and men have exposures to very different environmental problems and risks, along with different perspectives on the degree of seriousness of environmental problems and on appropriate interventions, adaptations and solutions. Further, because of the social construction of gender roles, women and men may have different - usually unequal - capacities and approaches for acting as agents of environmental interpretation and change" (UNEP, 2016).

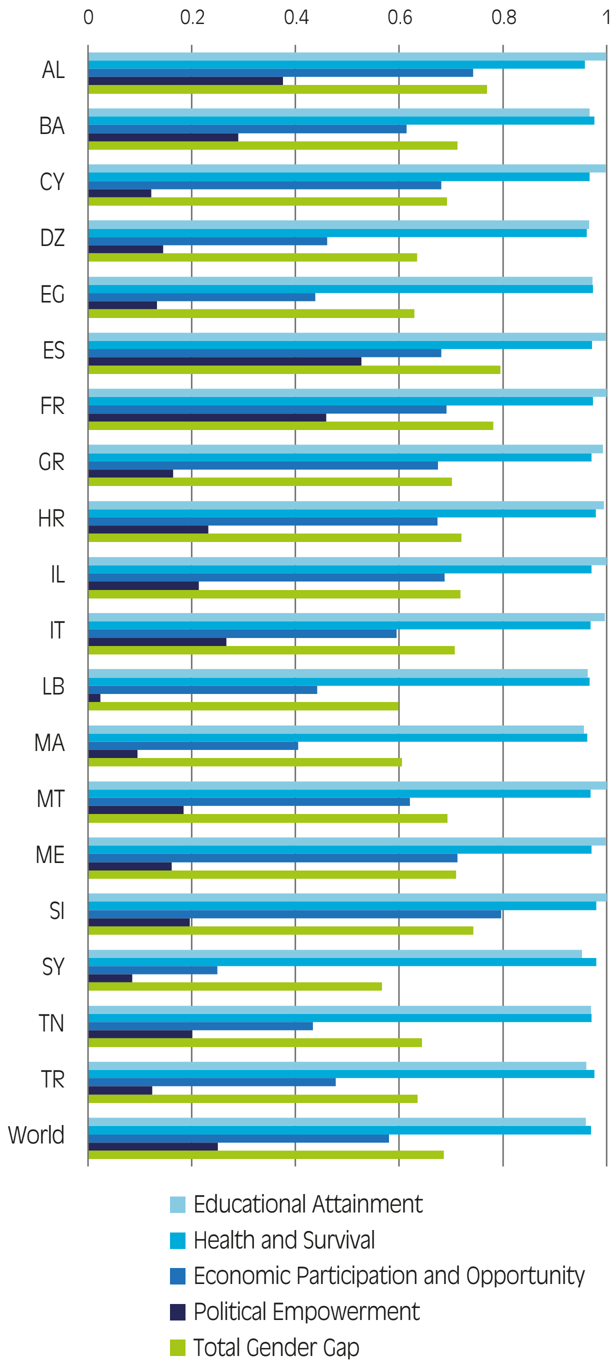


Figure 10 - Gender gap index in Mediterranean countries and globally in 2020
(Source: World Economic Forum, 2020)

Achieving gender equality and empowerment of women and girls as agents of change, as reflected in the 2030 Agenda for Sustainable Development, is critical on the way towards transformative change for sustainability (United Nations Environment Assembly of the United Nations Environment Programme, 2019).

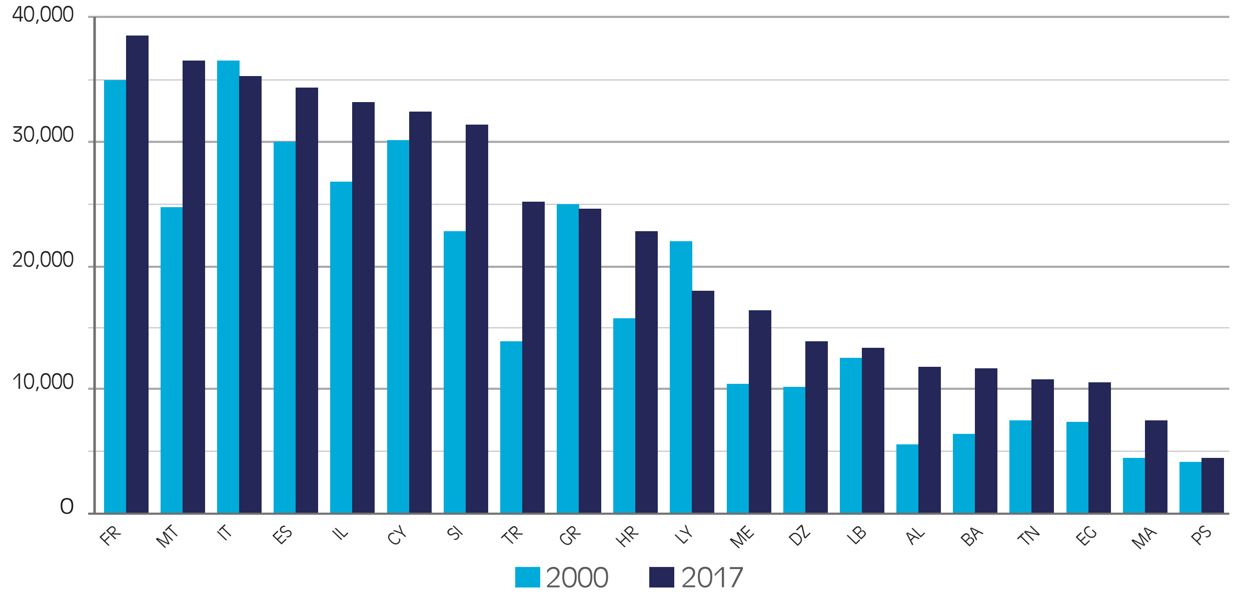


Figure 11 - Gross Domestic Product (GDP) per capita, 2000 and 2017, PPP in 2011 constant US dollars
(Source: World Bank, 2018)

1.2.4 Disparities persist in economic wealth

Economic wealth creation, expressed as the Gross Domestic Product (GDP), varies largely among Mediterranean countries, with a persisting gap between NMCs and most SEMCs. The EU Mediterranean countries account for 60% of the total GDP generated by Mediterranean countries. In 2017, the average GDP per capita in SEMCs was three times lower than the average income in the EU Mediterranean countries. The Mediterranean countries' economy grew less than the world average between 2000 and 2017, leading to a decreasing share of the Mediterranean GDP in the world GDP: from 12.9% in 2000 to 11% in 2010 and 9.8% in 2017. During the same period, the share of the Mediterranean population has remained constant at around 7% of the world population.
The past decade was marked by economic instabilities. The 2008 financial crisis did not affect all Mediterranean countries equally. Members of the EU experienced a double-dip recession, first due to the 2008 crisis and then linked to the European sovereign debt crisis. Recently, the economies of southern EU countries have been slowly recovering: their GDP growth is now above 2%, but GDP per capita has hardly recovered its pre-crisis level and unemployment remains high, especially among youth (particularly in Spain and Greece). Economies in the western Balkans and Turkey also plummeted in 2008. Although they were less hit by the 2012 crisis since they were not part of the EU, they still felt the negative spillover effects from their weakened partners. Southern Mediterranean countries have shown a relative resilience to the 2008 crisis, but the added political instability and conflicts since the Arab Springs have left the region with a growth of 2 to 3% which is by far insufficient to absorb the high levels of unemployment given the demographic dynamics.

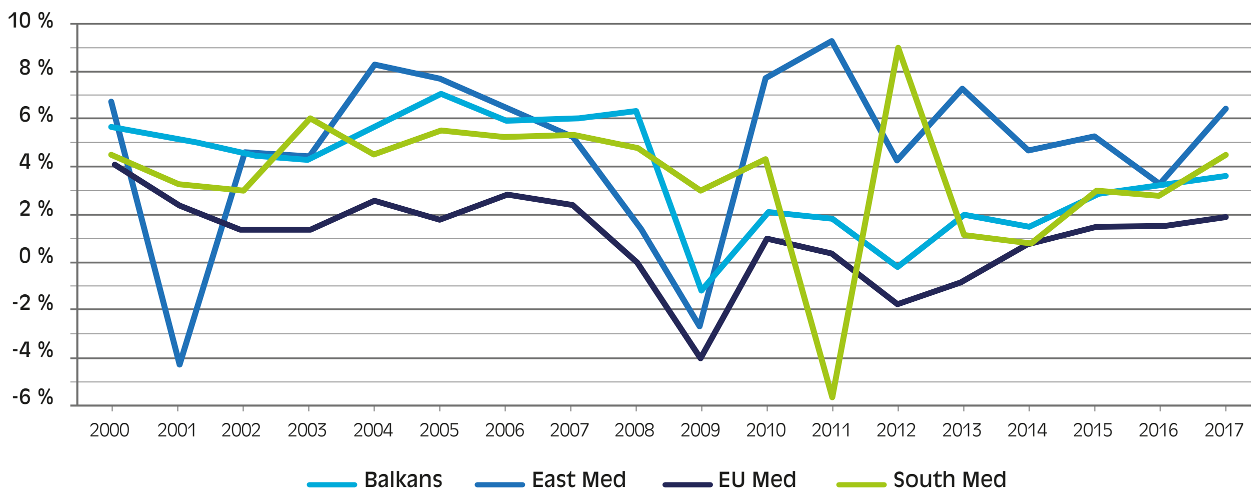


Figure 12 - GDP growth by country group in the Mediterranean, 2000-2017
(Source: World Bank, 2019a)

The continuing presence of **a significant informal sector** is another important characteristic of many Mediterranean economies. According to calculations by the International Labour Organization (ILO)[10], the share of informal employment in total employment is above 15% in all of the Mediterranean countries documented but 4 (Croatia, Cyprus, France and Malta). Informal employment is close to or above 60% in Albania, Egypt, Morocco, the Syrian Arab Republic, and Tunisia (59%), reaching 80% in Morocco. Such high levels of informal activities restrict government capacities to regulate environmental impacts and invest in sustainable development programmes. Women and youth are disproportionately represented among informal and precarious workers, limiting their capacity to access credit, innovate and build an ambitious future.

In southern Europe, the public bailout of the financial system, coupled with revenue loss from taxes and increased social spending, have significantly deteriorated the health of public finance, and the coordinated fiscal consolidation that followed did not work as expected to stabilize government debt because of their recessionary effect.

The share of agricultural and industrial value added has continued to decrease in Mediterranean economies in favour of services, but significant disparities between countries remain. The contribution of the agricultural sector to GDP, in particular, has declined in most countries, but remains very disparate (between 1 and 19% in 2017 compared to more than 1.5 to 57% in 1995).

In SEMCs, the contribution of agriculture to GDP is between 9% and 13% in Algeria, Egypt, Morocco and Tunisia, and does not exceed 4% of GDP in Israel, Lebanon and the State of Palestine. Compared to 1995, the contribution of agriculture to GDP has fallen in the State of Palestine, Turkey, Lebanon and, to a lesser extent, Morocco. Only Algeria has seen this contribution increase significantly. In the Balkan countries, the share of agricultural value added in GDP has fallen. Albania is the country where agriculture contributes the most to GDP, with a share of more than 56% in 1995, and still 19% in 2017. In Bosnia and Herzegovina and Montenegro, the share in 2017 was between 5% and 7%. In EU Mediterranean countries, the share of agriculture in GDP in 2017 was between 1 and 3.5%, with a strong decrease in most

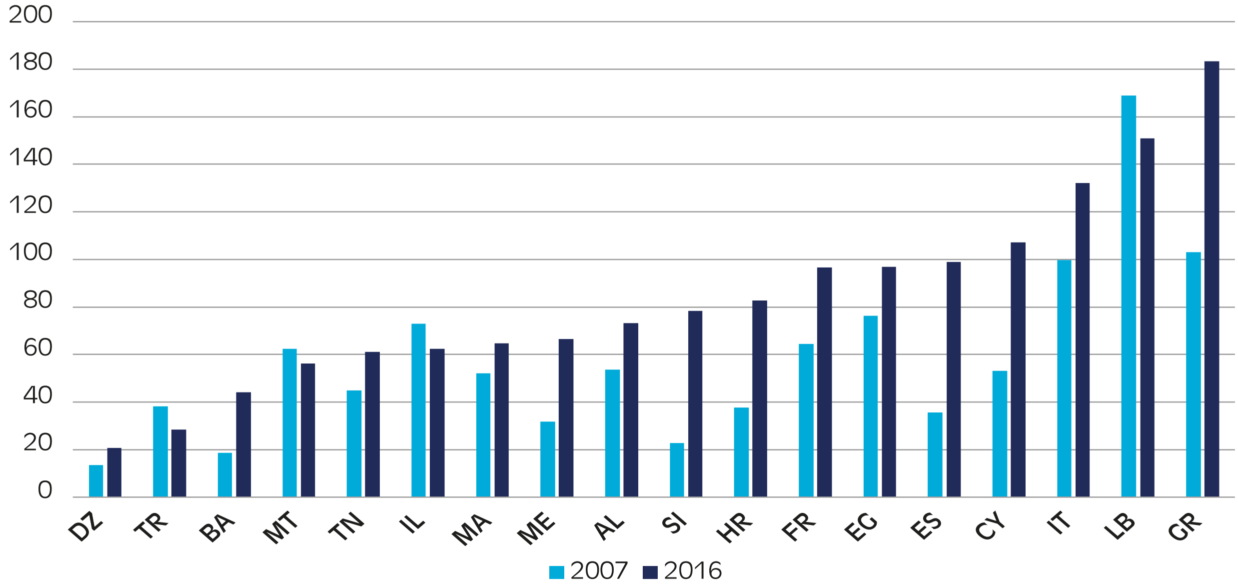


Figure 13 - General Government Gross Debt, % of GDP, 2007 and 2016
(Source: IMF, 2018)

The individual situations in other Mediterranean countries are mixed, but levels of government debt *(Figure 13)* have generally increased and now represent a challenge in terms of the countries' ability to make necessary public investments in education, health, infrastructure and the environmental transition.

1.2.5 Mediterranean economies continue their tertiarization with unequal opportunities for growth

countries and especially in Cyprus and Malta (less than half of the 1995 value).

The share of industrial value added in GDP fell in most Mediterranean countries over the 1995-2017 period, except in Egypt. In SEMCs, Algeria (with a highly gas- and oil-dependent economy), Egypt (the only Mediterranean country that experienced a notable increase in the contribution of industry to GDP) and Turkey had an industry contribution to GDP around,

[10] Calculations based on micro-datasets from household surveys, with latest data ranging from 2012 to 2017 (2003 for the Syrian Arab Republic). https://www.ilo.org/re-Search/informality/map1_en.html; data retrieved from ILO website in October 2019.

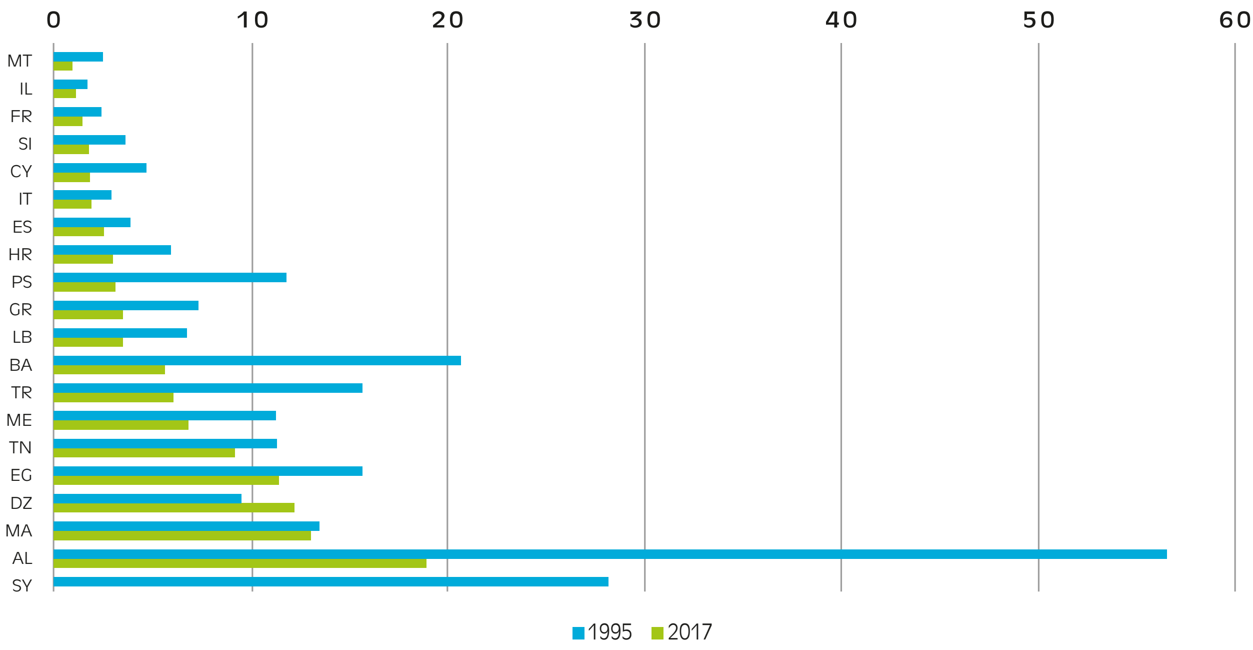


Figure 14 - Contribution of agricultural sector value added to GDP in 1995 and 2017
(Source: World Bank, 2019a). Note: Israel, State of Palestine and Tunisia: 2016 data.

or greater than, 30% in 2017. Israel and Lebanon are the SEMCs where industry contributes the least to GDP (19% and 12%), showing that these are service-oriented economies in 2017. In the Balkans, industry accounted for 24% of value added in GDP in Bosnia and Herzegovina and 16% in Montenegro in 2017. Slovenia is the EU country with the largest industrial share of GDP (29%), followed by Croatia (23%). Malta with only 12% in 2017 is the country with the greatest decline, with a two-fold reduction over the past 20 years.

The share of value added generated by services has been increasing or remained stable over the past decade in almost all Mediterranean countries. Notable decreases of the share of services in GDP between 2010 and 2018 took place only in Slovenia (from 59 to 56%) and Greece (from 62 to 58%). Services accounted for less or around 50% of GDP in Albania (48%), Algeria (46%), Egypt (51%), and Morocco (51%), 54% in Turkey, 56% in Bosnia and Herzegovina, 58% in Croatia and 59% in Montenegro. All other Mediterranean countries register a share of services at or above two thirds of their national GDP, with particularly high rates in Lebanon and Malta (both 75%) and Monaco (more than 80%).

At first sight, the transition to a mainly service-based economy may seem to be a development that favours less resource and material consumption and less pollution. However, service-based economies continue to rely on significant and varying amounts of resources and emit different types of pollution. The relationship between the transition towards the tertiary sector and environmental impact is, in reality, complex and ambiguous. In addition, it is associated with a displacement of environmental impacts to countries with larger manufacturing and agricultural sectors from which goods are imported.

1.3 Flows, nodes and powers: the Mediterranean in the global system

One of the main hopes in bridging some of the gaps described above laid in stronger integration between Mediterranean countries and the rest of the world. The acceleration and intensification of trade have historically created periods of closer commercial and cultural ties between the different continents of the Mediterranean. Does the Mediterranean Sea still play this role of a "junction", as Élisée Reclus stated in the 19th century (Deprest, 2002)? What do current goods, capital, resource and human flows reveal about its level of regional integration? On a global scale, is it still on the periphery of globalization? Or, on the contrary, do the initial signs point to the fact that the region is reopening its geographical horizons following the rise of new countries on the world stage?

1.3.1 Trade patterns show continued North-South asymmetry but also new emerging routes in the South and East

After several years of growth, trade peaked for all Mediterranean countries in 2008, with disparities at a regional level. Mediterranean imports accounted for just 11% of world trade (USD 2,000 billion of a total of USD 18,000 billion in 2017 (UNCTAD, 2019)). Exports between Mediterranean countries fell slightly between 2001 and 2016 (from 31 to 29%) (Tozy, Trifaia & London, 2018). Exports and imports remain strongly concentrated in European countries, which control around 80% of regional trade. Southern countries (Morocco, Algeria, Tunisia, Libya, Egypt), Eastern countries (Israel, Turkey, Lebanon) and the Balkans (Albania, Bosnia and Herzegovina, Croatia, Montenegro) respectively hold a 10.1%, 8.4% and 2% share of regional import and export flows.

The amount, origin and destination of Foreign Direct Investment (FDI) show the effects of double geographical marginalization. FDI in the Mediterranean region increased by 23% between 2012 and 2016, significantly below the global average increase of 39%. Despite the net growth of FDI recorded over the same period by Turkey (+87%, 20th country in the ranking of economies attracting the most FDI in 2015), Egypt (+49%) and Morocco (+46%), and the significant decline in some countries like Greece (-42%), the EU countries have retained their dominant position in absolute terms as FDI senders and recipients in the region.

It is difficult to explain the paradox between the strong political will since the 1990s to create a large Euro-Mediterranean free trade area, which, in reality, has more modestly resulted in an increased number of bilateral agreements[11], and the low level of intra- and extra-Mediterranean trade integration. The first reason is structural, as the economic structure of SEMCs (except for Israel) is still based, to a greater extent, on the agricultural and industrial sectors and is less competitive than in European countries. There are also a number of contextual factors, including the 2008 economic crisis, the Arab Springs from 2010, and the development of tax measures, anti-dumping measures, quotas, etc. primarily targeting agricultural produce and the steel and iron industry.

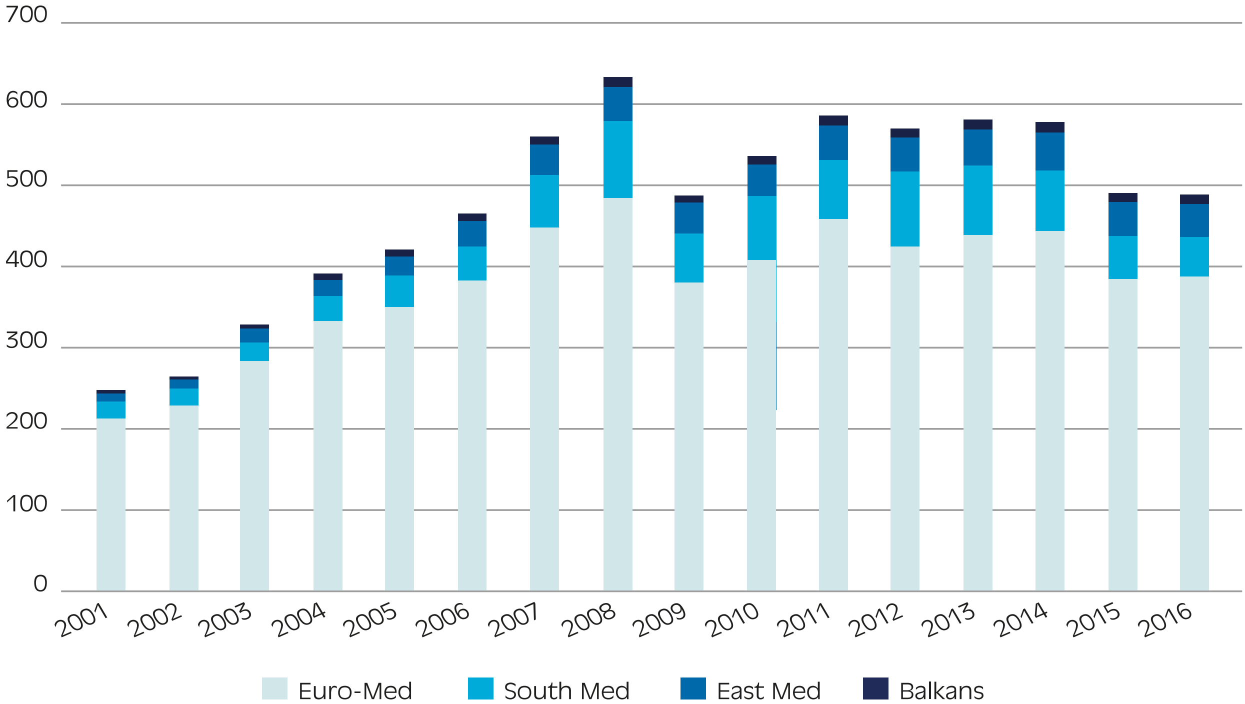


Figure 15 - Total exports by subregion towards the Mediterranean region, in billions of USD
(Source: Intracen, 2018)

Since the 2000s, there has been a clear trend towards an economic diversification of SEMCs. The industrialization policy of boosting the manufacturing sectors[12] and offsetting imports followed by Turkey and, to a lesser extent, North African countries, has opened new trade routes. There has been a sharp decline in textile exports in these countries, making way for higher added-value sectors like the automotive industry, electrical goods, chemicals, and information and communication

[11] Mainly between the EU and other countries (the most recent agreements were Deep and Comprehensive Free Trade Areas (DCFTAs) between the EU and Tunisia in 2013, and the EU and Morocco in 2015). Recently, subregional agreements have been drawn up between southern and eastern countries, such as the Greater Arab Free Trade Area (GAFTA) in 2005, and the Agadir Agreements in force since 2007, including Morocco, Egypt, Tunisia and Jordan. Turkey has developed its own trade network, entering into bilateral agreements with various Arab countries (Egypt, Tunisia, Morocco) and Balkan countries (Albania, Bosnia and Herzegovina, Montenegro, Serbia).

[12] Sectors can be boosted via an industrialization strategy that involves gradually changing the specialization, from manufacturing with low technological content (requiring poorly qualified labour) towards manufacturing with higher added value, which requires increasingly qualified labour to manufacture increasingly complex goods that use new technologies.

technologies (ICT). Tunisian and Moroccan ICT exports to European countries (primarily Spain, Italy and France) rose from around 10 to 15% between 2000 and 2007 to 25 to 30% of their total exports between 2012 and 2016. It significant public/private investments, and are located in Turkey (Marmara, Izmir and Mersin), Egypt (Port Said, Alexandria, Damietta) and Morocco (Tanger-Med, Casablanca, Agadir).

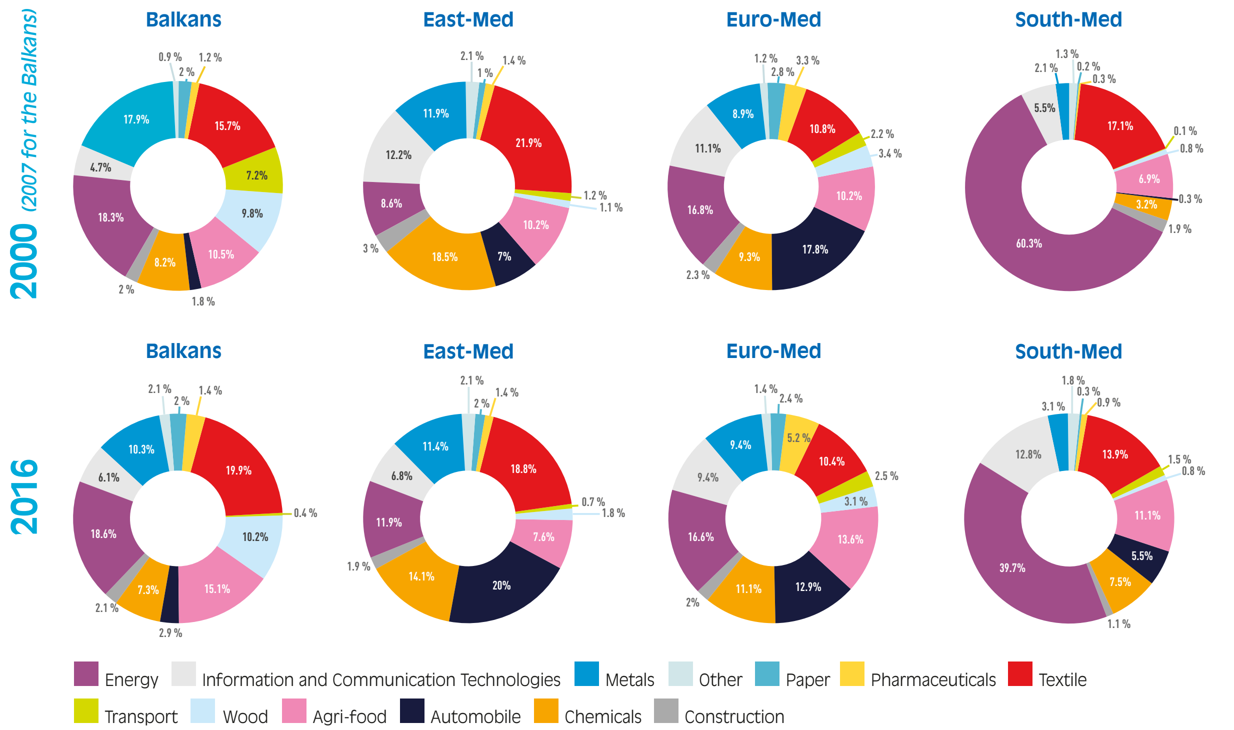


Figure 16 - Breakdown of product categories in exports from subregions in 2000 and 2016
(Source: UN-COMTRADE, 2018, calculations by COFACE)

is no longer rare to find cars manufactured in Turkey or Turkish brand electrical goods on the European and Arab markets.

International trade represents over 70% of maritime traffic in the Mediterranean and maritime transport has experienced strong growth. The region's transit capacity increased by 58% between the 1990s and 2000s, in addition to an average 30% increase in ship size over the same period. Maritime transport has continued to rise with an average annual growth rate of 4% up to 2018 (AGAM, 2013; Piante & Ody, 2015). The extension of the Suez Canal in 2015 has allowed ships to sail in both directions at the same time. Over 17,000 ships used the Canal in 2017 (compared to 14,000 in 2001), transporting over 1 billion tonnes of goods (compared to 500 million tonnes in 2001) (Doceul & Tabarly, 2018). The "Kanal İstanbul" project (Morvan, 2011) aims to enhance transit capacity between the Mediterranean and the Black Sea.

Despite the growth of ports in SEMCs, the largest ports are still mainly located in the North. SEMCs are home to just three (Arzew-Bethioua, Izmit and Alexandria) of the 12 largest ports in terms of tonnage (alongside Marseille, Algeciras, Valencia, Genoa, Trieste, Barcelona, Gioia Tauro, Taranto and Tarragona). This situation has led to the development of new hubs since the 2000s. The largest ports are the products of ambitious national policies and

1.3.2 While the submarine cable network densifies, the digital divide remains important across the Mediterranean

It is easy to forget that the extensive networks drawn across land and sea by trade lines and hubs are mirrored by a less visible footprint of globalization. In the Mediterranean, the seabeds are carpeted with digital cables and bundles of fibre optic cables through which an enormous mass of data is continually transiting. Without these hidden hard connections and the data centres to which the entire network is connected, the Internet could never have developed worldwide. Since the mid-2000s, Internet traffic and access have soared, boosted by new digital uses (audiovisual media, social media, cloud storage, etc.). For the main global telecommunications operators, and more recently the GAFA (Google, Amazon, Facebook, Apple), the Mediterranean seems to be a key location for laying cables to satisfy the rising demand of national customers and interconnect with the "intangible" flows of a globalized economy. With dozens of connections with North Africa, the Middle East and Asia, Marseille has successfully established itself as the new connection platform for the Mediterranean, which may result in the reorganization of its urban economy around digital activities.

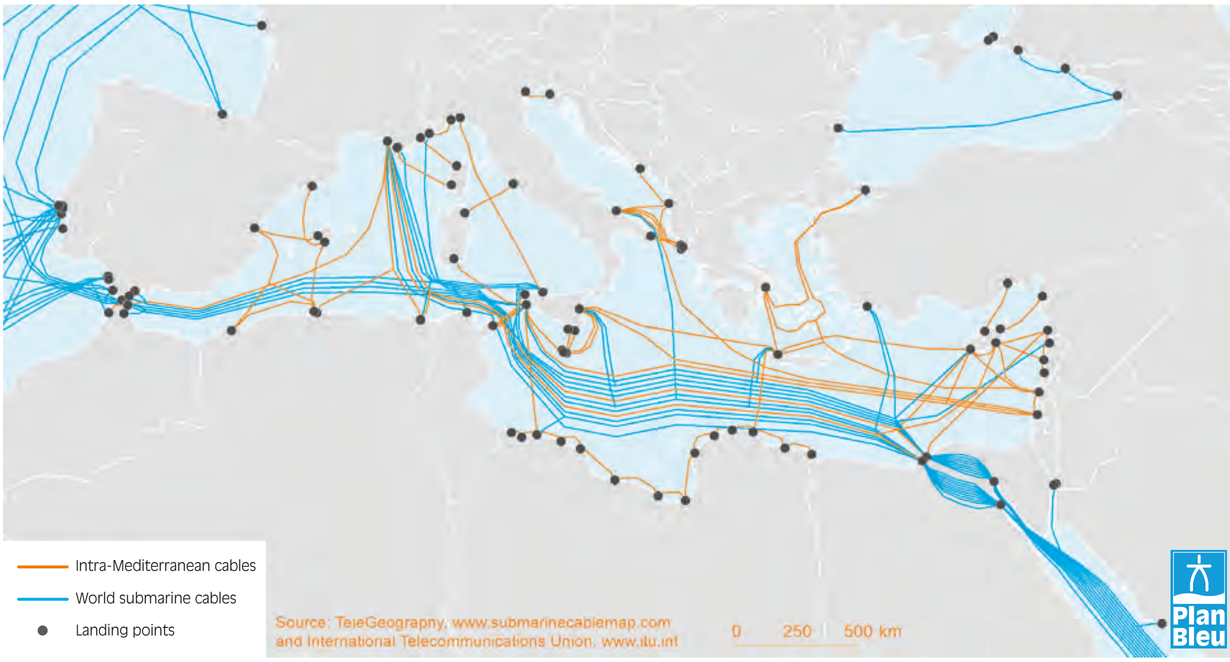


Figure 17 - Submarine cables in the Mediterranean, 2019
(Source: International Telecommunications Union, 2019; TeleGeography, 2019)

The imbalanced deployment of submarine cables, which promotes the connection of the most developed regions of the world, maintains a digital divide in SEMCs. Large swathes of their populations are still excluded from the opportunities of ICT, either because they cannot access technologies (telephones, Internet, computers) or because they do not have the skills to use them. Massive and rapid progress can nevertheless be seen, as demonstrated by the spectacular increase in the number of Internet users between 2000 and 2019 across all North African and Eastern Mediterranean countries. The digital transition seems slower, more encumbered and almost certainly mainly focused on urban areas in Algeria, Egypt, Libya, Tunisia and the Syrian Arab Republic, compared to the near-universal mobile telephone and Internet service and equipment in Morocco, Lebanon and Turkey. During the Arab Springs, social media and mobile phones played a decisive role in accessing sources of information, communicating with people overseas (primarily in Europe and North America rather than in the Near and Middle East) and organizing local activities. These events demonstrated the power of the effects of a social transformation, particularly among the younger generations, due to the digitalization of developing economies, and highlighted the influence of these social and material dynamics.

The digital revolution also raises climate and energy issues. Digital technologies are estimated to cause 4% of greenhouse gas emissions worldwide, which is more than civil aviation. This rate could reach 8% by 2025 (The Shift Project, 2019). The practice of watching videos online has massively increased in recent years and generated worldwide over 300 Mt of CO_2 in 2018, accounting for 1% of global greenhouse gases (Efoui-Hess, 2019). Given the

Key ICT Indicators	World	Europe	Africa	Algeria	Egypt	Lebanon	Libya	Morocco	Arab Republic	Tunisia	Turkey
Mobile cellular sub. per 100 inhab. - 2017	103.6	120.4	74.4	120.7	105.5	84.4	94.4	122.9	85.7	124.3	96.4
3G Coverage (% of population) - 2017	87.9	98.3	62.7	90	98.7	99	78.1	96	82	88	97.4
Households with Internet access (%) - 2017	54.7	80.6	19.4	40.3	49.2	84.4	23.7	70.2	45	50.1	80.7
Number of Internet users in 2019 and growth compared to 2000	4,422 M	719 M	525 M	21 M	49.2 M	5.5 M	3.8 M	22.5 M	6.3 M	7.8 M	69.1 M
	+ 1,125 %	+ 585 %	+ 11,533 %	+ 41,900 %	+10,800%		+ 37,000 %	+ 22,467 %		+ 7,798 %	
Number of Facebook subscribers - 2017	2,146 M	340 M	204 M	19 M	35 M	3.6 M	3.5 M	15 M	4.9 M	6.4 M	44 M

Table 1- Deployment of Information and Communication Technologies in some SEMCs, 2017
(Source: International Telecommunications Unit, 2018; and Internet World Stats, 2019)

magnitude of this climate impact, there is an urgent need for debate on how to moderate digital use. Energy security of digital infrastructure is another issue, given the growth in electricity needs caused by the anticipated growth in data centres (a huge number of which are currently powered via fossil fuel generators) and networks (cables, optical fibres, modems, mobile network antennas). In SEMCs, future sociotechnical approaches will be all the more significant as their energy system is already under pressure to deal with the more widespread access to electrical devices (computers, smartphones, televisions, etc.).

1.3.3 The increase in energy demand in SEMCs requires cooperation on energy in order to move towards a new geopolitical approach to the carbon-based energy sectors

Primary energy demand is expected to increase by 50% in SEMCs by 2040. This would mark a turning point, as energy demand in SEMCs would then exceed that of NMCs.

In this context of increasing demand, the priority given to energy security has created a race for fossil fuel supplies, which largely dominate the energy mix now, and will continue to do so over the coming decades, despite the possibilities of massively increasing the use of renewable energies presented in proactive energy transition scenarios. Energy trading between Mediterranean countries moves almost exclusively from South to North. Around 60% of oil and more than 80% of the natural gas exported from the Middle East and North Africa are consumed in the European Union.

The increase in electricity needs in SEMCs have resulted in:

- reduced export volumes from oil-producing countries (Egypt, Algeria, Libya) to meet the growth in internal demand. The structure of energy trading flows in the Mediterranean also seems to be changing with a decrease in gas and oil exports in favour of refined products. According to a Coface study, Greece and Malta have established themselves as petrol/diesel export platforms, primarily for Turkey, Lebanon, Egypt and Tunisia (Tozy, Trifaia & London, 2018);

- diversification of natural gas import routes by the EU to reduce and avoid dependency on Russia. The recent construction of the TANAP (Trans-Anatolian Pipeline) was supported by the European Commission and identified Turkey as the Southern European gas corridor. The TANAP will soon be connected to the TAP (Trans-Adriatic Pipeline) to reach Greece and Italy, and provide the EU with access to the 16 billion m³ of gas extracted by Azerbaijan from the Caspian Sea every year;

- a genuine "black gold rush" for offshore exploration, with intensive prospection of gas fields over the past ten years *(see Chapter 4)*.

BOX 3

The Mediterranean Solar Plan

To reinforce the energy security of all countries around the Mediterranean, an ambitious solution was structured around the "Mediterranean Solar Plan". This large-scale regional cooperation project has been led since 2008 by the Union for the Mediterranean and supported by the EU. Its aim is to produce electricity (20 GW by 2020, 100 GW by 2050) and to transmit part of it (5 GW) from the Southern to the Northern shores of the Mediterranean. This plan aims to take advantage of the solar potential of the Sahara Desert - which could cover 90% of the region's electricity needs for an estimated price of 20 to 30% lower than current tariffs - by installing large thermal and photovoltaic solar power stations. Responsibility for energy production should have been taken up by the DII industrial consortium (Desertec Industry Initiative), created in 2009 on the initiative of German companies. Meanwhile, the Medgrid consortium (formerly Transgreen), created in 2010 by mainly French industrial companies, was tasked with creating a supergrid for transmission and electrical interconnection between Mediterranean countries. Just a few years after its launch, and despite some isolated initiatives, the Mediterranean Solar Plan is at a standstill (Schmitt, 2018). Today, the Desertec project is attempting to reinvent itself following the withdrawal of its founding shareholders in 2013, while Medgrid ceased operations in 2015 since the project to export solar energy flows was too expensive and abandoned. Since 2015, the European Union has nevertheless been attempting to pursue this objective of building an integrated intercontinental space for electricity flows, through the Mediterranean Transmission System Operators association (Med-TSO), which brings together Mediterranean electricity transmission grid management authorities.

Without examining in detail all of the factors contributing to the failure of the Mediterranean Solar Plan (slowing of economic growth, Arab Springs, diplomatic and technical differences between countries, detrimental effect of competition between many national and international renewable energy development projects, asymmetrical power relations, etc. (De Souza et al. 2018)), this large-scale project reveals one important factor: the Mediterranean scale envisaged as the framework for political regulation of energy flows is currently not able to merge into the frameworks for the territorialization of electricity grids, which have historically been built on a national scale. This requires international stakeholders responsible for promoting the development of green technologies to better take into account the specifics of the local contexts.

1.3.4 The Mediterranean region is part of a global infrastructure network created by the Chinese Belt and Road Initiative (BRI)

Although China has not developed a Mediterranean strategic vision as such (Ekman, 2018), under its New Silk Roads Belt and Road Initiative (BRI), the Mediterranean is nevertheless a shipping zone of strategic importance. Chinese policy in the Mediterranean mainly takes the form of port investments, whether for the construction of new infrastructure (El Hamdania in Algeria, Venice Offshore Onshore Port Systems (VOOPS) in Italy), the modernization of container terminals (Port-Said in Egypt) or the acquisition of existing infrastructure (Piraeus in Greece, Valencia in Spain, Damietta and the Suez Canal in Egypt).

BOX 4

The New Silk Roads - the Chinese Belt and Road Initiative

The "Belt and Road Initiative" (BRI, referred to as "one belt, one road" between 2013 and 2017) was incorporated into the constitution of the Chinese Communist Party in 2017. This initiative expresses a long-term strategic vision, reviving the ancient imagery of the old silk roads, with the aim of placing China at the centre of an international trade network. Railway convoys now link the world's second economic power with around fifteen European railway stations (Vénissieux, Hamburg, Duisburg, London, Madrid, etc.), travelling 10,000 kilometres in 19 days, half the time taken by maritime transport. In a context where the country's internal growth is slowing, the main objective of the New Silk Roads for the Chinese government is to secure its trade routes and access growing markets on every continent. The BRI will initially be implemented on land, linking China to Europe via Central Asia and Russia. In addition, the shipping route connects China to Europe via the Indian Ocean and the Suez Canal. Since 2018 the creation of new trade links in Africa, South America and via the Arctic Ocean has also been on the agenda. The BRI project institutionalizes a pre-existing economic expansion strategy, in many different forms (bilateral and multilateral free trade agreements, transnational networks[13]), which has enabled China to become the world leader in the international trade of manufactured goods.

In this context, the Chinese government is investing massively in infrastructure, via various financial networks that it controls (Asian Infrastructure Investment Bank, Silk Road Sovereign Fund, Exim Bank, Chinese Development Bank). Since 2013, it has invested more than USD 70 billion, including USD 50 billion in the energy sector (renewable energy systems (RES) or thermal power plants, electricity grids, pipelines), USD 15 billion in transport (airports, ports, motorways) and USD 10 billion in digital (Eder & Mardell, 2019).

Chinese state companies have already planned investment in the ports of Zarzis (Tunisia), Rijeka (Croatia) and Italy on the Adriatic coast. In this way, China is seeking to develop a "mesh of platforms" (Ekman, 2018) to redistribute and accelerate the penetration of its products into the growing markets of Europe and the Middle East.

Figure 18 - New Silk Roads project: a worldwide tool for China to use, acquire and build roads, ports and pipelines
(Source: MERICS, 2018)

[13] See Belguidoum & Pliez (2019) for more information.

Country	Year	Investors, Acquisition and Amount
France	2013	China Merchants bought 49% of CMA CGM's activities with its affiliate Terminal Link in Marseille, Malta, Tangier and Casablanca ports - USD 530 M
Spain	2017	China Ocean Shipping bought 51% of Noatum Ports (Valencia) - USD 230 M
Morocco	2008	China Railway Construction won a contract to build two highways - USD 260 M
Algeria	2009	China Railway Construction won a contract to build two major railway projects - USD 2,570 M
	2016	China State Construction Engineering Corporation (CSCEC) and China Harbour Engineering Company (CHEC) will be part of the construction of the new El Hamdania port (70 km from Algiers) and will own 49% of the operating company - USD 1,720 M
Libya	2008	China Railway Construction won the 2008 contract to build 352 km of coastal railway from Khoms to Sirte, with a later addition of 172 km from Tripoli to Ras Ejder on the Tunisian border. The Chinese firm was also contracted to build an 800 km track between Misrata and Wadi Shatti near Sebha, an area rich in iron ore deposits - USD 2,600 M
Egypt	2005	Cosco acquired 40% of the Maersk port terminal in Port Said.
	2007	China Shipping took over 20% of the Damietta terminal. Cosco acquired a stake in the Suez Canal container terminal.
	2008	China Harbour Engineering Company and China Communications Construction Company signed construction contracts for the eastern terminal of Port Said and Al Adabiya port, at the southern entrance of the Suez Canal - USD 380 M
	2011	USD 290 M invested in the Egyptian shipping sector (no details found).
	2015	China Railway Construction was awarded a USD 600 M contract to upgrade the Egyptian national railway.
	2017	China's AVIC International and China Railway Group will build a 66 km railway network with 11 stations in districts surrounding Cairo - USD 1,240 M
Israel	2014	China Communications Construction won the bid to build a new port in Asdhod - USD 950 M
	2015	Shanghai International Port Group won the right to manage the newly-built port in Haifa. China Railway Engineering will be part of the consortium to build tunnels and underground stations in the western sector of the Tel Aviv Light Rail Red Line - USD 400 M
	2017/2018	Two rail contracts won by Chinese companies (no details found) - USD 880 M
Turkey	2005	China National Machinery Import and Export Corporation and China Railway Construction Corporation won the bid to implement Turkey's Ankara-Istanbul high-speed railway.
	2015	Cosco and China Merchants Holding acquired 65% of shares in the Kumport port (3rd Turkish container airport, located in Istanbul).
Greece	2008	35-year concession to operate Piraeus Pier no. 2 was given to Cosco - USD 5,800 M
	2015	Cosco acquired 67% of shares in the fully-privatized Piraeus - USD 420 M
Italy	2015	A Chinese consortium won the bid to build VOOPS, which will serve three ports in Italy, one in Slovenia and one in Croatia.
	2016	Cosco took the control of 49.9% of Vado Terminal in North Italy.

Table 2 - Chinese Shipping and Rail Investments in Mediterranean countries
(Source: American Enterprise Institute & Heritage Foundation, 2019; Hache & Mérigot, 2017)

Chinese involvement in infrastructure in the Mediterranean region should be considered in context. Analysis of the origin of 1994-2018 investments in infrastructure in low- and medium-income Mediterranean countries fails to demonstrate a massive influx of Chinese capital. On the contrary, it is clear not only that the main investors in the energy, transport and water/sewage sectors are national governments or European companies, but also Chinese companies are facing strong competition from the Gulf states, and to a lesser extent, from Russia and Turkey. These countries are also seeking to increase their sphere of influence in the region (Blanc, 2010; Delanoë, 2014; Jabbour, 2014). In recent years, a number of countries initially involved in the BRI have expressed concern about the level of debt incurred with Chinese financial bodies and China's dominant role. Alternative initiatives have emerged: in 2016 Japan presented the "Expanded Partnership for Quality Infrastructure", Japan and India also launched the "Asia-Africa Growth Corridor" in 2017. Russia is developing its own project called "Greater Eurasia", with the aim of including member states of the Commonwealth of Independent States, the Shanghai Cooperation Organization, and potentially, countries in the Association of Southeast Asian Nations (ASEAN).

Another limit of the BRI project is that it raises serious environmental issues, due to its scale and the priority assigned to infrastructure development. No impact assessment has yet been carried out at the scale of the Mediterranean Basin. The World Wild Wide Fund for Nature (WWF) has nonetheless expressed its concerns about the threats of environmental damage posed by the project at

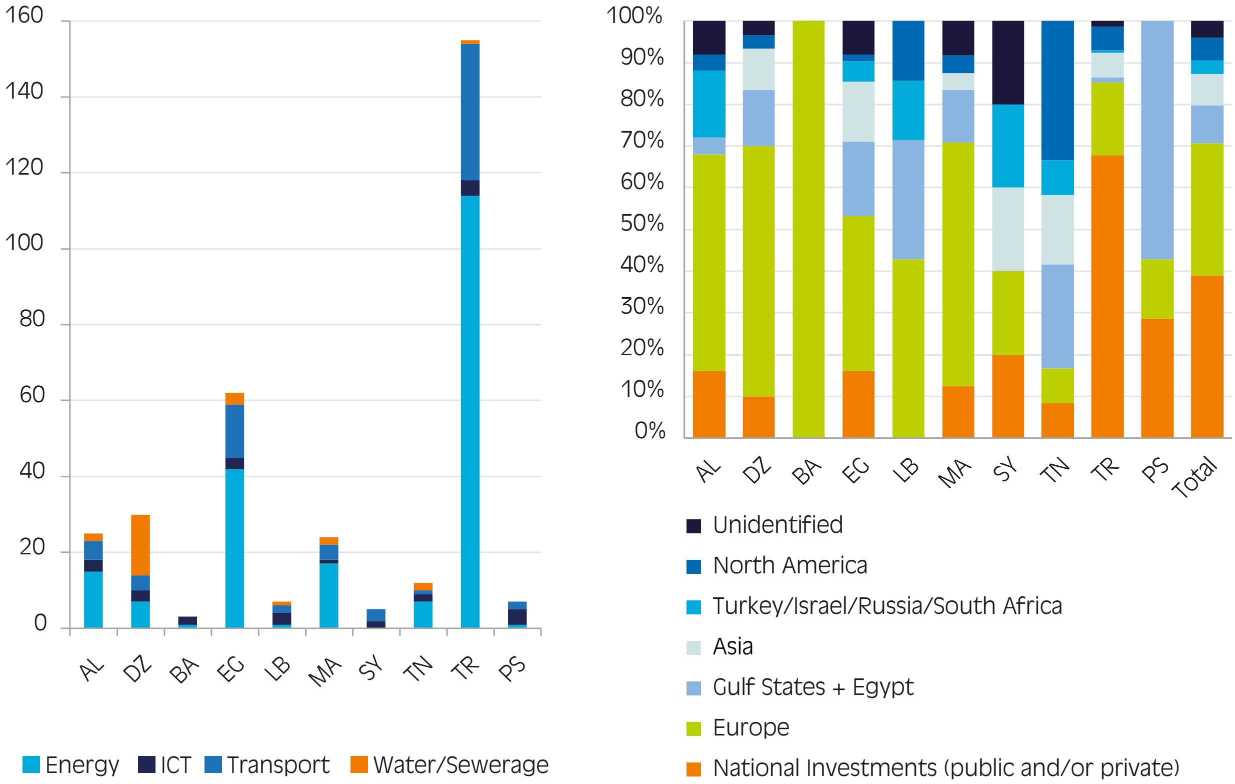


Figure 19 - Private Participation in Infrastructure: number of operations by sector between 1994 and 2018 in some Mediterranean countries (left) - Origin of infrastructure investments: 1994-2018 (right)
(Source: World Bank, 2019b)

the global scale with regards to biodiversity and natural resources in the different corridors for land- and sea-based transport defined in the initial project. Based on a spatial analysis, the WWF study (WWF, 2017) concludes that:

- BRI corridors overlap with the range of 265 threatened animal species;
- BRI corridors overlap with 1,739 Key Biodiversity Areas or important bird areas and 46 biodiversity hotspots or Global 200 Ecoregions;
- 32% of the total area of all protected areas in 64 countries crossed by BRI corridors are potentially affected;
- BRI increases pressure on water-related ecosystem services and the associated risks of large floods.

1.3.5 The Mediterranean region is a hotspot for population flows

The Mediterranean region is also a global hotspot for voluntary and forced migration, much of it due to geopolitical instability. This issue is associated with environmental pressures and needs, and significantly impacts human development. Meeting the basic human needs of incoming migrants requires a flexible and effective response in the host countries. Access to water, food and sanitation services, as well as waste management, are of specific concern in refugee camp operation.

Among others, environmental and climate changes are considered important drivers of migration, especially for water-scarce countries and in vulnerable areas (e.g. rainfed farmland, water-contaminated sites and urban slums). Although attributing direct causality is controversial (Selby et al. 2017), climate change is likely to have played a role in triggering the Syrian crisis as the country was struck by the longest and most intense drought in the last 900 years when the crisis began (Cook et al. 2015).

Figure 20 shows net migration over 5 years in 2012 and 2017 in Mediterranean countries and the share of immigrants in the national population. Net migration is clearly negative in the case of the Syrian Arab Republic and, to a lesser extent Libya, as a result of crises, but positive in the case of Lebanon and Turkey, which have received high numbers of immigrants. The stock of immigrants as a percentage of the total population is particularly high in Lebanon (many immigrants from forced displacement), but even more so in Monaco (generally not from forced displacement)[14]. These numbers do not take into account all irregular migrants (e.g. migrants working in the informal economy of host countries), as well as asylum seekers and refugees, which would significantly raise the share of migrants with regard to the countries' population in some countries.

[14] Monaco is an exceptional case with regard to migration, counting almost exclusively non-forced cases of migration. The top five countries of origin of immigrants to Monaco are France, Italy, the United Kingdom, Switzerland and Germany.

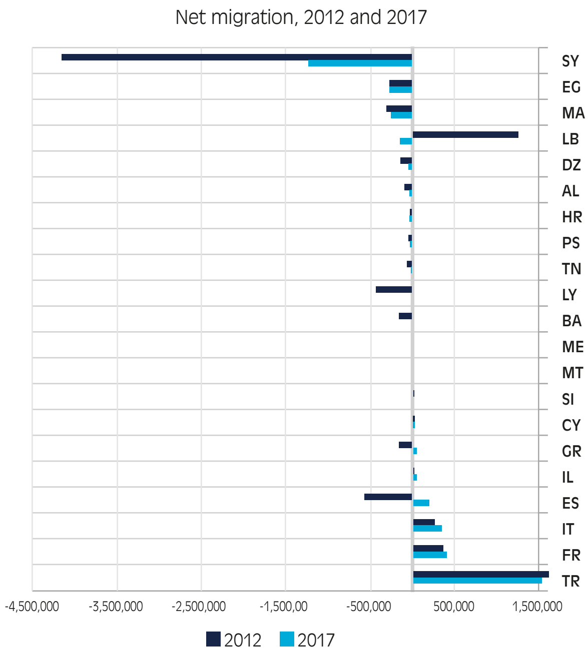
Mediterranean geopolitics have been shaken by tensions and instabilities, and the region has become a global hotspot of forced displacement of people

Over the past decade, a number of countries have witnessed disruptive social and political transformations. In NMCs, the rise of populist demands has turned the threat of fragmentation of the European Union into a plausible future scenario (among others). The rise of democratic aspirations in large parts of the population in SEMCs and the upsurge of extremism has led to turmoil and a series of upheavals, with severe consequences and uncertainties for the region's economies and societies. Tensions have escalated in several areas in the region, such as in Libya and the Syrian Arab Republic, where civil uprisings have unfolded into ongoing international armed conflicts (Ayadi & Sessa, 2017).

In this context, forced displacement has made the Mediterranean a global hotspot of refugees, with three global records (UNHCR, 2017):
- Turkey hosts the highest number of refugees worldwide, estimated at 3.54 million people, and counts more than 300,000 asylum seekers (UNHCR, 2017);
- Lebanon has the highest proportion of refugees in the world (16.4% of total population) (UNHCR, 2017); and
- The Syrian Arab Republic is the country from which the highest number of refugees originate in the world, with an estimated 34.5% of its population having left the country.

There was an unprecedented peak in the number of refugees and migrants who entered Europe via the Western (Spain), Central (Italy) and Eastern (Greece) Mediterranean routes in 2015; with more than 1 million arrivals that year, compared to around 370,000 in 2016, 185,000 in 2017 and 140,000 in 2018 (UNHCR, 2019). The main countries of origin include the Syrian Arab Republic, the State of Palestine, Maghreb countries and Sub-Saharan African countries. In Euro-Mediterranean countries, the inflow of migrants has led to dialogue between countries and institutional capacity challenges (Werz & Hoffman, 2017), with the EU struggling to find a satisfactory common response to this ongoing refugee crisis. Meeting the basic human needs of incoming migrants requires responses in the host countries. Access to water, food and sanitation services, as well as waste management, are core concerns for operating refugee camps and require strong connections to local infrastructure and planning.

Availability and comparability of data on refugees is difficult in the region. When available, data on refugees is often based on successful asylum applications, and therefore fails to take into account those who have not been granted refugee status, or those who have not registered through the UN Refugee Agency (UNHCR) or the United Nations Relief and Works Agency for Palestine Refugees in the Near East (UNRWA).



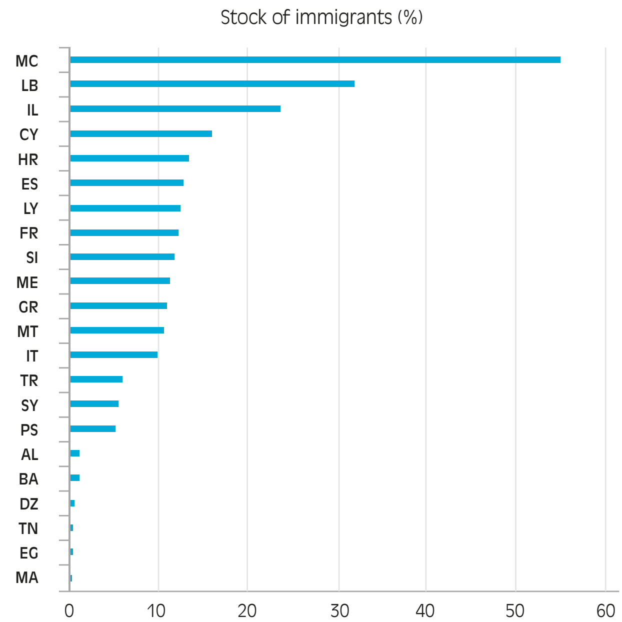


Figure 20 - Net migration over 5 years, 2012 and 2017 (left) - Stock of immigrants as a % of the total population, 2018 (right)
(created by CMI based on United Nations, 2019)

SDG No./ Countries	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	SDG World Index 2019 rank	SDG score (100= best)	Spillover score (100= best)
AL	↑	→	↗	↑	↗	↑	↑	→	↗	...	↗	...	↑	↗	↗	↗	...	60	70.3	89.7
BA	↑	↗	↗	...	→	↗	↗	→	→	...	↗	...	→	...	→	→	...	69	69.4	96.4
CY	↑	→	↑	...	↗	↑	↗	↗	↗	...	↗	...	↗	→	...	↗	↓	61	70.1	49.6
DZ	↑	→	↗	→	↗	↗	↗	→	↑	...	→	...	→	→	→	→	...	53	71.1	97
EG	↑	↗	↗	→	↗	↗	↑	↗	↗	...	→	...	↑	↗	→	...	...	92	66.2	98.7
ES	↗	↗	↑	↑	↗	↑	↑	↑	↗	→	↗	...	→	↗	→	↗	→	21	77.8	70.1
FR	↑	↗	↑	↑	↗	↗	↗	↗	↑	↑	↗	...	→	↗	↗	↗	→	4	81.5	61.5
GR	↗	↗	↗	↗	↗	↗	↑	↗	↑	→	↗	...	↗	↗	↗	↗	↓	50	71.4	64.6
HR	↑	↗	↑	→	↗	↑	↗	↑	↗	...	↗	...	↗	↗	↗	↗	...	22	77.8	85.9
IL	↗	↗	↑	↗	→	↑	↗	↑	↑	→	→	...	→	→	↓	↗	↗	49	71.5	62
IT	↗	↗	↑	↗	↗	↑	↑	↗	↗	→	↗	...	↗	→	↑	↑	↗	30	75.8	65.6
LB	↑	→	↗	↓	↓	↑	...	→	↗	...	...	...	↑	...	→	→	...	94	65.7	84.2
LY	...	↓	↗	...	→	↗	...	...	...	...	...	...	↓	→	...	→	...	n/a	n/a	n/a
MT	↑	↗	↗	→	↗	↑	↗	↑	↗	...	↗	...	→	↗	...	→	→	28	76.1	62.9
MC	...	...	...	...	...	↑	...	...	...	...	...	...	↑	...	...	...	...	n/a	n/a	n/a
ME	↑	→	↗	↗	↗	↑	↗	↗	↗	...	→	...	→	↓	↓	→	...	87	67.3	65
MA	↑	↗	↗	↗	↗	↗	↗	...	↗	...	→	...	↑	→	→	↗	...	72	69.1	96.1
SI	↑	↗	↑	↗	↗	↗	↑	↗	↗	↑	↗	...	↗	...	↑	↑	→	12	79.4	70
SY	...	↓	→	...	→	→	↗	...	→	...	...	...	↑	→	→	...	...	123	58.1	96.8
TN	↑	→	↗	...	→	↑	↗	...	↗	...	→	...	↑	→	↗	...	...	63	70	93.2
TR	↗	→	↗	↑	→	...	→	↗	↗	→	→	...	↓	→	→	↓	...	79	68.5	90.8

SDG Dashboard	% of occurrence	SDG Trend Dashboard [15]	% of occurrence
SDG achievement	5%	↑ On track (increases at the rate needed to achieve the SDG by 2030 or performance has already exceeded the SDG achievement threshold)	17%
Challenges remain	26%	↗ Moderately increasing (at a rate above 50% of the required growth rate but below the rate needed to achieve the SDG by 2030)	35%
Significant challenges remain	38%	→ Stagnating (Score remains stagnant or increases at a rate below 50% of the growth rate needed to achieve the SDG by 2030)	20%
Major challenges remain	26%	↓ Decreasing (i.e. country is moving in the wrong direction)	3%
Data unavailable	5%	... Data unavailable	25%

no.	SDG title	no.	SDG title
1	No poverty	10	Reduced inequalities
2	Zero hunger	11	Sustainable cities and communities
3	Good health and well-being	12	Responsible consumption and production
4	Quality education	13	Climate action
5	Gender equality	14	Life below water
6	Clean water and sanitation	15	Life on land
7	Affordable and clean energy	16	Peace, justice and strong institutions
8	Decent work and economic growth	17	Partnerships for the goals
9	Industry, innovation and infrastructure		

Figure 21 - SDG dashboard and trends for Mediterranean countries
(Source: Sachs et al. 2019)

[15] Historic data (2015-2018, i.e. since SDG adoption) is used to estimate how fast a country has been progressing towards an SDG and to determine whether – if extrapolated into the future – this pace will be sufficient to achieve the SDG by 2030.

1.4 An unsustainable socioeconomic system, relying on resource consumption and fossil fuels

Despite progress, the economic and social trends described above are not sustainable.

1.4.1 Mediterranean countries are not on track to achieve the SDGs

A recent report from the Sustainable Development Solutions Network (SDSN; Sachs et al. 2019) shows that all Mediterranean countries are currently far from achieving the SDGs and that no promising trend can be identified in any Mediterranean country that suggests they will be achieved by 2030 *(Figure 21)*. Nine of the 21 countries had not achieved any of the SDGs in 2019, and for almost two thirds of the SDGs, significant or major challenges remain for their achievement. In most situations, efforts undertaken since 2015 have brought about positive developments, but changes have occurred at a level and/or pace that is insufficient for achievement of the SDGs by 2030. The situation is particularly critical for SDG 2 on hunger, nutrition and sustainable agriculture, SDG 5 on gender equality, SDG 11 on sustainable cities and communities and SDG 14 life below water - which is most relevant to the Barcelona Convention - for which none of the Mediterranean countries are considered to be on track to reach the SDG targets by 2030.

NMCs are generally closer to achieving the SDGs than SEMCs. France obtained the highest 2019 SDG score (a score of 81.5/100 but still only one SDG had been achieved, with promising trends for the achievement of 4 other SDGs by 2030), while the Syrian Arab Republic has the greatest difficulty (score of 58.1/100, no SDG achieved so far and only one SDG on track for achievement by 2030) and Libya has too large of a data gap to calculate its SDG score.

The SDSN report also presents a "spillover score", which measures a country's impact on the ability of other countries to meet the SDGs. Mediterranean high-income countries generate significant socioeconomic and environmental spillover effects by exporting a large amount of pollution, waste and other negative externalities. These can limit the ability of other countries to achieve sustainable development (Sachs et al. 2019). Critical issues that especially affect lower-income countries in and outside of the Mediterranean region include: international demand for palm oil and other commodities which fuel tropical deforestation, tax havens leading to difficulties raising public revenue to finance the SDGs, and tolerance for poor labour and environmental standards in international supply chains, etc.

1.4.2 Energy use and material consumption are growing more slowly than national economies, but ecological footprints in the Mediterranean remain higher than the world average and exceed biocapacity

In the Mediterranean region in 2015, the energy intensity varied from 1.8 MJ/USD 2011 Purchasing Power Parity (PPP) in Malta to 4.6 MJ/USD 2011 PPP in Slovenia and 8.7 MJ/USD 2011 PPP in Bosnia and Herzegovina. In most Mediterranean countries (in 18 countries out of 21), the energy intensity decreased between 1997 and 2015. The value in 2015 was less than half that of 1997 in Malta, while it increased in Algeria, Bosnia and Herzegovina and the State of Palestine. Although a decrease of the energy intensity of Mediterranean countries is a positive development towards an environmental transition of the regional economy, this must be put into perspective with the dominant consumption of fossil fuels. Mediterranean economies remain highly dependent on fossil fuels, which represented more than 90% of the total fuel consumption (World Bank, 2019a).

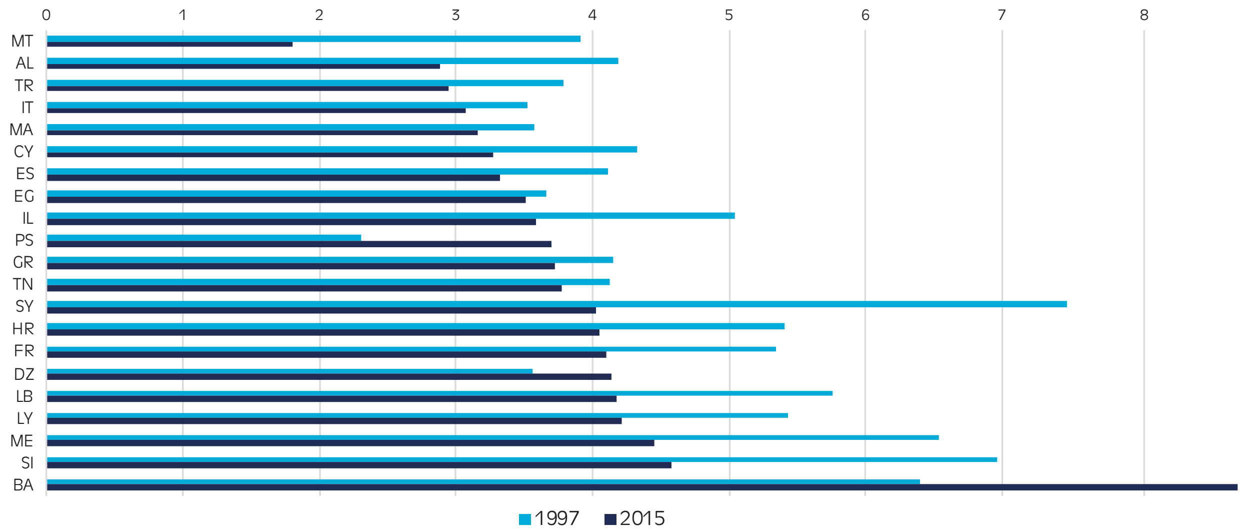


Figure 22 - Changes to energy intensity (ratio between energy supply and GDP at PPP) between 1997 and 2015 in MJ / GDP in USD 2011 PPP
(Source: World Bank, 2019a)

In line with the overall decreasing energy intensity, the Mediterranean economy achieved a "relative decoupling" of economic growth from resource use (fossil fuels, metal ores, industrial and construction minerals, biomass) in the 2000-2017 period, which means that the income or GDP of most Mediterranean countries increased faster than the amount of materials used (UNEP IRP, 2018). This is not the case in Algeria, Libya and the Syrian Arab Republic, where material consumption per unit of GDP increased significantly over the same period. In Albania, Bosnia and Herzegovina and Lebanon, it is less clear whether or not a relative decoupling has been achieved. Regarding Turkey, the Organisation for Economic Cooperation and Development (OECD) concluded in 2019 that *"Since 2008, Turkey's strong economic growth has been relatively decoupled from air emissions, energy use, waste generation and water consumption. However, the high resource intensity of Turkey's economy and its heavy reliance on fossil fuels will continue to increase these environmental pressures in absolute terms. More progress is needed in the transition to a low-carbon, circular economy to improve the country's environmental performance."* (OECD, 2019).

From 2010 to 2014, the ecological footprint per capita decreased in most Mediterranean countries. However, the Mediterranean ecological footprint (3.2 gha per capita) is higher than the global ecological footprint (2.8 gha per

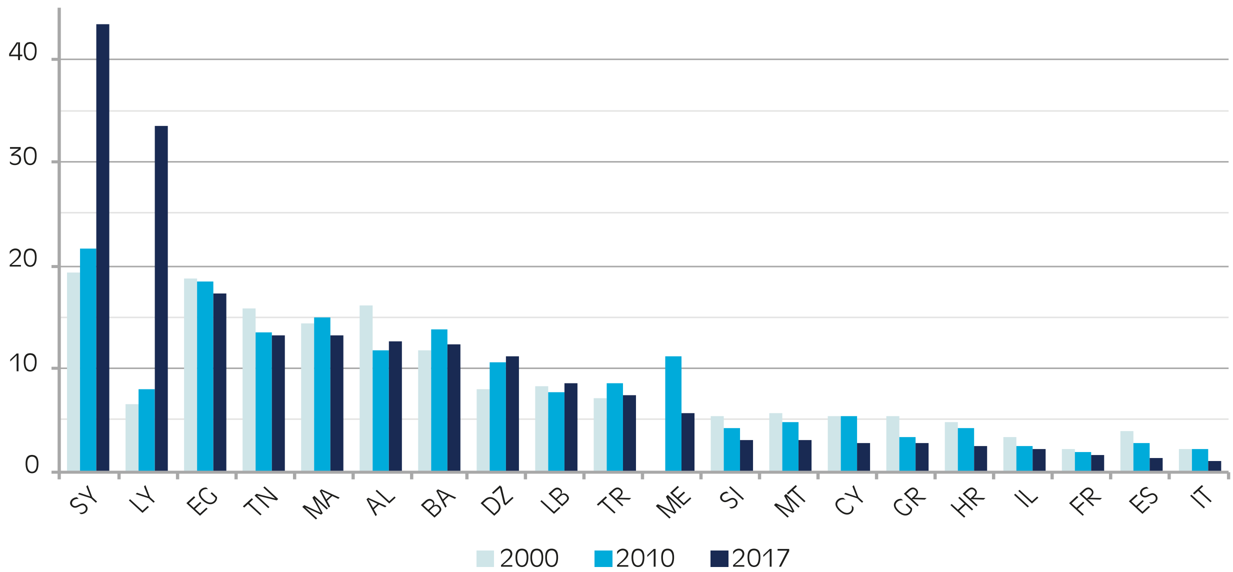


Figure 23 - Domestic material consumption per unit of GDP, in kg per constant 2010 US dollars, 2000, 2010, 2017
(Source: UNEP IRP, 2018)

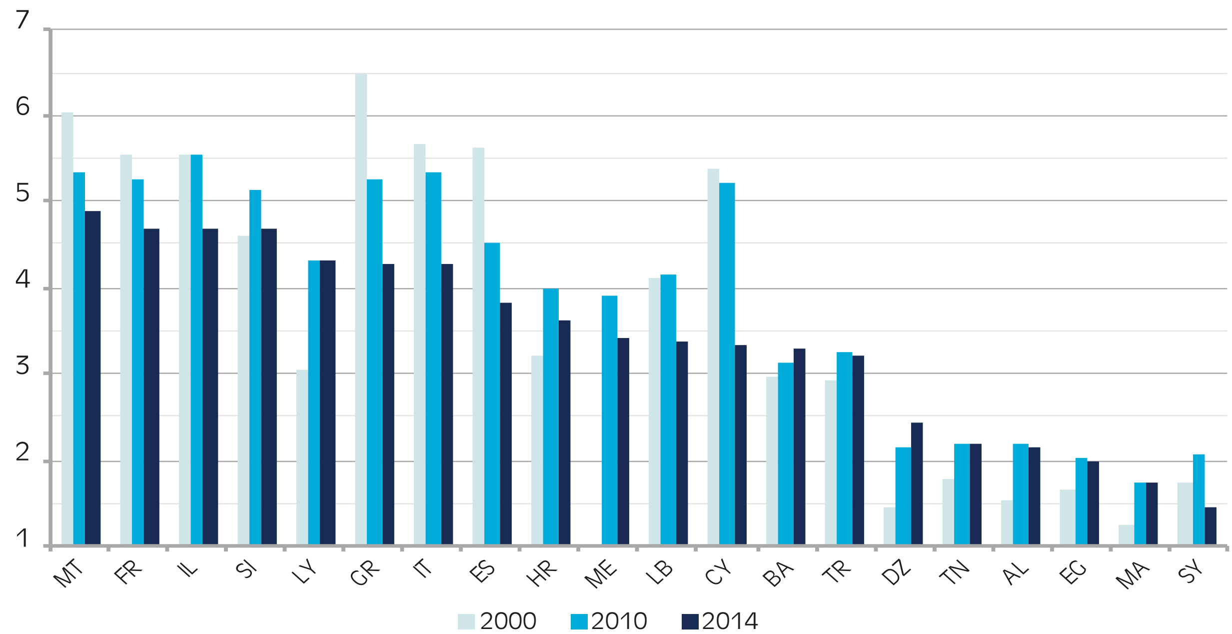


Figure 24 - Ecological footprint per capita, 2000 - 2014 in Global hectares per capita
(Source: Global Footprint Network, 2018)

capita) and the Mediterranean's ecological deficit (2.02 gha per capita) is twice as high as the world's ecological deficit (1.1 gha per capita).

The ecological footprint of NMCs has decreased in recent years (from 5 gha per capita in 2010 to 4.2 gha per capita in 2014). This is mostly due to the effects of the economic crisis, which slowed down resource consumption and, primarily, CO_2 emissions.

The ecological footprint per unit of GDP is less than 160 gha per million USD in most northern countries, except in the Balkan countries (316 in Bosnia and Herzegovina). In the southern countries, the maximum values are for Libya (254 gha per million USD) and Lebanon (231).

1.4.3 Environmental changes impact national economies and well-being

Environmental changes strongly impact critical sectors in the Mediterranean region and put impede local economies under stress.

A report on the cost of environmental degradation in Morocco in 2014 (requested by the Government of Morocco and published by the World Bank in 2017) estimated the total cost of environmental degradation to Moroccan society at approximately 3.5% of national GDP *(Figure 25)*. The cost associated with water degradation alone represented around 1.6% of Moroccan GDP, followed by air pollution at 1.05% of GDP. Costs of land degradation are associated with erosion issues and the conversion and desertification of rangeland. The report also states that damage to the coastal zone is considerably underestimated, as it is largely captured under other categories (air pollution, land and water degradation). In addition to national impacts, greenhouse gas emissions cause damage to the global community, which was estimated at 1.6% of GDP in 2014.

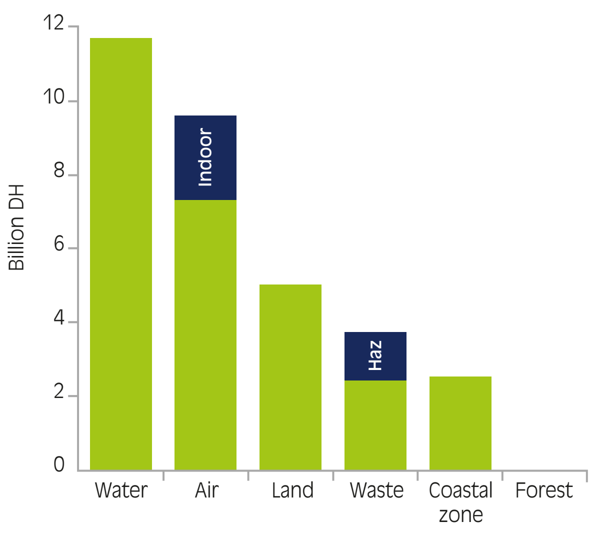


Figure 25 - Cost of environmental degradation in Morocco in 2014
(Source: Croitoru & Sarraf, 2017)

Earlier studies in Lebanon and Tunisia (Croitoru & Sarraf, 2010) estimated the overall cost of water degradation and groundwater overexploitation in Tunisia at 0.6% of GDP in 2004, with the greatest cost in the agricultural sector, mainly because of the impacts of salinity and waterlogging on irrigated agriculture. Groundwater overexploitation was the second largest cost due to the expense of pumping additional water and building new wells. Tourism, health and fishing were also significantly impacted. In Lebanon, damages associated with the oil spill and waste caused by the 2006 hostilities were estimated at 3.6% of GDP in 2006. This degradation, associated with a 34-day conflict, is higher than the degradation caused in a whole year during peacetime, which was estimated a few years earlier at 3.4% of GDP (Sarraf, Larsen & Owaygen, 2004).

2. Climate change

Climate change is exacerbating existing environmental fragilities and degradations in the Mediterranean basin. The region is considered a hotspot for climate change due in particular to more rapid warming in both the air and the sea than the global average and by changes in water regimes in a region where water scarcity is already a reality. CO_2-induced acidification is further threatening its marine ecosystems. The region is also vulnerable to the impacts of sea level rise with dense human settlements, infrastructure and heritage sites situated close to the shore and often limited adaptive capacity. Mediterranean countries are engaging in a multitude of commitments and efforts to mitigate and adapt to climate change, at the international, regional, national and local levels. These efforts need to be enforced and their ambition further increased in a multi-stakeholder context, by, for example, minimizing and adapting to the "multiple stresses and systemic failures" related to climate change forecast for the Mediterranean (IPCC, 2014).

2.1 Introduction: Greenhouse gas emission reductions fall behind global ambitions

Carbon dioxide (CO_2) is the most prominent greenhouse gas, which - along with other greenhouse gases, such as methane (CH_4), halocarbons and nitrous oxide (N_2O) - plays a key role in sustaining a habitable temperature on earth. Since the Industrial Revolution, consumption of fossil fuels has led to a rapid increase in CO_2 emissions, disrupting the global carbon cycle and leading to planetary warming, modification of rainfall patterns, changed extreme events, sea level rise and ocean acidification. CO_2 emissions from Mediterranean countries accounted for around 5% (1,954 Mt) of annual world emissions in 2014 (World Bank, 2019a), while the total population of Mediterranean rim countries represents around 6.7% of the world population.

Northern Mediterranean Countries (NMCs) are responsible for higher CO_2 emissions than South-Eastern Mediterranean Countries (SEMCs). Emissions reached a peak in 2005 in NMCs and have since decreased *(Figure 26)*. CO_2 emissions from SEMCs, driven by population growth and economic development, have been increasing continuously since the 1960s, and are now catching up with those of NMCs. Both were responsible for around 1 Gt of CO_2 emissions in 2014.

Between 2000 and 2014, total CO_2 emissions from Mediterranean countries experienced an upward trend which peaked in 2007 and was followed by a downward trend that began in 2008 at the time of the global economic and financial crisis[16], bringing CO_2 emissions in 2014 back to the level of emissions in 2000. Comparable data covering emissions from all Mediterranean countries after 2014 is not available. However, Greenhouse gas emission data is available for many NMCs[17]. This data shows that since 2014, there has been an upward turn in greenhouse gas emissions in these countries *(Figure 27)*, probably linked to the economy catching up. Given this recent increase in emissions in NMCs, and the continuously increasing trend of emissions in SEMCs, the 2007 CO_2 emission peak is unlikely to represent a historical trend inversion.

According to the Paris Agreement, net CO_2 emissions must significantly decline, and that includes the Mediterranean region. At a global level, a reduction in CO_2 emissions by

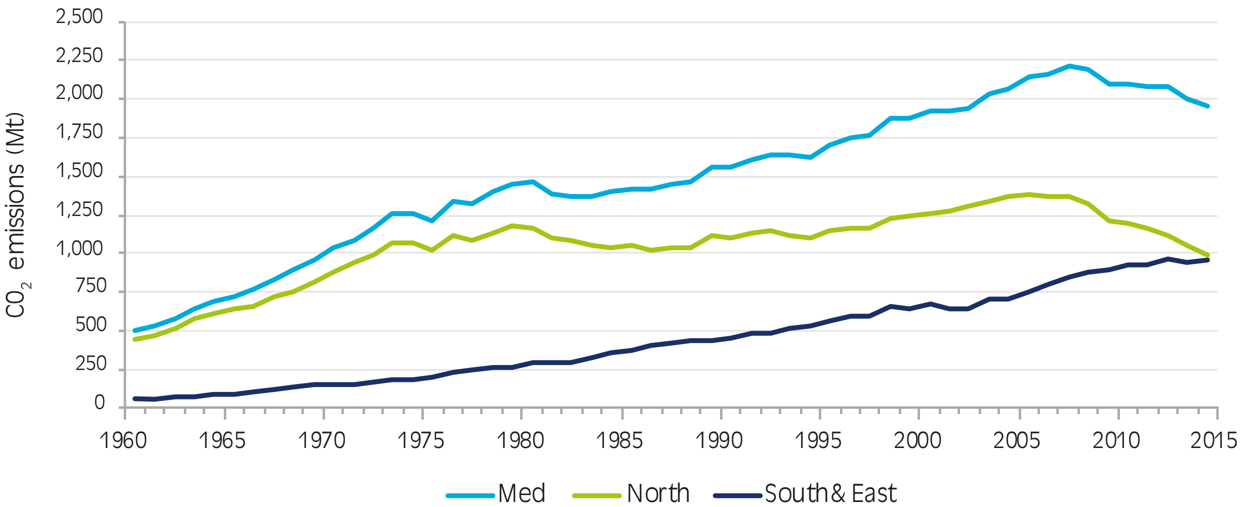


Figure 26 - CO_2 emissions of Northern and South-Eastern Mediterranean countries and total CO_2 emissions of Mediterranean countries
(Source: Carbon Dioxide Information Analysis Center, Environmental Sciences Division, Oak Ridge National Laboratory, Tennessee, United States; data taken from World Bank, 2019b)

[16] In 2014, GDP in most NMCs (Croatia, Cyprus, Greece, Italy, Slovenia, Spain) was still below the 2007 (pre-crisis) level (World Bank database, GDP in constant USD).

[17] Croatia, Cyprus, France, Greece, Italy, Malta, Monaco, Slovenia, Spain.

2030 of about 45% from 2010 levels would be needed for compatibility with a 1.5°C warming scenario (IPCC, 2018). A unique case is Morocco[18], one of the only two countries in the world for which current climate action pledges and policies appear to be compatible with the global 1.5°C warming objective of the Paris Agreement[19].

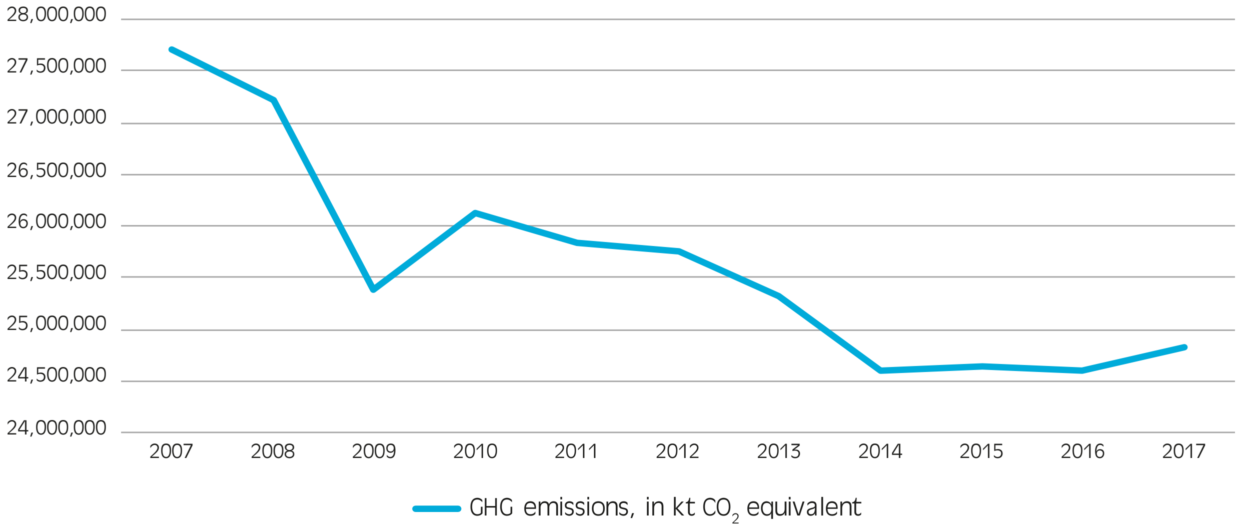


Figure 27 - Greenhouse gas emissions in kt CO_2 equivalent, total of Croatia, Cyprus, France, Greece, Italy, Malta, Monaco, Slovenia and Spain, 2007-2017
(Source: UNFCCC, consulted in September 2019)

BOX 6

The French carbon footprint

National greenhouse gas emissions do not cover the full responsibility of a country. This is why the "carbon footprint" concept is also used, referring to the sum of all CO_2 equivalent emissions associated with all the products and services consumed by a country. The French High Council for Climate *(Box 12)* assessed the French carbon footprint in 2017. The Council found that France's carbon footprint (749 Mt of CO_2 equivalent) is much higher than its emission production (465 Mt), due to high emission imports (421 Mt), as shown in *Figure 28*.

The Council also found that, while national greenhouse gas emissions have been decreasing since 2005, the national carbon footprint is not following the same trend *(Figure 29)*.

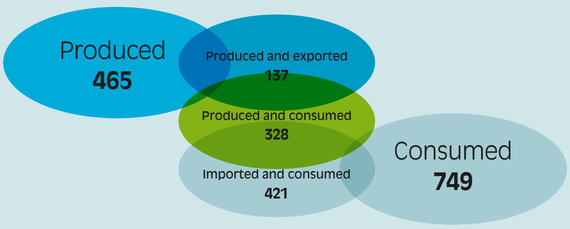


Figure 28 - Calculating the French carbon footprint, in millions of tons of CO_2 equivalent, 2017
(Source: Fontan et al. 2019)

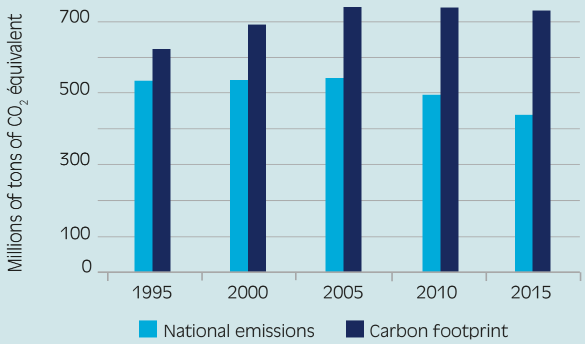


Figure 29 - National emissions and carbon footprint of France, in millions of tons of CO_2 equivalent, 1995-2015
(Source: Fontan et al. 2019)

[18] Along with the Gambia.
[19] Climate Action Tracker, referred to in Sachs et al (2019).

CO_2 emissions vary greatly among Mediterranean countries, with the highest per capita CO_2 emissions in Libya and Israel *(Figure 30)* and largest emissions per year in Turkey, Italy and France in decreasing order *(Figure 31)*.

industries and construction (20%) (World Bank, 2014). The economic growth of these sectors is linked to CO_2 emissions. Globally, CO_2 intensity (amount of CO_2 emitted per unit of GDP) has steadily decreased since 1990 (see

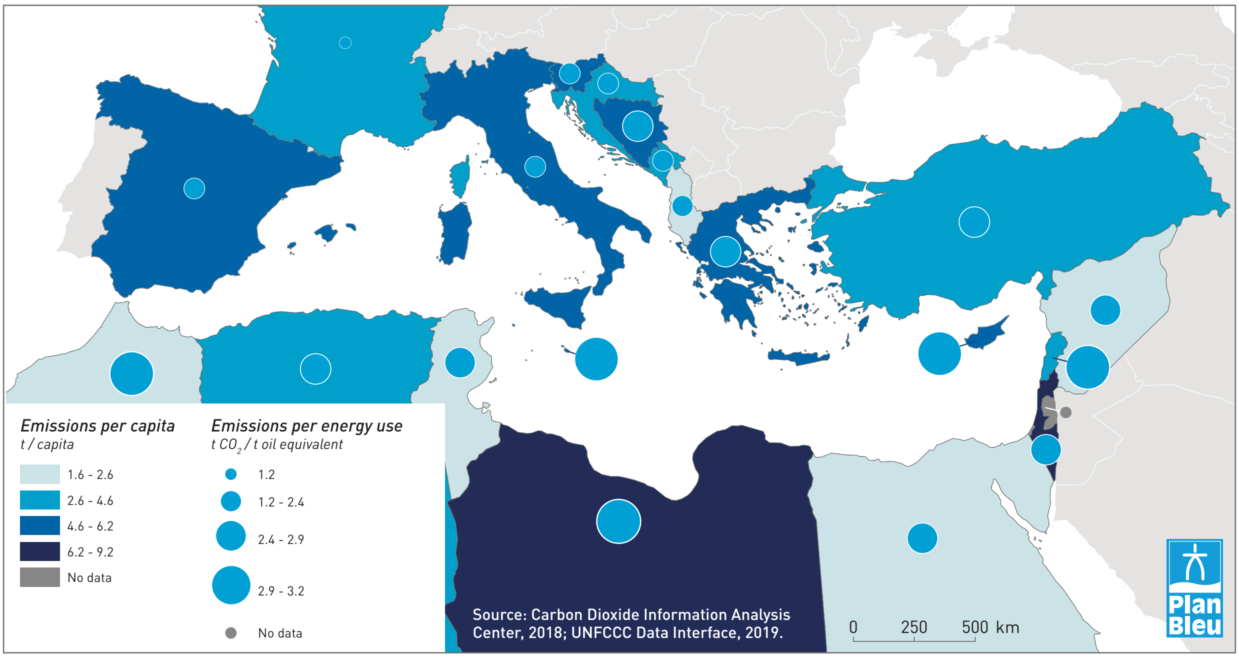


Figure 30 - Carbon dioxide emissions of Mediterranean countries, 2014
(Sources: Carbon Dioxide Information Analysis Center, Environmental Sciences Division, Oak Ridge National Laboratory, Tennessee, United States; data taken from World Bank, 2019b; UNFCCC Data Interface, 2019)

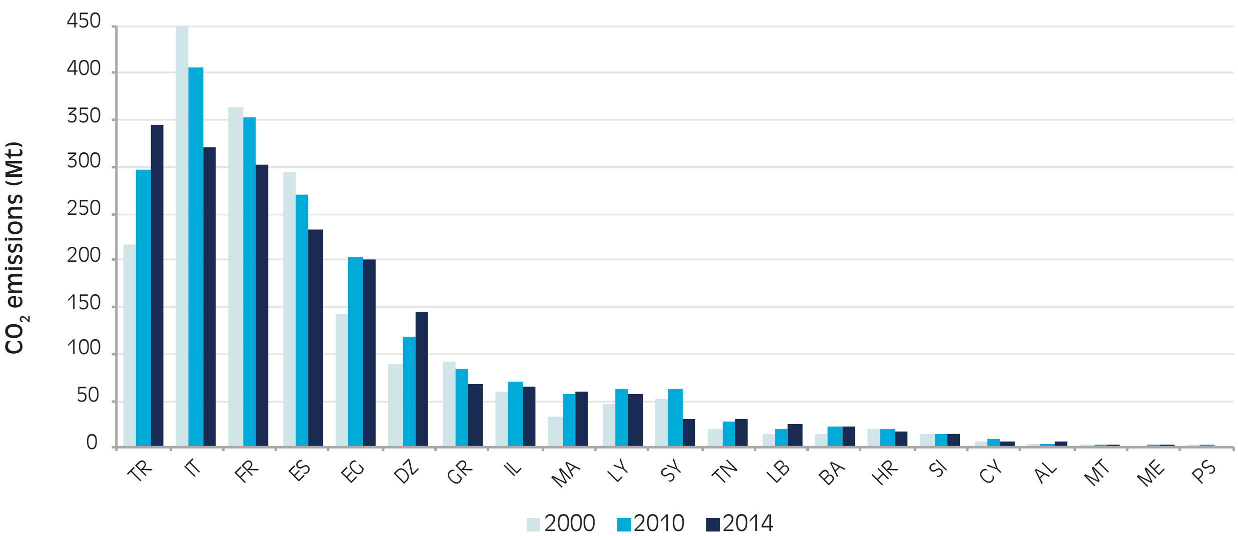


Figure 31 - CO_2 emissions by country in 2000, 2010 and 2014
(Source: Carbon Dioxide Information Analysis Center; World Bank, 2019b)

Annual CO_2 emissions from fuel combustion per capita average around 4 tonnes, ranging between 0.5 t per capita in the State of Palestine to 9.2 t per capita in Libya in 2014 *(Figure 32)*.

Globally, CO_2 emissions from fuel combustion derive principally from the electricity and heat production sector (50%), followed by transport (20%), and manufacturing

chapter 1), as a result of the increase in the relative share of renewables, improved energy and technology efficiency and increasing capacity of renewable energy sources. Despite the declining trend in the carbon intensity of national economies, economic growth continues to be coupled with further CO_2 emissions. Decarbonization efforts need to be further strengthened, as current trends and efforts are not sufficient to meet global climate targets.

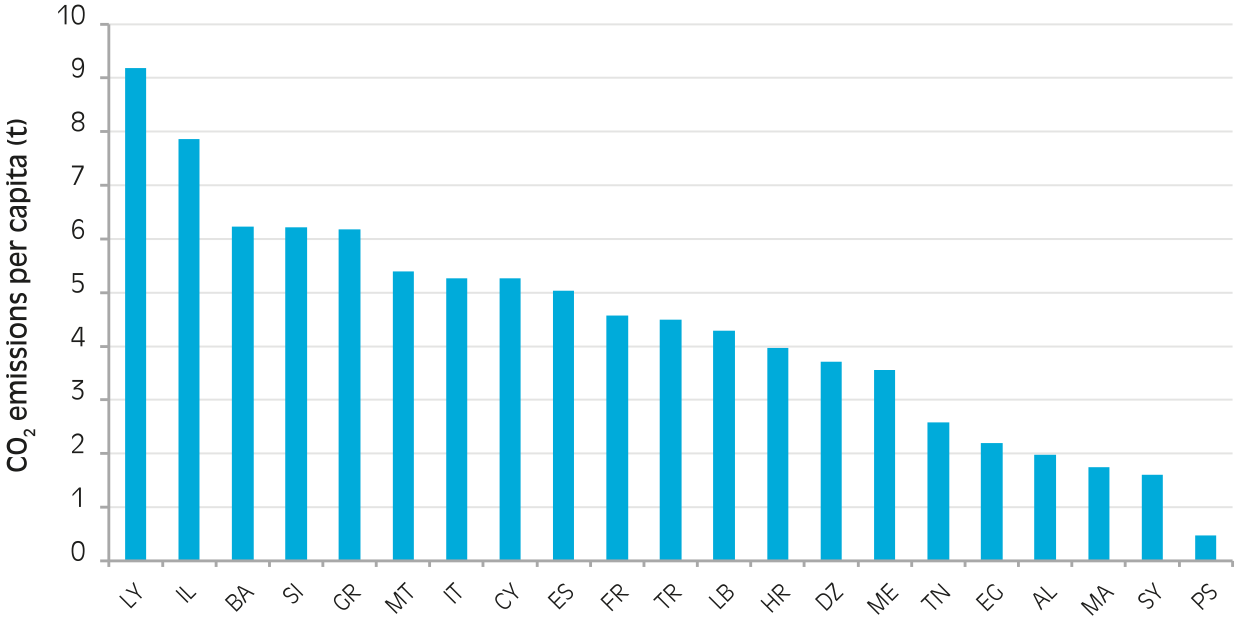


Figure 32 - CO_2 emissions from consumption of solid, liquid, and gas fuels and gas flaring, per capita by country in 2014
(Source: Plan Bleu calculations based on country CO_2 emissions and population estimates)

BOX 7

The contribution of maritime transport to climate change

Shipping contributes to around 2.6% of total global greenhouse gas emissions, a figure that could more than triple by 2050 (IMO, 2015). According to the International Transport Forum (ITF), carbon emissions from global shipping are projected to reach approximately 1090 million tonnes by 2035 under a baseline scenario with no new policy measure. This would represent 23% growth from 2015 to 2035 (OECD/ITF, 2018a). *Figure 33* presents CO_2 emission projections across shipping routes for 2035.

Several measures that could decarbonize international shipping by 2035 have been identified (OECD/ITF, 2018b):

- Alternative fuels and renewable energy (e.g., biofuels, complemented by other natural or synthetic fuels such as methanol, ammonia and hydrogen, and wind assistance and electric propulsion),
- Technological measures to improve ships' energy efficiency such as hull design improvements, air lubrication and bulbous bows,
- Operational improvements such as slower ship speeds, smoother ship-port coordination and use of larger, more efficient ships, and
- Port solutions, such as green port fees (i.e., fees based on environmental performance of ships), alternative energy/clean burning fuels incentives, green procurement and shore power facilities.

Figure 33 - CO_2 emission projections across shipping routes for 2035
(Source: OECD/ITF, 2018a)

Unlike for other sectors, at the global level, no greenhouse gas emission reduction target has been established for maritime transport, under the United Nations Framework Convention on Climate Change (UNFCCC). In 2011, the International Maritime Organization (IMO) adopted mandatory energy-efficiency measures for shipping that entered into force in 2013. These consist of technical, design and operational requirements for new and existing vessels. According to these regulations, by 2025, new ships must be 30% more energy efficient than those built in 2014. Statistical analysis based on IMO data concluded that a substantial share of the new build fleet already complies with or exceeds current and future (2025) design efficiency requirements (Transport & Environment, 2017).

In addition, a mandatory data collection system for fuel oil consumption of ships was adopted at IMO and entered into force in March 2018. This initiative aims to provide robust data to serve as a basis for future policy decisions on additional reductions. In April 2018, IMO adopted a strategy to reduce greenhouse gas emissions. Under this strategy, IMO members' goal is to reduce total annual greenhouse gas emissions by at least 50% by 2050 compared to 2008. This strategy is due to be revised by 2023. It is also expected that the implementation of shipping greenhouse gas emissions reduction measures will be supported by international technical cooperation projects, such as the IMO Global Maritime Energy Efficiency Partnerships (GloMEEP) Project (https://glomeep.imo.org).

More information about maritime transport in the Mediterranean can be found in chapter 4.

2.2 Climate change impacts, vulnerabilities and risks

2.2.1 The Mediterranean Basin - a climate change hotspot

The Mediterranean Basin benefits from climatic conditions that have allowed the development of rich landscapes with high biodiversity and sophisticated land use systems, providing numerous services to people, such as a broad variety of some of the world's most nutritious and healthy food products. A key characteristic of the Mediterranean climate is hot and dry summers, creating water-stressed conditions that mean that vegetation can only develop via the substantial replenishment of groundwater resources from heavy rainfall in winter in the coastal regions and the melting of snow and ice in the high mountains during summer. These unusual conditions occur in just a few regions of the world.

The Mediterranean Basin has been affected by recent climate change at rates exceeding global averages, in particular by more rapid warming during all seasons, in the air and sea. There is an unequivocal trend towards drier conditions, with the noticeable specificity that most climate models are in stronger agreement about expected rainfall changes in the Mediterranean than they are anywhere else in the world. Economic activities (agriculture, fisheries, tourism, etc.) and supporting infrastructure (cities, ports, agriculture in low-lying river deltas, etc.) are tightly tuned to recent climatic and environmental conditions, particularly the precise current level of the sea surface, making Mediterranean countries highly vulnerable to changes in these conditions. Many Mediterranean countries (in the South and the East) are living under high economic pressure with little budget available for adaptation. All these factors together make the Mediterranean Basin a climate change hotspot. It is certainly not the only place on earth where large populations are victims of climate change impacts already now and in the very near future, but it is one of the most exposed.

2.2.1.1 Air temperature: a faster increase than global average

Recent climate change in the Mediterranean exceeds global trends for a number of variables. While global mean surface temperature is now about 1.1°C (±0.10°C likely range, IPCC, 2019a) above pre-industrial values, the Mediterranean region approaches 1.54°C *(Figure 34)*, Cramer et al. 2018). Given the present global trend of 0.02±0.01°C per year, the 1.5°C global warming threshold will likely be passed globally at around 2040. In the Mediterranean region, the trend is about 0.03°C per year, implying that, when the world passes the 1.5°C level identified in the Paris Agreement, the region will already have warmed by +2.2°C[20].

Since the mid-20th century, the major cause of air temperature increase in the Mediterranean region is anthropogenic forcing[21] (Adloff et al. 2015). This also includes the observed increases in hot extremes and decreases in cold extremes (Bindoff et al. 2013; Schleussner, Pfleiderer & Fischer, 2017). Summer months have warmed more than

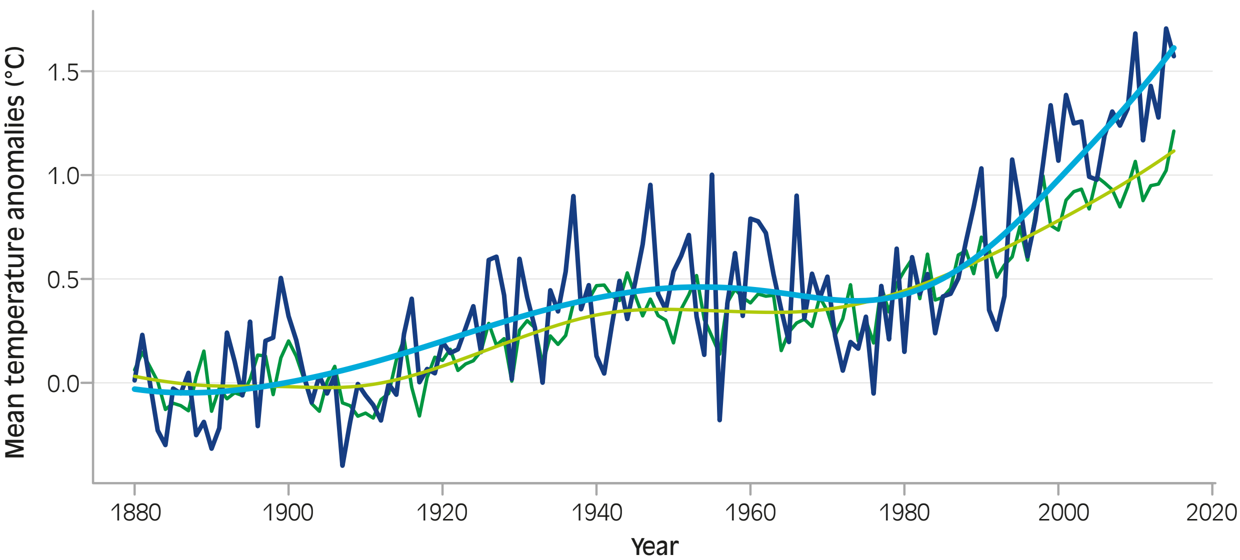


Figure 34 - Historic warming of the atmosphere, globally and in the Mediterranean Basin
Annual mean air temperature anomalies are shown with respect to the period 1880-1899, with the Mediterranean Basin (blue) and the planet (green) presented with and without smoothing.
(Source: Data from Berkeley Earth cited in Cramer et al. 2018)

[20] Daytime maxima.
[21] Anthropogenic forcing is a change in the Earth's energy balance due to human economic activities.

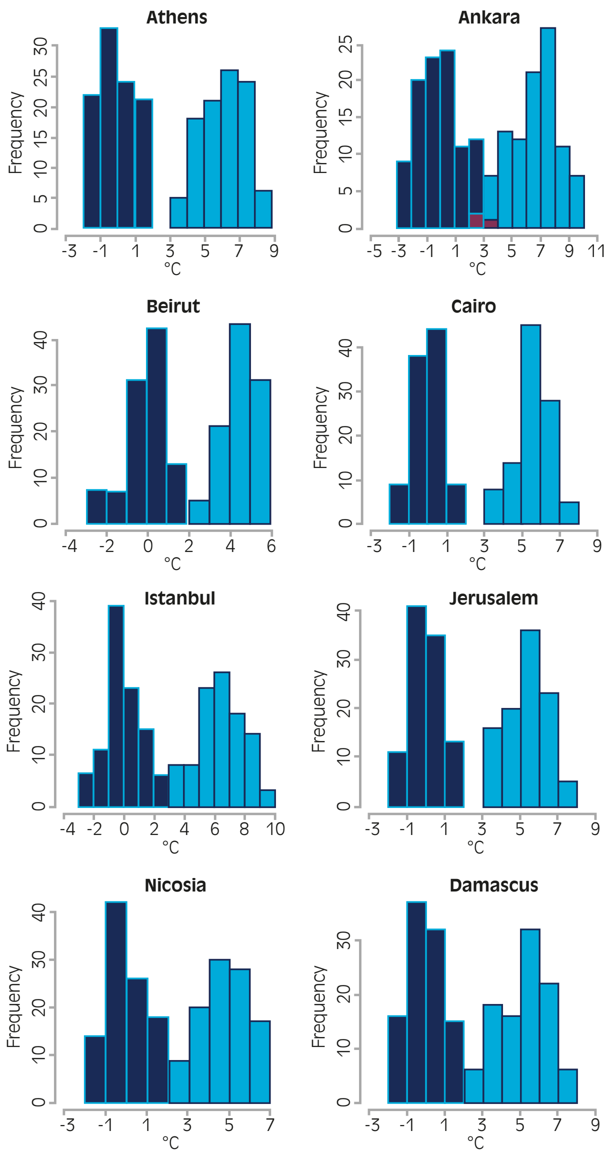


Figure 35 - Recent (1961-1990) and expected end-of-century (2070-2099) temperature anomalies for selected cities in the Mediterranean region

The model calculated frequencies (%) of summer daytime maximum temperature anomalies relative to the period 1961-1990, based on the A1B scenario which assumes a rapid economic growth with CO_2 concentration increasing to 600 ppmv in 2100 (current concentration is about 400 ppmv). Dark blue bars for the period 1961-1990 (hence centred on 0ºC) and light blue bars for the period 2070-2099 (Lelieveld et al. 2013).

winter months. The annual maximum daily high temperature has already increased by 2°C, the annual minimum daily low temperature by only 1°C. For any year, the longest consecutive period with daily maximum temperature above the 90% quantile of the 1960-1979 reference period has reached 12 days. In southern Europe, heatwaves have been occurring more frequently since 1960 and the increase is also stronger than at the global level (Jacob et al. 2014). In the eastern Mediterranean, heatwave return periods (mean time interval between two occurrences) have changed from once every 2 years to multiple occurrences per year (Zittis et al. 2016). The summer amplification of daily temperature ranges is further amplified in cities by the "urban heat island"[22] effect, as shown in *Figure 35*. This figure shows that the probability distributions of temperatures in most Mediterranean cities at the end of the 20th and 21st centuries are completely separated, implying that the current warmest years are colder than the future coldest ones (with a scenario of 600 ppmv in 2100).

2.2.1.2 Precipitation: towards drier conditions and more heavy rainfall events

Observed precipitation varies very strongly from year to year and also between regions - it is therefore not possible to assume a reduction in rainfall across the whole Mediterranean. But the frequency and intensity of droughts have increased since 1950 (Kelley et al. 2015; Vicente-Serrano et al. 2014). Heavy precipitation events have changed significantly during the period 1991-2010 compared with 1960-1979 (Schleussner et al. 2017).

For the future, global warming of 2°C will likely be accompanied by a reduction in summer precipitation of about 10-15% in Southern France, North-western Spain and the Balkans and up to 30% in Turkey (Jacob et al. 2018; Vautard et al. 2014). Still warmer scenarios with 2 to 4°C increases in the 2080s for Southern Europe would imply widespread decreases in precipitation of up to 30% (especially in spring and summer months) (Forzieri et al. 2014). For each degree of global warming, mean rainfall will likely decrease by about 4% in much of the region (Lionello & Sciarascia, 2018) *(Figure 36)*, particularly in the south, lengthening dry spells by 7% for 1.5°C global average warming (Schleussner et al. 2016). Heavy rainfall events are likely to intensify by 10 to 20% in all seasons except the summer (Toreti et al. 2013; Toreti & Naveau, 2015).

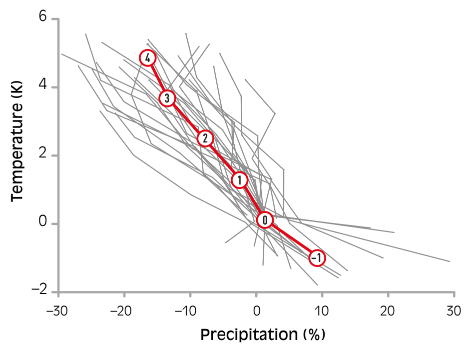


Figure 36 - Evolution of the Mediterranean regional climate towards warmer and drier conditions

(Temperature anomalies as a function of precipitation anomalies). The grey lines represent the evolution of the individual models (28 CMIP5 global simulations) and the red line represents the mean evolution (the ensemble mean as a function of global mean temperature change denoted in the red circles (K or °C)). All values are anomalies with respect to the corresponding 1971-2000 mean. (Source: redrawn from Lionello & Scarascia 2018; Cramer et al. 2018)

[22] An urban heat island is an urban or metropolitan area that is significantly warmer than its surrounding rural areas due to human activities.

2.2.1.3 Ocean temperature: accelerating warming

In recent decades, the surface of the Mediterranean Sea has warmed by around 0.4°C (Macias, Garcia-Gorriz & Stips, 2013). Anthropogenic forcing has been the major factor behind this warming since 1970 (Adloff et al. 2015). Projections for 2100 vary between 1.8°C and 3.5°C (Adloff et al. 2015), with high spatial heterogeneity *(Figure 37)* and hot spots expected to the east of Spain and in the Eastern Mediterranean.

Worldwide, marine heatwaves[23] have doubled in frequency and last longer, are more intense and also more extensive. Between 84 and 90% of marine heatwaves that occurred between 2006 and 2015 are attributable to anthropogenic warming (IPCC, 2019b). Simulations project at least one long lasting marine heatwave every year by the end of the 21st century, much longer, more intense and more severe than present-day events (Darmaraki et al. 2019). These are expected to occur in the Mediterranean from June to October and to affect the whole region at their peak.

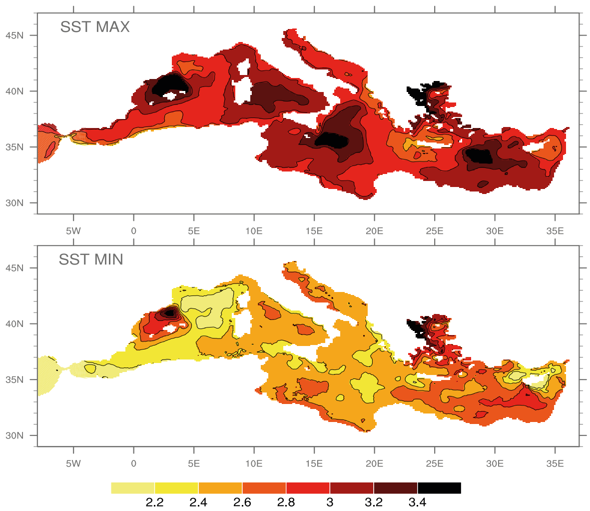


Figure 37 - Composite of sea surface temperature anomalies

Maxima (top) and minima (bottom) for the 2070-2099 period (vs. 1961-1990). The largest (maxima) or smaller (minima) anomaly out of the 6 scenario simulations is represented at each grid point. Units are in °C.
(Source: Adloff et al. 2015)

2.2.1.4 Sea level: uncertain scenarios, with potentially serious concerns

Globally, mean sea level has been rising since the late 19th century, reaching an overall rise of 0.16 m between 1902 and 2015 (IPCC, 2019b). In the last decade (2006-2015), the rate of sea level rise has accelerated and has now reached a level unprecedented in the last century of 3.6 mm per year, about 2.5 times the 1901-1990 rate of 1.4 mm per year (IPCC 2019). In the Mediterranean, sea level rise is comparable to global trends (Tsimplis et al. 2013). The main contributions to sea level rise are from thermal expansion as well as from glacier and ice sheet mass loss, caused primarily by anthropogenic forcing since 1970 (Slangen et al. 2016).

BOX 8

Sea level changes in Venice and Alexandria

Observations from tide gauge stations and results of modelling show the increase in sea level in Venice (Italy) and Alexandria (Egypt).

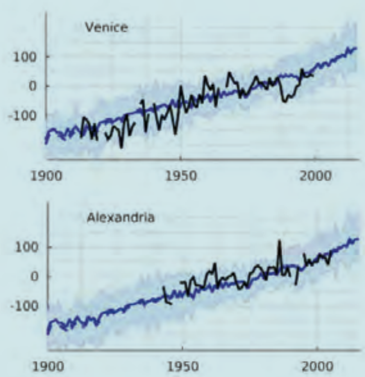


Figure 38 - Observed from tide gauge stations (black) and modelled (blue) relative sea level changes in Venice and Alexandria, 1900-2015, in mm of sea surface height
(Source: IPCC, 2019b)

Current estimates of future sea level rise show a relatively wide range from 0.43 m to 2.5 m by 2100, depending on scenarios and projection methodology. Under a scenario with sharp emission cuts that limits warming to well below 2°C, the IPCC suggests a rise of 0.43 m by 2100 compared to 1986-2005 (IPCC, 2019b) and a rise of up to 1.1 m under a less ambitious emissions reduction scenario. Other studies suggest sea level rise of 1.9 m above present levels (Vermeer & Rahmstorf, 2009), exceeding 2 m (Bamber et al. 2019), and reaching even 2.5 m (Garner et al. 2018), all by 2100. The IPCC projects sea level rise to continue by between 4 and 15 mm per year in 2100 depending on the emission scenario, indicating the importance of emission reductions for limiting sea level rise (IPCC, 2019) and pointing out the instabilities in Greenland and especially Antarctic ice sheets possibly resulting in sea level rises of several metres on centennial to millennial timescales. The global rise will impact the Mediterranean Sea through the transport of water through the Strait of Gibraltar (Adloff et

[23] A marine heatwave: defined as when the daily sea surface temperature exceeds the local 99th percentile over the period 1982 to 2016 (IPCC, 2019b).

al. 2018; Jorda & Gomis 2013). For Mediterranean coasts, local sea level is affected by regional changes in river runoff, resultant salinity changes and also significant land movements in the Eastern basin (Adloff et al. 2015). Such changes could induce additional local differences in sea surface height of up to 10 cm. The sum of these changes will impact coasts throughout the basin substantially, although few local studies exist. In Southern Italy, for example, substantial coastal inundation is expected by 2100 (Antonioli et al. 2017; Aucelli et al. 2017), as well as along the Egyptian Mediterranean coast (Shaltout, Tonbol & Omstedt, 2015). Significant shoreline modifications are also expected elsewhere, such as in the Balearic Islands (Enriquez et al. 2017).

2.2.1.5 Ocean acidification and oxygen loss: following global trends

About 30% of CO_2 emitted by human activities has been absorbed by the ocean, where its increasing uptake is leading to both an increase in the partial pressure of CO_2 and total dissolved inorganic carbon as well as a decrease in pH, a process commonly termed "ocean acidification" (Stocker et al. 2013). Ocean pH has decreased by 0.1 units since the pre-industrial period, an unprecedented change over the last 65 million years (Ridgwell & Schmidt, 2010). Globally, CO_2 uptake by the oceans is expected to lead, by 2100, to acidification of 0.15-0.41 pH units below 1870-1899 levels (Magnan et al. 2016).

The Mediterranean Sea is an important carbon sink, similar to other marginal seas (Lee et al. 2011) because its water column holds more CO_2 than many other oceanic basins (Hassoun et al. 2015; Schneider et al. 2010). The fast formation of deep water areas combined with the warm and highly alkaline waters of the Mediterranean make these waters more prone to absorb CO_2 from the atmosphere and to transport it to intermediate and deep layers via active overturning circulation in this basin (Álvarez et al. 2014; Krasakopoulou et al. 2009; Touratier et al. 2016). Since the pre-industrial period, acidification in the Mediterranean ranges from -0.055 to -0.156 units (Flecha et al. 2015; Hassoun et al. 2015; Ingrosso et al. 2017; Palmiéri et al. 2015), with a rate of 0.09 to 0.028 pH units per decade observed in the upper layers of both the Western (Kapsenberg et al. 2017) and the Eastern Mediterranean Sea (Hassoun et al. 2019).

2.2.1.6 Projected lower wave height and fewer but more intense extratropical cyclones

Average wave heights[24] are projected to decrease across the Mediterranean Sea (IPCC, 2019b).

Marine heatwaves in the Mediterranean Sea may trigger intense extratropical cyclones, referred to as "medicanes" (González-Alemán et al. 2019). Despite a projected decrease in frequency (Michaelis et al. 2017; Zappa, Shaffrey & Hodges, 2013), "medicanes" could become more hazardous and destructive, because they are projected to last longer and produce stronger winds and rainfall, mainly in autumn.

2.2.2 Impacts of climate change on the terrestrial environment

Land ecosystems are affected by many environmental parameters, but the climate (temperature, rainfall, and their variability over short and long timescales) is a key factor. The distribution of ecosystems in the Mediterranean Basin reflects, in part, the main climatic gradients (including those between coastal and inland areas, and lowland and mountains), but also, often to a larger degree, land use, such as agriculture, forestry, urbanization, etc. The biodiversity of Mediterranean ecosystems is exceptionally high. For example, although Mediterranean forests represent only 1.8% of world forest areas, they contain 290 wood species, twice as much as the rest of Europe (Gauquelin et al. 2016). Mediterranean ecosystems provide an exceptionally high and diverse number of services to people, ranging from numerous types of food, including medicinal and aromatic plants, to fibre-based products and substantial other benefits such as storage of carbon and water, purification of water, spiritual values and opportunities for recreation.
Given the nature of the Mediterranean climate, many species of plants and animals are well adapted to drought conditions through various mechanisms such as thick leaves or phenological avoidance of the hot summer months, but there are limits to these adaptations.

2.2.2.1 Past and current changes: driven by both changes in human practices and climatic conditions

Most of the recent changes in Mediterranean ecosystems and their biodiversity are linked with human activities, which have changed many times through history since the Neolithic period. A large share of Mediterranean biodiversity is a consequence of human action (agriculture, forestry, pastoralism, breeding of plants and animals, etc.) and presents considerable value. Nevertheless, natural climate variability has also played a role during past millennia indicating potential limits to adaptation (Guiot & Cramer, 2016). For many plant species in the Mediterranean region, shifts in phenology, geographic range contraction and decline in vigour have been observed and attributed to decreased precipitation and warming (Settele et al. 2014).

2.2.2.2 Risks for the future: difference between 1.5°C and 2°C warming is highly significant

The drier and still warmer conditions expected during coming decades directly affect the productivity of land ecosystems and therefore put their functioning and

[24] The average height from trough to crest of the highest one-third of waves.

survival at risk if certain thresholds are exceeded. The expected continuation of the current increase in aridity, due to reduced precipitation but also warming, is likely to be among the most important threats to Mediterranean land ecosystems (Duguy et al. 2013; Gouveia et al. 2017; Peñuelas et al. 2013, 2017; Santonja et al. 2017; Williams et al. 2013). Under an optimistic climate scenario (global temperatures below +1.5°C to +2°C above preindustrial values), western Mediterranean forests may largely survive under future climate conditions in most locations, except for some sites dominated by conifers. With higher warming, forests suffer strong reductions in growth and survival (Gea-Izquierdo et al. 2017). This suggests that western Mediterranean forests are vulnerable to a climate warmer than +2°C unless the trees develop a strong fertilization response to increased atmospheric CO_2. Overall, for land ecosystems in the Mediterranean region the difference between 1.5°C and 2°C warming is highly significant (Guiot & Cramer, 2016; Schleussner et al. 2016). Only if global warming is constrained to 1.5°C can biogeographical shifts unprecedented in the last 10,000 years be avoided - whilst 2°C warming results in a significant decrease (12-15%) of the region's capacity to support Mediterranean ecosystems.

Other components of global change, such as the expansion of high intensity land use, pollution and overexploitation of resources, will likely continue or even accelerate. Therefore, decreases in ecosystem integrity, biodiversity and carbon storage capacity are expected, and these could lead to soil erosion, soil fertility loss, and desertification in some areas. The diversity of many forests, grasslands and rural landscapes is threatened by urbanization, habitat fragmentation, unsustainable tourism and unstable practices in forestry and agriculture (e.g., overgrazing, forest fires), sea level rise and biological invasions (Médail, 2017). The combination of these factors will likely reduce the capacity of land ecosystems to provide important services to people, including food production and the regulation of water quality (Doblas-Miranda et al. 2017; Garcia-Nieto et al. 2018). Another important consequence of forest loss would be a reduction of their role as carbon sink, especially during drought years (Munoz-Rojas et al. 2015; Rambal et al. 2014).

The agricultural sector has already been experiencing negative impacts in the Mediterranean area (Olesen et al. 2011; Peltonen-Sainio et al. 2010). An overall reduction

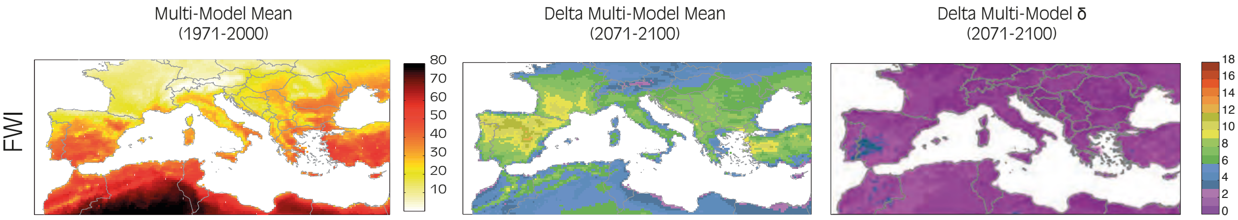


Figure 39 - Control (1971-2000) and future projections (delta, 2071-2100) of the Canadian Fire Weather Index (FWI)
(Source: Bedia et al. 2014)

in crop productivity in large parts of the Southern Mediterranean is expected over the next decades (Iglesias et al. 2012; Olesen et al. 2011). Depending on crop type and region, there will be significant subregional differences in terms of yield increase or decrease (Skuras & Psaltopoulos, 2012). A decrease (in value terms) of 21% by 2080 is expected for the whole Mediterranean agricultural production, with a peak of an almost 40% decrease in Morocco and Algeria (UNEP/MAP PAP/RAC, 2015).

Forests, wetlands and coastal ecosystems in the Mediterranean Basin will be affected by changes in extreme weather conditions. Fire is a natural component of the dynamics of many Mediterranean forests, but higher fire risk, longer fire seasons, and more frequent large and severe fires are expected as a result of increasing heatwaves in combination with drought and land use change (Duguy et al. 2013; Ruffault et al. 2016; Turco et al. 2014) *(Figure 39)*. These fires are the result of fuel accumulation during the wet season and increased droughts during the dry summer season. The large fires triggered by extreme climate events, especially heatwaves, have caused record maxima of burnt areas in some Mediterranean countries during the last decades (Ganteaume et al. 2013; Ruffault et al. 2016). These risks will increase along with an increase in the occurrence of high danger days and in fire season length.

In Mediterranean inland wetlands (Zacharias & Zamparias, 2010) and freshwater ecosystems, wildlife is impacted by falling water levels and reduced water quality (both driven by climate change, Hermoso & Clavero, 2011; Klausmeyer & Shaw, 2009).

2.2.3 Impacts of climate change on the coastal environment

The Mediterranean coastal environment is home to about 150 million people[25]. Worldwide, sea level rise and other oceanic climate changes are leading to salinization, flooding and erosion. They also affect human and ecological systems, including health, heritage, freshwater, biodiversity, agriculture, fisheries and other ecosystem goods and services. This is particularly true in the Mediterranean region, where a small tidal range and relatively limited storm surges have led to the development of specific coastal infrastructure, land use systems and

[25] Plan Bleu calculations, national sources (based on NUTS 3 or equivalent).

human settlements, all closer to mean sea level than in most world regions (Becker et al. 2012). The city of Venice, built into a shallow lagoon, is perhaps the most striking example. Coastal zones frequently offer the ideal growing conditions for a range of valuable crops (e.g., vegetables, olives, and grapes), in addition to the primary activities linked to fisheries and aquaculture, which are important for the food security and economy of coastal communities. As a consequence, the vulnerability of the Mediterranean coastal zone to changes in climate and sea level is very high. Past and current changes affect delta regions in particular.

Loss of arable lands due to coastal erosion and salinization due to sea level rise and flooding are starting to occur, affecting agricultural production in coastal areas of the Mediterranean. The link with climate change is not always clear. All major river deltas are affected by reduced sedimentation rates, caused by dams and changed irrigation systems upstream. In Egypt, about 30% of irrigated farmlands are affected by salt intrusion (Hegazy et al. 2005). For cultivated land, 60% in the north and 20% in both central and southern Delta regions are considered to have salt-affected soil (Rubio et al. 2009). Seawater intrusion is one of the geochemical processes governing groundwater chemistry in the Western Nile delta area (Salem & Osman, 2017). This environmental degradation pushes an increasing population into more and more concentrated areas (ACSAD, 2000).

The effects of sea level rise are expected to be high for most low-lying coasts of the Mediterranean basin, even in the areas where reduced marine storminess is expected (Gualdi et al. 2013; Lionello et al. 2016). Marine storms, "medicanes" and related storm surges represent a major issue at the local scale for assessing coastal risk. The uncertainty in the occurrence of disastrous events is one key factor in assessing coastal vulnerability and managing hazards related to marine storms (Gualdi et al. 2013). Extreme rainfall and droughts also contribute to coastal hazards and in particular to flooding and erosion risks. Extreme precipitation combined with storm surges leads to coastal flooding (Lian, Xu & Ma, 2013). Runoff collected by drainage systems flows directly or is pumped into the sea or into coastal plains. Inland flooding, caused by extreme precipitation, impacts the drainage capacity and may also lead to backward flow, increasing the negative effects of coastal flooding from marine storms. All these factors may enhance coastal erosion which occurs where rivers which have historically supplied beaches with sediment now have a depleted sediment yield due to reduced runoff. River flow may also be reduced due to the impact of droughts and thus exacerbate coastal erosion (Bird & Lewis, 2015).

The potential socioeconomic consequences of climate variability and change vary for the different key coastal sectors in the Mediterranean subregions. Inundation related to accelerated sea level rise increases the risk of infrastructure damage including the flooding of roads, railways, houses and other coastal structures. Storms may impact maritime transport and ports (Travers, Elrick & Kay, 2010). The risk of wave overtopping in Northern Mediterranean ports increases (Paz & Tourre, 2010; Rohr et al. 2011). Increasing property losses from more intense cyclone events are not mitigated by possible reductions in the frequency of such events (Handmer et al. 2012). The relationship between intensity and damage is likely to be exponential, with research suggesting a 30 to 40% increase in damage linked to a wind speed increase of just 10% (Strobl, 2012). These coastal risks are very high along the Southern and Eastern shores (Karaca & Nicholls, 2008; Frihy & El-Sayed, 2013; Snoussi, Ouchani & Niazi, 2008), where monitoring systems are limited and the adaptive capacity is generally lower than in the North. About 15 large Mediterranean cities (port cities with a population greater than 1 million in 2005) are at risk of flooding due to sea level rise, unless further adaptation is undertaken (Hallegatte et al. 2013; Hanson et al. 2011). These cities are at risk of witnessing severe storm-surge flooding, rising sea and local land subsidence (Nicholls & Amelung, 2008). By 2050, for the lower sea level rise scenarios and current adaptation measures, cities in the Mediterranean will account for half of the 20 global cities with the highest increase in average annual damages (Hallegatte et al. 2013).

Areas at extremely high risk are predominantly located in the Southern and Eastern Mediterranean region including Morocco, Algeria, Libya, Egypt, the State of Palestine, and the Syrian Arab Republic (Satta et al. 2015). Some of these countries are currently experiencing political instability, and are often less able to deal with the additional environmental pressures and associated challenges in their daily lives. In North Africa, a sea level rise of 1 m would impact approximately 41,500 km² of land and at least 37 million people (Tolba & Saab, 2009). It is not currently possible to reconcile these estimates with European estimates (Ciscar et al. 2005) for a full Mediterranean assessment, but they indicate an order of magnitude of people impacted by coastal risks.

With close to 20 million people living at less than 5 m above sea level within the 100 km Mediterranean coastal belt (Schiavina, Freire & MacManus, 2019), the exposure of the Mediterranean shoreline to the coastal risk of flooding and erosion is a major challenge, in particular in Egypt (Nile Delta) and Italy (Venice lagoon). In Egypt, more than 11.5 million people live at less than 5 m above sea level within the 100 km Mediterranean coastal belt, while this number is at around 2 million in Italy and around 1 million in Spain, as well as in Tunisia and Turkey (Schiavina, Freire & MacManus, 2019). Coastal erosion and flooding will also generate loss of coastal land where important cultural heritage sites are located (Reimann et al. 2018) *(Figure 41)*.

2.2.4 Impacts of climate change on the marine environment

The Mediterranean Sea hosts 4-18% of all identified marine species in the world, while accounting for only 0.82% of the global ocean surface (Coll et al. 2010). The

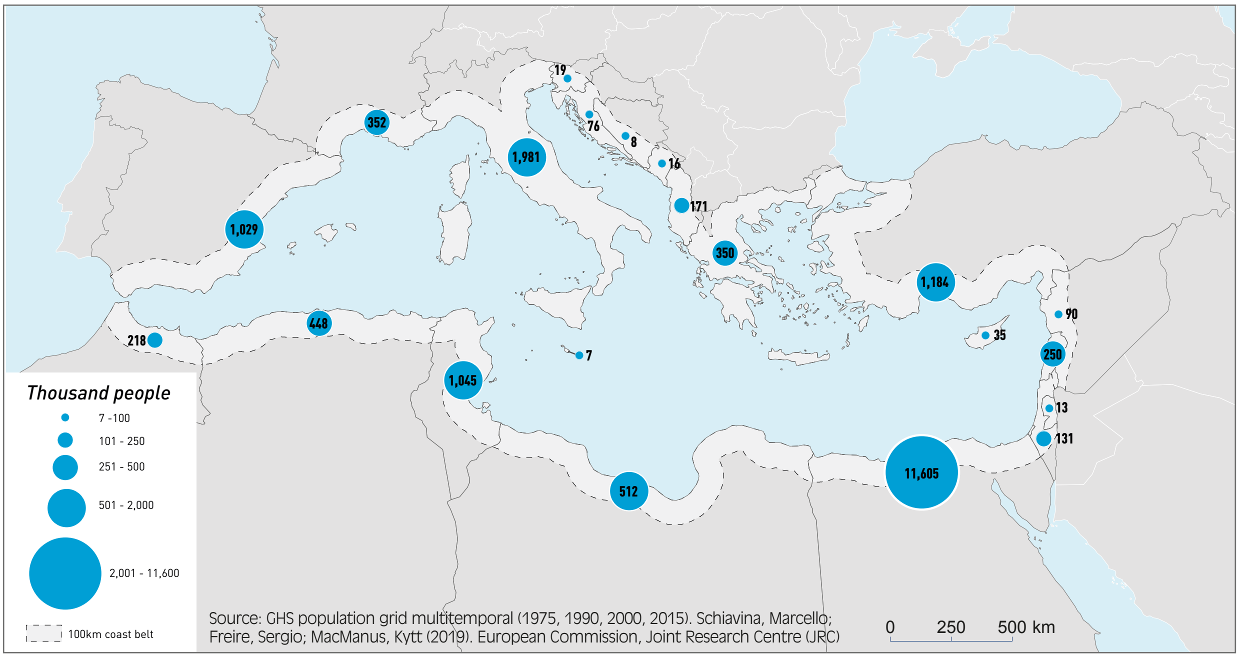
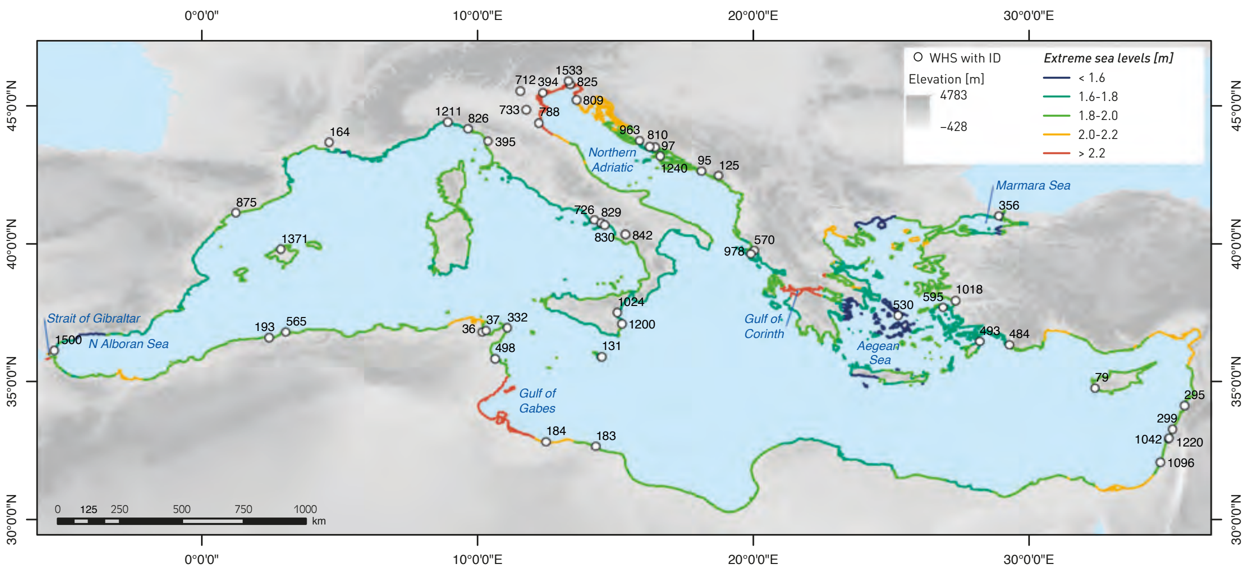


Figure 40 - Population living at less than 5 m above sea level within the 100 km Mediterranean coastal belt, per country
(Source: Schiavina, Freire & MacManus, 2019)



36	Medina of Tunis
37	Archaeological Site of Carthage
79	Paphos
95	Old City of Dubrovnik
97	Historical Complex of Split with the Palace of Diocletian
125	Natural and Culturo-Historical Region of Kotor
131	City of Valletta
164	Arles, Roman and Romanesque Monuments
183	Archaeological Site of Leptis Magna
184	Archaeological Site of Sabratha
193	Tipasa
295	Byblos
299	Tyre
332	Punic Town of Kerkuane and its Necropolis
356	Historic Areas of Istanbul
394	Venice and its Lagoon
395	Piazza del Duomo, Pisa
484	Xanthos-Letoon
493	Medieval City of Rhodes
498	Medina of Sousse
530	Delos
565	Kasbah of Algiers
570	Butrint
595	Pythagoreion and Heraion of Samos
712	City of Vicenza and the Palladian Villas of the Veneto
726	Historic Centre of Naples
733	Ferrara, City of the Renaissance, and its Po Delta
788	Early Christian Monuments of Ravenna
809	Episcopal Complex of the Euphrasian Basilica in the Historic Centre of Poreč
810	Historic City of Trogir
825	Archaeological Area and the Patriarchal Basilica of Aqui leia
826	Portovenere, Cinque Terre, and the Islands (Palmaria, Tino and Tinetto)
829	Archaeological Areas of Pompei, Herculaneum and Torre Annunziata
830	Costiera Amalfitana
842	Cilento and Vallo di Diano National Park with the Archeological Sites of Paestum and Velia, and the Certosa di Padula
875	Archaeological Ensemble of Tárraco
963	The Cathedral of St James in Šibenik
978	Old Town of Corfu
1018	Ephesus
1024	Late Baroque Towns of the Val di Noto (South -Eastern Sicily)
1042	Old City of Acre
1096	White City of Tel-Aviv --the Modern Movement
1200	Syracuse and the Rocky Necropolis of Pantalica
1211	Genoa: Le Strade Nuove and the system of the Palazzi dei Rolli
1220	Bahá'i Holy Places in Haifa and the Western Galilee
1240	Stari Grad Plain
1371	Cultural Landscape of the Serra de Tramuntana
1500	Gorham's Cave Complex
1533	Venetian Works of Defence between 15th and 17th centuries: Stato da Terra – western Stato da Mar

Figure 41 - Location of UNESCO cultural World Heritage sites in the Mediterranean low elevation coastal zone
(Source: Reimann et al. 2018)

Mediterranean also has a long history of highly diverse fisheries, contributing substantially to the economy, health and general well-being of the population.

2.2.4.1 Past and current changes: marine biodiversity and human activities are already affected

Increased water temperature has led to mass mortality events, especially in coralligenous habitats (Coma et al. 2009), but also in sponges and molluscs (Garrabou et al. 2009). Coralligenous assemblages bleach under warm temperature, because they expel the algae living in their tissues. The most dramatic events occurred during the summers of 1999 and 2003. Since 1999 mass mortality events for different species have been reported in the Mediterranean almost every year (Rivetti et al. 2014).

Seagrass is also vulnerable to seawater warming (Jordà, Marbà & Duarte, 2012) and heatwaves, with high risks of diversity loss, alterations in ecosystem structure and functioning (Chefaoui, Duarte & Serrão, 2018; Rilov, 2016) and a reduction in general plant fitness. The migration of tropical herbivores into Mediterranean seagrass meadows is expected to cause an increasing intensity of herbivores on seagrasses (Hyndes et al. 2016; Vergés et al. 2018).

species (Calvo et al. 2011) at the expense of cold-affinity species. This is well illustrated by the recent changes in the geographic distribution of many native species. Due to recent warming, Mediterranean warmth-loving fish species, like the blue runner *(Caranx crysos)*, the Mediterranean parrotfish *(Sparisoma cretense)*, the common dolphinfish *(Coryphaena hippurus)*, the grey triggerfish *(Balistes capriscus)* or the barracuda *(Sphyraena viridensis)* are all moving northwards (Azzurro, Moschella & Maynou, 2011). Over the last several decades, the extent and intensity of jellyfish outbreaks have increased, probably in part due to warming, in particular with outbreaks of *Pelagia noctiluca,* a planktonic predator of fish larvae and of their zooplankton prey (Licandro et al. 2010).

The effects of climate and environmental change are particularly serious in areas where range shifts of species are physically constrained such as in the Ligurian Sea, one of the coldest sectors of the Mediterranean (Parravicini et al. 2015). The replacement of species has been reported in Mediterranean submarine caves, which are confined biotopes. For endemic cave mysids *(Crustacea)*, cold-water stenothermal species *(Hemimysis speluncola)* are replaced by closely related species with warmer affinities *(Hemimysis margale)* (Chevaldonné & Lejeusne, 2003).

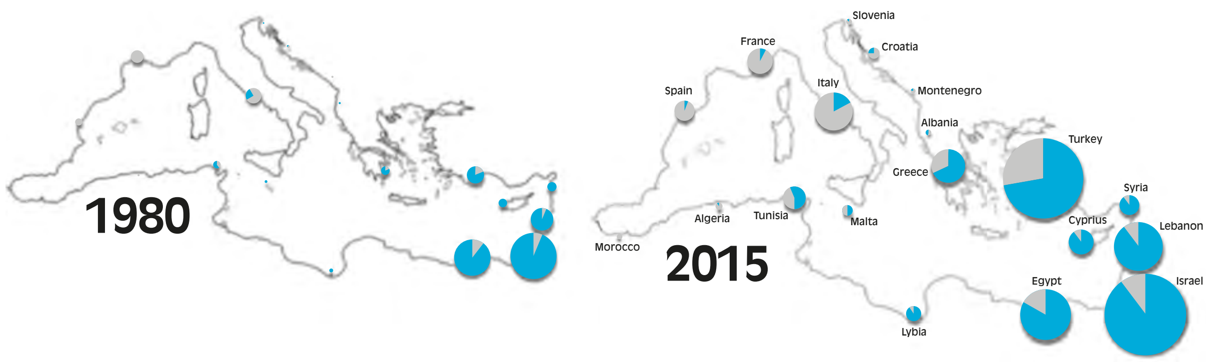


Figure 42 - Non-indigenous species (NIS) in the Mediterranean Sea: size of pie charts proportional to number of NIS in a country; proportion of Lessepsian species in blue
(Source: Galil, Marchini & Occhipinti-Ambrogi, 2018)

The 2003 heatwave resulted in large-scale mortality of the seagrass *Posidonia oceanica* during flowering (Díaz-Almela, Marbà & Duarte, 2007). Around 70% of habitat loss of *Posidonia oceanica* is projected by 2050 with a potential for functional extinction by 2100 (IPCC, 2019b). For *Cymodosea nodosa,* the seagrass species with the highest tolerance to relatively higher temperatures (Savva et al. 2018), warming is expected to lead to a reduction of meadows by around 46% in the Mediterranean by 2100, potentially partly compensated for by future expansion into the Atlantic (Chefaoui, Duarte & Serrão, 2018).

Ocean warming already influences marine native species causing a 'meridionalization'[26] of the biota, by favouring warm-affinity native species and the arrival of foreign

The spread of alien species represents another stress factor for marine ecosystems (Mannino, Balistreri & Deidun, 2017). More than 1000 non-indigenous marine plant and animal species have been recorded so far in the Mediterranean (UNEP/MAP, 2017), many of which are favoured by the warmer conditions (Azzurro, Moschella & Maynou, 2011; Marbà et al. 2015). Of these, more than 600 have established populations in the Mediterranean (Galil et al. 2018). The number of species in the Mediterranean coming from the Red Sea is rising, representing more than 50% of non-indigenous species in the Mediterranean *(Figure 42)*. The transport of alien species through corridors and ballast water from ships increases dissemination. The Eastern Mediterranean displays the most severe environmental effects of invasive species. Some tropical

[26] Meridionalization refers to a northward range expansion of marine native species due to warming.

invasive species have important consequences on ecosystems, such as the tropical rabbitfish *(Siganus spp)* devastating algal forests (Vergés et al. 2014).

Ocean acidification begins to impact a wide array of organisms producing carbonate shells and skeletons (Kapsenberg et al. 2017; Palmiéri et al. 2015). These effects are biological (e.g., early stage survival) as well as ecological (e.g., loss in biodiversity, changes in biomass and trophic complexity) (Gattuso et al. 2015). Recent acidification in the Mediterranean Sea has also led to a decrease in the thickness of coccoliths, calcareous plates harboured by some phytoplankton, between 1993 and 2005 (Meier et al. 2014). Overall, effects are highly species-dependent. At the community level, modifications in species composition and abundance shifting from assemblages dominated by but not limited to calcifying species to non-carbonated species (e.g., erect macroalgae) have been reported, even under moderate decrease in pH (Hall-Spencer et al. 2008; Kroeker et al. 2011; Linares et al. 2015).

2.2.4.2 Risks for the future: food webs are likely to be impacted

In coming decades, synergies between warming and acidification are likely to affect a large number of marine species including commercial species such as mussels (Rodrigues et al. 2015).

Generally, seawater warming is expected to lead to a shift in dominant species towards the smallest species (picophytoplankton and nanoflagellates) and a decrease in diatoms. Acidification may also result in a decrease in the biomass of calcifying plankton organisms such as coccolithophores (MerMex Group, 2011). The shifts in plankton composition will likely cause changes in the abundance of organisms feeding directly on plankton and then on all levels of the food web. Primary production of these organisms is critical to maintain biodiversity and support fishery catches in the world's oceans (Brown et al. 2010). Increasing water temperature provokes an increase in the proportion of small-sized species, young age classes and a decrease in size at age (Bergmann's rule). As a consequence, in the Mediterranean Sea, the average maximum body weight of fish is expected to shrink by 4 to 49% between 2000 and 2050 due to water warming and decreased oxygenation (Cheung et al. 2013).

Seawater acidification in the Mediterranean will have further negative impacts on many pelagic and benthic organisms with calcareous body parts, such as corals, echinoderms, mussels, pteropods, sponges, coccolithophores and foraminifers (Bramanti et al. 2013; CIESM, 2008; Dias et al. 2010; Goodwin et al. 2014; Martin et al. 2011; Meier et al. 2014) *(Figure 44)*. Observations made near natural, submarine CO_2 vents show that a decrease from pH 8.1 to 7.9 leads to a dramatic shift in highly diverse and structurally complex habitats. Forests of *Laminaria rodriguezii* kelp replace the otherwise dominant habitats (i.e., coralligenous assemblages and rhodolith beds), which are mainly characterized by calcifying organisms (Linares et al. 2015).

Marine storms, associated with strong winds, strong waves and currents, as well as heavy rains and flash floods, are known to damage marine and coastal ecosystems such as *Posidonia* meadows (Gera et al. 2014). The effects of marine storms decrease with depth and only affect the layers above 50 m. At least 20% of *Posidonia* meadows on sandy substrates at depths below 10 m are seriously damaged and destroyed (Sanchez-Vidal et al. 2012).

Some particular marine species are also threatened by sea level rise. This is the case for the calcified cushion-like red alga *Lithophyllum byssoides,* which forms algal rims highly resistant to waves and storms, but are dependent on a stable or only slightly rising sea level. Today, these algal rims have begun to be submerged and will be highly threatened in the future (Thibaut, Blanfuné & Verlaque, 2013). Research also suggests a loss of 59% and 67% of nesting areas for the Mediterranean green turtle *(Chelonia mydas)* and the loggerhead turtle *(Caretta caretta)* respectively under a 1.2 m sea level rise (Varela et al. 2019).

Surface water warming in the Mediterranean and the consequent increase of water column stability may favour the transformation of marine snow (small amorphous aggregates with colloidal properties) into marine mucilage, large marine aggregates representing an ephemeral and extreme habitat (Danovaro et al. 2009). Three algae (*Nematochrysopsis marina, Chrysonephos lewisii* and *Acinetospora crinita*) constitute the principal components of the mucilaginous aggregate in the Mediterranean. The production of mucilage by other species, such as *Gonyaulax fragilis* as well as *Cylindrotheca closterium,* and *Cylindrotheca*

BOX 9

Aquaculture losses due to water warming in the Thau lagoon, France, 2018

In August 2018, unusually high water temperatures over an extended period (exceeding 29°C over eight days) combined with no wind led to radically reduced oxygen levels (anoxia) in the Thau lagoon close to Montpellier on the French Mediterranean coast. These climatic conditions led to high mortality of shellfish farmed in the lagoon, with mortality rates for oysters of between 30% and over 60% depending on the zone in the lagoon, and 100% for farmed mussels. Losses represented 2,703 tonnes of oysters, worth EUR 4.73 million, and 1,218 tonnes of mussels, worth EUR 1.22 million (Prefecture of the Hérault Department, France, 2018).

Shellfish aquaculture is one of the main economic activities in and around the Thau lagoon. It provides 10% of total French Pacific oyster *(Crassostrea gigas)* production, involves around 500 companies, and provides direct employment for about 1,700 people (Lane, Chatain & Roque d'Orbcastel., 2018). To adapt to the projected prolonged and more frequent heatwaves in the future, aquaculture in the Thau lagoon has to reinvent itself.

fusiformis has also been observed (Pistocchi et al. 2005). Mucilage is a threat to gorgonians (common names for a subset of this order are sea fans or sea whips), because they provide the best support for mucilage growth. Mucilage becomes entangled in projecting branches and necrotizes the coenenchyme below, leaving the axial skeleton bare. *C. lewisii* mainly affects the yellow gorgonian *(Eunicella cavolini)* and white gorgonian *(Eunicella singularis)* while *A. crinita* mainly affects the purple gorgonian (*Paramuricea clavate*), which colonizes greater depths (Giuliani et al. 2005).

Several species of toxic dinoflagellates (single-celled eukaryotes usually considered algae) are warm-affinity species. Their distribution range and abundance therefore increase with rising water temperature in the Mediterranean, like *Gymnodinium catenatum* (Gómez, 2003) or *Alexandrium catenella,* paralytic shellfish poisoning (PSP) toxin producers (Laabir et al. 2011), *Ostreopsis ovata, Prorocentrum lima* and *Coolia monotis. O. ovata* can form floating clusters at the seawater surface and releases marine aerosols, causing respiratory problems and irritations. To date, the most extensive health-related events have occurred in Italy (2005-2006), Spain (2004), Algeria (2009) and France (2006-2009) (Ben-Gharbia et al. 2016), presenting a risk not just for local populations but also for economic activities, such as tourism.

The introduction and spread of a pathogenic *Vibrio* might have been promoted by climate warming. Gorgonians were among the most affected species during recent disease outbreaks from infections with *Vibrio* in the north-western Mediterranean (Bally & Garrabou 2007, Vezzulli et al. 2010). In cases of temperature-induced disease in the starfish *Astropecten jonstoni* near the coast of Sardinia, Vibrio was associated with diseases of stressed marine invertebrates (Staehli et al. 2009).

The influence of climate change on fisheries depends on complex interactions between environmental factors, use of resources and economic drivers (Daw et al. 2009). Most fish stocks of commercial value are overexploited in the Mediterranean Sea, making the fisheries sector particularly vulnerable to further pressures. In many cases it is difficult to distinguish between the effect of excessive fishing and the impacts of climate change. Heatwaves and acidification potentially cause impacts on populations of less mobile species and on aquaculture. Such impacts could involve negative consequences on fisheries and aquaculture for some commercially important species of gastropods, bivalves and crustaceans. *Figure 45* shows the observed impact and risk scenarios of global ocean warming and acidification for important organisms and critical ecosystem services.

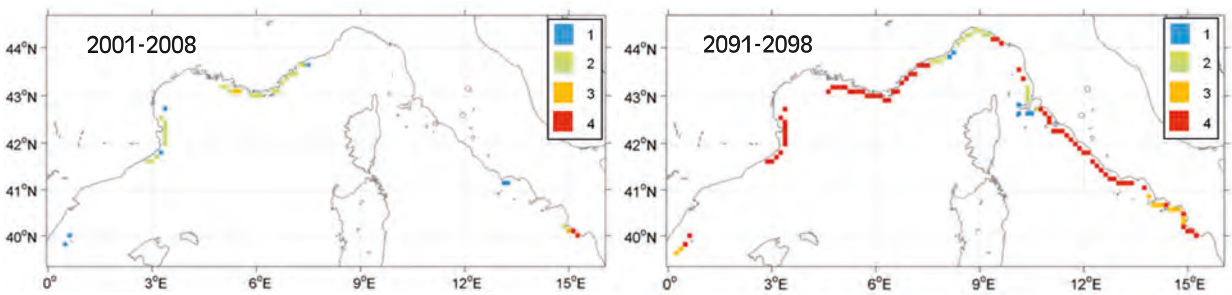


Figure 43 - Impact mapping on the risk of mortality outbreak for the purple gorgonian (Paramuricea clavata)
at the beginning (Top) and end (Bottom) of the 21st century along the continental coastal strip north of 39°N in the NW-Mediterranean Sea. The colour scale, from 1 to 4, corresponds to sub-lethal, moderate, high and extreme lethal impacts respectively
(Source: Bensoussan et al. 2013)

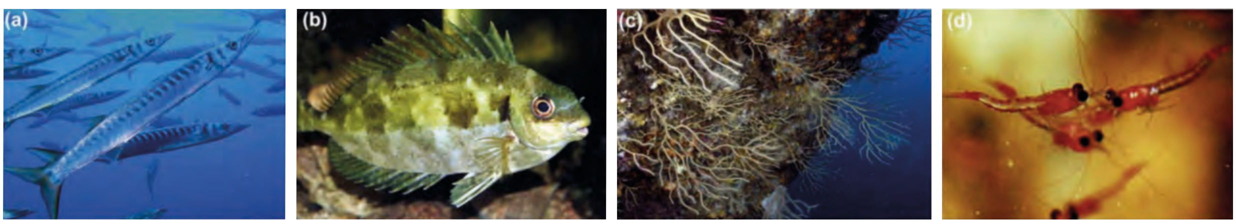


Figure 44 - Representative examples of marine species responding to climate change in the Mediterranean
(a) The natural distribution range of the Sphyraena viridensis *barracuda has increased greatly over the last 30 years; (b) the Lessepsian herbivorous rabbitfish* Siganus rivulatus *is affecting Eastern Mediterranean ecosystems, and its introduced range area is increasing. In 2008, it was found in the Gulf of Lions (Carry-le-Rouet, France); (c) a seascape of dead* Paramuricea clavata *sea fans after the 2003 thermal anomaly in the NWM; (d) the* Hemimysis spp. *crustacean mysids are a classic example of a species shift related to climate change.*
Photographs (reproduced with permission) by T. Pérez (a), J.G. Harmelin (b) and R. Graille (c, d) (Source: Lejeusne et al. 2010)

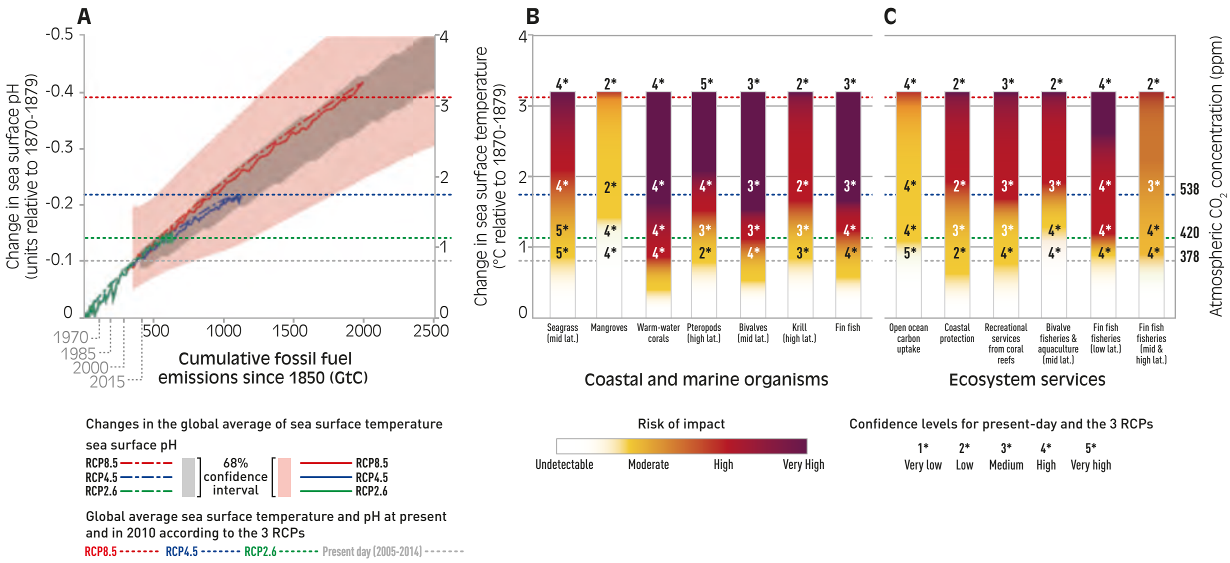


Figure 45 - Observed impact and risk scenarios of global ocean warming and acidification for important organisms and critical ecosystem services

"Present- day" (grey dotted line) corresponds to the period from 2005 to 2014. Impact levels are for the year 2100 under the different projections shown and do not take into account genetic adaptation, acclimatization, or human risk reduction strategies (mitigation and societal adaptation). (A) Changes in global average sea surface temperature and pH versus cumulative fossil fuel emissions. (B) Risk of impacts resulting from elevated CO₂ on key organisms that are well documented in the literature. (C) Risk of impacts resulting from elevated CO₂ on critical ecosystem services.

(Source: Gattuso et al. 2015; note that this study is at the global level, but its conclusions also apply to the Mediterranean Sea)

2.3 Responses: climate change mitigation policies

2.3.1 The existing global frameworks tackling climate change

2.3.1.1 UNFCCC: From the Kyoto Protocol to the Paris Agreement

The United Nations Framework Convention on Climate Change (UNFCCC) was adopted in 1992 and entered into force in 1994. It established a framework for global climate action, and its main goal is to "[stabilize] *greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system"* (Art. 2). To date, there are 197 Parties (196 States and the European Union) to the UNFCCC[27] (UNFCCC website). In 1995, international negotiations were launched to implement the Convention and strengthen global climate action. In 1997, industrial countries formally committed to reducing emissions under the Kyoto Protocol, with a first commitment period running from 2008 to 2012. In 2012, the Parties adopted the Doha Amendment to the Kyoto Protocol, launching a second commitment period (2013-2020). While the Doha Amendment constitutes the framework for increased ambitions before 2020, it has not yet entered into force.

The first climate agreement bringing together all Parties to the UNFCCC was adopted in 2015 (COP21, Paris). The main difference between the Kyoto Protocol and the Paris Agreement is a reversal of global climate governance dynamics. The Agreement is based on a principle of reality, advocating unified cooperation against climate change, as well as on the principle of common but differentiated responsibilities, and commits all countries to determining their own contributions for its implementation. To that extent, the Agreement requires the Parties to submit, upon ratification, their Nationally Determined Contributions (NDCs) - national climate action plans reflecting the countries' ambition for emissions reduction and adaptation to climate change, building upon their own circumstances and capabilities. Through the aggregate effect of the NDCs, the aim is to reach the long-term goal of the Agreement by 2100, i.e., maintaining the increase in global average temperatures to well below 2°C above pre-industrial levels, while pursuing efforts to limit it to 1.5°C (Art. 2).

In 2019, 85% of the Contracting Parties to the Barcelona Convention have already ratified the Paris Agreement (only Lebanon, Libya, and Turkey are yet to do so)[28], and all of these countries as well as the State of Palestine have submitted their first NDCs to the Secretariat of the UNFCCC[29].

[27] Status of ratification of the UNFCCC as accessed on the UNFCCC website in April 2019.
[28] Paris Agreement ratification status as per UNFCCC website consulted in October 2019.
[29] UNFCCC NDC online registry consulted in October 2019. Note: The European Union (EU) submitted its NDC on behalf of its member countries, which means that Cyprus, Croatia, Bosnia and Herzegovina, France, Greece, Italy, Malta, Slovenia, Spain and the EU have a single NDC.

BOX 10

Focus on the Paris Agreement

The Paris Agreement strengthens the global response to climate change in many ways. To reach its long-term temperature goal (Art. 2), it commits countries to achieving global peaking and 'climate neutrality' by the second half of the century (Art. 4), by mitigating greenhouse gas emissions (Art. 3) and conserving and enhancing sinks and reservoirs (Art. 5). It allows voluntary cooperation as well as market and non-market-based approaches (Art. 6). The Agreement also establishes a global goal on adaptation (Art. 7) as well as a specific article related to loss and damage (Art. 8). Other mechanisms and instruments relate to finance, technology and capacity-building support (Art. 9, 10 and 11), transparency (Art. 13), and implementation and compliance (Art. 15). The Paris Agreement constitutes the main framework for global climate action after 2020. Countries negotiated its guidelines from 2016 to 2018, which were then adopted at COP24 (Katowice, December 2018), to allow full implementation.

2.3.1.2 The Green Climate Fund (GCF) and climate finance

With the Paris Agreement, countries established the objective of making *'finance flows consistent with a pathway towards low greenhouse gas emissions and climate resilient development'* (Art. 2(c)). This goal builds on previous commitments to finance climate action, including the objective for developed countries to jointly provide USD 100 billion annually by 2020 for climate change mitigation and adaptation. The Paris Agreement thus commits developed countries to providing financial resources to assist developing countries in continuation of their existing obligations under the Convention, and encourages other countries to provide such support voluntarily (Art. 9). The three main UNFCCC financial mechanisms are the Green Climate Fund (GCF), the Global Environment Facility (GEF) and the Adaptation Fund (AF). In years to come, the GCF is intended to become the main UNFCCC financial mechanism. It was announced at COP15 (2009) and its first investments were made in 2015. 2016 was the GCF's first full year of operation, resulting in a portfolio of 35 projects for a total of USD 1.5 billion (ENERGIES 2050, 2018a). The GCF works through accredited entities and national designated authorities. Investments can take the form of grants, and loans and must be equitably distributed between mitigation and adaptation. To date[30], the GCF has validated 111 projects, for 310 million beneficiaries and 1.5 billion tons of CO_2 equivalent avoided. By target, the funding amounts are shared between mitigation (39%), adaptation (25%) and cross-cutting (36%) issues.

Climate finance is critical for ambitious climate action, particularly within Southern Mediterranean countries. A 2018 study by the European Investment Bank (EIB) estimated the overall financial needs over the next 10 years for these countries at USD 250 billion (EIB, in ENERGIES 2050, 2018a). A European Commission report released at COP 23 (2017) showed that UNFCCC's financial mechanisms approved USD 252 million of funding in 2016 in Mediterranean countries. Most came from the GCF (USD 192 million), followed by the GEF (USD 49.97 million), the AF (USD 9.23 million) and other financial mechanisms such as the Clean Technology Fund (CTF) and the Forest Investment Partnership (FIP). The report also states that this USD 252 million only represented 5% of the total funds approved the same year for climate-related projects and programmes in these countries (European Commission, in ENERGIES 2050, 2018a). In conclusion, climate finance needs to be scaled up to address countries' needs and strengthen unified climate action towards Paris Agreement implementation over coming years.

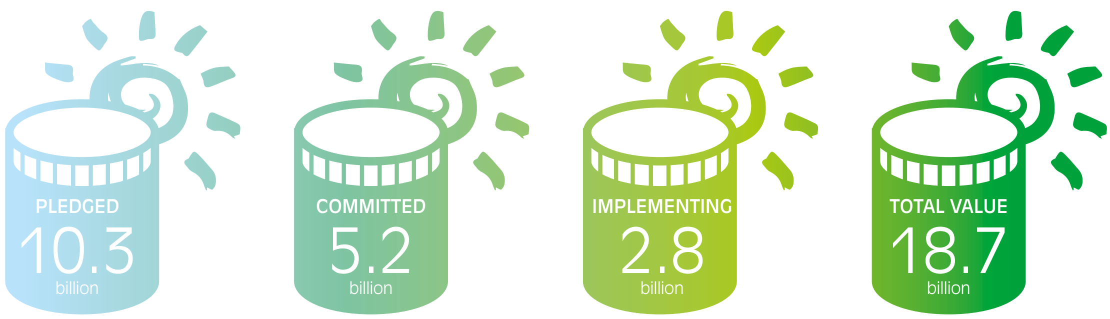


Figure 46 - GCF Portfolio, October 2019
(Source: Green Climate Fund online dashboard, 2019)

[30] Green Climate Fund portfolio dashboard consulted in October 2019).

2.3.2 Regional responses to climate change mitigation

The Mediterranean region has been at the heart of the International Climate Agenda since 2015. Two Mediterranean countries - France and Morocco - organized COP21 and COP22. Marseille and Tangier have hosted major conventions for climate action in the Mediterranean, including stakeholders from non-governmental organizations and subnational governments, with MedCOP21 held in Marseille in June 2015 and MedCOP Climate in July 2016 in Tangier. The MedCOPs allowed Mediterranean countries to join forces and improve coordination in preparing for the Conferences of the Parties to the UNFCCC. They led to other initiatives, such as the creation of the Mediterranean Climate House in Tangier, which held its first meetings in December 2017. Such events provided, and continue to provide, opportunities to consider national and regional specificities and realities in the Mediterranean to help develop a shared, inclusive and participatory action strategy (ENERGIES 2050, 2018a). At the same time, regional organizations are fostering cooperation between Mediterranean countries on climate change adaptation and/or mitigation policies. These include the Union for the Mediterranean (UfM) with its Climate Change Expert Group, and the United Nations Environment Programme/ Mediterranean Action Plan (UNEP/MAP) - Barcelona Convention system which adopted the Regional Climate Change Adaptation Framework for the Mediterranean Marine and Coastal Areas (2016). Significant efforts have also been made to bring together and mobilize scientists with the creation of the network of Mediterranean Experts on Climate and Environmental Change (MedECC), which is preparing its first report on the current state and risks of climate and environmental changes in the Mediterranean, to be published in 2020. This network was a proposition of the Agenda of Solutions of the Marseille MedCOP. Close collaboration between this network, UfM and UNEP/MAP has created an important science policy interface.

2.3.3 National responses to climate change mitigation

2.3.3.1 Nationally determined contributions (NDCs)

The NDCs are at the heart of the Paris Agreement. They constitute the global response to climate change (Art. 3) and all Parties are to undertake and communicate ambitious efforts as defined in Articles 4 (mitigation), 7 (adaptation), 9 (finance), 10 (technology), 11 (capacity building) and 13 (transparency). NDCs are submitted by the Parties to the Paris Agreement upon ratification, and represent a progression over time in order to achieve the Agreement's long-term goals, while recognizing the need to support developing countries for effective implementation (Art. 3).

By 2019, 18 Parties to the Barcelona Convention have submitted their NDCs, and all of them contain a mitigation component, aiming to limit or reduce greenhouse gas emissions through (ENERGIES 2050, 2018b):

- an absolute emissions reduction target (11 NDCs: Cyprus, Croatia, France, Greece, Italy, Malta, Montenegro, Monaco, Slovenia, Spain and the EU);
- a derivation from a business-as-usual (BAU) scenario (4 NDCs: Albania, Algeria, Bosnia and Herzegovina and Morocco);
- a carbon intensity reduction target (2 NDCs: Tunisia and Israel);
- the introduction of mitigation policies and measures (1 NDC: Egypt).

Analysis of the Mediterranean countries' NDCs (ENERGIES 2050, 2018b) shows that a range of sectors and domains are targeted by priority policies and measures). Measures include for example the use of market mechanisms, the development of monitoring tools, links with the United Nations' sustainable development goals (SDGs) or other international conventions (e.g., the 1992 Rio Conventions), etc.

BOX 11

Providing knowledge on Climate Change through a science policy interface, the case of the MedECC

Gathering, updating and consolidating the best available scientific knowledge about climate and environmental changes in the Mediterranean basin and rendering it accessible to policymakers, key stakeholders and citizens, are the main objectives of the network of Mediterranean Experts on Climate and environmental Change (MedECC). MedECC was launched during a side event organized at the 'Our Common Future under Climate Change' (CFCC) conference in Paris, (France) in July 2015 and has since evolved into an open and independent network of more than 600 scientists working towards a regional science policy interface. Through its reports, developed with key stakeholders, MedECC aims to contribute to the improvement of sustainability policies across the Mediterranean Basin. MedECC's work is fully focused on the highest possible scientific standards, with full participation of experts from all Mediterranean regions and relevant scientific disciplines. It is inspired by the Intergovernmental Panel on Climate Change (IPCC), which aims to provide the world with an objective, scientific view of climate change and its political and economic impacts.

The Secretariat of the Union for the Mediterranean (UfM) and Plan Bleu (UNEP/MAP Regional Activity Centre) jointly support MedECC and rely on the network for the assessment of climate and environmental impacts on the Mediterranean. Synergies with other policy dialogue structures are developed, especially with the UNEP/MAP - Barcelona Convention system via the Mediterranean Commission on Sustainable Development (MCSD) and Plan Bleu Focal Points.

Sectors	AL	BA	CY	DZ	EG	ES	FR	GR	HR	IL	IT	LB	LY	MA	MC	ME	MT	PS	SI	SY	TN	TR	Nb of parties
Energy efficiency		X		X	X					X				X	X	X					X		8
• Construction		X		X										X	X						X		
• Industry					X									X							X		
• Agriculture					X																X		
• Transport														X							X		
• Tourism														X									
Renewable energy		X		X	X					X				X	X	X					X		8
Industry		X		X	X					X				X		X					X		7
Transport	X			X	X					X				X	X								6
Waste management		X		X	X									X	X						X		6
Urban dev.		X		X	X					X				X	X								6
Agriculture			X		X	X	X	X	X		X			X			X		X		X		11
Forestry		X	X	X		X	X	X	X		X			X			X		X		X		12
Other sectors	X	X		X	X									X	X		X				X		8

Table 3 - Overview of the mitigation policies and measures indicated in the NDCs of the Parties to the Barcelona Convention by sector

Parties to the Barcelona Convention that have indicated policies and measures in this sector within their NDCs.

(Source: adapted from ENERGIES 2050, 2018b)

BOX 12

The French High Council for Climate and its first annual report

(Source: Fontan et al. 2019)

The French High Council for Climate was created by decree in May 2019. Its objective is to provide an independent opinion and recommendations concerning the implementation of public policies and measures to reduce greenhouse gas emissions in France, in line with the country's international commitments and in particular the Paris Agreement and the country's aim to reach carbon neutrality by 2050. The Council is asked to provide neutral information on the French government's actions and associated socioeconomic and environmental impacts. The Council is currently composed of eleven members, appointed for five years and chosen for their scientific, technical and economic expertise in the field of climate science.

In its first annual report, the High Council for Climate states that current efforts made by France are not sufficient to achieve the set objective of carbon neutrality by 2050, especially in the building/housing and transport sectors. The report compares EUR 75 billion of public and private investments that are "unfavourable for the climate" with EUR 41 billion of investments that are "climate-friendly" in the period 2015-2018. The seven main recommendations stemming from the report are as follows:

1. **Ensure the compatibility of laws and major national projects with a low-carbon national strategy**, because major projects or laws (e.g., laws on mobility, housing, spatial planning or taxation) do not sufficiently take into account greenhouse gas emission reduction targets.
2. **Strengthen climate policy instruments** (including standards, environmental taxes, subsidies, public investment, carbon market and information instruments), because current climate policy instruments are insufficient to reach the targets.
3. **Identify and implement the necessary transformative changes to prepare the French economy and society for carbon neutrality** (acting on the development of cities and countryside, developing and financing new infrastructure, particularly for transportation, and strengthening education on the low-carbon transition to change production and consumption patterns), because the profound transformations needed are not yet underway.
4. **Ensure a just transition** (fair distribution of costs, efforts and benefits between households, businesses, local authorities and the State), because the social and economic implications of emission reduction measures are currently not sufficiently taken into account.
5. **Coordinate the national low-carbon strategy at all levels: from local level to the international level,** because there is a lack of consistency between local, national and European policies.
6. **Systematically assess the greenhouse gas emission impact of policies and measures,** because the potential or actual greenhouse gas emission impact of policies and measures is not known.
7. **Strengthen the draft national low-carbon strategy** (to also cover international transport and carbon imports and to make it the reference point for all public and private investments), because it does not currently cover all consumption-related emissions and is not at the centre of public action.

2.3.3.2 Using market-based instruments and funding mechanisms

Among other provisions, Article 6 of the Paris Agreement recognizes the importance of "market-based approaches" (Art. 6, para. 8) (OIF/IFDD, 2018). Five Contracting Parties to the Barcelona Convention (Albania, Egypt, Montenegro, Morocco and Tunisia) indicated in their NDCs that they would use the Article 6 mechanism or other market-based mechanisms to implement their mitigation targets. If not indicated, market mechanisms could nonetheless be of a substantial use for other Parties, such as the European Union and its Member States. To achieve the EU's overall greenhouse gas emissions reduction target for 2030, the EU revised its Emissions Trading System (EU ETS), through Directive (EU) 2018/410, which entered into force in April 2018. The revised Directive aims, in the period 2021-2030, to reduce emissions by 43% compared to 2005 levels in the sectors covered by the EU ETS through a mix of interlinked measures (European Commission, 2019).

Climate financial mechanisms will be crucial for the implementation of a number of NDCs, particularly for developing countries. In the Mediterranean, Algeria, Egypt, Morocco and Tunisia indicated that they would need financial support for a full implementation of their NDCs (ENERGIES 2050, 2018b). For example, Egypt assessed the initial costs of mitigation and adaptation measures at USD 73 billion. Morocco indicated that USD 50 billion would be necessary to implement their mitigation targets, of which USD 24 billion to be mobilized through international finance. Finally, Tunisia estimated needs at USD 18 billion for mitigation activities.

2.3.3.3 Technology development

Article 10 of the Paris Agreement aims to strengthen cooperative action on technology development and transfer to improve resilience to climate change and reduce greenhouse gas emissions. It establishes a technology framework to support the implementation of the Agreement. Along with finance and capacity building, technology will be crucial for reaching NDC targets. Many Parties to the Barcelona Convention have indicated policies and measures that would require technology developments in various sectors and fields. Examples of detailed measures are the replacement of existing thermal power plants with 30% average efficiency with new plants with approximately 40% average efficiency (Bosnia and Herzegovina); or the use of advanced locally appropriate and more efficient fossil fuel technologies, in addition to new generations of nuclear power (Egypt).

As indicated in their NDCs, technology developments will be decisive in various other sectors, e.g.:

- Renewable energy: By 2030, reach a 27% share of renewable energy in electricity generation through the deployment of photovoltaic and wind power as well as thermal solar energy, along with the integration of cogeneration, biomass and geothermal energy (Algeria);
- Industry: By 2030, construct co-generation plants fuelled by wood chips and wood waste from the wood processing industry, with a total power generation capacity of 70 MW (Bosnia and Herzegovina);
- Transport: 20% shift from private to public transportation (Israel);

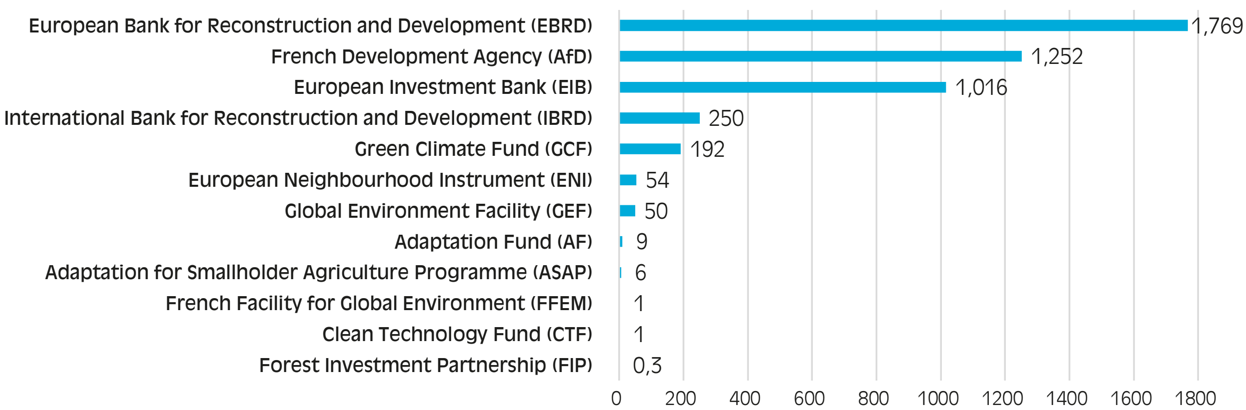


Figure 47 - Climate finance from non-state actors in the Mediterranean region in million USD, 2018
(Source: ENERGIES 2050, 2018c)

Non-state players, including companies, cities, subnational regions, investors and civil society organizations, can play a significant role in climate change mitigation. UNFCCC understood that addressing climate change will take ambitious and systemic action by all sectors of society, both public and private, and launched the Global Climate Action (NAZCA) portal in 2014. The portal allows non-state stakeholders to display their climate ambition and commitments.

- Waste management: By 2020, establish landfill and recycling centres for domestic waste to benefit all urban areas (Morocco);
- Urban development: By 2030, reach an overall urban sewerage connection rate of 100% (Morocco).

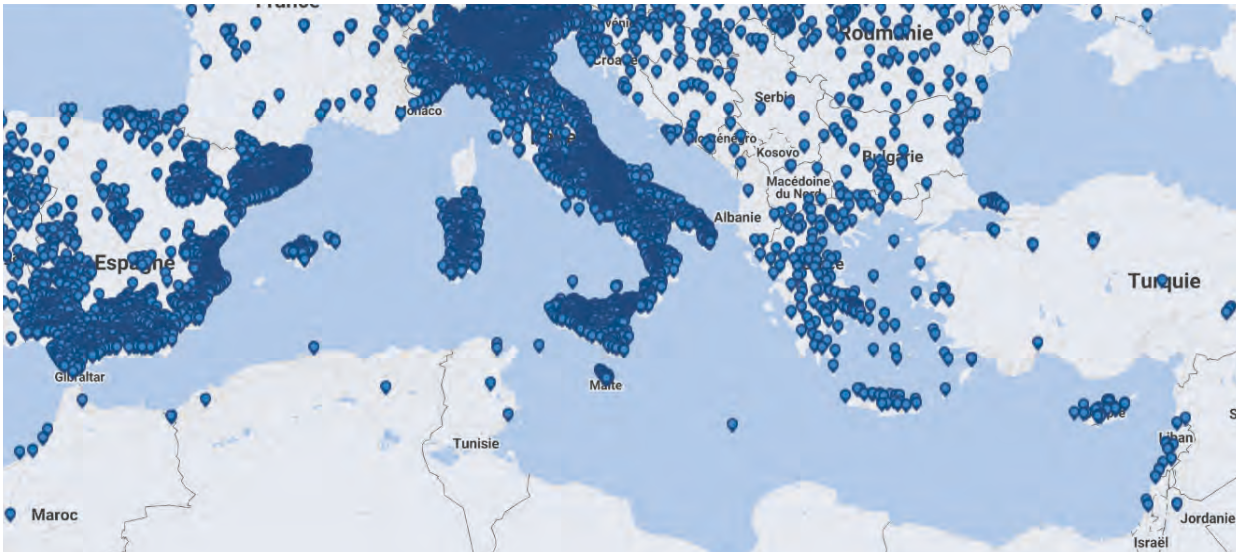


Figure 48 - Climate action taken by non-state actors in Mediterranean countries
registered on the UNFCCC NAZCA database, (UNFCCC NAZCA database interactive map consulted on 6 August 2019; this database is not necessarily representative of all actions taken and only shows actions that have been registered)

2.3.3.4 Local ecosystem-based approach and Nature-based Solutions

The Paris Agreement highlights the importance of an ecosystem-based approach and Nature-based Solutions to reach its long-term temperature goal. It commits Parties to achieving a balance between anthropogenic emissions by sources and removals through carbon sinks in the second half of this century (Art. 4.1), and to take action to conserve and enhance, as appropriate, sinks and reservoirs of greenhouse gas, including forests (Art. 5). The Paris Agreement also strengthened REDD+ (OIF/IFDD, 2018). Another major step was achieved at UNFCCC COP23 (Fiji/Bonn, November 2017), where Parties adopted a landmark agreement on agriculture: the Koronivia Joint Work on Agriculture (KJWA)[31]. The KJWA roadmap to 2020 addresses subjects such as: improved soil carbon, soil health and soil fertility as well as integrated systems, including water management; improved nutrient use and manure management towards sustainable and resilient agricultural systems; improved livestock management systems; etc. (OIF/IFDD, 2018).

In their NDCs, the Contracting Parties to the Barcelona Convention also show how important ecosystem-based approaches and Nature-based Solutions are to achieving their mitigation goals. Twelve Parties indicated policies and measures in the Agricultural sector and 13 in the Forestry sector. For both sectors, the EU and its Member States only indicated in their NDC that a *"Policy on how to include Land Use, Land Use Change and Forestry in the 2030 greenhouse gas mitigation framework will be established as soon as technical conditions allow and in any case before 2020"*. Other Parties detailed mitigation measures, with some examples highlighted in *Table 4*.

2.3.3.5 Public participation, awareness, education, and information systems

Article 12 of the Paris Agreement indicates that "Parties shall cooperate in taking measures, as appropriate, to enhance climate change education, training, public awareness, public participation and public access to information, recognizing the importance of these steps with respect to enhancing

Sectors	Examples of policies and measures
Agriculture	Mitigation measures on enteric fermentation; manure management; rice cultivation; agricultural soils; field burning of agricultural residues (Algeria); Improved use of natural resources and their sustainable management (Morocco); Low emissions practices, e.g., optimizing the diets of domestic animals, promoting biological agriculture or conservation-oriented agricultural practices (Tunisia).
Forestry	Reforestation of 1,245,000 ha (Algeria); Maintain the forest sequestration capacity (app. 6,470 GgCO_2 in 2015) (Bosnia and Herzegovina); Planting of 447,000 hectares of olive trees in areas that are unfit for year-round crops to limit soil erosion and improve small farmers' income (Morocco); Intensify the CO_2 absorption capacities of forestry and arboriculture by stepping up reforestation and consolidating and increasing carbon reserves in forest and pastoral environments (Tunisia).

Table 4 - Example of policies and measures for agriculture and forestry sectors indicated in the NDCs of the Parties to the Barcelona Convention

[31] Decision 4/CP.23

actions under this Agreement". For example, the Algerian NDCs indicate the implementation of information, awareness and communication actions on issues and climate change challenges and implementation of a national climate change programme for education, training and research.

2.3.4 Priorities for action

Urgent action is required worldwide to mitigate climate change. Although Mediterranean countries are not the highest CO_2 emitters in the world, they have the potential to contribute to global mitigation efforts. In this sense, urgent and systemic mainstreaming of climate change mitigation into planning at all levels, into all economic sectors including the financial sector, education systems and research will be key. To achieve the objectives of the Paris Agreement, the Agreement needs to be further applied and operationalized at regional, national and local levels, by taking into account the notion of carbon budget.

2.4 Responses: adaptation to climate change - a necessary anticipation

2.4.1 The Regional Climate Change Adaptation Framework for the Mediterranean Marine and Coastal Zones

The overall risks of climate change impacts can be reduced through mitigation, i.e. by limiting the rate and magnitude of climate change. Under all mitigation scenarios, risks from adverse climate impacts remain. Anticipation of and adaptation to a wide range of climate-related risks are therefore essential. To improve the overall resilience of the

Objectives	Areas	Measures and Results
Objective 1: Promoting action by Member States	Adoption of action plans in each Member State	In 2017, 25 Member States had adopted national adaptation strategies (European Environment Agency, 2018).
	Governance	Improved coordination/cooperation through meetings of the working group on adaptation (each Member State has appointed a focal point).
	Monitoring	Creation of a dashboard for adaptation in 2015 - performance indicators to assess the resilience of Member States and adapt policies.
		Member States report climate actions under the European monitoring and reporting system - information included in the country profile pages of Climate-ADAPT.
	Evaluation	2017-2018 Evaluation of EU Strategy on adaptation, Report from the Commission to the European Parliament and the Council on the implementation of the EU Strategy on adaptation to climate change, and information by country.
	Local actions	Monitoring and implementation of Mayors Adapt and the new Covenant of Mayors in 2015.
	Funding	Financial Instrument - LIFE Programme.
Objective 2: Better informed decision-making	Climate-ADAPT	European climate adaptation platform, providing access to information on adaptation. Links with Covenant of Mayors and other platforms.
	Horizon 2020	Fund dedicated to research and innovation - 35% of funds allocated to climate-related research - Research of the Joint Research Centre (JRC).
	Copernicus Climate Change Service	EU programme on climate analysis and observation to support adaptation policies.
Objective 3: Promoting adaptation in key sectors	Budget	At least 20% (up to EUR 80 billion) of the multiannual European financial framework allocated to climate action. Over EUR 114 billion received for climate actions from European structural and investment funds, including EUR 56 billion from the European Agricultural Fund for Rural Development and EUR 55 billion from the European Regional Development Fund and Cohesion Fund.
	Water Framework Directive	Presentation before 2015 of river basin management plans by each Member State, including the climate issue. Floods Directive requires that Member States conduct risk assessments and implement prevention/protection plans.
	Common Agricultural Policy	Incorporates the climate issue by rewarding sustainable practices; imposing environmental targets, promoting environmental action on the part of Member States and supporting a climate-resilient economy.
	Other directives	EU Forest Strategy. EU Biodiversity Strategy to 2020. EU Green Infrastructure Strategy. EU Environment Action Programmes.

Table 5 - European Policy on adaptation.
(Source: European Environment Agency, 2016)

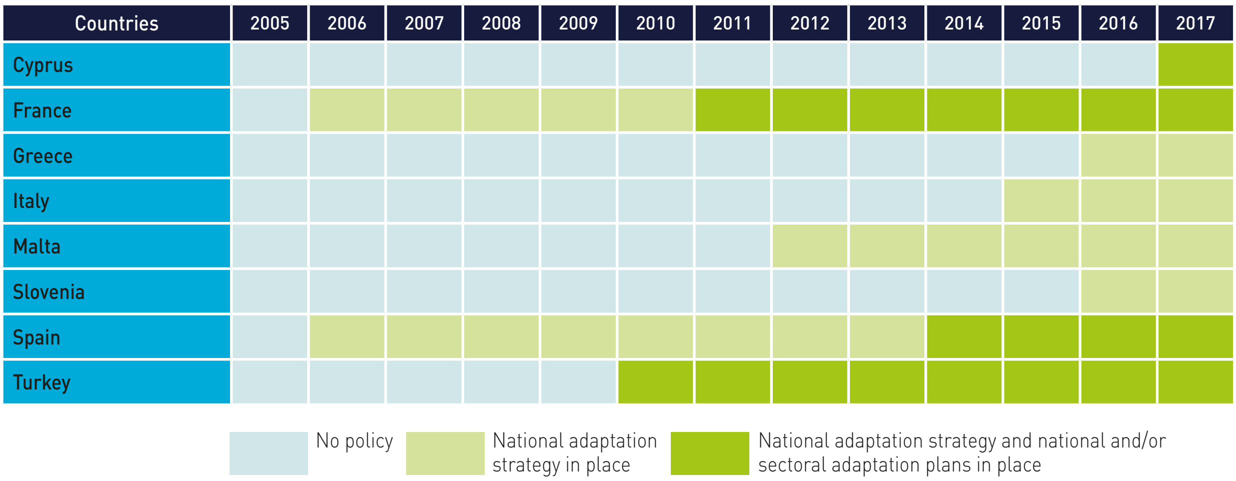


Table 6 - Adoption of climate change adaptation strategies and plans in Mediterranean countries in the EU and Turkey
(Source: ENERGIES 2050, Institut de la Mediterranée & FEMISE (2018) based on European Environment Agency)

Algeria	Plans to develop a national adaptation plan in a number of sectors (ecosystems, agriculture, health, water management, etc.).
Egypt	Adaptation measures for coastal areas, water resources and irrigation, agriculture, health, tourism and energy.
Israel	Final stages of developing the adaptation plan.
Lebanon	Sustainable development strategy under development which underscores adaptation. Actions intended for biodiversity, forests and agriculture, water.
Morocco	Integrated multisector strategy. Morocco has allocated 64% of its climate budget to adaptation. Needs estimated at USD 35 billion.
State of Palestine	National adaptation plan in all sectors (energy, agriculture, etc.) with a detailed cost assessment.
Tunisia	USD 1.9 billion required to finance adaptation for water and coastal areas, ecosystems, agriculture and tourism.

Table 7 - Adaptation in INDCs/NDCs in Southern and Eastern Mediterranean countries
(Source: ENERGIES 2050, Institut de la Méditerranée & FEMISE, 2018)

Mediterranean marine and coastal zone in particular, short-term and reactive local emergency measures are insufficient and costly. Building environmental and socioeconomic resilience at the regional level requires proactive, long term and integrated planning, and needs to address existing aspects of unsustainable development as drivers of vulnerability. As climate risks extend well past territorial boundaries, a cross-border collaborative and coordinated regional approach to adaptation is required, promoting synergies with other initiatives and agreements.
In this context, the Regional Climate Change Adaptation Framework for the Mediterranean Marine and Coastal Zones was endorsed by the Contracting Parties to the Barcelona Convention at their COP19 in Athens, Greece, 2016. The Framework aims to define a regional strategic approach to increasing the resilience of the Mediterranean marine and coastal natural and socioeconomic systems to the impacts of climate change, and to assist policy makers and stakeholders across the Mediterranean in the development and implementation of coherent and effective policies and measures. The development of the Framework was guided by a vision for the marine and coastal areas of Mediterranean countries and their communities to have increased their resilience to the adverse impacts of climate variability and change, in the context of sustainable development, by 2025. Common objectives, cooperation, solidarity, equity and participatory governance are key to achieving this aim.

2.4.2 National adaptation responses

Adaptation in Northern Mediterranean countries: recent yet active European commitment.

Climate change adaptation was taken into account in Europe much later than mitigation (ENERGIES 2050, Institut de la Mediterranée & FEMISE, 2018). Work began in 2007 and eventually led to a white paper in 2009, which became the basis for the European Union adopting its first strategy for adaptation to climate change in 2013).

This strategy is meant to complement and/or draw inspiration from the actions of Member States, some of which had already begun implementing formal adaption policies. Although the EU was considered somewhat behind in this field in the early 2000s, it is now relatively advanced. All EU

BOX 13

Examples of resilience actions: adaptation projects supported by UNDP

(Source: ENERGIES 2050, 2018c)

The United Nations Development Programme (UNDP) supports a number of actions in Southern Mediterranean countries to improve resilience to climate change.
Lebanon "Strengthening disaster risk management capacities in Lebanon" project:

- Assessment of the risks and technical and institutional capacities to improve disaster preparedness and raise public awareness;
- Establishment of a Disaster Risk Reduction and Management Unit, a national Disaster Risk Reduction (DRR) coordination centre under the authority of the Prime Minister;
- Establishment of the national emergency operations centre at a governate level and sectoral emergency response centres;
- Support for the National Council for Scientific Research of Lebanon through training and equipment;
- Public awareness campaign with the participation of government agencies and schools, including a campaign on the resilience of towns and cities in 300 municipalities.

In Tunisia, the "Enhancing community resilience and human security of vulnerable communities in urban settings" project focuses on the assessment of urban risks, urban planning for DRR, technical capacity building and community preparedness. The project is funded by the United Nations Trust Fund for Human Security (UNTFHS).
In the State of Palestine, with the support of Iceland, the "Resilience Against Natural Disasters" project supported:

- a national institutional assessment to identify the main stakeholders affected by disaster and climate risk management;
- a national risk assessment to identify the main risks and vulnerable areas, towns/cities, infrastructure and populations;
- disaster preparedness, education and awareness;
- cross-border cooperation;
- integration of disaster and climate risk reduction in development and urban planning strategies;
- development of a national disaster management strategy focused on hydrometeorological and climate risks, such as floods, droughts and storms.

In Egypt, the aim of the "Adapting to risks of climate change associated with sea level rise in the Nile Delta through integrated coastal zone management" project is to improve Egypt's resilience and reduce its vulnerability to the effects of climate change by adopting an adaptation capacity approach for human and natural systems. The project has tested several low-cost dyke systems in order to protect the international coastal road crossing the Nile Delta from storms. The project also set up a national oceanographic observation system in order to assess water levels and the impacts of climate change. Training in coastal engineering, numerical modelling and dyke construction has also been organized.

Local projects
There have also been several local Euro-Mediterranean climate projects. The ENERGIES 2050, Institut de la Méditerranée & FEMISE (2018) report presents **ClimaSouth,** which supports climate change adaptation and mitigation in 9 Southern Mediterranean countries (Algeria, Egypt, Israel, Jordan, Lebanon, Libya, Morocco, State of Palestine and Tunisia). The project was launched in February 2013 under the European Neighbourhood Policy (ENP). It involves government technical and operational services responsible for developing policies, the UNFCCC national focal points, decision makers, local authorities and representatives from civil society.

Mediterranean countries have a national adaptation strategy or plan. A broad range of funding instruments also exist to finance adaptation in Europe (European Commission website, 2018)[32] and the 2014-2020 multiannual financial framework ensures that at least 20% of the European budget will be allocated to climate-related spending. This will be increased to 25% for the 2020-2025 budget (European Commission website, 2019).

Adaptation in Southern Mediterranean countries: focus on resilience

The Intended Nationally Determined Contributions (INDCs) and NDCs of Southern and Eastern Mediterranean countries all contain both mitigation and adaptation actions. These countries are facing particularly significant vulnerabilities due to their high exposure to climate change and lower adaptation capacities than in the North.

An overview of Mediterranean commitments in national climate plans under the Paris Agreement is provided in the boxes below. Algeria, Egypt, Israel, Morocco, and Tunisia have communicated policies and measures focused on the resilience of the sectors most vulnerable to climate change (e.g. agriculture, water, forestry, health, fisheries and aquaculture). Some countries have indicated that national adaptation plans are in the process of being prepared and finalized (Algeria, Israel).

2.4.3 Priorities for action

The Regional Climate Change Adaptation Framework for the Mediterranean Marine and Coastal Areas highlights four priority strategic objectives *(Table 8)* set out in fourteen strategic directions, which need to be urgently implemented as part of a systemic approach to increase the Mediterranean region's resilience to climate change.

The integration of Nature-based Solutions (NbS) into national climate change adaptation plans is a cross-cutting objective across Mediterranean countries. In 2019, Plan Bleu published a policy paper on the subject in collaboration with a network of partners with broad experience in promoting and implementing NbS (Plan Bleu, 2019). While the importance

[32] In particular, the Water Directive and Common Agricultural Policy include an important climate component.

BOX 14

Paris Agreement and intended adaptation measures

(Source: ENERGIES 2050, 2018c)

Theme	Egypt	Tunisia
Water resources	To adapt to decreasing water resources or increasing Nile flows: i. Increasing water storage capacity, ii. Improving irrigation and drainage systems, iii. Changing cropping patterns and farm irrigation systems, iv. Desalination, v. Increased use of deep groundwater reservoirs, vi. Promoting best practice for rationalizing water use and improving precipitation measurement networks.	Projects to transfer and reuse treated wastewater and to improve and secure the water supplies of large urban centres, especially Greater Tunis, Cap-bon and Sfax.
Agriculture	Improve the capacities of private and institutional stakeholders, particularly by disseminating best management practices for planting, harvesting and irrigation, and promoting the use of more crops that are more tolerant to heat. Improve research to create a long-term adaptation strategy.	Capacity-building and institutional development measures, including: i. Adapting irrigated crops in the central regions, ii. Adapting mixed farming-livestock production in vulnerable regions, iii. Updating the agricultural map, iv. Introducing a climate monitoring and early warning system, as well as an insurance mechanism against climatic hazards
Coastal areas	Capacity building of Egyptian society by enhancing national and local partnerships in managing risks related to climate change.	Rehabilitating coasts and preventing coastal erosion, redeveloping and displacing coastal industrial zones, rehabilitating and protecting existing infrastructure against the risks of climatic impacts and developing farms and aquaculture infrastructure.
Health	Study to identify health risks resulting from climate change and raise community awareness.	Capacity-building and institutional support: i. Risk assessment and prevention of a proliferation of respiratory pathologies; ii. Introduction of a network to monitor the main vector-borne diseases; iii. Strengthening of the entomological monitoring network and efforts to fight mosquitoes and sand flies; iv. Programme to adapt the healthcare system to climate change, especially through protection against water-borne diseases (training for medical staff, etc.); v. Communication strategy for raising awareness about health risks related to climate change.
Ecosystems		i. Rehabilitation of forest nurseries and the expansion of indigenous and multi-use species; ii. Holistic management of cork oak forests in high-risk zones in the north-west of the country; iii. Management of the degraded rough grazing and esparto areas in the central and southern regions; iv. Conservation of the ecological functions of low-lying coastal areas; v. Integrated development of vulnerable drainage basins, sub-drainage basins and flood control; vi. Biological consolidation of work to combat silting in the south of Tunisia and support the implementation of regional action plans to counter desertification.
Tourism		i. Restoration of the Tunisian touristic sea coast and protection of tourist areas against the advance of the sea; ii. Definition of climatic and touristic regions and adaptation of the division of ecotouristic circuits; iii. Development of a range of services that are at once alternative and complementary to seaside tourism, particularly in terms of health, culture, sport and the environment; iv. Launch and promotion of the concept of ecological hotels; v. Optimization of the management of water resources by the tourist sector and installation of mini seawater desalination plants using renewable energies.

of NbS is largely recognized, in particular for the co-benefits they provide, their implementation faces several bottlenecks including: a higher level of uncertainty than human-made infrastructure in particular for approaches highly dependent on the local context or not fully tested; complex bureaucratic processes to obtain necessary permits; lack of technical guidance to prepare projects or review applications; sometimes significant land requirements in a context of complex land tenure situations or high pressure on land; difficulty in obtaining funding for often relatively small investments; ; management costs not always offset by monetary revenues. The paper outlined the following key policy recommendations:

i. *"Within the framework of the Barcelona Convention, develop a strategy to fully integrate NbS into national policies across sectors so as to significantly enhance countries' climate resilience by 2030.*
ii. *In particular, mainstream NbS into national plans for climate mitigation and adaptation, such as the NDCs (Nationally Determined Contributions) and National Adaptation Plans required under the Paris Agreement, and DRR (Disaster Risk Reduction) plans under the Sendai Framework.*
iii. *Foster "Green City" schemes throughout the region to improve citizens' resilience to heatwaves, flood surges and coastal erosion, and possible water and food shortages.*
iv. *Promote sustainable and biodiversity-friendly practices and initiatives in the field of agriculture and aquaculture, such as agroecology, local integrated nature-based production systems and sustainable fisheries to secure food security, rural and coastal livelihoods and employment opportunities.*
v. *Manage coastal and marine ecosystems, including wetlands, in a sustainable manner to enhance their capacity as carbon sinks and buffers, restore depleted fish stocks and protect marine biodiversity.*
vi. *Overall, implement adequate institutional structures, economic incentives and land tenure instruments to facilitate the uptake and implementation of NbS and overcome existing obstacles to their implementation with a view to moving towards a blue-green and circular economy and ensure society's long-term resilience."*

Strategic Objectives	Strategic Directions
Appropriate institutional and policy frameworks, increased awareness and stakeholder engagement, and enhanced capacity building and cooperation	Enhancing awareness and engagement of key stakeholders on climate adaptation.
	Promoting adequate institutional and policy frameworks.
	Promoting a regional approach on Disaster Risk Management.
	Improving implementation and effectiveness of adaptation policies through monitoring and reviewing progress.
	Integrating climate adaptation into local plans for the protection and management of areas of special interest.
Development of best practices (including low regret measures) for effective and sustainable adaptation to climate change impacts	Identifying adaptation needs and best practices.
	Mainstreaming, exchanging and adopting best practices.
Access to existing and emerging finance mechanisms relevant to climate change adaptation, including international and domestic instruments	Prioritizing public spending relative to climate adaptation and mobilizing national sources of climate finance.
	Accessing international financing.
	Building alliances with the banking and insurance sectors.
Better informed decision-making through research and scientific cooperation and availability and use of reliable data, information and tools	Understanding of the vulnerability of natural and socioeconomic systems and sectors and of possible impacts.
	Building capacities and promoting the use of vulnerability and risk assessment at regional to local levels.
	Strengthening Science policy interface and accessibility of related knowledge.
	Developing Regional climate information at a resolution suitable for adaptation planning.

Table 8 - Strategic Objectives and Directions for climate change adaptation in Mediterranean Marine and Coastal Areas
(Source: Regional Climate Change Adaptation Framework for the Mediterranean Marine and Coastal Areas, 2017)

3. Biodiversity and ecosystem services

Mediterranean Coastal and marine ecosystems have a high level of biodiversity and endemism. The Mediterranean Sea is considered a biodiversity hotspot, representing just 0.3% of the global ocean volume while hosting 7% of identified global marine species, with the highest rate of endemism (20-30%) of marine species in the world.

Driven by human activities in recent decades, Mediterranean biodiversity has experienced increasing human-induced pressures such as pollution, the overexploitation of biological resources, land-use change and coastal infrastructure development, changes in fluvial dynamics, increasing sea use and climate change effects. These pressures have reduced the extent of wild areas and natural ecosystems on land and at sea, and have altered the ecosystems' capacity to provide ecosystem services that are vital to humans. Around 11% of marine species and 14% of coastal terrestrial species are threatened with extinction, most of which are endemic. Non-indigenous species are increasingly present in the Mediterranean Sea, with a total of more than 1,000 non-indigenous marine species recorded, of which more than 100 are invasive.

United Nations Environment Programme/Mediterranean Action Plan (UNEP/MAP) has made biodiversity one of the main pillars of its Ecosystem Approach, with the aim of achieving Good Environmental Status (GES) of the Mediterranean Sea and supporting the development of effective action to safeguard and restore biodiversity. Such action must be undertaken urgently to avoid irreversible losses in terms of ecosystem services and biodiversity. One measure that has been proven effective, if implemented correctly, consists in setting up Marine Protected Areas (MPAs). MPA coverage has increased throughout the past decade, and is close to the 10% coverage set as a 2020 objective in the Aichi Targets. However, management effectiveness and enforcement remain challenging.

3.1 Introduction

Over recent decades, human activities in the Mediterranean have increasingly reduced the extent of natural coastal and marine ecosystems on land and at sea. Natural wetlands, which are important feeding, breeding and nursery grounds for terrestrial and marine species and which offer many services to humans (e.g. flood protection, groundwater replenishment, sediment retention), have experienced a continuous decline in spatial extent, mostly due to land conversion to agriculture. Forest areas seem well conserved in protected areas, however other wooded lands are in decline and forest fragmentation due to land cover change (urban sprawl and infrastructure expansion) and fire risks remain challenging throughout the region. Other coastal ecosystems (beach, dune systems, muddy environments, hard and soft rocky shores and cliffs) have experienced a decline and degradation due to the development of coastal structures and pollution, and the services they provide (e.g. shoreline stabilization, buffering, nutrient cycling) have therefore been weakened. Seagrass meadow species *Posidonia oceanica* and *Zostera marina* are regressing and coralligenous assemblages are strongly impacted by fishing, invasive species, pollution, and seawater temperature change and acidification.

The Mediterranean has low primary production with values decreasing from the western part to the eastern part of the basin. Nevertheless, some specific areas are known to locally host high productivity, such as the Alboran Sea or the northern zones of the Adriatic Sea.

Numerous coastal species, including endemic ones, are threatened, especially in Spain, France, Italy and Morocco, mainly due to tourism and recreation areas, urbanization, agriculture, livestock, recreational activities and invasive species.

Species encountered in the Mediterranean Sea can be distinguished between (i) endemic species, (ii) warm temperate species of Atlantic origin, (iii) northern species of Atlantic origin, (iv) subtropical species of Atlantic origin, (v) species of broad oceanic distribution and (vi) Indo-Pacific species (Bianchi & Morri, 2000). The variety of hydrological and climate conditions and the existence of communication and introduction paths and corridors for non-indigenous species (Boudouresque, 2004) affect the distribution of these different species (cold-affinity species in the northern basin and warm-affinity species in the south). There is a high species abundance and endemism in Mediterranean marine ecosystems (especially in deeper, dark habitats for the latter). The level of endemism in the Mediterranean Sea (from 20 to 30% according to the authors) is the highest in the world, with two particularly emblematic species: red coral (*Corallium rubrum,* Metazoa, Opisthokont) and *Posidonia oceanica* (Magnoliophyta, Viridiplantae, Plantae). A high number of marine species are threatened with extinction, especially in France, Spain, Italy and Greece, and mostly due to fishing. There is also a large number of invasive species, mostly introduced by maritime transport.

The knowledge about Mediterranean marine species and ecosystems varies between countries, and between the shallow and deep waters. The continental shelf (from 0 to 200 m depth) is better known than the deeper areas of canyons, trenches and seamounts, reaching more than 5267 m deep in the Ionian Sea.

With biodiversity selected as the theme of its first Ecological Objective, the Ecosystem Approach (EcAp) to the management of human activities with a view to conserving natural marine heritage and protecting vital ecosystem services recognizes the importance of habitats and species for achieving Good Environmental Status.

3.2 Coastal ecosystems and biodiversity

3.2.1 Wetlands and coastal aquifers[33]

Wetlands[34] represent an estimated 6% of global land and are among the most diverse and productive ecosystems on the planet. The ecosystem services they provide (e.g. protection against floods, filtration, carbon sequestration) are disproportionately larger than their relative land surface. In particular, coastal wetlands play a key role in connecting salt and freshwater systems. The status and trends of Mediterranean wetlands were assessed by the Mediterranean Wetlands Observatory (MWO)[35] in 2012 and 2018. Coastal aquifers contribute to the integrity and functioning of the coastal and marine ecosystems through the hydrological processes that commonly occur in this land-sea interface.

3.2.1.1 Status and trends of wetlands and coastal aquifers and associated biodiversity

The Mediterranean basin hosts 19 to 26 million hectares of wetlands (MWO, 2018). A sample of 400 Mediterranean wetland sites lost, on average, 48% of their natural wetland habitats between 1970 and 2013, far more than the average on the three surrounding continents (Africa - 42%, Asia - 32% and Europe - 35%), or than the world overall (- 35%) (Ramsar, 2018; UNEP-WCMC, 2017).

Within Mediterranean ecosystems, wetlands are important for biodiversity. Although they occupy only around 2% of the land area, they are home to more than 30% of the basin's vertebrate species, and there are twice as many endangered species in wetlands than in Mediterranean ecosystems as a whole. Coastal wetlands are crucial for many species and ecosystem processes. Coastal lagoons provide important feeding areas for many species of marine origin and are therefore strongly involved in ensuring the sustainability of fish stocks exploited at sea (e.g. the sea bream: *Sparus aurata*). They are also a preferred habitat for juveniles of the European eel *(Anguilla anguilla)*, a migratory fish, considered Critically Endangered by the International Union for Conservation of Nature (IUCN) Red List (Jacoby & Gollock, 2014). Several coastal rivers are characterized by a high level of endemism, with a number of highly range-restricted species (many freshwater molluscs and fish). River deltas host tens of millions of migratory, wintering, and breeding waterbirds travelling from as far as the Arctic and Southern Africa. *Figure 49* shows Mediterranean wetlands of international importance for waterbirds, which regularly host more than 20,000 waterbirds and/or more than 1% of the species population of the Mediterranean flyway.

Populations of coastal wetlands specialist fish species strongly declined between 1990 and 2013 (MWO, 2018; *Figure 50*). Conversely, waterbird populations show a general positive trend, most likely due to three reasons.

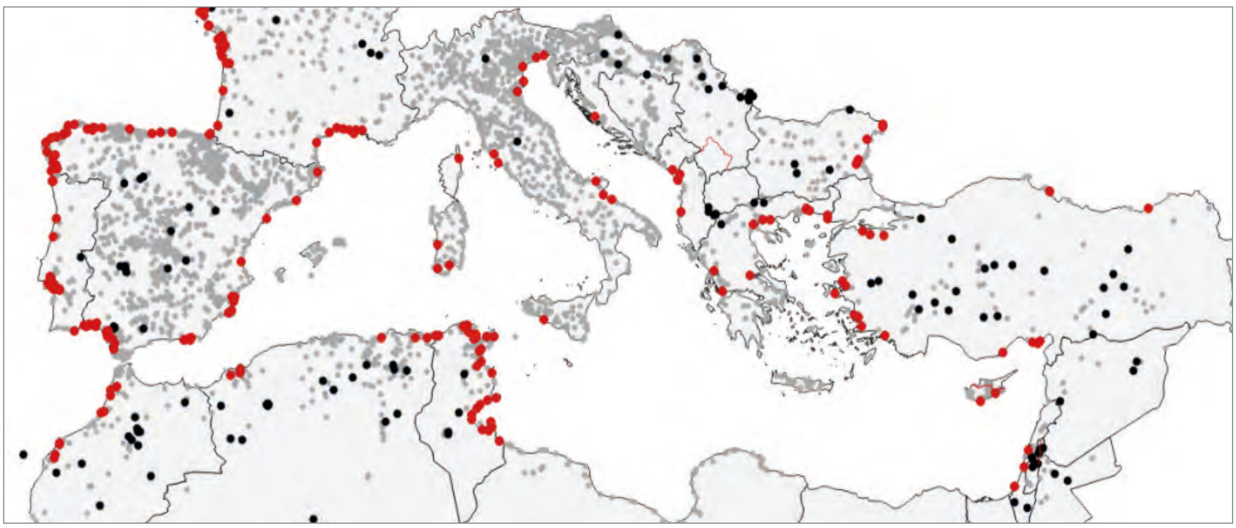


Figure 49 - Wetlands of international importance for waterbirds (black and red points) which regularly host more than 20,000 waterbirds and/or more than 1% of the species population of the Mediterranean flyway (based on mid-January counts carried out during the 1991-2012 period). Sites in red (resp. black) are located less (resp. more) than 30 km away from the coast. Grey points are the other wetlands sampled by the International Waterbird Census (Wetlands International)
(Source: Popoff et al. unpublished work shared by the author)

[33] Coastal aquifers are developed here only with regard to the biodiversity and the ecosystem services provided. Water resources are developed in Chapter 6 of the report.

[34] The Ramsar Convention on Wetlands defines wetlands as: "areas of marsh, fen, peatland, or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water, the depth of which at low tide does not exceed six metres".

[35] Encompassing countries bordering the Mediterranean Sea, in addition to Portugal, Andorra, Serbia, Bulgaria, Jordan and North Macedonia (FYROM).

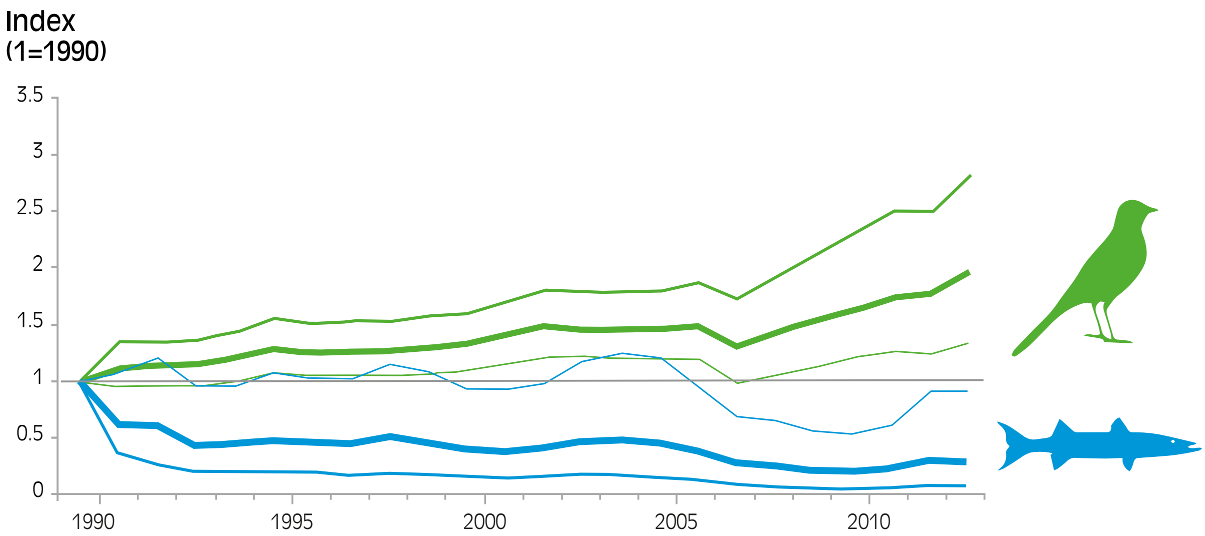


Figure 50 - Living Planet Index for birds and fish dependent on coastal wetlands in the Mediterranean basin

The index gives the relative abundance over time for populations of birds and fish for which data is available. The value of the index was set as 1 in 1990, meaning that values lower than 1 in later years indicate a significant reduction in the general abundance of the species monitored (95% confidence intervals are shown as thinner lines). The bird index (green) is based on 10,611 time-series of 54 species and the fish index (blue) is based on 2,171 time series of 18 species.

(Source: Galewski, unpublished work shared by the author)

First, many waterbirds have suffered massive destruction in the past, resulting in a low baseline in 1990. Second, specific protection laws (e.g. the EU Birds Directive) and effective governance have led to a significant increase of breeding populations in some countries (Gaget et al. 2018; MWO, 2018). Third, artificial water bodies have also increased, providing additional habitats for some waterbirds (MWO, 2018).

In the Mediterranean region, groundwater is an essential source of water supply used in many socioeconomic sectors. Excessive abstraction of groundwater for irrigated agriculture is leading to a rapid depletion of aquifers (Dalin et al. 2017), inducing significant environmental degradation, such as land subsidence and seawater intrusion (Caló et al. 2017; Custodio, 2018). Most groundwater conservation and management efforts focus on protecting groundwater for drinking and other human uses, but tend to neglect addressing the viability of groundwater biodiversity and Groundwater-Dependent Ecosystems (GDEs). Nevertheless, trends of increased degradation of the health of coastal aquifers and GDEs have become major environmental concerns in the Mediterranean basin (UNEP/MAP/MED POL, 2004). Alterations of the quality (temperature, chemistry, etc.) and quantity of groundwater, as well as changes to seasonal patterns, present a threat to GDEs, and consequently to their biodiversity. The most important impacts on the ecological values of underground aquifers affect invertebrates, namely stygobites and oligochaetes (Achurra & Rodríguez, 2008), as well as water quality and the ecosystem goods and services provided by GDEs and connected ecosystems, such as wetlands, springs, lagoons, rivers, and lakes. Hydro-ecological approaches are essential corrective management schemes to reduce the implications of anthropogenic disturbance (Abdul Malak et al. 2019).

3.2.1.2 Ecosystem services

Wetlands and coastal aquifers contribute in many different ways to the well-being of people (MWO, 2018; Ramsar, 2011; Ramsar, 2018). Examples of the ecosystem services provided include, and are not limited to: 1) purification of water; 2) mitigation of floods and droughts; and 3) water provision (Griebler & Avramov, 2015; Ramsar, 2011). Water availability for people and nature is of particular importance in the Mediterranean climate but is under increasing pressure due to lower groundwater levels. Even in coastal wetlands, many ecosystem services are derived or supported by the presence of groundwater inflow because of its role in regulating the hydrology (UNEP/MAP & UNESCO-IH, 2015).

Ecosystem service contributions from wetlands and aquifers are increasingly under pressure (Geijzendorffer et al. 2018; MWO, 2018). The loss of natural wetland habitats reduces the capacity of Mediterranean wetlands to provide services, whereas the demand for and use of ecosystem services have been rapidly increasing. Investments in management, facilities and accessibility have led an increasing number of people to visit and enjoy Mediterranean wetlands during leisure time or for educational outings. However, the continued loss of natural wetland habitats caused by dam building or drainage creates enormous carbon emissions and reduces the availability and quality of groundwater. In particular, the capacity of wetlands to mitigate the impacts of floods has been significantly reduced (by 20% between

BOX 15

Ichkeul Ecosystem Services

Ichkeul National Park in Northern Tunisia is a Ramsar site covering 12,600 hectares (ha), including 8,500 ha of lake and 2,700 ha of peripheral marshes. Highly threatened in the 1990s due to water diversion and dam building on its tributaries, a change in management strategy, assisted by a series of wet years, avoided an impending ecosystem collapse. The park is internationally important for its waterbird populations and also provides very diverse ecosystem services to local and regional populations. These were recently assessed and quantified in 2015, and amounted to around USD 3.2 million per year, or USD 254 per hectare. Regulating services accounted for the bulk of this value (73%), followed by provisioning services (18%) and cultural services (9%). In particular, protection against floods (34%), groundwater replenishment (23%) and sediment retention (12%) were the specific services with the highest value, followed by grazing (10%), recreation/tourism (9%) and fisheries (7%). Of the various habitats present, the lake had the highest value of services provided per hectare (USD 268 per ha per year). The total value of annual services is almost 10 times the annual expenses for park management (i.e. USD 335,000 per year), which are therefore highly justified. Although the share of the total value benefiting the local population is comparatively low (11%), the actual amount per household is far from negligible and amounts in average to ca. USD 1,600 (resp. 1,000) per year for households located inside (resp. outside) the National Park. All these values will be used to argue for water releases from upstream dams in order to maintain the wetlands and the services they deliver, and to communicate locally on the importance of the park for the economy in order to obtain local support.
According to Daly-Hassen (2017).

1987 and 2016 in a sample of five Mediterranean coastal watersheds), mainly due to the conversion of natural wetland habitats into agricultural and urban zones, and intense development of human activities in areas prone to flooding (MWO, 2018).

3.2.1.3 Major pressures

Mediterranean coastal wetlands face many anthropogenic pressures, including alteration of hydrological functioning, water pollution, the conversion of wetlands to agricultural and urban areas, overfishing and coastline retreat.

The Mediterranean Region is characterized by its water stress situation, largely caused by population increase, economic and social development, and irrigated agriculture, but also climate change (Black, 2009), which impacts coastal wetlands and aquifers. The intensive use of water in Mediterranean catchment areas to meet human demand may lead to groundwater depletion and seawater intrusion. The main consequences are the salinization of soils and underground resources, and a trend for freshwater wetlands to become more brackish. Several coastal aquifers along the densely-populated Mediterranean coasts are already suffering seawater intrusion (e.g. the Nile Delta aquifer in Egypt, Akrotiri in Cyprus), and the problem is expected to be exacerbated due to climate change (Kundzewicz & Döll, 2009). Excessive water abstraction upstream also reduces the duration and extent of flooding in many wetlands downstream, and affects their overall ecological functioning. Conversely, farmland irrigation can locally increase water inputs to wetland habitats, increasing the flooding period in naturally temporary habitats, leading to eutrophication and to dramatic changes in plant and animal communities (e.g., Álvarez-Roge et al. 2007; Chappuis, Gacia & Ballesteros, 2011).

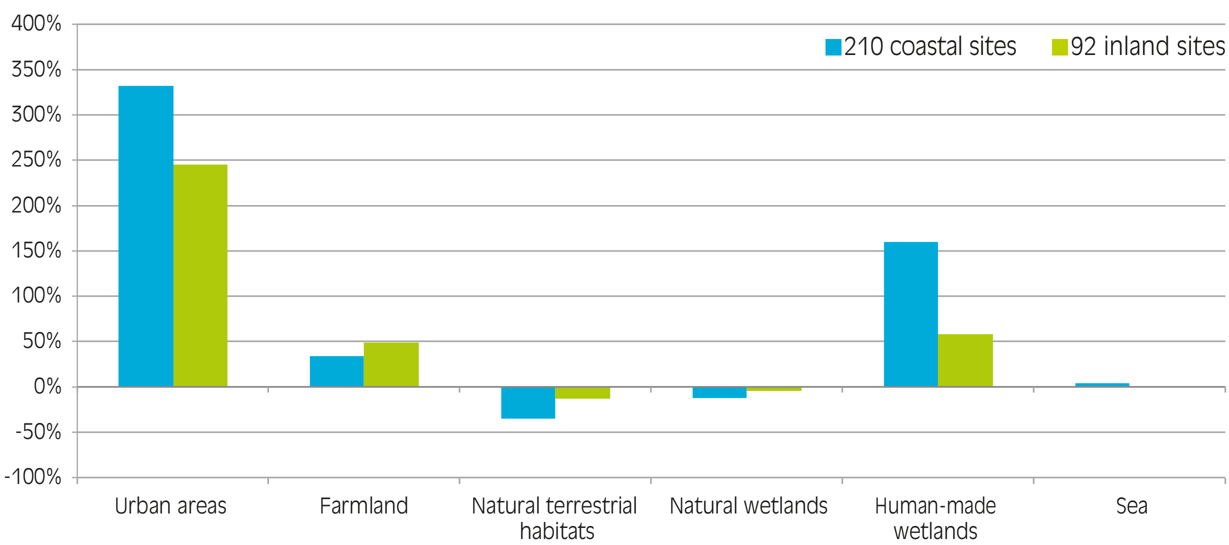


Figure 51 - Rate of change between 1975-2005 of the main land-cover categories in coastal vs. inland sites
(Source: Perennou & Guelmami, unpublished work shared by the author)

BOX 16

Agriculture and Mediterranean wetlands

While livestock and agricultural intensification have, in many cases, provided food security and agricultural employment, these models have also contributed to exploiting more water resources, including groundwater, and to the pollution of many bodies of water, with sometimes serious and irreversible consequences on the habitats and biodiversity of some natural wetlands (Ramsar, 2014). Indeed, the expansion of cultivated land is one of the main direct causes of wetland loss in the Mediterranean: of 302 sites monitored by the MWO, more than 46% of the loss of natural wetland habitats is due to their conversion to agricultural areas.

Intensive agriculture also indirectly affects the ecological integrity of natural wetlands through a decrease in water inputs due to water overexploitation, particularly following retention at upstream dams. This is especially true for Mediterranean regions characterized by a high concentration of irrigated agriculture, because even if rainfed crops remain largely dominant in terms of area (approximately 80% of all exploited land), there has been a net increase in the total irrigated land area over the past 3 decades (CIHEAM & Plan Bleu, 2009). The consequences of such practices can sometimes be catastrophic for natural wetlands, and may also include a deterioration of water quality with pollution from pesticides, chemical fertilizers, antibiotics, disinfectants or animal waste and sediment from eroded pastures (FAO, 2016). They can also disrupt wet ecosystems by introducing exotic and potentially invasive species, often for economic and / or aesthetic reasons.

Groundwater recharge is expected to be further reduced in the Mediterranean, especially along the southern rim. The situation will be further exacerbated because of water quality degradation in coastal Mediterranean aquifers and seawater intrusion, contributing to the ongoing salinization of coastal areas, wetlands and agroecosystems (Hoff, 2013). Groundwater-Dependent Ecosystems (GDEs) are under pressure from excessive groundwater abstraction and land-use activities that impact the amount or seasonal patterns of groundwater flow or alter groundwater chemistry or temperature. Threats also include the leaching of nitrate and pesticides from agriculture, aggravated by the increased production of biofuels, promoted by some EU policies. Leaking sewage pipes, particularly in urban areas, channel and introduce nitrates and other contaminants that pollute groundwater and GDEs (Klove et al. 2011).

The most radical and frequent phenomenon affecting wetlands, including coastal ones, is habitat loss. This often starts with the conversion of a natural habitat to farmland, then potentially to an urban area (MWO, 2014; MWO, 2018). The MWO quantified this phenomenon by measuring changes in 302 major wetland sites (210 coastal and 92 inland) throughout the Mediterranean basin. Between 1975 and 2005, more transformations took place in coastal than in inland sites *(Figure 51)*, with the exception of farmland expansion. In both coastal and inland sites, natural wetland habitats were converted predominantly into either farmland or manmade wetlands, while conversions to other land-cover types remained minimal. The south-eastern part of the basin has seen by far the greatest changes in land cover, followed by the Maghreb, the Balkans and South-Western Europe (MWO, 2018).

3.2.1.4 Management of wetlands and coastal aquifers

Groundwater resources have generally not been managed in an integrated way to date. As aquifer systems are difficult to observe, they are mostly ignored in spatial planning decisions (Klove et al. 2011). The diversity of wetlands and GDEs makes it difficult to provide a one-size-fits-all management solution, since each ecosystem has different ecological water requirements, contains different species, fosters specific habitat conditions, and can face a variety of threats from groundwater basin activities.

Through the EU Water Framework Directive (WFD), EU Mediterranean countries adopted an Integrated Water Resources Management (IWRM) approach focusing on the recovery and conservation of the ecological status of rivers, lakes, wetland and coastal waters. Furthermore, it is mandatory under this legislation to take into account the interaction of underground water resources with wetlands and other water ecosystems, and to consider the water cycle in a holistic way (GWP, 2000). The main obligations of the WFD, and its associated Directive on Groundwater Protection in relation to GDEs, refer to achieving good groundwater status and preventing significant damage to terrestrial ecosystems that directly depend on groundwater bodies.

Overall in South-Western Europe, water quality has improved in many water bodies, at least with regard to nutrients and heavy metals, through the application of the EU WFD. However, North African and Middle Eastern countries which do not benefit from the WFD still witness an overall degradation of their water quality and an intensification of the overexploitation of water resources (MWO, 2018).

At the international level, the Ramsar Convention is the key instrument promoting wetland protection. The number and surface of Ramsar sites[36] in the MedWet countries[37] have steadily increased over time, with the designation of 397 sites covering 6.7 million hectares since 1971. In 2017, 44% of the Mediterranean Ramsar sites had management plans, 30% of which had been implemented (MWO, 2018).
Other measures taken to manage wetlands include the restoration of wetlands as Nature-based Solutions (NbS)

[36] Wetlands of International Importance.

[37] 26 Mediterranean and peri-Mediterranean countries that are Parties to the Convention on Wetlands (Ramsar, Iran, 1971).

BOX 17 Examples of the application of Nature-based Solutions to coastal urban ecosystems, wetlands and seagrass meadows

At the 2016 World Conservation Congress, IUCN members adopted a resolution (WCC-2016-Res-069-EN) on a Definitional Framework for Nature-based Solutions, with a set of eight preliminary principles:

Nature-based Solutions...

1. embrace nature conservation norms (and principles);
2. can be implemented alone or in an integrated manner with other solutions to societal challenges (e.g. technological and engineering solutions);
3. are determined by site-specific natural and cultural contexts that include traditional, local and scientific knowledge;
4. produce societal benefits in a fair and equitable way in a manner that promotes transparency and broad participation;
5. maintain biological and cultural diversity and the ability of ecosystems to evolve over time;
6. are applied at a landscape scale;
7. recognise and address the trade-offs between the production of a few immediate economic benefits for development, and future options for the production of the full range of ecosystems services;
8. are an integral part of the overall design of policies, and measures or actions, to address a specific challenge".

The resolution defines NbS as "actions to protect, sustainably manage, and restore natural or modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits".

As an umbrella and integrative concept, NbS have been further defined, adopted and applied differently by the IUCN and other organizations, such as the European Commission and the World Bank. Despite the diversification of the concept, all share a common goal of contributing to all dimensions of sustainability, the scientific, political and practical dimensions (Nesshöver et al. 2017).

Nature-based Solutions move beyond safeguarding nature and include people´s need to address societal challenges such as climate change, biodiversity loss, food security, water security, disaster risk or health effects from changing conditions. They bring together established ecosystem-based approaches such as ecosystem-based adaptation and ecological engineering with the social and economic dimension. NbS can be applied and adapted to all types of ecosystems, as a wide range of NbS exists.

Despite the complexities, uncertainties and trade-offs in their implementation, NbS can provide multiple benefits and foster win-win situations. Examples of successful implementation of the NbS concept can be found in the "Ecosystems Protecting Infrastructure and Communities" and "Water Infrastructure Solutions from Ecosystem Services Underpinning Climate Resilient Policies and Programmes" (WISE-UP) projects.

Several institutions, such as the IUCN Centre for Mediterranean Cooperation, the IUCN French and Spanish National Committees, Plan Bleu, *Tour du Valat,* and *Conservatoire du Littoral,* are promoting the dissemination and encouraging the implementation of NbS across the Mediterranean region through two main actions: 1) generating knowledge by collecting information from project implementation in the field and research on what benefits NbS can provide; 2) seeking government and stakeholder engagement through participatory processes to achieve more integrated policies and guarantee NbS acceptance.

Examples of NbS application have been identified by the above institutions to represent the range of ecosystem services and societal challenges that can be addressed by NbS operations. Building an evidence base for NbS is key in order to support future replication and the upscaling of these solutions in this rapidly-changing, modern world. This evidence will provide conservation and development practitioners, policymakers, researchers, and NGOs with a useful basis for understanding what NbS offer in terms of benefits for humans and nature. The Global Standard for the Design and Verification of Nature-based Solutions, under development by the IUCN, will contribute to the consolidation of this innovative approach as of 2020.

Examples of NbS adapted to natural ecosystems

The Oristano area in Sardinia (Italy) is rich in wetlands, including the 6 Ramsar sites in the MARISTANIS project. The water and food sectors are strongly linked to traditional fisheries, while livestock farming is a source of water pollution. Conflicts between stakeholders in ecosystem conservation and in the food sector have arisen, since birds feed on fish and crop seed, especially in rice fields. The MARISTANIS project is looking into NbS, such as growing reed for improving water quality and enhancing food production as a way to reducing the excess load of nutrients from agriculture.

The Ad'Apto project highlights the strategies of ten representative sites on the French coast, in order to demonstrate that flexible coastline management is feasible and efficient regarding adaptation to climate change. The project to restore the Camargue salt flats, lagoons and marshes has a similar objective of restoring coastal ecosystems for nature conservation and coastal protection.

Other marine habitats, such as seagrass meadows, are considered important habitats under the NbS criterion. The Life Blue Natura project aims to quantify the carbon deposits and sequestration rates of marsh and seagrass meadows along the Andalusian coast. The aim of the project is to generate the tools necessary for designing carbon offset projects that could be incorporated into the recently approved Climate Change Act of Andalusia, because no tools for marine ecosystems exist to date. To this end, the most threatened areas and/or those with the most valuable blue carbon ecosystems (seagrass and coastal wetlands) will be identified to implement conservation and revegetation projects, which contribute to climate change mitigation and coastal protection.

to mitigate the impacts of flooding by rivers and the sea, sustainable water use to ensure the sustainable provision of water for ecosystems during droughts, and the protection of remaining natural wetland habitats and their water quality.

There is great potential and opportunity for the Mediterranean region to combine IWRM and Integrated Coastal Zone Management (ICZM) approaches that would contribute to Integrated Coastal Area and River Basin Management (ICARM) in the Mediterranean.
A holistic and effective approach to the management and conservation of GDEs is required, including the prioritization of the most valuable ecosystems and services. The management of groundwater and GDEs should better consider the total economic value. Taking into account the natural and social sciences can contribute to a broader understanding of the relevant processes and problems associated with GDE management and help design consistent policies. These kinds of solutions that use holistic management approaches in Mediterranean coastal areas raise political challenges that must be dealt with in order to reduce pressures on coastal wetlands and groundwater aquifers, and consequently on the biodiversity of their GDEs.

3.2.2 Forests

3.2.2.1 Status and trends of Mediterranean forests

According to the Global Forest Resources Assessment programme (FAO, 2015), the forest area of Mediterranean countries at a national scale has increased from 68 million hectares in 1990 to 82 million hectares in 2015, representing an increase of 0.72% per year over 25 years (Appendix 1). This moderate yet stable upward trend has been accompanied by an increase in growing stock (from 6.3 billion m³ in 1990 to 9.2 billion m³ in 2015, i.e. + 1.56% per year) and carbon storage (from 3.2 billion tonnes in 1990 to 4.6 billion tonnes in 2015, i.e. + 1.52% per year). The 0.86% net increase in forest area per year between 1990 and 2010 was largely the result of forest expansion (0.66% per year), with reforestation contributing 0.25% per year and deforestation remaining at a low level of 0.06% per year (despite an upward trend). *Figure 52* shows a typical Mediterranean forest area.

Figure 52 - Esterel Park, South-East France
Typical Mediterranean forests are composed of both evergreen and deciduous broad-leaved species, mainly oaks (e.g. Quercus ilex, Q. suber, Q. coccifera*) and conifers (e.g.:* P. halepensis, P. brutia, P. Pinea*). The degradation of such forests has produced low-density woody vegetation known as macchia and garrigue.*

One specificity of the Mediterranean region is the prominence of other wooded lands, reflecting the importance of small trees, shrubs and bushes in these dryland ecosystems. In 2015, these other wooded lands accounted for an additional 32 million hectares in Mediterranean countries. Contrary to forests, the surface area of other wooded lands has been constantly decreasing from 36 million hectares in 1990 to 32 million hectares in 2015 (- 0.45% per year over 25 years) (Appendix 1).

Another specificity of the region is the preponderance of trees outside forests, which are found in extensive agroforestry systems, urban forests and as landscape elements. In 2015, these trees outside forests covered more than 8.2 million hectares in the Mediterranean, with an area that increased between 2000 and 2010 (FAO & Plan Bleu, 2018).

Because forest statistics are provided at country level and not according to the biogeographical Mediterranean region, some forest growth has taken place outside the Mediterranean biome. Geospatial information supplementing country-level statistics (such as the Copernicus High Resolution Layer Forest) are required to locate forest areas and monitor their spatio-temporal trends. Based on the global maps of forest cover change by Hansen et al (2013), forests cover 9.1% of the Mediterranean countries' territory. When restricted to the Mediterranean biome, this proportion increases to 18%. When further restricted to coastal areas (land within 5 kilometres of the coastline), this figure increases to 28% (Appendix 1). Therefore, forests are proportionally three times more widespread in Mediterranean coastal areas within 5 kilometres of the coastline than at the country level.

Although forest coverage is showing increasing trends in Mediterranean countries, forests are subjected to several drivers of change that have impacts on their condition, biological diversity and functional capacity.

Statistics on forest area and land-cover changes in the Mediterranean region tell us little about forest degradation. While new forests are generated from ecological succession after land abandonment, or from national afforestation programmes, Mediterranean forests are subjected to fragmentation due to land-cover change, including urban sprawl and the expansion of infrastructure. It has been estimated that 80 million hectares of land in the Mediterranean, including forests, have been degraded (Martín-Ortega et al. 2017), thus making land degradation a major issue for the region.
Short-term climate change effects are also visible, where observed shifts in vegetation to the north of the

Mediterranean climate are likely to continue (Lelièvre, Sala & Volaire, 2010), with corresponding changes in Mediterranean climate-adapted vegetation (Dreyfus, 2007). In the longer term, projected trends in Mediterranean forests are highly uncertain; on the one hand, because of the uncertainty of vegetation models (Keenan et al. 2011) and, on the other hand, because the response of vegetation to climate change is intrinsically non-linear, with a gradual change in climate potentially resulting in drastic switches in vegetation once a tipping point has been reached (Scheffer et al. 2001).

3.2.2.2 Ecosystem services

Based on an analysis of the total economic value, one specificity of Mediterranean forests is that their value relies more on non-wood forest products and services than on wood products (Croitoru, 2007). At the same time, the value of non-wood products and services in Mediterranean forests is largely unrecognized or undervalued by decision makers, leading to the paradox that Mediterranean forests have become a sink of public resources, despite their potential role as green infrastructure to address the challenges faced by the region (Martínez de Arano, Garavaglia & Farcy, 2016).

Mediterranean forests deliver various ecosystem services and contribute directly or indirectly to human well-being by improving food, water and energy security, reducing risks, being instrumental for local and global economies, and playing an essential role for cultural identity and personal development (FAO & Plan Bleu, 2018; *Figure 53*). Forest ecosystem services associated with productive activities include pollination, pest control and the supply of wood and non-wood forest products, which can be especially important for rural populations. Forests are important providers of recreational, cultural and aesthetic services close to urban centres. Ecosystem services provided by trees in urban areas include improving air quality, removing pollutants, providing green spaces for open-air activities and recreational spaces in which people can socialize and relax. Trees outside forests (scattered across the landscape) also provide important ecosystem services such as their role as ornamental and amenity trees, food production, noise and/or air pollution filters, windbreaks and rain gardens (for runoff management).

It is essential to raise the local population's awareness of the importance of their natural and cultural heritage and conserving these unique habitats, such as *Dehesas*[38], and of their economic valuation.

Recognizing the goods and services provided by Mediterranean forest ecosystems involves the assessment of their economic value. Participatory approaches will be key in the development of economic valuation methods. The participation of local communities and stakeholders in the valuation process itself can be beneficial in order to observe the method in practice, provide information and understand the results. The economic valuation of goods and services is key in order to structure value chains in the Mediterranean, especially the value chains of non-wood forest products that are currently poorly understood, with limited official information available concerning their added value, stakeholders and inter-linkages (Vidale, Da Re & Pettenella, 2015). Incentives from climate change policy (wood products as substitutes for other products with a carbon footprint, adaptation to climate change) will also be key to promoting the ecosystem services provided by Mediterranean forests.

3.2.2.3 Major pressures

Climate change and human population growth are two overarching processes whose impacts (conversion from forests to shrublands, wildfires, pest and pathogen outbreaks, overgrazing and land abandonment) threaten Mediterranean forests. For instance, the area burned by wildfires in five southern European countries witnessed a downward trend from 570,000 hectares per year between 1980 and 1985 to a minimum of around 320,000 hectares in 2014, but has been rebounding in the last four years, mainly because of increasing burned areas in Portugal. A similar pattern of increasing burned areas in recent years has also been observed in North Africa and the Middle East, with a total burned area of 119,491 hectares in 2017 (mostly in Algeria and Tunisia), around three times the amount recorded in 2016 (San-Miguel-Ayanz et al. 2018).

Ecosystem services	Provisioning services	Regulating services	Cultural services
Benefits	Products obtained from Mediterranean forests.	Indirect benefits obtained from the regulation of Mediterranean forests processes.	Non-material benefits people obtain from Mediterranean forests.
Contributes to...	-Food and energy security. -Maintenance of local economies (exportations, employment, etc.) -Population health.	-Protection from risks. -Population health. -Food security.	-Good social relations and positive living environments. -Personal development. -Cultural identity. -Educational values. -Population health.

Figure 53 - Benefits derived from Mediterranean forest ecosystem services
(Source: FAO & Plan Bleu, 2018)

[38] Traditional pastures in Spain.

Mediterranean forest ecosystems are resilient to wildfires, with active prevention activities and grazing increasing this resilience, but repeated or intense fire events are beyond the coping capacity of most species, resulting in forest degradation, the loss of biodiversity and ecosystem services (Bradshaw et al. 2011) and emissions of large quantities of CO_2.

The consequences of forest degradation include the alteration and pollution of water resources, land degradation and fragmentation, forest dieback and the decline of regeneration, soil erosion, biodiversity loss and genetic erosion. Mediterranean forests are generally located close to human settlements; untreated solid waste landfills are therefore often established in forest areas, with a negative impact on freshwater quality.

Impacts from soil erosion are serious in Mediterranean forests where soils are thin and poor, particularly in mountain areas following disturbance events (fires, windstorms and pest outbreaks) (De Rigo et al. 2016). European woodland landscapes, which account for 70% of the subcontinent, are poorly connected (Estreguil et al. 2013), making them more vulnerable to fragmentation. The combined effect of warming and drought has resulted in several instances of forest decline or dieback of oak, fir, spruce, beech and pine species in Spain, France, Italy and Greece (e.g. Peñuelas et al. 2007). Forest dieback has also occurred along the Mediterranean basin's southern rim, particularly impacting the *Cedrus atlantica* in Algeria, but also other tree species, including pine, oak and juniper.

3.2.2.4 Forest management

All Mediterranean countries have policy documents on forest management (FAO & Plan Bleu, 2018). National forest policies vary and range from extensive documents to declarative, long-term sectoral visions. Forest policies in the region are affected by a number of legally-binding or non-legally-binding international and regional agreements and conventions, such as the United Nations Strategic Plan for Forests 2017-2030, the three Rio Conventions, the Paris Agreement (signed by all Mediterranean countries except the Syrian Arab Republic), the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), the Ramsar Convention and the World Heritage Convention. International commitments on forests are particularly relevant for Mediterranean forests but, since the average validity of national forest programmes is 20 to 25 years, the most recent international and regional agreements may not yet be fully reflected in national forest policy documents.

Sustainable forest management is consistently prioritized in national forest policy programmes and statements across Mediterranean countries. Other issues are not systematically present in policy documents, such as ecosystem services and wood and non-wood forest products; forest restoration; biodiversity conservation; climate change mitigation and adaptation; wildfire prevention; and communication, coordination, cooperation and capacity building. Biodiversity is integrated in forest policies throughout the region, with a focus on the biodiversity-climate change nexus (FAO & Plan Bleu, 2018). Fifteen countries in the region and the European Union have an action plan or a strategy in line with the Convention on Biological Diversity (CBD). Nine countries have mapped national targets against the Aichi Biodiversity Targets.

Efforts on forest conservation have been made in the region through protected areas. Over 42% of land area in protected areas in the Mediterranean has tree cover of more than 10%, compared with 19% of land area in the Mediterranean biome (including both protected and unprotected areas), which shows that protected areas in the Mediterranean are densely covered with forests. More efforts for regional planning are needed to ensure connectivity between forests by building green infrastructure and increasing forest

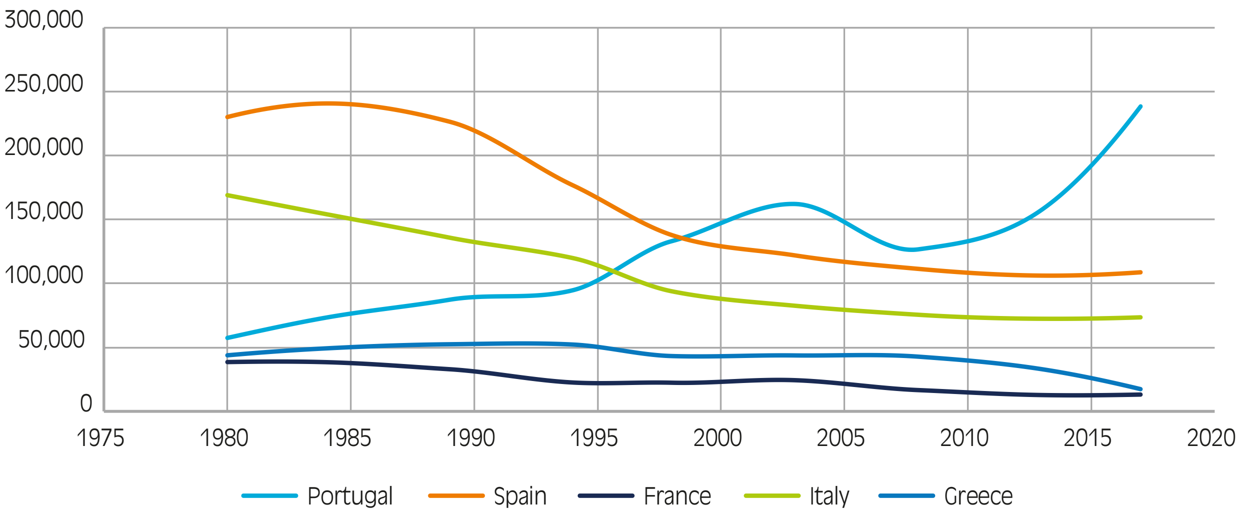


Figure 54 - Area (in ha) burned by wildfires in four EU Mediterranean countries and Portugal
(Source: San-Miguel-Ayanz et al. 2018). Note: Annual data is smoothed using a local second-degree polynomial regression with a smoothing parameter of 0.75.

function and resilience, which are essential in order to reduce the impact of climate change, pest outbreaks, etc.

Wildfire prevention is a priority in the Mediterranean. Forest wildfires are often treated as an emergency rather than as part of a continuous interaction between society and the environment in the context of climate change. At the national level, extinction generally receives much greater attention and funding than prevention, while more investment in prevention would reduce overall expenditure. *Figure 54* shows the area burned by wildfires in five EU Mediterranean countries and Portugal.

Mediterranean countries have included pledges for forest and landscape restoration and afforestation plans in their policy documents. Restoration is the process of regaining ecological functionality and enhancing human well-being across degraded landscapes. For instance, ten Mediterranean countries have adopted the Agadir Commitment to support forest and landscape restoration, with the target of restoring eight million hectares of degraded lands in the Mediterranean by 2030 on a voluntary basis.

Policies and instruments for climate change mitigation and adaptation are in their initial phase in the Mediterranean region. Nationally Determined Contributions (NDCs) and the Paris Agreement are not mentioned in most forest policies. The primary focus of forest policy in the Mediterranean region is on researching the eco-physiological response of forests to climate change. Policies are therefore oriented towards an adaptive approach to climate change. In the short run, revisions of forest policies are expected to take place to include the role of forests in NDCs. In the longer run, fostering the role of forests in a green low carbon economy (e.g. as a renewable resource that can substitute for products with a large carbon footprint) is expected to take place.

3.2.3 Other coastal ecosystems: soft and rocky shores

The Mediterranean coastline is a heterogeneous landscape, influenced mostly by factors like winds and storm surges, but also strongly affected by past and current human activities. The tidal oscillation is generally small (of the order of a few centimetres), except for the north Adriatic Sea, the north Aegean Sea and the Gulf of Gabès where tidal amplitudes can reach 1 metre during spring tides (Tsimplis, Proctor & Flather, 1995).

The total length of the Mediterranean coastline is approximately 46,000 kilometres, including 19,000 kilometres of island coastline (UNEP/MAP, 2012). Approximately 54% of the Mediterranean coastline is formed of sea cliffs and rocky shores (Furlani et al. 2014), while the rest is comprised of soft sedimentary shores made of beaches, fine-sediment estuarine shores, coarse-sediment (shingle, gravels and coarse sand) shores in the upper reaches of estuaries and muddy shores found in association with coastal lagoons and river mouths. The following describes these main four types of coastal environments:

- Soft-sediment coasts: Beach and dune systems
- Soft-sediment coasts: Muddy environments
- Hard rock coast: Rocky shores and cliffs
- Soft sea cliffs and rocky shores

3.2.3.1 Status and trends

Soft-sediment coasts: Beach and dune systems

Mediterranean soft-sediment coasts, mostly formed by sandy beaches backed by dunes, boulders or sandstone, are dynamic ecosystems driven by diverse prominent physical processes, notably wind incidence and storm intensity, as well as wave exposure, shoreline orientation, sediment supply and geology (Sabatier et al. 2009; Simeone & De Falco, 2012). Sand and gravel supply is made from the discharge of rivers. On Mediterranean coasts without rivers or with low fluxes of particulate matter from the land to the sea, the sand comes mostly from marine sedimentation or a result of coastal erosion processes. Another particularity of many sandy beaches along the Mediterranean is the deposit of large volumes of Posidonia oceanica wrack (leaves and rhizomes) forming a permanent or semi-permanent structure on the beach, named banquettes (Otero et al. 2018).

Although not as rich in species as other coastal habitats, species in sandy shores show high adaptation to changes in salinity and water levels. The beach habitat is home to annual plants such as the European sea rocket *(Cakile maritima subsp. Aegyptica)* and the tumbleweed Salsola kali. On less-trampled beaches, some perennial plants also occur, such as the knotgrass *Polygonum maritimum* and the purple spurge *Euphorbia peplis*. It is also inhabited by crustaceans able to live outside water, such as *Talitrids* of the *Orchestia* genus, predator insects such as tiger beetles (some species of the Cicindela genus), algal grazers as shore flies *(Ephydridae)*, beach flies *(Tethinidae)*. This habitat is used for nesting by the loggerhead turtle, *Caretta carett*, and the green turtle, *Chelonia mydas*, in the Eastern Mediterranean. Adjacent coastal dunes host highly specialized fauna and plant communities, relatively few of which are shared with other neighbouring environments. Their dynamic nature includes a large proportion of bare sand and young vegetation species that evolve into a more stable ecosystem dominated by different stages of woody shrubs and tree species (Grove, 2012).

Figure 55 - Cakile marítima *and* Caretta caretta

There is no quantitative data on the total area and trends of soft-sediment coastline in the Mediterranean. Some estimates from EU countries indicate that sandy beaches could represent around 8,509 km^2 (Otero, 2016a), with a loss of 30% of this particular habitat inferred from the development of harbours, dykes and others coastal structures over the past 50 years. Dams are the prime reason for the loss of sand supply to the coastal environment (and its beaches). For coastal dunes, habitat decline has been estimated at more than 20% over the past 50 years in EU Mediterranean countries, with a range of 10 to 40% depending on the country (Acosta, 2015).

Soft-sediment coasts: Muddy environments

Muddy shores are present but not common in the four sub-basins of the Mediterranean. These very rich habitats in terms of biodiversity are typically found in association with coastal lagoons and river mouths. They are feeding grounds for several types of birds that feed on the high variety of invertebrates that occur in these grounds. The most extensive examples are found around the deltas of the Ebro (Spain), the Rhône (France) and the Po (Italy), while smaller, very localized pockets are present across the region (Soldo, 2016).

Hard rock coasts: Rocky shores and cliffs

Cliff and rocky coasts represent more than 50% of the coast in the Mediterranean. The interaction of waves, weathering and relative sea level changes shaped these types of rocky coastlines and their main landforms, including sloping and horizontal shore platforms with flat rock surfaces, and cliffs that sometimes are indented by rocky promontories, bays, sea arches, inlets and coves. Limestone coasts are also common features of many coastlines in the basin and have further allowed the development of a rich set of karst landforms in some areas.

Supralittoral rocky shores are typical habitats for maritime communities of yellow and grey lichens, such as *Xanthoria parietina, Caloplaca marina, Lecanora atra* and *Ramalina spp*, and the black lichen *Verrucaria maura* is also present. The higher parts of sea cliffs are colonized by disjunct assemblages of salt-tolerant crevice plants (chasmophytes) or by salt-tolerant grasslands.
In the surf zone on areas of bedrock, boulders and stones, associated marine species are adapted to endure long periods of emersion.

Mediterranean Sea cliffs harbour numerous endemic species with extremely local occurrence. Some plant species belonging to the *Limonium* genus, which comprises at least 43 Mediterranean cliff species, are restricted to a few localities. Several of these species are threatened, for instance the *Limonium remotispiculum* of Southern Italy and the *Limonium strictissimum* of Corsica and Caprera. Some stable and high coastal cliffs are inhabited by the shrub communities *Ficus carica, Colutea arborescens* and *Ulmus minor.*

At a few locations along the Mediterranean coastline, unique bio-concretions made of reefs with the red algae *Lithophyllum byssoides* and rim platforms formed by the algae *Neogoniolithon brassica-florida* and the vermetid gastropod *Dendropoma petraeum* develop just above the mean sea level, where waves break. Their distribution is restricted to the warmest part of the basin and only in specific areas where the climatic, hydrological and sedimentary conditions are suitable. This habitat has experienced a continuing decline in spatial extent and biotic quality, affecting 30% of the habitat over the past 20 years. It is considered vulnerable on the EU Red List of Habitats (Chemello & Otero, 2015).

Quantitative data on cliff retreat and the erosion of rocky shore platforms is scarce and restricted to a few localities (Furlani et al. 2014). The extent of this environment is declining; it is estimated that approximately 20% has been lost over the past 50 years in EU countries (Otero, 2016b).

Soft sea cliffs and rocky shores

Rocky coasts formed of soft materials along coastal cliffs and slopes are less common in the Mediterranean and have been less studied. The combination of the local morphological setting, lithological features (e.g. cliffs on marine conglomerates, cliffs on sandstone, and cliffs on continental deposits), tectonic setting and geomorphological processes produces the diverse variability of landforms along these coastlines. These coastlines are poorly resistant to the natural processes of erosion and landslides, and retreat rates are highly variable on the type of shore platforms formed. In general terms, there is little information on their ecological and floristic features or status. Soft rocky shores are more easily colonized by vegetation. Erosion is much quicker than on hard cliffs and vegetation is therefore restricted to pioneer stages in many places. They may support scrubs similar to the ones on dunes, with species like the *Hippophae rhamnoides, Juniperus spp.* and *Crataegus monogyna,* as well as breeding populations of vulnerable bird species (e.g. the yelkouan shearwater *Puffinus yelkouan* (Tzonev, 2015a)).

3.2.3.2 Ecosystem services

Coastal ecosystems provide shoreline stabilization and buffering services. For example, seagrass banquettes on beaches reduce erosion by mitigating wave impact, while sandy and rocky shores serve as a first line of defence, mitigating and responding to natural forces like waves and storms (Boudouresque et al. 2016; Drius et al. 2019).

Many of the coastal ecosystems linked to soft-sediment coasts (beach and dune systems or muddy environments) also have outstanding ecological, socioeconomic and cultural values, and play important roles in providing a diversity of ecosystem services linked to the nutrient and energy exchange in the coastal landscape. Several studies have also demonstrated the role of soft-sediment environments such as dunes in coastal defence, groundwater storage and water purification, while their importance in the nutrient cycling, soil formation and climate regulation (for carbon sequestration) is less known (e.g. Bazzichetto et al. 2016).

Obtaining further quantitative information concerning the ecosystem capacity of these types of Mediterranean ecosystems would be valuable in order to provide management options and relevant information for decision-making. The provision of these ecosystem services is strongly linked to the distribution, size and conservation status of the different natural habitats (Maes et al. 2012). *Table 9* shows an overview of ecosystem services provided by some coastal habitats in the Mediterranean.

3.2.3.3 Major pressures

Like all coastal ecosystems, soft-sediment coasts and rocky and soft cliffs and shores are subject to multiple impacts that are often from inland sources (Orth et al. 2006). Accelerated erosion is a widespread phenomenon around most of the basin, mainly because of anthropogenic interventions, for example, the proliferation of marinas and other urban and tourism infrastructure, sea level rise as a result of global warming, reduced river sediment inputs as a consequence of damming, river bed quarrying, land use changes, harbours and other coastal defence structures (Otero, 2016a).

The development of coastal projects (marinas, urban and tourism infrastructure) and altered flow regimes have had a significant effect on soft-sediment coasts with beaches and coastal dunes by altering their quality and quantity, and the erosion-accretion dynamics of the coastal zone. In some countries, invasive non-native species such as the succulent plant species, *Carpobrotus acinaciformis* or *C. edulis,* also represent an important threat for this ecosystem.

For rocky shores and cliffs, the main pressures and threats are associated with substratum loss due to direct destruction by human modifications of the coastline from the development of harbours, dykes and other coastal structures, and also from degraded water quality. Urban and industrial wastewater discharged directly into the sea

	Provisioning	Regulating	Supporting	Cultural
Soft-sediment coasts				
Beaches	Import marine organic matter and nutrients from the sea to the coastal ecosystems.	Erosion control. Recycling of nutrients.	Habitat/refugium for coastal biodiversity - gastropods, small crustaceans, myriapoda, insects, etc. Nesting areas for marine turtles and shorebirds.	Recreation and tourism: more people use sandy beaches than any other type of seashore.
Dunes	Soil formation - sand and other minerals to beaches.	Erosion control. Water purification.	Habitat/refugium for coastal biodiversity - dunes provide unique habitats for highly specialized plant and animal species due to the strong environmental sea-inland gradient. The lower slopes of sand dunes with natural vegetation such as Goat's Foot and *Spinifex* are ideal nesting sites for turtles (Choudury et al. 2003).	Recreation and tourism: image of natural sand dunes and beach fronts as part of their marketing packages.
Muddy environment	Food provi-sioning -e.g. shellfish.	Nutrient cycling Storm protec-tion Decomposi-tion and fixing processes.	Habitat/refugium for coastal biodiversity - the high biodiversity and abundance of invertebrates is the feeding basis for many birds. Bacteria in mud flats help to break down contaminants from urban runoff, such as heavy metals, hydrocarbons (oil, gasoline, solvents) and other organic chemicals.	
Soft rocky shores				
Soft sea cliffs and rocky shores	Raw material.		Habitat/refugium for coastal biodiversity - sea cliffs harbour a diversity of vegetation types with variable maritime influence.	Tourism: nature watching.
Hard rocky coast				
Rocky shores and cliffs	Food provisioning - finfish and seaweed are collected on rocky coastlines.	Sea defence.	Habitat/refugium for coastal biodiversity - sea cliffs harbour a diversity of vegetation types with maritime influence. It is an important feeding area for birds and fish in ponds, and nursery grounds for invertebrates.	Recreation and tourism: recreational fishing.

Table 9 - Ecosystem services provided by some coastal habitats in the Mediterranean

in some areas and pollution with chemical contaminants have led to the reduced growth of some associated species and a general degradation of the habitat (Chemello & Otero, 2015).

The major threats facing soft sea cliffs and rocky shores are new urbanized areas and tourism development in coastal areas, particularly the construction of homes, roads and other infrastructure in erosion-prone areas. Additionally, natural disasters and storm events could further drive erosion (Tzonev, 2015b).

3.2.3.4 Management of soft and rocky shores

There are various legal provisions and policies that relate to the above-mentioned types of ecosystem landscapes at a national level, an EU level (Habitat and Birds Directive, the Marine Strategy Framework Directive (MSFD) and Maritime Spatial Planning (MSP)), as well as under the ICZM Protocol of the Barcelona Convention. Together, these Mediterranean policies constitute a good umbrella for the development of national policies and coastal and marine area planning and management at a national and a local level. In addition, other regional and national policies aim to protect local coastal features while maintaining a commitment to manage the development of coastal areas.

Soft-sediment coasts

For EU countries, most plant communities growing on coastal dunes lining the Mediterranean have been listed as Habitats of Community Interest in Annex I of the Habitats Directive. EU countries are also encouraged to designate Natura 2000 sites, and some beaches are protected because of the presence of sea turtle breeding sites. Nevertheless, it is important to highlight that, in many situations, the coverage of Natura 2000 sites and the designation of protected areas has focused on single habitats, without considering the functional connectivity between continuous habitats in the land-sea interface (e.g. Otero et al. 2018). Improving the integration and management of these connected habitats will reduce the fragmentation and facilitate the ecological integrity of the coastal environment.

Some Mediterranean countries have implemented strict limits and a minimum distance from the coast for the dredging of sand and gravel from beaches. Additional beneficial actions could include the legal protection of vulnerable habitats (dunes); better planning and limitation of coastal development; preventing activities such as coastal protection works that destabilize the habitat or interfere with the natural dynamics; beach nourishment schemes using appropriate materials; and developing management practices for beach cleaning which avoid heavy machinery. For muddy flats, estuaries or deltas, management and mitigation measures could be improved and prioritized to diminish land- and marine-based pollution sources such as improved treatment of wastewater discharges, including industrial effluents and agricultural runoff.

Hard and soft rocky shores and cliffs

These types of ecosystem landscapes are not subject to specific conservation measures, but they occur in some protected areas, linked to the presence of endangered and protected species, or as part of a larger area with multiple objectives.

Beneficial priority actions could include measures to improve water quality and the regulation of coastal development in order to avoid both direct and indirect damage. Establishing new protected sites and restoring degraded coastal areas are also important actions to be taken.

3.2.4 Genetic diversity and threatened species of coastal ecosystems

Genetic diversity is one of three forms of biodiversity recognized by the IUCN as deserving conservation, along with species and ecosystem diversity (McNeely et al. 1990). High levels of genetic variability provide species with a buffer against environmental change by increasing the likelihood that at least some individuals will survive (Pilczynska et al. 2016).

Many coastal habitats have isolated spatial patterns, highly changing environmental conditions and strong influence of the surrounding environment. The organisms that are able to survive in these ecosystems frequently experience strong selective pressures and constrictions on gene flow, which could contribute to increased genetic divergence among populations (Vergara-Chen et al. 2010). If natural populations consist of reduced numbers of individuals, the loss of genetic variability may dramatically influence the populations themselves, since genetically impoverished populations might fail to adapt to future environmental changes, eventually causing their disappearance.

The fragmentation of formerly continuous sand dune habitats is most likely leading to the local extinction of species and the loss of genetic diversity (Frey et al. 2015). Although there are only a few studies on genetic diversity for Mediterranean coastal species, an example of such a case with low genetic diversity levels is the Stachys maritima plant. It is a typical species of coastal dunes that has been subjected to severe fragmentation throughout the past century (Massó et al. 2016). Therefore, management programmes with the objective of enhancing the conservation status of the species need to consider connectivity patterns and gene exchange among populations in their planning (Palumbi, 2003).

Currently, more than 6,000 species living in the Mediterranean region, including all vertebrates and many invertebrates and plants, have been registered on the IUCN Red List of Threatened Species (IUCN RLTS). Among these, around 1,247 species are recorded as native and occurring in coastal terrestrial habitats, and 253 are endemic to the Mediterranean region.

Taxonomic Group	CR	EN	VU	NT	LC	DD	RE	EX	Total coastal taxa threatened	Total coastal taxa assessed	% of coastal species threatened in the Mediterranean region *
Vascular plants	**29**	**27**	**28**	**37**	**271**	**40**	**0**	**0**	**84**	**432**	**21%**
Vertebrates - Total	**19**	**15**	**29**	**49**	**458**	**13**	**2**	**1**	**63**	**586**	**11%**
• Freshwater Fish	9	2	0	1	42	5	0	0	11	59	20%
• Amphibians	2	1	3	6	33	1	0	0	6	46	13%
• Reptiles	2	5	6	16	59	1	0	0	13	89	15%
• Birds	3	3	12	19	255	0	0	1	18	293	6%
• Mammals	3	4	8	7	69	6	2	0	15	99	16%
Invertebrates (freshwater) - Total	**1**	**17**	**3**	**11**	**179**	**15**	**0**	**0**	**21**	**229**	**10%**
• Freshwater mol-luscs	0	2	1	1	21	6	0	0	3	31	12%
• Freshwater crabs, crayfish and shrimps	0	0	1	1	1	0	0	0	1	3	33%
• *Odonata* (dragonflies and damselflies)	0	0	0	1	48	1	0	0	0	50	0%
Invertebrates (insects) - Total	**1**	**15**	**1**	**8**	**109**	**8**	**0**	**0**	**17**	**145**	**12%**
• Butterflies	1	2	0	2	85	2	0	0	3	95	3%
• Dung Beetles	0	10	1	6	14	6	0	0	11	37	35%
• Saproxylic beetles	0	3	0	0	10	0	0	0	3	13	23%
Total	49	59	60	97	908	68	2	1	168	1247	14%

Table 10 - Conservation status of species inhabiting Mediterranean coastal habitats
based on the results of the extinction risk assessments of the IUCN Red List at a global and Mediterranean regional level. The IUCN Red List categories CR, EN and VU correspond to the number of species at risk of extinction. IUCN Red List categories: CR Critically Endangered, EN Endangered, VU Vulnerable, NT Near Threatened, LC Least Concern, DD Data Deficient, RE Regionally Extinct, EX Extinct.
*Mid-point (CR + EN + VU) / (assessed - EX - DD) Source: IUCN, 2018

At least 168 (14%) of the coastal species assessed in the IUCN RLTS (IUCN, 2018) (101 of which are endemic) are threatened with extinction at a global or regional level in the Mediterranean region *(Table 10)*. Half of the threatened coastal species are animals (84 species), with birds and insects (18 and 17 species) making up the greatest number of threatened animals. The other half are plants accounting for 84 threatened species.

In declining order, Spain, France, Italy and Morocco have the highest number of threatened species living in coastal habitats. Most of the threatened coastal birds are found in France and Spain, a high number of freshwater fish occur in Spain, and the highest number of threatened amphibians and reptiles are found in Spain and Italy. The highest number of threatened invertebrates and plants are also found in Spain and France. *Table 11* shows numbers of threatened coastal species by country.

3.2.4.1 Major pressures on coastal biodiversity

Analysis of the threats affecting 163 Mediterranean coastal species at risk of extinction in the IUCN Red List (IUCN, 2018) showed that tourism and recreation areas, urbanization, agriculture, livestock, recreational activities and invasive species are the main drivers of species extinction in coastal areas *(Figure 56)*.

In coastal lowlands, the Mediterranean has experienced urbanization and development associated with tourism for decades (Grenon & Batisse, 1989; Vogiatzakis et al. 2005). These include the reduction in plant diversity and the deterioration or destruction of coastal dunes by tourism infrastructure, the drainage of wetlands, which is leading to a loss of habitat for migratory birds and many other aquatic

Coastal taxa threatened in the Mediterranean region												
Countries	Amphibians	Aves	Reptiles	Mammals	Freshwater fish	Freshwater molluscs	Freshwater crabs, shrimps and crayfish	Butterflies	Dung beetles	Saproxylics	Plants	Total
Spain	**2**	**18**	**4**	5	4				**6**	2	22	**63**
France	1	**18**		6	1				5	**3**	**28**	**62**
Italy	**2**	16		3	2	1			4	2	19	**49**
Morocco		16	3	**9**				1	4	1	14	**48**
Greece		15	1	5	**5**			1			12	**39**
Algeria		14	2	7	1				1	2	9	**36**
Turkey	1	15	2	**9**	3		1	1			2	**34**
Israel	1	16	1	6		1					4	**29**
Croatia	1	14	1	4	3				1		3	**27**
Tunisia		12	3	6	1				1	1	2	**26**
Egypt		13	2	4					1		4	**24**
Montenegro	1	15	1	5	1				1			**24**
Syrian Arab Republic		12	2	6							4	**24**
Lebanon		10	2	6							2	**20**
Bosnia and Herzegovina	1	13	1	3								**18**
Slovenia	1	11		4							2	**18**
Albania		10		3	2				1			**16**
Malta		11							1		4	**16**
State of Palestine	1	9		2		1					3	**16**
Cyprus		12		2							1	**15**
Libya		10	1	1					1		1	**14**
Monaco		4		2								**6**

Table 11 - Number of threatened coastal species by country
The highest number of threatened species (under IUCN Red List categories CR, EN and VU at global and/or Mediterranean level) by taxonomic group in bold.
(Source: IUCN, 2018)

species. Water-related leisure activities damage aquatic plant communities (seagrass and coralligenous species) and sea turtle nesting areas.

The prospects of short-term financial gain from tourism often win out over securing biodiversity in the long term and maintaining ecosystem services. Furthermore, some of the endemic taxa in the hotspot are confined to islands and small river catchments and have a narrow genetic base, which reduces competitive abilities and limits dispersal opportunities, thereby increasing their vulnerability.

The composition of coastal ecosystems may change as a result of climate change, with a greater risk of extinction of species, especially those with a restricted climatic distribution, those that need highly specific habitats and/or small populations that are naturally more vulnerable to modifications to their habitats. Climate change is also expected to amplify biological invasions and the proliferation of pathogens and diseases, fostered by the rise in temperature of marine waters.

3.2.5 Invasive species in coastal ecosystems

Invasive Alien Species (IAS) are introduced species that out-compete native species and cause economic and ecological damage to natural ecosystems (IUCN SSC Invasive Species Specialist Group, 2000). They have been recognized as the second cause of species disappearance at a global level, behind habitat loss and deterioration, especially affecting islands and isolated ecosystems. The globalization of markets has raised the rate of introduction of non-indigenous species (NIS) everywhere, but only a small number of introduced non-native species have established themselves and caused detrimental ecological impacts (Genovesi & Shine, 2004).
It is not certain exactly how many non-native coastal species are present within the Mediterranean, although this is much better known for the marine environment than the terrestrial biome. On a regional scale, the number of terrestrial non-native animal and plant species seems to be quite low in comparison to the marine alien species invasions. Among the best-known examples are the brown

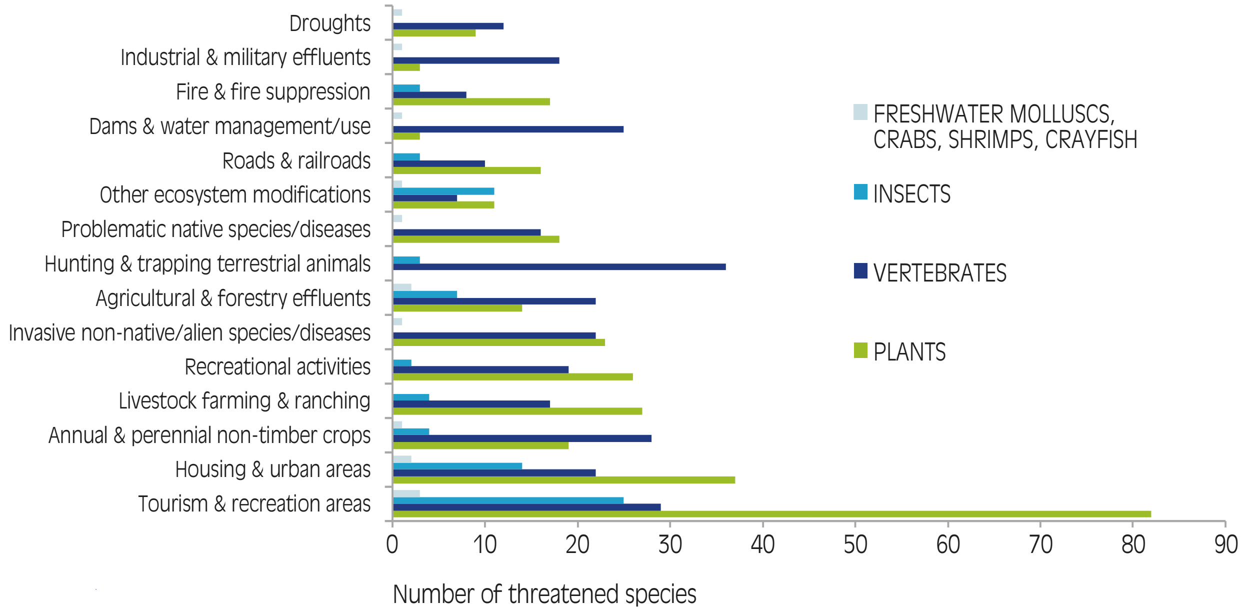


Figure 56 - Main threats affecting coastal species at risk of extinction (IUCN Red List Categories CR, EN and VU) in the Mediterranean region

rat, *Rattus norvegicus,* with strong negative effects on native fauna, particularly on islands; the red-eared slider turtle *Trachemys scripta elegans* in ponds; or the *Spartina patens* and *S. densiflora* cordgrass in Mediterranean marshes (Duarte et al. 2018; MIO-ECSDE, 2013).

Even well managed protected areas suffer from the introduction and settling of invasive alien species (Otero et al. 2013). Their effects on the biodiversity and habitats of the Mediterranean cannot be generalized, as alien species can cause very diverse effects at different locations and times, sometimes with a strong invasive component.

Several alien species are also affecting freshwater communities in the Mediterranean, endangering native species and altering ecosystem processes. Illustrative examples are the stone moroko fish, *Pseudorasbora parva,* and the brook trout, *Salvelinus fontinalis,* which are among the world's 100 most invasive species. Others like the tiger mosquito, *Aedes albopictus,* are also among the most invasive alien species in the region (MIO-ECSDE, 2013).

3.3 Marine ecosystems and biodiversity

3.3.1 Marine ecosystems

The Mediterranean basin is a globally unique biodiversity hotspot with high diversity and endemism of flora and fauna. It represents 0.3% of the global oceans' volume and hosts 4 - 18% of the identified global marine species. The complexity in the ecology of the Mediterranean Sea is mainly attributed to its geological history, combined with the diverse climate conditions prevailing in its different zones. These have resulted in the coexistence of many ecosystems with a wide range of extent and distribution.

Endemism, i.e. numerous species living exclusively in the Mediterranean, is a marked feature of marine biodiversity in the Mediterranean. It is greater in the Mediterranean than in the Atlantic (Bianchi & Morri, 2000). At biogeographical level, Mediterranean biota include 55 to 77% of Atlantic species (present in the Atlantic and the Mediterranean), 3 to 10% of pantropical species (species from the globe's hot seas), 5% of Lessepsian species (species from the Red Sea) and between 20 and 30% of endemics. This ratio of endemism varies with taxonomic groups *(Table 12)*: 18% for decapodal crustaceans, 27% for hydras, 40% for Rhodobionta (Plantae), 46% for sponges, 50% for ascidians, and 90% for nesting sea birds (Metazoa) (Boudouresque et al. 2009; Zenetos et al. 2017). These are basically neo-endemics such as the *Cystoseira* genus (Chromobionta, Stramenopiles), with over thirty species known in the Mediterranean, 20 of which are endemic, and to a lesser extent, paleo-endemics like species of the *Rodriguezella* genus (Rhodobionta, Plantae), the red coral *Corallium rubrum* (Metazoa, Opisthokont, and *Posidonia oceanica* (Magnoliophyta, Viridiplantae, Plantae) (UNEP/MAP SPA/RAC, 2010).

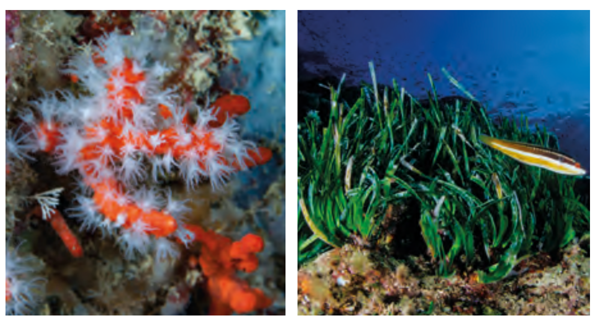


Figure 57 - Corallium rubrum *and* Posidonia oceanica

Phylum/class	Number of species in the Mediterranean	Number of endemic species	% of endemism
Echinodermata	134	32	24
Priapulida	1	0	0
Polychaeta Errantia	371	88	24
Echiura	6	1	17
Sipuncula	20	4	20
Brachiopoda	15	2	13
Mollusca	401	65	16
Crustacea Decapoda	286	52	18
Pogonophora	1	1	100
Phoronida	4	0	0
Hemichordata	5	2	40
Pisces	638	117	18
Total	1,882	364	19

Table 12 - Rate of endemism for some taxonomic groups in the Mediterranean
(Source: Boudouresque, 2004)

The most typical Mediterranean habitats lie in the coastal strip. These include *Lithophyllum byssoides* (e.g. *L. lichenoides* and *L. tortuosum*) rims in the medio-littoral stage, seagrass meadows, notably *Posidonia oceanica* meadows and Fucal forests (biocenoses with *Cystoseira*) in the infra-littoral stage, and coralligenous assemblages in the circa-littoral stage (Boudouresque, 2004; Zenetos et al. 2017). These habitats are also home to Vermetid platforms and the *Neogoniolithon brassica-florida* concretion (Boudouresque, 2004).

Seagrass meadows, coralligenous formations and beds and dark habitats (habitats where the absence of light precludes photosynthesis, from caves in the coastal strip

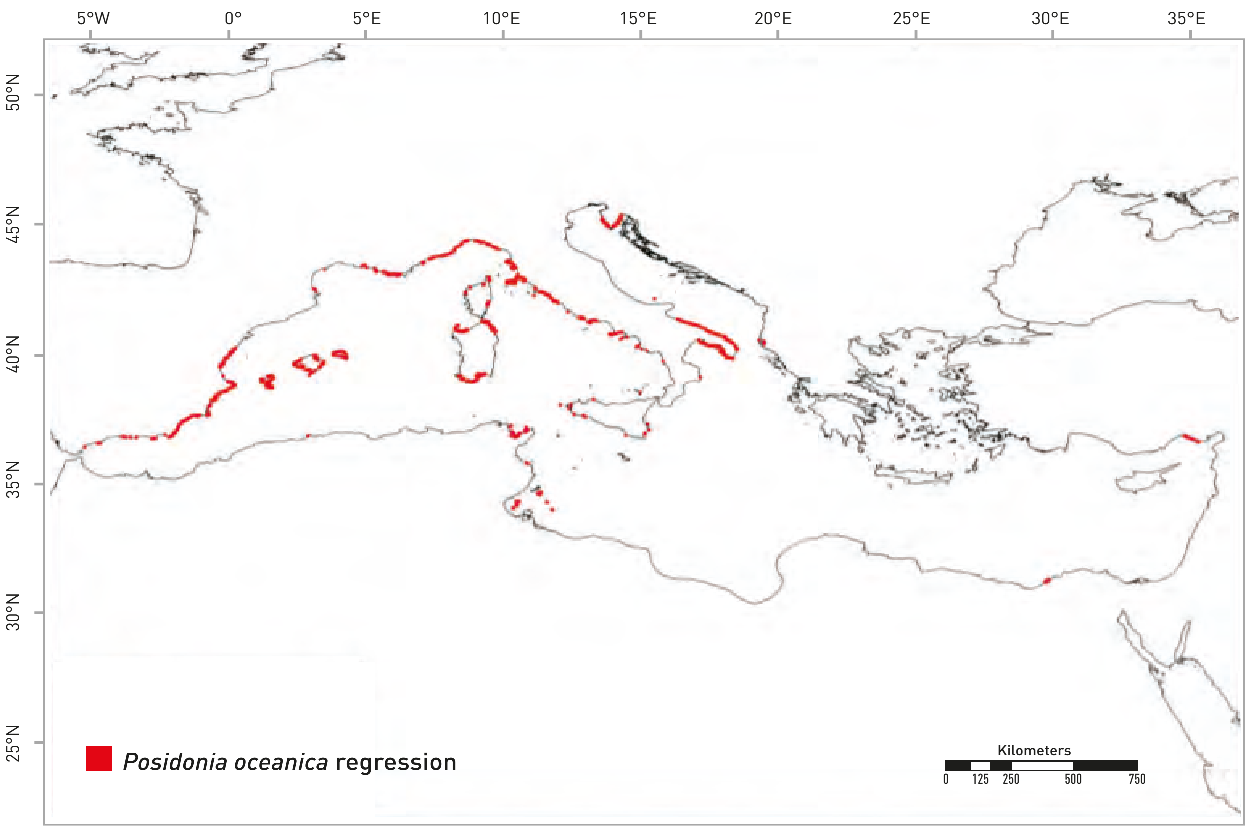


Figure 58 - Coastline regression of Posidonia oceanica *meadows over the last 50 years*
(Source: Telesca et al. 2015)

to deep seas in the open ocean) are among the components that are considered particularly representative of Mediterranean ecosystems. All of them are facing crucial conservation challenges, which prompted the Contracting Parties to the Barcelona Convention to adopt specific Action Plans for their conservation within the framework of joint coordinated efforts by all Mediterranean countries and partner organizations (further developed below).

Marine systems play a crucial role in the global carbon cycle by absorbing an important share of anthropogenic CO_2 from the atmosphere. The Mediterranean Sea acts as a net carbon sink and is responsible for sequestrating 0.7% of the total yearly emissions of the neighbouring countries (Melaku Canu et al. 2015). The value of the "blue carbon" sequestration made possible by the biological processes of the Mediterranean Sea is found to range between Euro 100 to 1,500 million per year for the whole basin. This represents a nature-based contribution to the efforts of climate change mitigation in the Mediterranean.

3.3.2 Seagrass meadows

There are five strictly marine seagrass species in the Mediterranean Sea: one is endemic (*Posidonia oceanica*), three are also found in the Atlantic Ocean (*Cymodocea nodosa, Zostera marina* and *Zostera noltii*) and one is a Lessepsian migrant (*Halophila stipulacea*) (Pergent et al. 2012).

3.3.2.1 Status and trends of seagrass meadows

Posidonia oceanica meadows are declining at alarming rates, with widespread regression throughout the Mediterranean Sea amounting to over 30% in the last 50 years (Telesca et al. 2015). The current spatial extent of *P. oceanica* is estimated at 1,224,700 hectares, with data gaps, especially in the south-eastern part of the basin. The most extensive meadows are found in the Gulf of Gabès (Tunisia), the Hyères and Giens bays (France), the eastern coast of Corsica, and the western coast of Sardinia and Sicily (Boudouresque, 2004). The regression of the meadows results from the impact of multiple anthropogenic pressures such as mooring, fishing, excessive sand and organic matter discharge and climate change (Pergent et al. 2012; Telesca et al. 2015). *Figure 58* shows the coastline regression of *P. oceanica* meadows over the last 50 years.

Cymodocea nodosa covers the second largest area in the Mediterranean Sea after P. oceanica and is found all over the Mediterranean basin, in the Sea of Marmara and in the Atlantic. Local regressions of *Cymodocea nodosa* have been recorded, however the species has taken advantage of the regression of *P. oceanica* in other areas, meaning that the trend in the species distribution is not as clear as for *P. oceanica*.

Zostera marina is the most widely distributed seagrass species at the global level (Green, Short & Frederics, 2003), although it is relatively rare in the Mediterranean, only growing very locally (mainly in the North-Western Mediterranean, the Adriatic, and the Aegean Sea) (Pergent et al. 2012). *Zostera marina* is a cold-affinity species and is therefore expected to regress in the Mediterranean Sea as a result of sea temperature increase. The species has already shown some indication of retreat from certain sites in the basin.

Zostera noltii in the Mediterranean is confined to coastal lagoons, the innermost part of some sheltered bays and small harbours, especially in the Western Mediterranean, the Adriatic, Greece, the Syrian Arab Republic and Egypt) (UNEP/MAP SPA/RAC, 2010). Although this species demonstrates high resilience, cases of regression have been reported and related to changes in salinity or nutrient enrichment (Bernard, Boudouresque & Picon, 2007; Shili et al. 2007).

Halophila stipulacea has colonized a large part of the Eastern Mediterranean basin (Fritsch, 1895).

3.3.2.2 Ecosystem services

When dried, seagrass meadows are used as a material for roof isolation, industrial waste absorbent, food for livestock or compost, and a bioindicator. They provide other ecosystem services when in the sea, such as water purification by filtration, coastline erosion protection, habitat for species, water oxygenation, nutrient cycling and carbon sequestration (Campagne et al. 2015). One of the greatest values of *P. oceanica* is that it acts as a reservoir for carbon accumulated over millennia, thereby mitigating the impact of global climate change (Pergent et al. 2014).

3.3.2.3 Major pressures

The main regressions of marine seagrass meadows recorded in the Mediterranean are related to shore restructuring, the management of living resources (fisheries and aquaculture), solid and liquid waste, the development of pleasure boating and tourism (cruises) and the introduction of exotic species. The rising water temperature and sea level rise could explain certain regressions (Marbà & Duarte, 2010).

The ecological characteristics of seagrass species in the Mediterranean enable them to cover a wide range of conditions, and their sensitivity to anthropogenic pressures also differs (Boudouresque et al. 2009). While *Posidonia oceanica* constitutes the "climax" species for a large proportion of Mediterranean shorelines, *Cymodocea nodosa* and, to a lesser extent, *Zostera noltii*, can constitute pioneer species in the succession, allowing for the settlement of *Posidonia oceanica* meadows (Boudouresque et al. 2016). Furthermore, when environmental conditions become unfavourable for one species, it may be replaced by another. However, while *Posidonia oceanica* can be replaced by native species, it can also be replaced by "introduced" species (Montefalcone et al. 2010). These substitutions by species with weaker structuring capacities may trigger profound changes within the communities.

3.3.2.4 Management of seagrass meadows

There has been an increasing interest and effort by Mediterranean countries over the last 20 years to protect seagrass meadows, especially the endemic and emblematic species *P. oceanica*. Seagrass meadow conservation is a priority target in international environmental directives, both at the Mediterranean level (Action Plan for the Conservation of Marine Vegetation in the Mediterranean Sea, SPA/RAC) and the European level (1992 Habitats Directive and 2000 Water Framework Directive). Fishing restrictions and sustainable alternative techniques for mooring have been set up in parts of the basin. However, stricter regulations and controls on trawling and mooring, especially at sea, are needed to ensure recovery and protection of the meadows. Pressure reduction, namely when building coastal infrastructure (harbours, sea walls, etc.) and discharging wastewater effluents, should take the ecosystem services provided by seagrass meadows into consideration. Successful examples of *P. oceanica* meadow protection resulted from the efforts of the Posidonia Surveillance Network established in the Provence-Alpes-Côte d'Azur Region in France in 1984, with the dual objective of (i) monitoring the long-term evolution of the state of Posidonia meadows, and (ii) using these meadows as a biological indicator of the overall quality of coastal waters.

3.3.3 Coralligenous ecosystems

3.3.3.1 State and trends of coralligenous ecosystems and associated biodiversity

Coralligenous assemblages are biological formations that are one of the most representative components of Mediterranean marine biodiversity. They are biogenic constructions present in many Mediterranean areas. The most recent estimates of their extent show that coralligenous outcrops cover around 2,760 km^2 and the maerl beds, another coralligenous component, cover around 1,655 km^2. Knowledge of the distribution, species composition and functioning of coralligenous and other calcareous bio-concretions remained fragmentary for a long time. Recent technical advances have made it possible to acquire more data on coralligenous ecosystems. Several coralligenous-rich sites have been identified and inventoried as areas of interest for conservation. In addition, it has been possible to highlight the negative effect of certain human activities, which is expected to be exacerbated by the interdependent effects of climate change and growing human pressure. Considering the ecological and natural heritage value of Mediterranean coralligenous assemblages, several international bodies have issued recommendations and adopted conservation and management measures targeting these assemblages (Barcelona and Bern Conventions).

Figure 59 - Womersleyella setacea *and* Caulerpa taxifolia

3.3.3.2 Ecosystem services

Coralligenous assemblages contribute to carbon storage and generate a remarkable natural productivity which contributes to the maintenance and development of fisheries resources. Numerous species (more than 1,700 species, i.e. 15 to 20% of Mediterranean species) use coralligenous environments as feeding, breeding or nursery grounds, including species of commercial interest for fisheries and endangered or threatened species. Furthermore, they are attractive for scuba diving activities, thereby supporting, in some Mediterranean areas, important recreational economic activities whose existence depends on the presence and the state of conservation of these assemblages.

3.3.3.3 Major pressures

The main pressure on coralligenous assemblages comes from the destructive effect of some fishing gear, such as bottom trawls or gill nets, as well as from boat anchoring systems (anchors and anchor chains) that exert mechanical aggression on coralligenous formations.
In addition, cases of invasion by invasive non-indigenous species have been recorded in some Mediterranean areas, where they covered the coralligenous beds, hindered their normal development and thus caused the regression of the assemblages. These invasive species include algae such as *Womersleyella setacea, Acrothamnion preissii, Asparagopsis taxiformis* and *Caulerpa taxifolia*.

Like the rest of the marine environment, coralligenous assemblages are affected by pollution and climate change (refer to chapter 2). Mass mortality events of species have been reported in recent years in depths of 30 to 40 metres and have been attributed by scientists to disturbances in the position of the thermocline, under the influence of marine water warming.

The simultaneous effects of multiple stressors - such as pollution, siltation, destructive fishing practices, anchoring, scuba diving, biological invasions, anomalies in the seawater temperature regime, etc. - generate irreversible consequences for these fragile biological formations.

3.3.3.4 Management of human activities impacting coralligenous ecosystems

Given the relatively limited knowledge about the geographical distribution of coralligenous habitats, as well as about the actual level of damages they undergo, priority should be given to (i) improving current knowledge to fill gaps in information about the occurrence of coralligenous communities (ii) promoting the use of standard methods for the inventory and monitoring of sites with coralligenous assemblages, (iii) capacity building in Southern and Eastern Mediterranean countries to improve skills in habitat mapping and (iv) information sharing /exchange among Mediterranean countries about the occurrence of invasive species that have the potential to negatively impact coralligenous ecosystems.

The Action Plan for the Conservation of Coralligenous and other Calcareous Bio-concretions in the Mediterranean was adopted by the Contracting Parties to the Barcelona Convention in 2016, including the following conservation and management activities:

- Drafting of a reference list of species that are found in coralligenous outcrops;
- Promotion of taxonomic identification of species constituting these assemblages through an inventory of taxonomist experts and researchers/institutions working in the field;
- Drafting of standardized methods for the inventory and monitoring of coralligenous assemblages;
- Mapping of sites with coralligenous formations, with a view to establishing Marine Protected Areas.

3.3.4 Dark habitats

3.3.4.1 Status and trends of Dark habitats and linked biodiversity

Dark habitats are one of the fragile components of Mediterranean marine biodiversity. They occur in deep zones as well as in areas with very limited luminosity, and are usually associated with specific geomorphological structures such as underwater caves, slopes and abyssal plains.

Since the absence of photosynthetic processes in these environments does not allow for the presence of herbivores, the species forming the biocenosis in dark habitats are mainly filter feeders, scavengers and carnivores. Unlike the Atlantic, the Mediterranean deep waters are characterized by the absence of typical deep-sea species (bathypelagic species like the foraminifera, *Xenophyophorea,* the sponges, *Hexactinellidae,* the sea cucumber of the *Elasopodida* order, etc.) (Gianni, 2004; Zenetos et al. 2017). Mediterranean deep-sea life forms are essentially eurybathic (wide depth range) species. Other faunistic groups (decapodal crustaceans, mysidacea, echinoderms and gastropods) are much less represented in the deep sea. The macrofauna of the Mediterranean deep sea is dominated by fish and decapodal crustaceans. Differences exist between the Western and Eastern Mediterranean in both specific composition and abundance. The species of macrofauna are typically smaller than those of the Atlantic. The meiofauna is less abundant in the Eastern Mediterranean.

In the deep sea, the rate of endemism for many taxa (i.e. 48% for amphipods) is clearly higher than the average endemism rate in the Mediterranean (UNEP/MAP SPA/RAC, 2010).

In the Mediterranean, dark habitats are the least surveyed elements of the marine environment, and the measures for their conservation and management remain very limited, in particular because of the substantial gaps in knowledge about the distribution and the extent of these marine habitats. Work published by the World Wide Fund for Nature (WWF) and the IUCN (Gianni, 2004) presents a broad overview of deep-sea ecosystems in the Mediterranean. The bathyal and abyssal zones cover respectively approximately 60% and 10% of the total surface area of the Mediterranean Sea (UNEP/MAP SPA/RAC, 2010). Deep-sea Mediterranean habitats include underwater canyons, chemosynthetic communities, cold water corals, seamounts and deep hypersaline habitats (UNEP/MAP SPA/RAC, 2010).

Mediterranean underwater canyons represent, for many species, places for reproduction and feeding (fish, cetaceans like *Grampus griseus* and *Physeter macrocephalus*). They are a remarkable reservoir of endemism (jellyfish, *polychaetes*).

Chemosynthetic communities are characterized by symbiosis between invertebrates and chemotrophic bacteria, which can synthesize the first organic molecules from carbonic gas and nutritive salts, using the energy freed by the chemical transformation of certain compounds of the hydrothermal fluid, in particular hydrogen sulphide, in hydrothermal springs. Their interest lies in their originality and rarity in the Mediterranean. These habitats are found in Southern Crete, Southern Turkey (Anaximander Seamounts) and off the coast of Egypt and Gaza (CIESM, 2003).

Cold water corals are habitats of great ecological value, threatened by deep-sea trawling and the effects of global warming (CIESM, 2003).

Seamounts are underwater mountains that emerge from the seabed and represent essential habitats for the life cycles of several species. They have high density levels of macro- and megafauna and a high rate of endemism (i.e. *hydrozoa*). They are also feeding places for many fish species and cetaceans. These habitats occur mainly in the Alboran Sea (Spain), the Balearic Sea (Spain), the Gulf of Lion (France) and in the abysses of the Ionian Sea.

Deep hypersaline habitats, known as brine pools, are important for biodiversity, particularly for extremophilic bacteria and metazoan meiofaunal assemblages (Gianni, 2004). Little data exists on these habitats, but they are considered to be important as they are specific to the Mediterranean (CIESM, 2003).

3.3.4.2 Ecosystem services

Besides their importance as natural heritage, dark habitats provide valuable services, in particular by supporting commercial fishing resources and through their role in the biogeochemical cycles sustaining the balance of the marine trophic chain (cycles of nitrogen, phosphorus, carbon, sulphur, etc.). For example, marine canyons play a very important role in the continents/oceans exchanges and are one of the main paths for surface/bottom transfers of energy and matter.

3.3.4.3 Major pressures

Land-based sources of pollution and other kinds of pressures generate the major impacts on dark habitats that may even reach those located in the deeper zone. The coastal river inputs significantly contribute to nutrient enrichment, marine acidification and the local disturbance of seawater temperature recorded in some dark habitats. The increasing oil and gas activities in Mediterranean deep zones constitute other sources of pressures for dark habitats, mainly drilling operations and the laying of pipelines. Furthermore, recent deep-sea surveys conducted in the Mediterranean revealed the increasing pollution of these habitats by solid waste, including lost or abandoned fishing gear and plastic containers/debris of terrestrial origin (Fabri et al. 2014; and others cited by Werner et al. 2016).

3.3.4.4 Management of human activities impacting dark habitat ecosystems

For decades, dark habitats, particularly those located in deep-sea zones in the Mediterranean, remained without any conservation or management measures. Following alerts from scientists and several conservation organizations, there is a growing awareness of the need to preserve such environments. One of the concrete measures taken was the ban decided by the General Fisheries Commission for the Mediterranean (GFCM) concerning the use of towed fishing gear in depths exceeding one thousand meters. Furthermore, several field surveys were undertaken to collect data about marine canyons, which led to the declaration of protected areas covering some of these sites; the declaration processes are still underway for others.
Nevertheless, preserving dark habitats remains a crucial challenge for the Mediterranean Sea. Its success requires additional efforts to improve knowledge concerning these environments and to overcome the technical and legal challenges faced, in particular, in areas beyond national jurisdictions.

3.3.5 Genetic diversity and threatened species of marine ecosystems

The Mediterranean Sea counts more than 17,000 marine species and contributes to an estimated 4 to 18% of the world´s marine biodiversity (Bianchi & Morri, 2000; Coll et al. 2010). Around 694 of the species assessed for the IUCN Red List in the Mediterranean are native and occur in the Mediterranean Sea, and 68 of them are endemic.

Past changes in oceanographic conditions in the Mediterranean Sea have influenced the current patterns of biodiversity and the genetic structure of species due to changes in environmental conditions over time (Coll et al. 2010). Differences between the western and eastern basins of the Mediterranean Sea, as the latter is more oligotrophic and warmer but less biodiverse than the western basin, coincide with the genetic boundaries described for various species, including seagrasses (Alberto et al. 2008, Chefaoui, Duarte & Serrão, 2017), fish (Bahri-Sfar et al. 2000), sea cucumbers (Valente, Serrão & González-Wangüemert, 2015), and bivalves (Nikula & Väinölä 2003).

Recovery from fragmentation or mass mortality events, whether natural or human induced, may be critical for some species in the Mediterranean Sea[39]. This is the case

Taxonomic Group	CR	EN	VU	NT	LC	DD	EX	Total of marine threatened taxa	Total marine taxa assessed	% estimated marine species threatened in the Mediterranean region (Mid-point)*
Anthozoa	1	9	7	10	40	69	0	17	138	25%
Marine fish (Bony fish)	1	3	7	8	316	120	0	11	455	3%
Marine fish (Cartilaginous fish)	20	11	9	10	12	13	0	40	75	65%
Marine mammals	1	3	3	0	3	7	0	7	18	64%
Marine reptiles	1	1	1	0	1	0	0	4	4	75%
Marine plants	0	0	0	0	4	0	0	0	4	0%
Total	**24**	**27**	**28**	**28**	**376**	**209**	**0**	**78**	**694**	**11%**

Table 13 - Conservation status of species inhabiting Mediterranean marine habitats
based on the results of the extinction risk assessments of the IUCN Red List at the global and Mediterranean regional level. IUCN Red List categories CR, EN and VU correspond to the number of species at risk of extinction. IUCN Red List categories: CR Critically Endangered, EN Endangered, VU Vulnerable, NT Near Threatened, LC Least Concern, DD Data Deficient, RE Regionally Extinct, EX Extinct.
*Mid-point (CR + EN + VU) / (assessed - EX - DD) Source: IUCN, 2018

[39] https://www.iucn.org/news/mediterraneo/201807/emergency-situation-pen-shells-mediterranean

of the pen shell, *Pinna nobilis*, a listed endangered species in the Mediterranean Sea (Barcelona Convention, SPA/BD Protocol, Annex 2) that has recently experienced mass mortality across the Mediterranean Sea. The high genetic diversity and low inter-population differentiation have strong consequences for the conservation of this species, as they directly influence how the species could naturally recover from the P. nobilis populations located elsewhere (Wesselmann et al. 2018).

At least 78 (11%) of the marine species assessed in the IUCN RLTS (68 of which are endemics) are threatened with extinction at the global or regional level in the Mediterranean region *(Table 13)*. Cartilaginous fish constitute the group with the highest number of threatened species (40 species), followed by anthozoa with 17 threatened species. The estimated percentages of threatened species by group indicate that reptiles and cartilaginous fish have the highest percentages of threatened species (75% and 65% of species), followed by marine mammals (64%).

The highest numbers of threatened species living in Mediterranean marine habitats are recorded in France, Spain, Italy and Greece, in decreasing order. Most of the threatened cartilaginous and bony fish are found in France. Threatened anthozoa are predominantly recorded in Greece, while many threatened marine mammals are found in Spain and Morocco *(Table 14)*. Although the assessed species represent an important percentage of Mediterranean biodiversity, there is no certainty that the high numbers of threatened species coincide exactly with the true distribution of the various taxa in the Mediterranean, and could instead be a function of the research efforts in certain regions.

3.3.5.1 Major pressures to marine biodiversity

Analysis of the threats affecting 77 Mediterranean marine species at risk of extinction in the IUCN Red List (categories CR, EN and VU) (IUCN, 2018) showed that fishing

	Marine threatened taxa in Mediterranean region					
Countries	Anthozoa	Marine Fish (Bony fish)	Marine Fish (Cartilaginous fish)	Marine Mammals	Marine Reptiles	Total
Spain	15	10	38	7	2	72
Italy	15	9	37	6	1	68
Greece	16	8	33	6	1	64
France	11	9	36	6	1	63
Croatia	11	8	30	6	1	56
Morocco	7	7	34	7	1	56
Algeria	9	7	33	6		55
Tunisia	8	8	31	6	1	54
Turkey	10	8	28	6	1	53
Albania	5	7	30	6	1	49
Montenegro	5	6	29	6	1	47
Egypt	2	7	26	6	3	44
Libya	2	7	27	6	1	43
Slovenia	4	8	25	5	1	43
Israel	3	6	26	5	2	42
Cyprus	3	7	22	6	2	40
Syrian Arab Republic	2	6	23	6	1	38
Lebanon	2	6	22	6	1	37
Malta	9	6	16	6		37
Bosnia and Herzegovina	1	3	23	6	1	34
Monaco	3	8	8	5		24
State of Palestine			12	3		15

Table 14 - Number of marine threatened taxa by Mediterranean country
(Source: IUCN, 2018)

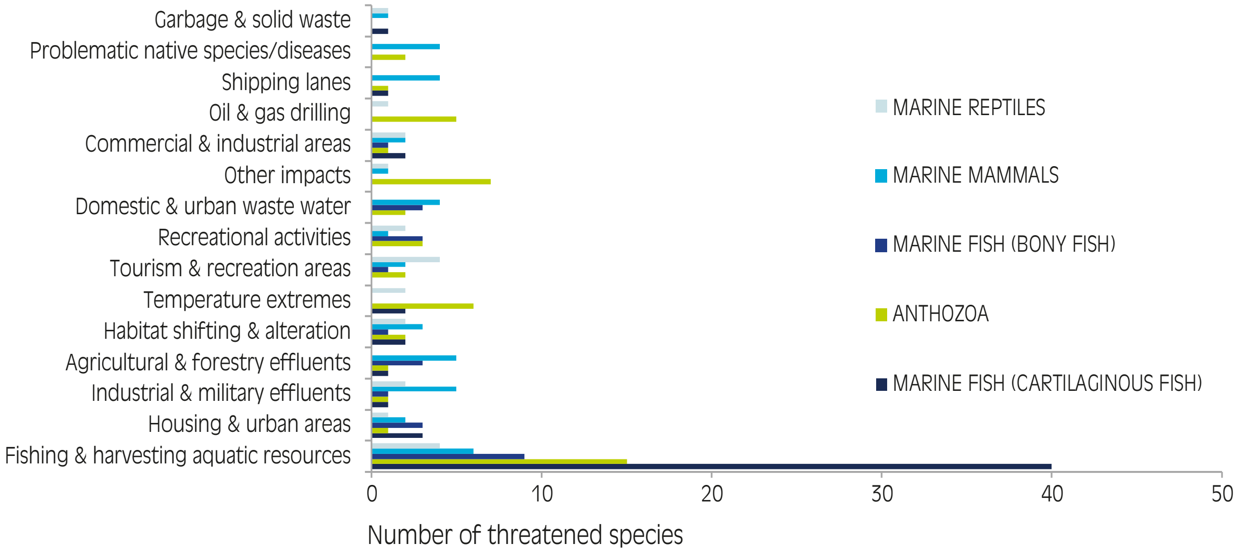


Figure 60 - Main threats affecting Mediterranean marine species at risk of extinction (IUCN Red List Categories CR, EN and VU) in the Mediterranean region

(overfishing, bycatch and impact damage on habitats) is the main driver increasing the species extinction risk. Other important threats are urbanization, pollution and climate change *(Figure 60)*. As human populations and levels of consumption increase, overfishing presents a growing threat to the region's fish diversity, with potentially significant indirect impacts on other species through, for example, depletion of food supply. For example, bottom trawling fisheries are identified as the main cause of the decline of the Maltese skate, *Leucoraja melitensis*, or the bamboo coral, *Isidella elongata*, by 80%, making both native species critically endangered and at risk of extinction (Dulvy et al. 2016; Dulvy & Walls, 2015; Otero et al. 2017).

3.3.5.2 Management

Under the Convention on Biological Diversity (CBD), Ecologically or Biologically Significant Marine Areas (EBSAs) are areas deserving management to ensure their sustainability using seven scientific criteria. These criteria

EBSA name	Countries
North Aegean	Greece, Turkey
Northern Adriatic	Italy, Slovenia, Croatia
Sicilian Channel	Italy, Tunisia, Malta
Akamas and Chrysochou Bay	Cyprus
East Levantine Canyons (ELCA)	Lebanon, Syrian Arab Republic
Gulf of Sirte	Libya
Nile Delta Fan	Egypt
Hellenic Trench	Greece, Turkey
North-East Levantine Sea	Greece, Turkey, Cyprus, Syrian Arab Republic
Gulf of Gabès	Tunisia
North-western Mediterranean Benthic Ecosystems	Spain, France, Monaco, Italy
Jabuka/Pomo Pit	Italy, Croatia
North-western Mediterranean Pelagic Ecosystems	Spain, France, Italy
Central Aegean Sea	Greece, Turkey
South Adriatic Ionian Straight	Italy, Montenegro, Albania

Table 15 - Ecologically or Biologically Significant Marine Areas (EBSAs) considered by the CBD Conference of the Parties in the Mediterranean Sea

were adopted at the 9th Conference of the Parties to the Convention on Biological Diversity in 2008[40]. The criteria are (i) uniqueness or rarity, (ii) special importance for life history stages of species, (iii) importance for threatened, endangered or declining species and/or habitats, (iv) vulnerability, fragility, sensitivity, or slow recovery, (v) biological productivity, (vi) biological diversity, and, (vii) naturalness. An EBSA process has been performed in the Mediterranean and has provided a list of 17 defined areas, 15 of which have been agreed upon by the countries to be officially listed in CBD Repository (*Table 15/Figure 61*). In 2010, the 10th Conference of the Parties to the Convention on Biological Diversity "Encourages Parties, other Governments and competent intergovernmental organizations to cooperate, as appropriate, collectively or on a regional or subregional basis, to identify and adopt, according to their competence, appropriate measures for conservation and sustainable use in relation to ecologically or biologically significant areas [...][41]" .

The Vulnerable Marine Ecosystem (VME) concept emerged from discussions at the United Nations General Assembly (UNGA) and gained momentum after UNGA Resolution 61/105 in 2006. The FAO International Guidelines for the Management of Deep-sea Fisheries in the High Seas (FAO DSF Guidelines) build on the resolution and provide details on the VME concept for fisheries management. In order to identify VMEs, five criteria have been agreed upon: (i) uniqueness or rarity, (ii) functional significance of the habitat, (iii) fragility, (iv) life-history traits of component species that make recovery difficult, and (v) structural complexity.

For the Mediterranean, the General Fisheries Commission for the Mediterranean (under the FAO) is developing a process for identifying, recording, declaring and managing VMEs in the region. A list of species that may contribute to forming VMEs has been prepared and a protocol has been proposed for VME identification and registration.

Concerning habitats, the IUCN is developing a methodology similar to the Red List of Species that will provide a classification of the status of ecosystems. Using this methodology, a recent project (2016 to 2017) developed by the European Union covered the Mediterranean waters of European countries and provided a provisional assessment of the existing benthic habitats on the continental platform (0 to 200 m). For the 47 habitats considered, the study indicates that none are critically endangered, 5 are endangered, 10 are vulnerable, 5 are near threatened, 4 are of least concern and 23 are data deficient. This last figure confirms that knowledge about the Mediterranean is still

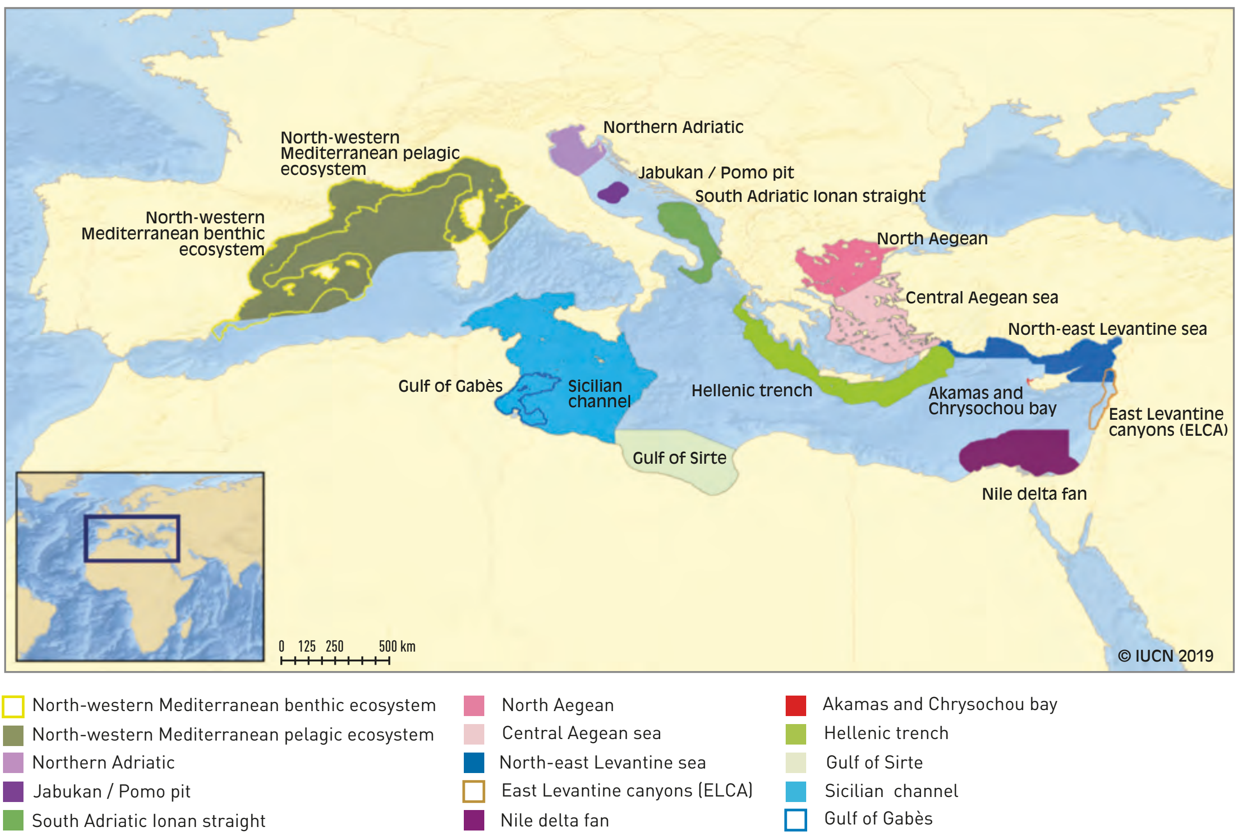


Figure 61 - Ecologically or Biologically Significant Marine Areas (EBSAs) considered by the CBD Conference of the Parties in the Mediterranean Sea

[40] CBD Decision IX/20, Annex I.
[41] CBD Decision X/29, para. 32

limited and that any assessment fails to represent the full reality, supporting a precautionary approach.

Some specialized organizations, such as the Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic Area (ACCOBAMS), have developed or are developing their own system for identifying critical habitats for the survival of species, considering the threats. Cetacean Critical Habitats (CCH) have been described in the Mediterranean and are helping countries to reduce the potential impacts by developing site-specific conservation plans. A similar approach has been taken by BirdLife for identifying Important Bird and Biodiversity Areas (IBAs).

Concerning threatened and endangered species, Annexes II and III of the SPA/BD Protocol of the Barcelona Convention are considered as reference lists of species in need of special care in the Mediterranean. These lists are regularly reviewed and, where necessary, amended through a process based on the expertise available at the national level as well as with the relevant intergovernmental organizations (IGOs) and non-governmental organizations (NGOs). The most recent amendment to these lists[42] concerns endangered and threatened species in the Mediterranean, including 163 species (Mammalia, Aves, Reptilia, Pisces, Echinodermata, Crustacea, Mollusca, Bryozoa, Cnidaria, Porifera, Rhodophyta, Heterokontophyta, Chlorophyta, Magnoliophyta).

As remarked by Boero (2015) and Templado (2014), Mediterranean marine ecosystems are going through important modifications with the following general trends:

- **Tropicalization:** non-indigenous species of warm-water affinity (tropical) are becoming increasingly established;
- **Meridionalization:** species that usually thrive in the southern part of the basin are expanding northwards, adding to tropical ones in changing northern biota;
- **Impairment of cold-water engines:** the Eastern Mediterranean Transient showed that, in a period of global warming, cold engines might fail to renew deep Mediterranean waters, with vast consequences on Mediterranean Sea ecosystems;
- **Changes in the phenology of species:** reproductive patterns are modified by different thermal conditions, whereby species of warm-water affinity have greater opportunities to grow and thrive than species of cold-water affinity;
- **Species extinction:** cold-water species will be pushed into deeper waters and their surface populations have already suffered severe mass mortalities, with a risk of extinction, although some of them may adapt to the new conditions (Boero, 2013);
- **Less fish, more jellyfish and jellyfish eaters:** the fish-jellyfish transition is already happening at a world scale, with a predicted potential increase in predators like sunfish and sea turtles;
- **Habitat destruction:** the cumulative effects of land-based human activities, along the watershed (e.g. pollution) and at the land-sea interface (e.g. maritime infrastructure) greatly contribute to habitat destruction (Claudet & Fraschetti, 2010).

BOX 18

The ACCOBAMS survey initiative, a Mediterranean large-scale survey for collecting new data on cetaceans, marine macrofauna and marine litter

The Mediterranean Sea is exceptionally rich in marine megafauna, and regularly or occasionally hosts more than 20 species of cetaceans, about half of which are considered threatened or with insufficient data.

Cetacean populations are subject to high anthropogenic pressures and benefit from particular attention from Mediterranean States willing to better coordinate actions in their favour. Coordinated by the Permanent Secretariat of the Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic Area (ACCOBAMS), the ACCOBAMS Survey Initiative (ASI) aims to establish an integrated, collaborative and coordinated monitoring system regarding the status of cetacean populations.

During the summer of 2018, an unprecedented large-scale synoptic survey combining visual and passive acoustic monitoring methods was conducted across the whole Mediterranean *(Figure 62)*. The ASI Survey represented a considerable logistical and administrative challenge, involving over 100 scientists from the region and beyond, mobilizing 6 ships and 8 aircraft, and more than 30 national and international partners who collaborated in this very unique effort. The ASI survey followed a multi-species approach, with cetaceans as primary targets, collecting data on elasmobranchii, sea turtles, seabirds and other mega-vertebrates, but also on anthropogenic pressures such as marine litter.

Analysis of the ASI data was conducted collectively in 2019, with the aim of developing accurate mapping of cetacean population distribution and abundance. The results of this survey will be cross-referenced with existing data on relevant indicators and will confirm existing areas of interest for cetacean conservation and potentially identify new ones (Cetacean Critical Habitats, Important Marine Mammal Areas - IMMAs). The results of this large-scale survey will also support the formulation and adoption of conservation actions, including MPAs. The ASI has proven to be a unifying project, both in terms of biodiversity conservation and for national capacity building around the Mediterranean. For the first time, all Mediterranean countries have collaborated in order to implement this unique biodiversity conservation effort.

[42] Through Decision IG23/10 that amended Annex II of the SPA/BD Protocol.

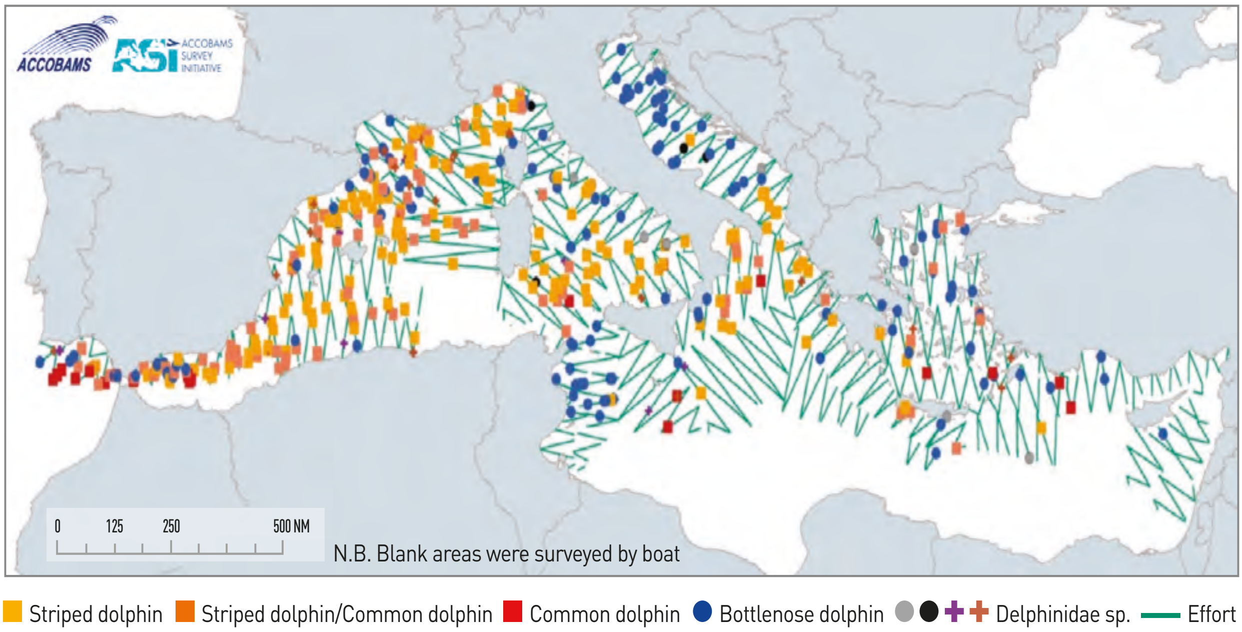


Figure 62 - ASI aerial observations of small cetaceans (summer 2018)

3.3.6 Invasive species in marine ecosystems

The Ecosystem Approach (EcAp) recognizes that to achieve good environmental status, "non-indigenous species introduced by human activities [must be] at levels that do not adversely alter the ecosystem". A total of more than 1,000 non-indigenous marine species were recorded in the Mediterranean, of which 618 are established (UNEP/MAP, 2017). Of those established species, 106 have been flagged as invasive. These estimates exclude vagrant species and species that have expanded their range without human assistance through the Strait of Gibraltar. The increase in the introduction rate goes back to recent decades and is attributed by specialists to the intensification of some human activities, such as shipping, and also to the global changes that have started to result in more favourable conditions that have facilitated the settlement of viable populations of alien tropical marine species in the Mediterranean.

Some of these non-native species proved to be invasive as per the CBD definition[43]. An assessment published in 2014 (Katsanevakis et al. 2014) concluded that 64 invasive species were reported to occur in the Mediterranean. The most represented groups were crustaceans (23 species), followed by molluscs (20 species) and macroalgae (16 species).

The introduction paths of non-native species to the Mediterranean include natural communication openings, but there is scientific evidence that most alien species recorded in the Mediterranean entered through corridors. Other introduction paths were also identified, in particular, ballast water and aquaculture.

Besides their impacts on the ecosystems, several macroalgae (e.g.: *Codium fragile, Gracilaria vermiculophylla, Grateloupia turuturu, Sargassum muticum, Undaria pinnatifida*) were reported to cause negative economic impacts on aquaculture and fishing by fouling shellfish aquaculture facilities, invading shellfish beds and obstructing dredges and other towed fishing gear. Cases of decline in commercial stocks due to direct predation or competition for resources by invasive species were also reported and affected several groups, such as decapods (*Homarus americanus* and *Paralithodes camtschaticus*), fish species (*Fistularia commersonii, Neogobius melastomus, Saurida undosquamis, Liza haematoche, Siganus luridus* and *S. rivulatus*), bivalves (*Crassostrea gigas* and *Pinctada imbricata radiata*) and gastropods (*Urosalpinx cinerea* and *Rapana venosa*). *Table 16* shows the number of marine non-indigenous species reported to generate significant adverse impacts on ecosystem services and biodiversity in 2014.

Management of invasive species

Given the seriousness of the issue of biological invasion by marine non-indigenous species, in 2003, the countries around the Mediterranean Sea adopted the Action Plan concerning Species Introductions and Invasive Species under the Barcelona Convention. To assist countries in implementing the Action Plan, SPA/RAC worked in consultation with Mediterranean experts to develop two

[43] CBD Definition of Invasive Alien Species: plants, animals, pathogens and other organisms that are non-native to an ecosystem, and which may cause economic or environmental harm or adversely affect human health. In particular, they impact adversely upon biodiversity, including decline or elimination of native species - through competition, predation, or transmission of pathogens - and the disruption of local ecosystems and ecosystem functions.

Phylum	Number of species	Phylum	Number of species
Crustacea	18	Cnidaria	3
Mollusca	18	Ascidiacea	3
Macroalgae	15	Tracheophyta	3
Fish	8	Bryozoa	2
Polychaeta	5	Ctenophora	2
Dinophyta (Myzozoa)	4	Haptophyta	1
Ochrophyta	3		

Table 16 - Number of marine non-indigenous species reported to generate significant adverse impacts on ecosystem services and biodiversity
(Source: compiled from Katsanevakis et al. 2014)

technical tools: "Guidelines for controlling the vectors of introduction into the Mediterranean of non-indigenous species and invasive marine species", and the "Guide for risk analysis assessing the impacts of the introduction of non-indigenous species". Furthermore, the Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea (REMPEC) and Regional Activity Centre for Specially Protected Areas (SPA/RAC) collaborated to develop the Mediterranean Strategy on Ships' Ballast Water Management, whose objective is to facilitate

BOX 19

Introduction of alien species via maritime transport

Shipping is a pathway for non-indigenous species introduction in the Mediterranean Sea via both ships' ballast water and hull biofouling. Translocation via ships' ballast water and sediments has been the focus of action, and as mandatory IMO regulations have recently entered into force, there is an expectation that the introduction of invasive species will be minimized by 2024, when all ships globally will have to be equipped with the required ballast water treatment systems. Biosafety risks from ship biofouling have so far been neglected despite the fact that the relationship between ship's biofouling and non-indigenous species introduction in marine ecosystems has been known for a long time.

Studies suggest that vessel biofouling accounts for more than 40% of all marine invasions and is therefore a major pathway for non-indigenous species introduction. Specifically, it has been estimated that at least 55% of the 1,780 recognized non-indigenous species detected around the world have life history characteristics that make them likely to be associated with biofouling on vessel hulls (Hewitt & Campbell, 2010), as shown in *Figure 63*.

While international measures (International Convention for the Control and Management of Ships' Ballast Water and Sediments) entered into force in September 2017, with a requirement for shipowners to equip their ships with a ballast water treatment system, there is no mandatory international framework to address marine bio-invasions from ship fouling. IMO has adopted Biofouling Guidelines (2011 Guidelines for the control and management of ships' biofouling to minimize the transfer of invasive aquatic species) that set out best practices to prevent, monitor and clean biofouling, but these are voluntary, and implementation is left to the willingness of countries and industry. This issue is gaining attention at IMO, given that some countries have developed or are developing domestic regulations to address bio-invasion risks from ship hull biofouling.

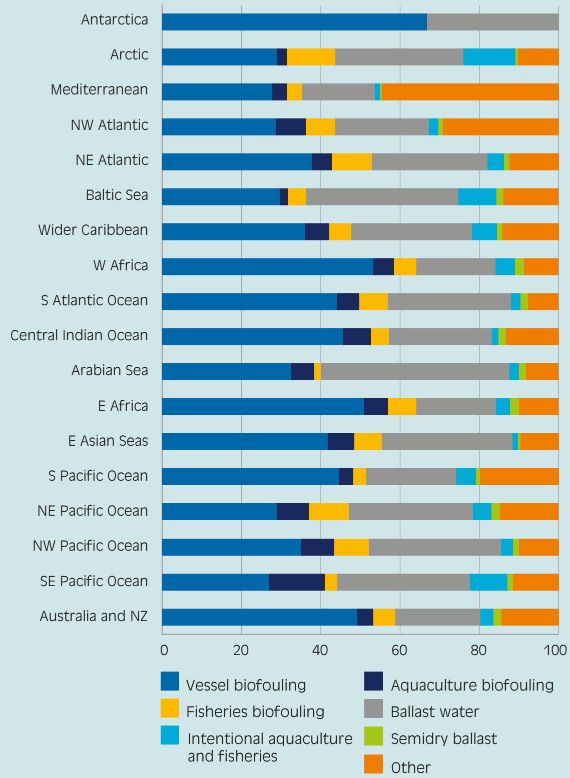


Figure 63 - Percentage of marine bio-invasions by region according to the contribution of specified transport mechanisms
(Source: Hewitt & Campbell, 2010)

implementation in the Mediterranean of the relevant provisions of the International Convention for the Control and Management of Ships' Ballast Water and Sediments (BWM Convention) adopted in 2004 under the umbrella of the International Maritime Organization (IMO).

3.4 Responses and priorities for action

The status of Mediterranean coastal and marine ecosystems depicted above shows they are strongly impacted by anthropogenic activities on land and at sea. Specific management responses to ecosystems degradation and loss include:

- Integrated Water Resources Management and the Water Framework Directive, the conservation and rational use of wetlands with the Ramsar Convention and Nature-based Solutions for wetlands and coastal aquifers (see Section 3.2.1.4),
- Legally and non-legally binding global, regional and national agreements and conventions/commitments for the protection, conservation and restoration of forests (see Section 3.2.2.4),
- Legal provisions and policies such as the ICZM Protocol, which limits the use of coastal areas in order to protect soft-sediment coasts and rocky and soft cliffs and shores (see Section 3.2.3.4),
- The Action Plan for the Conservation of Marine Vegetation in the Mediterranean Sea, SPA/RAC and 1992 Habitats Directive (see Section 3.3.2.4),
- For marine ecosystems, an Action Plan for the Conservation of Coralligenous and Other Calcareous Bio-constructions (see Section 3.3.3.4), fishing restrictions by the GFCM (see Section 3.3.4.4), under the Convention on Biological Diversity, Ecologically or Biologically Significant Marine Areas, Vulnerable Marine Ecosystems and Cetacean Critical Habitats deserving specific management, classification of the status of ecosystems by the IUCN, the SPA/BD Protocol for protecting marine biodiversity, the ACCOBAMS Survey Initiative, as well as at the EU level the Marine Strategy Framework Directive (MSFD) and the Maritime Spatial Planning Directive (MSPD) (see Section 3.3.5),
- For fighting invasive species, the Action Plan concerning Species Introductions and Invasive Species and the associated SPA/RAC technical tools, the Mediterranean Strategy on Ships' Ballast Water Management, and the Biofouling Guidelines (see Section 3.3.6).

In addition to these specific solutions, more general ones are presented below.

3.4.1 Marine and coastal protected areas

A Protected Area is a clearly defined geographical space, recognized, dedicated and managed through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values (Dudley, 2008). In order to develop a coherent, representative and well-managed network of Marine Protected Areas (MPAs) or Other Effective Area-Based Conservation Measures (OECMs), as recommended by the CBD, and in particular, Aichi Target 11, as well as by the UN Sustainable Development Goal 14 (SDG 14), to preserve 10% of the waters under their jurisdiction by 2020, Mediterranean countries have to develop a proper legal and institutional system for the management and monitoring of these areas. Most of them have, to-date, established a system based on regulations related to the environment, fisheries, ICZM, maritime spatial planning or other legal tools, allowing for better implementation of management, including control and surveillance, funding, fishing or maritime transport.

Within the framework of the CBD, countries have to prepare and adopt a National Biodiversity Strategy and Action Plan (NBSAP). Most of them have done so, for a given period, and are currently revising it. Others have adopted it until 2030 (Egypt and Algeria). These documents normally include a section on Marine and Coastal Protected Areas (MCPAs). In parallel, some of these countries have prepared or adopted a national strategy or plan for MCPAs or for MPAs, such as Albania, Algeria, Egypt, France, Lebanon and Libya.

At least, 251,690 km² of the Mediterranean Sea should be covered by MPAs or OECMs by 2020 to reach Aichi Target 11 and SDG 14. Based on MAPAMED *(Box 20)*, considering all the categories/labels, national and international designations, and Other Effective Area-Based Conservation Measures (OECMs) declared under international governance instruments, the number of MPAs and OECMs in the Mediterranean has reached 1,233. The areas covered include national MPA declarations (approximately 82,600 km²), the Natura 2000 declarations for European countries (approximately 59,700 km²), the Pelagos Sanctuary concerning three countries (France, Italy and Monaco, approximately 87,300 km²), the Strait of Bonifacio Particularly Sensitive Sea Area (IMO) concerning two countries (France and Italy, approximately 11,000 km²), the Fisheries Restricted Areas (GFCM) with an objective to conserve ecosystems or species in three countries (Cyprus, Egypt and Italy, approximately 15,700 km²), the Ramsar sites (approximately 3,300 km²), the World Heritage Sites (UNESCO, approximately 200 km²), the Biosphere Reserves (UNESCO, approximately 1,600 km²) and the Specially Protected Areas of Mediterranean Importance - SPAMIs (UNEP/MAP-Barcelona Convention, approximately 90,000 km²). The values are not cumulative since several areas have multiple designations. Further recording of areas attributable to OECMs under national legislations might also increase total values.

In 2018, there was a strong boost towards achieving the Aichi Target 11 and SDG 14 through the declaration of the Spanish Cetacean Corridor MPA along the east coast of Spain on 30 June 2018, encompassing 42,262.82 km². Following this, the marine area covered by conservation measures (MPAs and OECMs) nearly reached 223,000 km², representing more than 8.9% of the Mediterranean Sea surface. The over eight-fold enlargement of Cabrera National Park and the SPAMI approved on January 2019, also in Spain, with 807.73 km² of open sea, including the deep sea, resulted in a Mediterranean national designation increase of 43,070.55 km², for a total Mediterranean surface up to just over 9%. Assuming the January 2019 coverage of 226,665 km², an additional 25,025 km² are needed by 2020 to reach Aichi Target 11 and SDG 14, without taking into account management effectiveness or whether regulations are implemented, which is challenging but not impossible.

The national fishery reserves (more than 120 in the Mediterranean) that aim to ensure the sustainable use of fishing resources and the conservation of species or ecosystems have not been considered, as it is necessary to review each site declaration in order to identify their specific objectives.

For the coming years, numerous areas are proposed (by experts) or considered by countries in their strategies for declaration as MPAs or OECMs, representing 118 sites in 12 countries. National fishery reserves that aim to ensure conservation of ecosystems, habitats or species are under development in numerous countries and will be included in the MAPAMED database in the future.

The legal and institutional aspects concerning the participation of all stakeholders in the different components of development and conservation, in particular for MPAs or OECMs, are taken into consideration by all countries, usually under the Environmental Impact Assessment (EIA)

BOX 20

The MAPAMED Database

MAPAMED, the Mediterranean database and Geographic Information System (GIS), including MPAs and Other Effective Area-Based Conservation Measures (OECMs) of the region and covering the marine and coastal environment, is a database developed by SPA/RAC and MedPAN to assist countries in the registration and spatial description of MPAs and OECMs in the region. As a database on sites of interest to the conservation of the marine environment in the Mediterranean Sea, MAPAMED can be used by the countries for preparing reports and assessing their activities.

In the MAPAMED database, a "Marine Protected Area" is understood as "a clearly defined marine geographical space - including subtidal, intertidal and supratidal terrain and coastal lakes/lagoons connected permanently or temporally to the sea, together with its overlying water - recognised, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values". *Figure 64* shows Mediterranean Protected Areas and Ecologically and Biologically Significant Areas (EBSAs) in 2019.

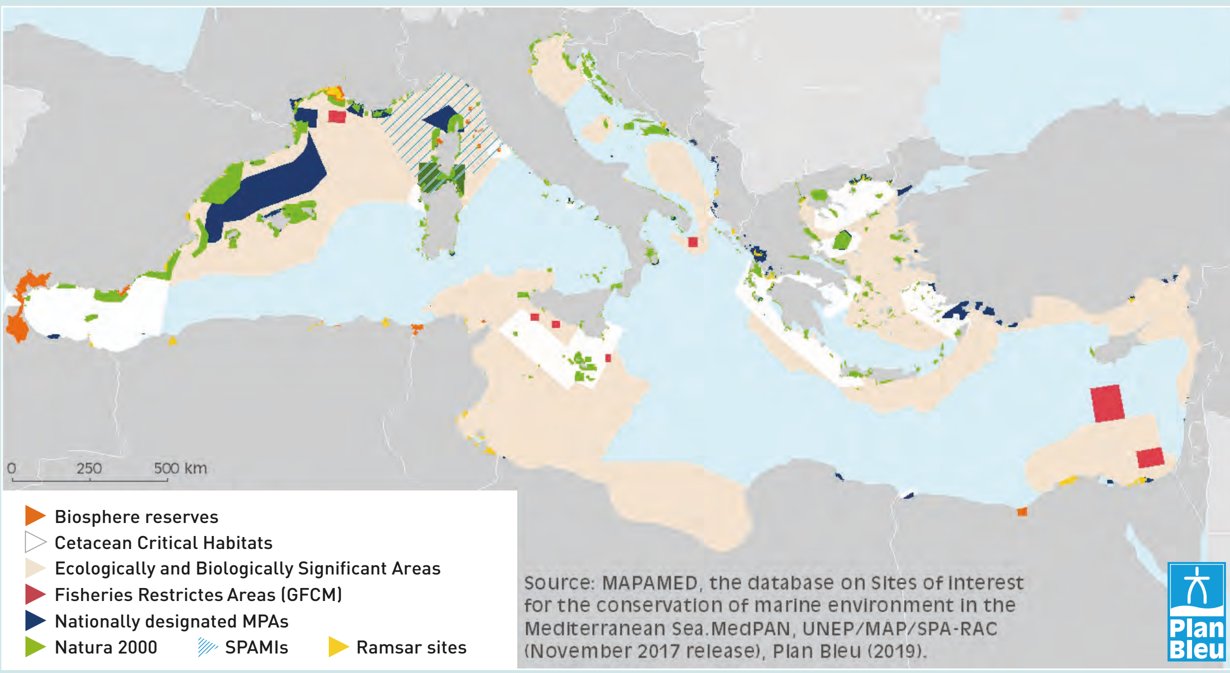


Figure 64 - Marine Protected Areas, Fisheries Restricted Areas, Particularly Sensitive Sea Areas and priority areas for management (Ecologically and Biologically Significant Areas, Cetacean Critical Habitats), 2017
(Source: MAPAMED, 2017; Plan Bleu, 2019)

process, complying with the principles of the United Nations Economic Commission for Europe (UNECE) Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters (Aarhus Convention).

Most countries have included in their legislation the obligation to adopt, implement and revise management plans for protected areas. In some countries, specific administrations have been identified for this purpose, and others for training national staff on management, enforcement or regulations. Nevertheless, management remains one of the weakest points in the Mediterranean, where it is estimated that only around 10% of existing MPAs or OECMs (MedPAN et al. 2016) have proper implementation of their management plans, with sufficient funds and skilled staff for ensuring all the necessary management and conservation tasks.

The main reasons behind these weaknesses are linked to the lack of financial resources, with only 12% of the needs for effective MPA management covered by regular financial resources (Binet, Diazabakana & Hernandez, 2015), in addition to a lack of skilled staff and gaps in the legislation and regulations governing the management of protected areas and the enforcement of conservation measures.

In line with all the proposals and recommendations made over the past 20 years, in particular, the Tangier Declaration and the updated 2020 Mediterranean MPA Roadmap (Monbrison et al. 2016) prepared during the Mediterranean MPA Forum of 2016, where all relevant stakeholders joined their efforts for the continuous improvement of conservation and the sustainable use of marine resources in the region, the following aspects seem to be key for the future of the Mediterranean region:

- Continuous efforts have to be made in specific countries and outside territorial waters using all existing options, including MPAs, OECMs or Fisheries Restricted Areas, but also voluntary options by stakeholder groups such as fishermen or local populations;
- The coverage and implementation of no-entry, no-take and no-fishing zones, within either existing or future MPAs, need to be increased from the current coverage of 0.04% of the Mediterranean Sea to reach at least 2% of no-take zones by 2020, especially in key functional areas;
- For the identification and declaration of new sites, it is essential to focus on representativity and connectivity, based on knowledge (including local communities), research (including mapping) and permanent monitoring of ecosystems, species and ecological conditions;
- For management, which is the weakest point at the present stage, various steps have to be taken, including:
  - assessment of legislation, and not only environmental legislation, but also looking at the fisheries, tourism, maritime transport and enforcement (police, coast guard, navy, using modern technologies) sectors. All these aspects are important for both the administration and MPA managers to fulfil their enforcement duties;
  - national training of individuals at all levels, including administrations, field staff, local stakeholders, as well as public awareness and education;
  - the development of co-management mechanisms, first between the competent ministries listed above, but also with local administrations and local communities, NGOs and private initiatives;
  - the need to establish national environmental funds and/or other mechanisms for supporting conservation actions and particularly MPA creation and management;
  - work towards creating a win-win relationship for MPAs with decision makers, donors and the private sector interested in marine and maritime spatial planning, integrated coastal zone management, blue growth strategies, sustainable tourism and sustainable fisheries policies, in order to respond to pressures beyond MPA borders, while considering MPAs as natural capital and a management instrument to reach sustainability targets.

For all these elements, networks of managers at different levels (i.e. national, regional and subregional) are and will be essential for achieving the above targets. Knowledge and capacity building, for a range of subjects, have been facilitated by Network of Marine Protected Areas managers in the Mediterranean (MedPAN). MedPAN has been developing a series of training courses, tools and experience-sharing between Mediterranean MPAs to support MPA management. In this regard, MedPAN, SPA/RAC and WWF have developed the long-term capacity-building strategy for Mediterranean MPAs since 2012 to support MPA management. These activities will also contribute to the objectives set in the "Regional Working Programme for the Coastal and Marine Protected Areas in the Mediterranean including the High Sea" and in the "Roadmap for a Comprehensive Coherent Network of Well-Managed Marine Protected Areas (MPAs) to Achieve Aichi Target 11 in the Mediterranean" adopted by the 19th Meeting of the Contracting Parties to the Barcelona Convention (Decision IG.22/13).

3.4.2 Regional regulatory tools, strategies and action plans

The Ecosystem Approach (EcAp) is a process developed by UNEP/MAP and adopted by the Parties to the Convention on Biological Diversity, with the aim of achieving Good Environmental Status (GES) of the Mediterranean Sea. It is defined as "a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way". Integrated ecosystem-based approaches replace and supplement sectoral approaches, taking into account the interactions among organisms and their environment and recognizing that humans are an integral component of ecosystems. The approach involves 7 steps (interactive EcAp roadmap), including one which consists in preparing the Integrated Monitoring and Assessment Programme (IMAP). Through this process, 11 ecological objectives and 27 indicators were identified to monitor biodiversity, Non-Indigenous Species (NIS), eutrophication, hydrography, coastal ecosystems and landscapes, contaminants, litter and energy *(Table 17)*. IMAP implementation is currently in its initial phase (2016-2019).

The EU Marine Strategy Framework Directive (MSFD), adopted in June 2008, aims to achieve Good Environmental Status (GES) of the EU's marine waters (including the Mediterranean Sea) by 2020 and to protect the resource base upon which marine-related economic and social activities depend. In order to achieve GES by 2020, each Member State is required to develop a strategy for its marine waters (or Marine Strategy), following detailed criteria and the methodological standards of the MSFD. An important effort was made to harmonize the EcAp process of the Barcelona Convention with the implementation of MSFD.

The Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean (SPA/BD), adopted in 1995, is the main tool for implementing the 1992 Convention on Biological Diversity in the Mediterranean. The Protocol is centred on three main elements: the creation, protection and management of Specially Protected Areas (SPAs), the establishment of a list of Specially Protected Areas of Mediterranean Importance (SPAMIs) and the protection and conservation of species.
As part of the Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean (SPA/BD), Regional Action Plans on Cartilaginous Fishes, Invasive Species, Bird Species, Marine Vegetation, Dark Habitats, Coralligenous and other Calcareous Bio-concretions, and the Conservation of the Monk Seal and Turtles have been developed and are being implemented by the Contracting Parties.

In 2003, the Strategic Action Programme for the Conservation of Biological Diversity in the Mediterranean Region (SAP BIO) was adopted by the Contracting Parties to the Barcelona Convention to respond to the regional challenges related to marine and coastal biodiversity. The programme was launched in 2004 by SPA/RAC, announcing a 15-year programme to promote the diagnosis, consultation and assessment of Mediterranean biodiversity at a national and a regional level, which was then extended to 2020 to match the CBD Strategic Plan for Biodiversity 2011-2020.

The fifth Meeting of National Correspondents of SAP BIO took place in February 2019 in Marseille, France, and consisted in reviewing an evaluation of the implementation of SAP BIO with the status of implementation of all Priority Actions and the main difficulties for implementation (UNEP/MAP, 2019). SPA/RAC currently coordinates the development of the new phase of SAP BIO (2021-2030).

As part of SAP BIO, National Action Plans (NAPs) and Reports addressing issues of particular relevance for the countries were prepared. Implementation remains limited due to a lack of human and financial resources.

Ecological objective	Description
EO 1 Biodiversity	Biological diversity is maintained or enhanced. The quality and occurrence of coastal and marine habitats and the distribution and abundance of coastal and marine species are in line with prevailing physiographic, hydrographic, geographic and climatic conditions.
EO 2 Non-indigenous species	Non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystem.
EO 3 Harvest of commercially exploited fish and shellfish	Populations of selected commercially exploited fish and shellfish are within biologically safe limits, exhibiting a population age and size distribution that is indicative of a healthy stock.
EO 4 Marine food webs	Alterations to components of marine food webs caused by resource extraction or human-induced environmental changes do not have long-term adverse effects on food web dynamics and related viability.
EO 5 Eutrophication	Human-induced eutrophication is prevented, especially the adverse effects thereof, such as losses in biodiversity, ecosystem degradation, harmful algal blooms and oxygen deficiency in bottom waters.
EO 6 Sea floor integrity	Sea floor integrity is maintained, especially in priority benthic habitats.
EO 7 Hydrography	Alteration of hydrographic conditions does not adversely affect coastal and marine ecosystems.
EO 8 Coastal ecosystems and landscapes	The natural dynamics of coastal areas are maintained and coastal ecosystems and landscapes are preserved.
EO 9 Pollution	Contaminants cause no significant impact on coastal and marine ecosystems and human health.
EO 10 Marine litter	Marine and coastal litter do not adversely affect the coastal and marine environment.
EO 11 Energy including underwater noise	Noise from human activities causes no significant impact on marine and coastal ecosystems.

Table 17 - Ecological Objectives under the Mediterranean EcAp
(Source: UNEP/MAP, 2016)

3.4.3 Economic and management tools

Sustainable financing of MPAs in the Mediterranean

In most developing or least-developed countries, MPAs remain underfunded, resulting in a less efficient protection of species and habitats. In the Mediterranean, MPAs also face operational difficulties, especially in non-European countries. According to a study lead by MedPAN, SPA/RAC and WWF in 2015 (Binet et al. 2015), 86% of MPA managers consider that their needs are not covered to effectively manage their MPA. There is an urgent need to consider an increase in current funding for existing MPAs in the Mediterranean region, given that only 8% of the financing needs for effective management of MPAs are covered by current resources.

In general, existing MPAs suffer from a significant lack of resources to finance recurring costs, including staff costs but also costs of equipment, monitoring, research, training and management, boundary demarcation, effective law enforcement and the provision of adequate park infrastructure. Existing financial contributions are well below requirements and reveal a strong disparity between the northern and southern basin. This all affects the performance of the protected areas and limits the setting up and implementation of management plans. Establishing sustainable financing for MPAs is therefore essential to help an MPA obtain effective management. Strategic Objective 4 of the 2016 Roadmap towards a comprehensive, ecologically representative, effectively connected and efficiently managed network of MPAs focuses on "increase[ing] the allocation of financial resources to establish and maintain an ecological network of effectively managed MPAs", calling for the development and/or adaptation of funding mechanisms in a Mediterranean context.

Currently, the main financial resources for MPAs come from national and local public funds and multilateral (Global Environment Facility - GEF) and bilateral cooperation (French Facility for Global Environment - FFEM, etc.). Other financial resources are: subregional projects (MAVA Foundation, etc.), European financing instruments (LIFE, Interreg MED, ENI MED, etc.), but also private funds (foundations, sponsorship, etc.), local financing mechanisms and self-financing. As described in *Box 21*, the Association for the Sustainable Financing of Mediterranean Marine Protected Areas, supported the creation of the MedFund in 2015 as a funding mechanism for Mediterranean MPAs.

The 2016 Mediterranean MPA Forum Tangier Declaration aims to:

- Encourage leverage mechanisms to support the Contracting Parties to the Barcelona Convention and other relevant organizations in guaranteeing the basic funding needs of their national MPA systems.
- Encourage Official Development Assistance agencies and private donors to invest in MPAs as a potential contributor to achieving SDGs through food security, poverty alleviation and climate change adaptation and mitigation.
- Support the development of small funding programmes within MPAs as means, inter alia, to develop local project management capacities and as a lever to attract new and matching funding sources.

BOX 21

The Association for the Sustainable Financing of Mediterranean Marine Protected Areas

The 2012 Mediterranean MPA Forum (Antalya, Turkey) highlighted the need to establish a regional financial mechanism to support the sustainable financing of the Mediterranean MPAs to help countries meet their commitments under the Barcelona Convention. Following this recommendation, France, Monaco, and Tunisia launched a joint initiative in October 2013 to develop such a mechanism.

In 2015, the Association for the Sustainable Financing of Mediterranean MPAs (M2PA) was created to bring together States and civil society to lead the establishment of this mechanism. The Association is a non-profit Monaco-based organization and a cooperation platform that aims to set up a regional conservation private-public donor trust fund. Since 2015, the MedFund has been dedicated to promoting sustainable funding in order to contribute to the long-term financing needs of MPAs and to cover their operational costs.

The founding members of the association are France, Monaco, Tunisia and the Prince Albert II of Monaco Foundation. Active members are Morocco, Albania, Spain and several organizations (Monaco Oceanographic Institute, UNEP-SPA/RAC, MedPAN, French Coastal Protection Agency, WWF-Med, IUCN Med, Mediterranean Small Islands Organization, Critical Ecosystem Partnership Fund).

The association is currently supported by the FFEM, the Government of Monaco, the GEF, the *Agence Française de Développement* - French Development Agency (AFD), the Prince Albert II of Monaco Foundation, the Leonardo Di Caprio Foundation, Zoo Basel, the Oceanographic Institute Prince Albert I of Monaco.
The initiative received political support from the countries bordering the Mediterranean at the Union for the Mediterranean Ministerial Meeting on Environment and Climate Change and from the Parties to the Barcelona Convention in 2016.

The MedFund has raised around one fourth of its 3-year financial endowment for supporting the management of 20 Mediterranean MPAs. The fund needs to be further endowed to cover its objectives and expand to additional MPAs in the Mediterranean.

- Support, as an example of innovative financial mechanism, the establishment of the Trust Fund for Mediterranean MPAs, MedFund, and welcome the recent progress made in this regard.
- Support the creation of a permanent financing facility to ensure, in case needed in times of crisis and during limited periods, the continuity of management in certain MPAs.

3.4.4 Major knowledge gaps

The major knowledge gaps highlighted throughout this chapter are:

- a lack of data on soft and rocky cliffs and shore ecosystems, their characteristics, the status of their retreat and erosion and the associated impacts on human livelihoods;
- poor inventories of invasive species and their impact, especially in coastal (terrestrial) ecosystems;
- limited information on the occurrence, distribution and composition of coralligenous communities;
- a lack of monitoring of the biodiversity of deep/dark habitats (canyons, trenches, seamounts).

These knowledge gaps should be filled by implementing national monitoring programmes in line with IMAP.

BOX 22

Difficulties in monitoring indicators of Good Environmental Status

Concerning the habitat distribution and the state of species and communities (CI1/EO1), there are significant gaps in the Southern Mediterranean Countries (SMCs) regarding the effects of the gelatinous macro zooplankton on the functioning ecosystems and more generally on deep Mediterranean systems and pelagic habitats. There is a wide disparity in the overall distribution of research efforts for marine mammals and marine reptiles (CI3/EO1). Indeed, most of the research is concentrated in the north-western part of the Mediterranean basin, where long series of data are available and provide a reliable picture of the situation of these species. In the absence of at least an equivalent effort in the SMCs, it is difficult to understand all the processes related to these species at the Mediterranean level. In SMCs, information on the occurrence and distribution of species is sporadic and highly localized. When it comes to marine reptiles, the knowledge deficit concerns several aspects, particularly the location of breeding / nesting sites, overwintering, feeding and development sites for adults, females and juveniles, connectivity between different Mediterranean sites and the vulnerability / resilience of these sites.

For many Southern and Eastern Mediterranean Countries (SEMCs), as well as for some Adriatic countries, information on seabird breeding populations (CI4 / EO1) is fragmented or absent. The same is true for the demography data of many populations of marine mammals, sea turtles and seabirds (CI5 / EO1).
Regarding non-native species introduced through human activities (CI6/EO2), the assessment of trends in both the abundance of these species and their spatial distribution is particularly lacking in the SMCs. In addition, the deficit in these countries, in taxonomy experts has most likely led to neglect several of these species. In the current state of knowledge acquired, it is difficult to have a detailed understanding of the processes of introduction, installation and adaptation of these species.

The level of information regarding spawning stock biomass (CI7/EO3) and fishing mortality (CI9/EO3) differs widely between countries on both sides of the Mediterranean but also between species and geographical areas. This information relates to some commercially exploited stocks and stocks for which reference points exist but are still very limited. In these conditions, it is difficult to give precise indications of current levels of biomass, especially considering the large deficit of long time series. In addition, and given the specificity of the fisheries in the southern Mediterranean region, dominated by artisanal fisheries, it is very difficult to have reliable data on total landings (CI8/EO3). This situation is further complicated by the lack of reliable estimates of illegal and / or reported fishing activities.

Regarding the location and extent of habitats directly impacted by hydrographic changes (EO7), there is a lack of sound methodologies and assessments. Assessments that estimate the extent of hydrographic alterations and intersections with marine habitats are currently rare in the Mediterranean, apart from local environmental impact assessment (EIA) and strategic environmental assessment (SEA) studies. In countries on the southern shores of the Mediterranean, experts with knowledge of the processes and methodologies used are not always available in sufficient numbers and quality.

Knowledge about the interactions and mechanisms that govern different biological and physical phenomena at the cross-border level, whether at the subregional (South) or regional (Mediterranean) level, remains largely unknown and under-documented. Today, this deficit does not allow a complete and correct understanding of the processes related to species migrations, introductions and biological invasions.

Until the early 2000s, most climate change studies and scenarios addressed the Mediterranean on a macro scale (IPCC group scale). This level of analysis provides broad indications but does not allow for an understanding of changes and effects at national and local scales. Since the Paris Climate Agreement (2016), several programs and research projects have been conducted to reduce the scale of observation in order to refine the analysis of climate processes and their effects on the region. The downscaling has almost systematically enabled the countries on the northern shore of the Mediterranean to substantially improve understanding of climate phenomena. On the other hand, due to lack of means and adequate resources and adapted local competences, important insufficiencies must be highlighted concerning the effects of climate change on the ecosystems and economies of the southern Mediterranean countries, as well as on their level of vulnerability and resilience.

The 2017 MED Quality Status Report also identified several knowledge gaps *(Box 22)*. On coastal and marine biodiversity, for example, data on marine habitats are still scarce, fragmented and discounted in time and would benefit from a complete mapping of the most significant marine habitats in order to direct management measures.

3.4.5 Priorities for action

Analysis of the status and trends, ecosystem services, major pressures and management of Mediterranean coastal and marine ecosystems throughout this report leads to define the following priorities for action:

- In the initial phase of IMAP (2016-2019), it is important that the countries adopt monitoring programmes for inventorying and mapping the coastal and marine species and habitats within their territories, based on the ecological objectives, targets and indicators proposed in EcAp (*Box 23* outlines tools for monitoring biological effects);
- Proper development and implementation of management plans for MPAs and OECMs should be supported, namely by increasing the operating and financing capacity of MPA managers;
- Mainstreaming of biodiversity considerations into sectoral policies and planning at all levels;
- The use of a hydro-ecology or eco-hydrology for the management of coastal wetlands and other groundwater-dependent ecosystems, in the form of Integrated Coastal Areas and River Basins Management (ICARM) in the Mediterranean, would help limit the degradation and loss of these ecosystems;
- As the functioning of wetlands, coastal aquifers and other coastal ecosystems is strongly impaired by land activities, there is a need to bear in mind the connectivity between habitats at the land-sea interface;
- Characterizing, valuing and prioritizing ecosystem services (including climate change mitigation and adaptation) should be considered as an essential part of coastal and marine ecosystem management, and integrated in policies/plans for development and implementation, and;
- Ecosystem preservation and restoration efforts at the national and local levels should be increased, especially through the development and implementation of sustainable operational and financial mechanisms to reduce land conversion and fragmentation.

BOX 23

Tools for monitoring biological effects in the Mediterranean

Generalizing the tools for monitoring biological effects in SMCs through the use of biomarkers (the lysosomal membrane stability (LMS) method; cetylcholinesterase (AChE) as a method for evaluating neurotoxic effects, and Micronucleus (MN) testing as a tool for assessing cytogenetic / DNA damage in marine animals).

Moving from habitat conservation approaches to biodiversity and ecosystem functioning approaches is more appropriate for the management and conservation of marine ecosystems. This shift calls for holistic, integrative and ecosystem-based approaches, which are still under development and will require a reassessment of how ocean monitoring, assessment and management are approached.

The risk-based approach for monitoring should be implemented to assess the distribution of marine mammals throughout the Mediterranean Sea. Additional efforts should be devoted to less-guarded areas where there is a risk. Species listed as those for which data are insufficient, according to the red list criteria, should be considered a priority.

It is vital to realise the importance of assimilating all the information on the distribution of green turtles and loggerhead turtles in the Mediterranean on breeding, foraging, development and wintering grounds in order to understand the links that unite these areas in a management and conservation perspective. In addition, parallel mitigation strategies are needed to strengthen the resilience of existing populations.

Demographic information on key populations and sensitive and / or commercially exploited species remains largely fragmented, often old, and subject to potentially high biases. It is necessary to improve the demographic knowledge of these populations.

Systematic and long-term photo-identification programs, coupled with the use of appropriate instruments to measure observed animals, would be essential tools for providing the basic knowledge of the population structure required for conservation plans (Demographic Characteristics of Marine Mammals).

Strengthening skills, particularly in taxonomy in Southern Mediterranean countries, to carry out and update national and regional inventories of exotic species and to evaluate their trajectories and impacts in these countries. The rate of introduction of new exotic species into the Mediterranean is increasing. Corridors are the main pathways for new introductions into the Mediterranean, followed by shipping and aquaculture. There is a need to improve coordination at the national and subregional levels for monitoring non-native species in order to achieve broad mapping for the Mediterranean basin. Regular monitoring and a long time series will be needed to estimate these trends in the future. The use of molecular approaches including bar coding is often useful in addition to the traditional identification of species.

The reduction of fishing mortality requires the adoption of subregional management plans under the GFCM, in addition to those already in place for the small pelagic fisheries of the Adriatic and the demersal fisheries of the Strait of Sicily, and the adoption of measures to manage fishing capacity.

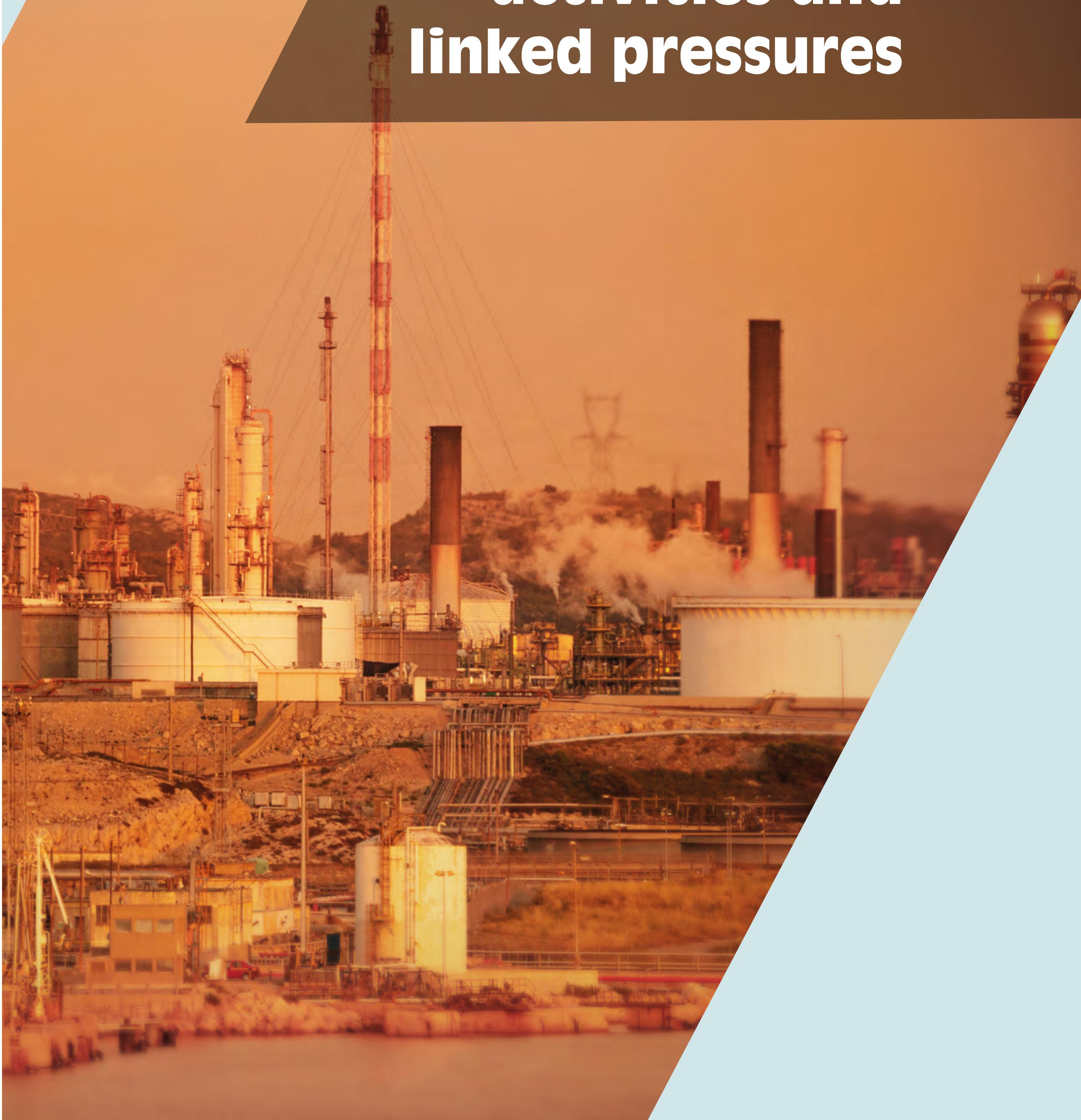
Appendix 1

Countries	Forest area (× 1000 ha)					Other wooded land (× 1000 ha)					Forested area as % of land area		
	1990	2000	2005	2010	2015	1990	2000	2005	2010	2015	country level	biome level	coastal areas
Albania	789	769	782	776	772	256	255	258	255	256	29.7%	28.8%	13.9%
Algeria	1,667	1,579	1,536	1,918	1,956	2,063	2,374	2,529	2,457	2,569	0.7%	4.7%	29.9%
Bosnia and Herzegovina	2,210	2,185	2,185	2,185	2,185	500	549	549	549	549	57.0%	35.1%	48.5%
Croatia	1,850	1,885	1,903	1,920	1,922	277	415	484	554	569	46.8%	32.6%	36.6%
Cyprus	161	172	173	173	173	195	214	214	213	213	20.1%	20.1%	20.1%
Egypt	44	59	67	70	73	20	20	20	20	20	0.9%	20.7%	22.4%
France	14,436	15,289	15,861	16,424	16,989	2,038	1,804	887	739	590	33.5%	49.1%	45.7%
Greece	3,299	3,601	3,752	3,903	4,054	3,212	2,924	2,780	2,636	2,492	36.2%	35.7%	36.2%
Israel	132	153	155	154	165	34	33	33	33	60	2.3%	6.0%	4.9%
Italy	7,590	8,369	8,759	9,028	9,297	1,533	1,650	1,708	1,761	1,813	34.9%	34.1%	25.5%
Lebanon	131	131	137	137	137	117	117	106	106	106	9.4%	9.4%	16.8%
Libya	217	217	217	217	217	330	330	330	330	330	0.0%	0.4%	1.0%
Malta						0	0	0	0	0	0.4%	0.4%	0.4%
Monaco	0	0	0	0	0	0	0	0	0	0	22.4%	22.4%	22.4%
Montenegro	626	626	626	827	827	118	118	118	137	137	51.9%	43.9%	56.3%
Morocco	4,954	4,993	5,401	5,672	5,632	407	407	607	607	580	2.8%	3.0%	12.1%
State of Palestine	9	9	9	9	9	0	0	0	0	0	0.3%	0.3%	0.2%
Slovenia	1,188	1,233	1,243	1,247	1,248	41	38	29	25	23	67.4%	67.4%	32.8%
Spain	13,809	16,977	17,282	18,247	18,418	11,997	10,360	10,259	9,278	9,209	28.5%	23.0%	20.4%
Syrian Arab Republic	372	432	461	491	491	35	35	35	35	35	0.8%	2.9%	16.7%
Tunisia	643	837	915	990	1,041	328	314	307	300	293	1.9%	2.9%	7.7%
Turkey	9,622	10,183	10,662	11,203	11,715	10,946	10,679	10,586	10,334	10,130	16.6%	20.2%	30.1%
Total	68,195	74,098	76,495	79,926	81,599	35,732	34,048	33,314	32,066	31,893	9.1%	17.8%	27.8%

Note: Forest area is the area that complies with the FAO definition of forests. Forested areas are areas with tree cover ≥10%. Coastal areas are land areas within 5 kilometres of the coastline of the Mediterranean Sea.

Table 18 - Area of forests and other wooded lands in Mediterranean countries from 1990 to 2015, and forested area in 2000
(Source: FAO, 2015 for forest area and other wooded land area; Hansen et al. 2013 for forested areas)

4. Economic activities and linked pressures



Current consumption and production patterns, characterized by high resource consumption combined with low recycling rates and unsatisfactory waste management, are unsustainable overall and lead to considerable environmental degradation in the Mediterranean region, including land take and degradation, water scarcity, noise, water and air pollution, biodiversity loss and climate change.

Pressures resulting from agriculture, fisheries and aquaculture, energy, tourism, transport and industries have the potential to be mitigated to a certain extent. To reach sustainability, they need to be accompanied by more environmentally responsible overall consumer behaviour as well as by the circular, local and resource-efficient production of goods and services. The transition to sustainable economic sectors will both reduce pressures on the environment and increase the resilience of economic activities that depend on quality natural environments, while increasing overall human well-being. Mediterranean countries have initiated many efforts and innovations to foster a green and blue economy. Still, the dominant pattern of economic activities in the Mediterranean remains resource-intense (including carbon), linear (not circular), and generates numerous types of pollution, which are characteristic of market failures inherent to common goods such as the environment. Transitioning to sustainable economic activities requires urgent and coordinated efforts both on production and consumption. On the production side, economic activities must be further regulated to correct the mentioned market failures through targeted policy mixes, including market-based instruments that favour environmentally friendly activities and disadvantage polluting ones. On the demand side, decision makers need enhanced support from the social and behavioural sciences to design measures that will lead to needed radical changes in consumer behaviour.

4.1 Introduction: current consumption and production patterns are not sustainable

4.1.1 Resource consumption patterns and pressures on natural ecosystems

Multiple sociocultural, economic and demographic factors need to be taken into account when looking at the current trends of resource consumption patterns in the Mediterranean region. First, since the start of the 20th century, food consumption patterns in the Mediterranean have been placing increasing pressure on natural resources (Hachem et al. 2016). The gradual shift away from traditional diets, which use local products, has evolved into a common phenomenon in all Mediterranean countries (Hachem et al. 2016). With the acceleration of modernization, globalization and urbanization, along with changes in demography and lifestyles, environmental impacts on natural ecosystems and biodiversity are considerable (Hachem et al. 2016). These trends are further exacerbated by food loss and waste, implying the massive losses of scarce resources, such as water, land and energy, and inputs, such as fertilizers (Lacirignola et al. 2014).

Secondly, this change in lifestyle also concerns the consumption of services. With the increase of living standards and globalized mobility patterns, certain recreational activities previously considered as luxurious have become increasingly accessible within Mediterranean countries, or have a direct effect on them as destination countries. For instance, coastal and maritime tourism has evolved from leisure activities reserved to the wealthiest to more 'democratic' activities, with the spread of the concepts of paid vacations and all-inclusive resorts as well as the growth of affordable means of transportation (Honey & Krantz, 2007). Such activities involve a high intensity of resource use (Lacirignola et al. 2014).

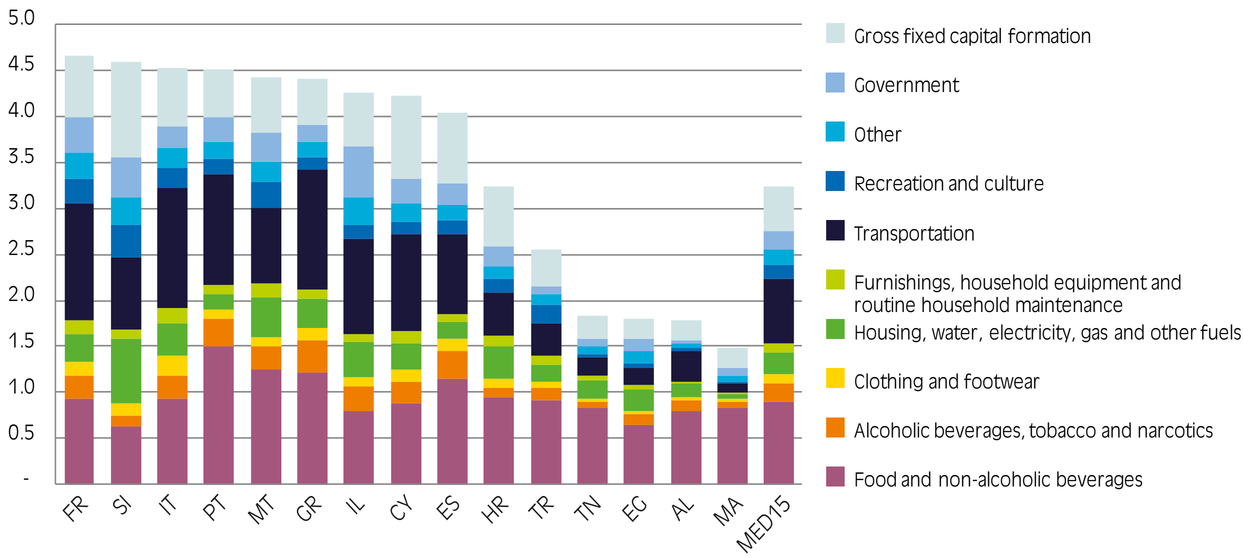


Figure 65 - Ecological Footprint of consumption for 15 Mediterranean countries in 2010[44]
(Source: Galli et al. 2017)

[44] Note: categories with a low contribution to national Ecological Footprint values, such as "Health", "Communication", "Education", "Restaurants and hotels", and "Miscellaneous good and services", have been grouped here under the category "Other".

The Mediterranean region is in a situation of severe ecological deficit, consuming, on average, around 40% more renewable natural resources and other ecosystem services than it provides (Galli et al. 2017). A large proportion of the pollution and intensive use of resources in the Mediterranean is also caused by inefficient industrial processes and unsustainable waste management in current production patterns (Galli et al. 2017). Mediterranean residents and tourists place multiple pressures on ecosystems within and outside their region due to food production, distribution and trade patterns, on top of final consumption patterns. Most Mediterranean countries, first of all Malta and Greece, have a daily food supply that is 20 to 40% higher than the average FAO-determined minimum daily dietary energy requirement.

Overall, current consumption and production patterns in the Mediterranean region lead to considerable environmental degradation (Lacirignola et al. 2014). The environmental footprints of these patterns show a precarious and unsustainable natural resource-consumption nexus in the region that largely causes the many environmental challenges facing the region, such as land degradation, water scarcity, noise, water and air pollution, biodiversity loss as well as climate change (Lacirignola et al. 2014). Unsustainable consumption and production patterns, combined with low recycling rates and inefficient waste treatment, increase pressures on biological and social systems, implying high ecological, carbon, and water footprints (MedReg, 2016) and marine litter. To address such trends, green/blue practices have been expanding in the region, tackling both the behaviour of consumers and producers, and the adaptation actions required.

4.1.2 The current contribution of the green and blue economy to the regional economy

According to the United Nations Environment Programme (UNEP), the green economy aims "to improve human well-being and social equity, while significantly reducing environmental risks and ecological scarcities" (Fosse et al. 2016). The blue economy can be considered a "green economy in a blue world" and is an approach promoted by the UNEP flagship report on the subject. It recognizes the crucial contribution of the seas and oceans to food, water and energy provision, especially with the growing number of people living in coastal areas and islands. This is particularly true in the Mediterranean, which is home to a coastal population of 150 million people, which doubles during the tourist season (UfM, 2016). The Mediterranean accounts for 20% of the "Global Marine Product" in an area which makes up only 1% of the world's ocean surface (Randone et al. 2017). The Mediterranean region is also the world's second-largest destination for cruises. The Mediterranean Sea is considered as a "superhighway of transport, trade and cultural exchange". The region boasts 450 ports and terminals and represents one of the busiest traffic lanes in the world, especially for oil traffic. Furthermore, the potential of marine areas for the economic development of Mediterranean countries is considerable. In the EU area alone, the blue economy is expected to unlock an additional two million jobs by 2020 (Randone et al. 2017).
The contribution of the blue economy to the regional economy is mostly due to coastal and maritime tourism. Compared to other sectors of the blue economy, tourism in coastal areas has the highest Gross Value Added (GVA), representing around 83% of the total blue economy's GVA (EUR 169 billion), and also the highest employment, representing around 79% of the total blue economy jobs (4.2 million jobs) (UfM, 2017). On the contrary, fishery and aquaculture, unlike common perception, is a relatively small sector in the Mediterranean blue economy, both in terms of GVA (less than 5%) and job creation (less than 10%) (UfM, 2017).

The purpose of this chapter is to provide an overview of the main macroeconomic features and indicators of key economic sectors in the Mediterranean region with significant interactions with the environment, highlighting their key challenges, opportunities, trends, as well as their potential for a sustainable transition towards a green, blue and circular economy.

Although this chapter dedicates a separate section to each sector, there are many relevant interlinkages between them (tourism in sea areas requires maritime transport, etc.), which highlights the importance of integration between them and a cross-sectoral approach to deal with the assessment of development strategies (UfM, 2017). In the following sections, each key sector of the Mediterranean region's economy is assessed, presenting an overview of its contributions to the economy, its impact on the environment and natural resource use, and potential improvements towards a sustainable economy.

4.2 Agriculture, fisheries and aquaculture

Agriculture (i.e. agriculture, fisheries and aquaculture) represents a key sector within the framework of the United Nations Environment Programme/Mediterranean Action Plan (UNEP/MAP). The socioeconomic aspects of its activities, including its importance in the Mediterranean culture, as well as the considerable pressures generated by this sector on natural resources and its environmental impacts on coastal zones, make agriculture an extremely relevant area of collaboration for Mediterranean countries. This sector reveals potentialities for a sustainable blue economy in the region, thereby reinforcing its role in achieving the objectives of the Barcelona Convention.

4.2.1 Agriculture

4.2.1.1 Overview of the sector

The share of agriculture[45] in GDP and employment has been steadily decreasing over time in almost all Mediterranean countries, due to the tertiarization of national economies (see Chapter 1). This downward trend, accompanied by an

[45] As defined by the FAO, the term "agriculture" and its derivatives include forestry, fisheries and aquaculture.

Countries	Agricultural GDP (%)	Employment in agriculture (%)			Productivity per worker (constant US dollars)		
	2017	1995	2005	2016	1995	2005	2016
Albania	18.9	70.3	54.0	40.7	2,013	3,015	5,442
Algeria	12.3	22.5	20.0	12.7	4,995	5,935	14,369
Bosnia and Herzegovina	5.8	48.1	24.5	19.2	-	4,591	6,037
Croatia	3.3	20.6	17.3	7.6	5,481	8,230	16,470
Cyprus	1.8*	5.3	4.7	3.6	35,709	30,592	21,655
Egypt	11.5	34.0	30.9	25.6	3,290	3,777	5,100
France	1.5	4.6	3.6	2.9	30,695	41,301	52,472
Greece	3.5	20.4	12.2	12.4	11,983	18,856	18,026
Israel	2.1*	2.9	2.0	1.1	31,743	63,695	84,612
Italy	1.9	6.6	4.2	3.9	27,020	40,027	44,242
Lebanon	3.5	3.3	3.4	3.2	45,846	33,478	23,681
Libya	1.2*	9.1	8.7	16.8	-	-	-
Malta	1.1*	2.6	2.1	1.3	-	-	-
Monaco	-	-	-	-	-	-	-
Montenegro	7.2	14.0	8.6	7.6		20,516	24,232
Morocco	13.1	42.0	45.5	37.7	1,677	1,929	3,150
State of Palestine	3.1*	-	-	-	-	-	-
Slovenia	1.8	10.4	9.1	5.0	8,814	9,872	20,790
Spain	2.0	9	5.3	4.2	21,333	30,065	47,281
Syrian Arab Republic	19.5**	28.4	21.2	22.8	-	-	-
Tunisia	9.2*	25.8	20.8	13.7	3,024	4,931	8,526
Turkey	6.1	43.4	25.7	19.5	6,058	12,188	15,108

*In 2016; ** In 2007

Table 19 - Agricultural GDP, employment and productivity of agricultural labour
(Source: FAO, 2018a)

increase in productivity per agricultural worker, is a relatively old phenomenon in northern countries and more recent in southern countries.

With the exception of Albania, where gross agricultural production amounts to 18.9% of total GDP, in non-EU Balkan countries, this rate is around 7.2% (Montenegro) and less than 2% in Mediterranean EU countries (Malta, Cyprus, Slovenia, France, Italy, Spain). A second group of countries, in particular those with low natural potential in land or water, show low rates, comparable to those of European countries: State of Palestine (3.1%), Libya (1%), Lebanon (3.5%) and Israel (2.1%). Agriculture contributes to around 10% of wealth creation in Tunisia, around 12% in Algeria and Egypt, and more than 13% in Morocco. These rates are well below those of the 1960s, when they amounted to nearly three-quarters of GDP. This decline in the contribution of agriculture to national (rural) economies can also be seen in the evolution of agricultural employment.
Between 1995 and 2016, the share of agricultural employment declined in North Africa, whether in Algeria (from 22.5% to 12.7%), Tunisia (from 25.8% to 13.7%) or a little more modestly in Morocco and Egypt. It fell more drastically in the Mediterranean countries of Eastern Europe (from 10.4% to 5% in Slovenia, and even in Albania where the share of agricultural employment has decreased from 70.3% to 40.7%). Turkey has seen its agriculture labour force participation fall by half in relative terms from 43.4% in 1995 to 19.5% in 2016. A group of countries with low agricultural potential (Malta, Cyprus, Israel, Lebanon and the State of Palestine) has also been affected by this downward trend in agricultural employment. In the North, the share of agricultural workers decreased in Spain from 30% in 1970 to just over 4% in 2016, in France from 14% to 2.8% and in Italy from more than 15% to less than 4%. This downward trend, which is currently continuing at a rate of around 2% per year, is parallel to that of the number of farms. Eurostat data (2017) indicates that Italy, which counted more than 2.6 million farms in 1975, had just over 1 million in 2013. In the case of France, the number of farms fell from 1.3 million in 1975 to 472,000 in 2013.

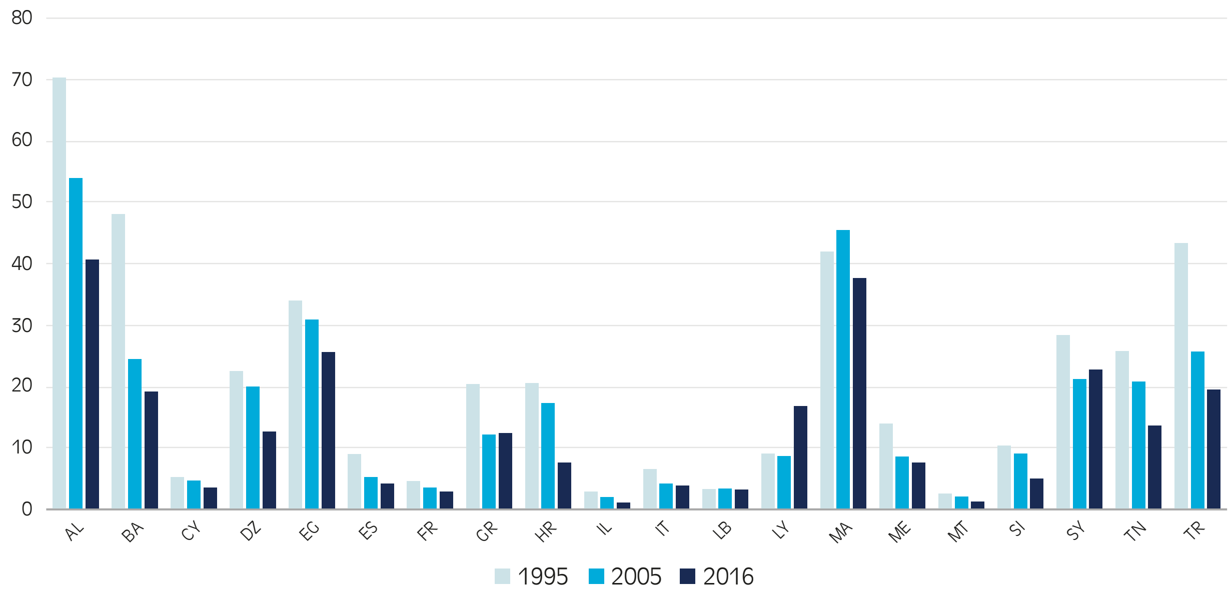


Figure 66 - Employment in agriculture, in % of total employment
(Source: FAO, 2018a)

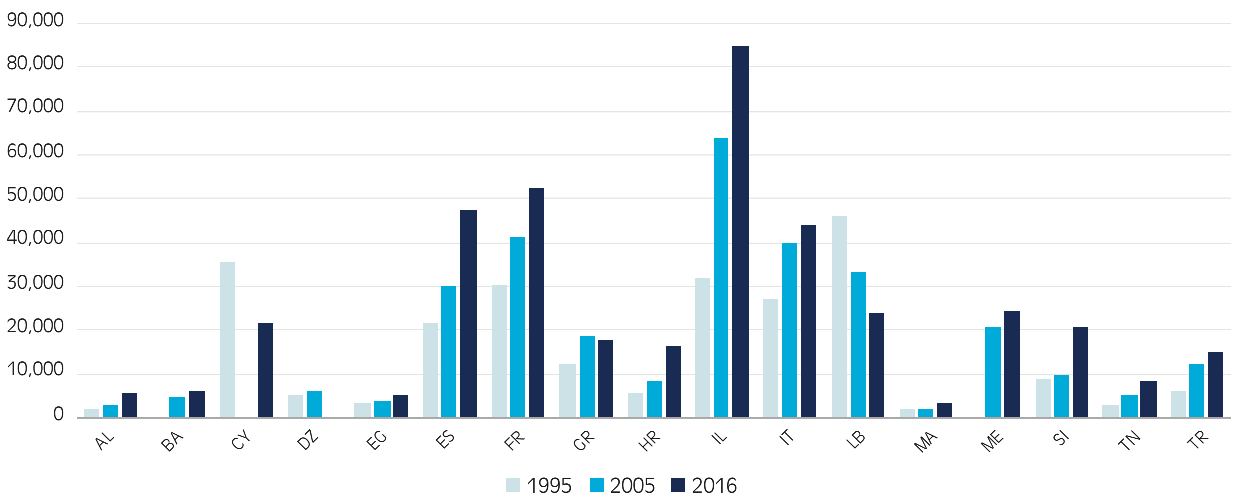


Figure 67 - Productivity per worker, in constant US dollars
(Source: FAO, 2018a)

Especially in Northern Mediterranean Countries (NMCs), the economic and social transformations brought about by agricultural modernization policies, conducted in the context of a structural transition of economies (see Chapter 1), have resulted in significant progress in labour productivity. The productivity of labour in agriculture today shows extreme differences between countries. The productivity of labour is USD 52,472 per worker in France and USD 47,281 per worker in Spain, while reaching only USD 3,150 per worker in Morocco and USD 5,100 per worker in Egypt. Technical and scientific innovations, as well as the mobilization of scarce water resources, make Israel the country where the productivity of land per worker is the highest in the region, at USD 84,612 per worker, more than 15 times that of Egypt and more than 25 times that of Morocco.

4.2.1.2 Pressures on the environment

The most common pressure of agriculture on the marine and coastal environment is the runoff of agricultural substances, described in more detail below. Other agricultural pressures are greenhouse gas emissions, land-use change, and water use, as illustrated by *Figure 75* and analysed in more detail in Chapter 6 "Water and Food Security".

Agricultural runoff: The main impacts of agriculture on the marine environment are due to the runoff of nutrients and agro-chemicals into the sea. Around 80% of marine pollution comes from land-based sources, mainly agriculture, industry, and municipal waste (Hildering,

24 Coastal agriculture in the Mediterranean: the case of France, Spain and Italy

The majority of the coastline in Spain, France and Italy is urbanized and the area granted to agriculture is decreasing considerably due to demographic pressures and the growth of competing coastal activities such as coastal and maritime tourism (Blanco, 2011). Data on coastal agriculture is extremely scarce - the latest data is from the 2000s - but the trends seem to have been similar over the last two decades (Blanco, 2011).

Countries	Share of useful agricultural land in the total surface area of coastal municipalities	National average share of useful agricultural land in the total surface area	Size of Mediterranean coastal farms
France	21%	51%	Much smaller than the national average with useful agricultural land in coastal municipalities representing only 0.6% of the national useful agricultural land while hosting 1.2% of the total national exploitations.
Italy	41%	41%	Extremely small, employ mostly family members.
Spain	< 40%		85% of coastal farms < 5 hectares

Table 20 - Coastal agriculture in France, Italy, Spain, 2000
(Source: Adapted from Blanco, 2011)

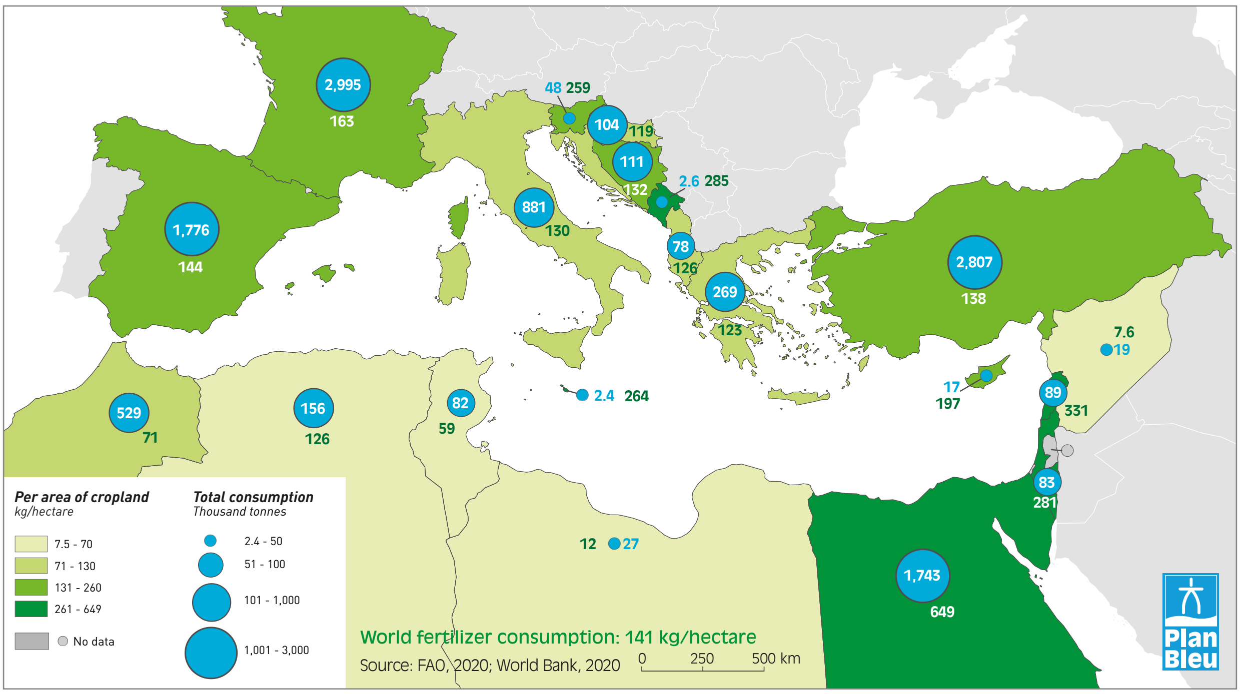


Figure 68 - Agricultural use of fertilizers in Mediterranean countries, 2016
(Source: FAOSTAT, 2020; World Bank, 2020)

Keessen & van Rijswick, 2009). As disaggregation of the impact from different sources of land-based pollution is difficult, there is no quantitative data concerning the effect of agriculture on the environment of the Mediterranean Sea. The runoff of inorganic nitrogen and phosphorus fertilizers leads to eutrophication, which in turn negatively impacts marine ecosystems. The toxins from algal blooms can also deplete local fish stocks. The runoff and infiltration of pesticides into the sea affects the marine environment at a slower pace by bioaccumulation higher up the food chain.

The average consumption of fertilizers[46] of countries in the Mediterranean basin increased by 10% between 2002 and 2016, from 160 kg per hectare to 174 kg per hectare of

[46] Fertilizers include nitrogen fertilizers, potash and phosphate (including natural lime phosphate fertilizers). Traditional nutrients, such as animal and plant manure, are not included in this indicator.

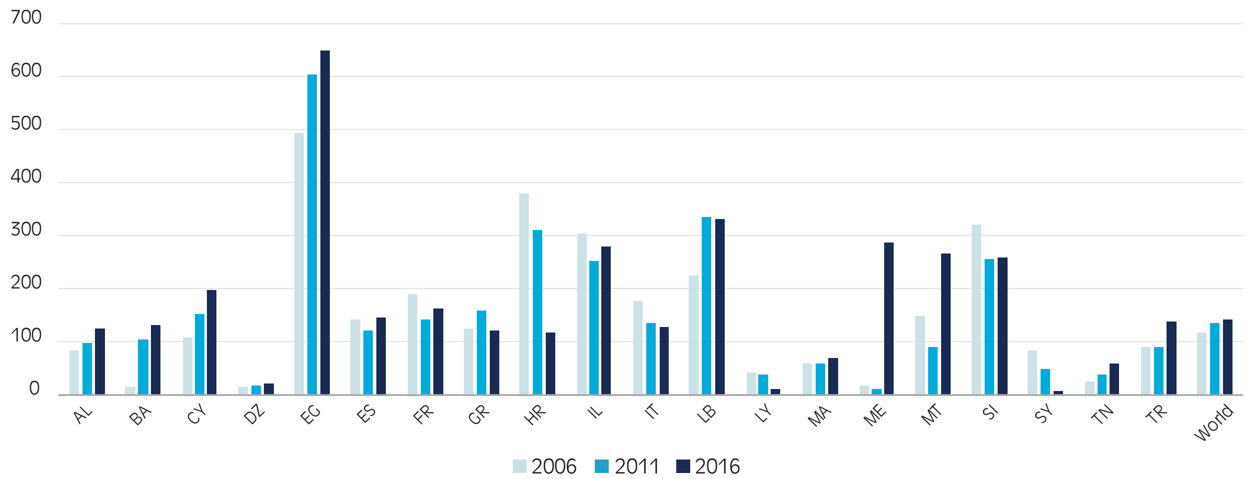


Figure 69 - Fertilizer consumption in the Mediterranean, in kilogram per hectare of arable land, compared to the global average
(Source: World Bank, 2020)

arable land (World Bank, 2020). This average is subject to significant differences, ranging from 8 kg per hectare in the Syrian Arab Republic to 649 kg per hectare in Egypt (World Bank, 2020). Around one third of Mediterranean countries show national consumptions of fertilizers above the global average of 141 kg per hectare of arable land (World Bank, 2020).

The main Mediterranean coastal areas historically affected by the inputs of nutrients are the Gulf of Lion, the Gulf of Gabès, the Adriatic, the Northern Aegean and the South-East Mediterranean (UNEP/MAP, 2017a). Maps showing the concentration of nitrate in the Mediterranean Sea and nitrogen and phosphorus emissions by agricultural areas illustrate coastal and marine areas potentially affected by runoffs of agricultural emissions.

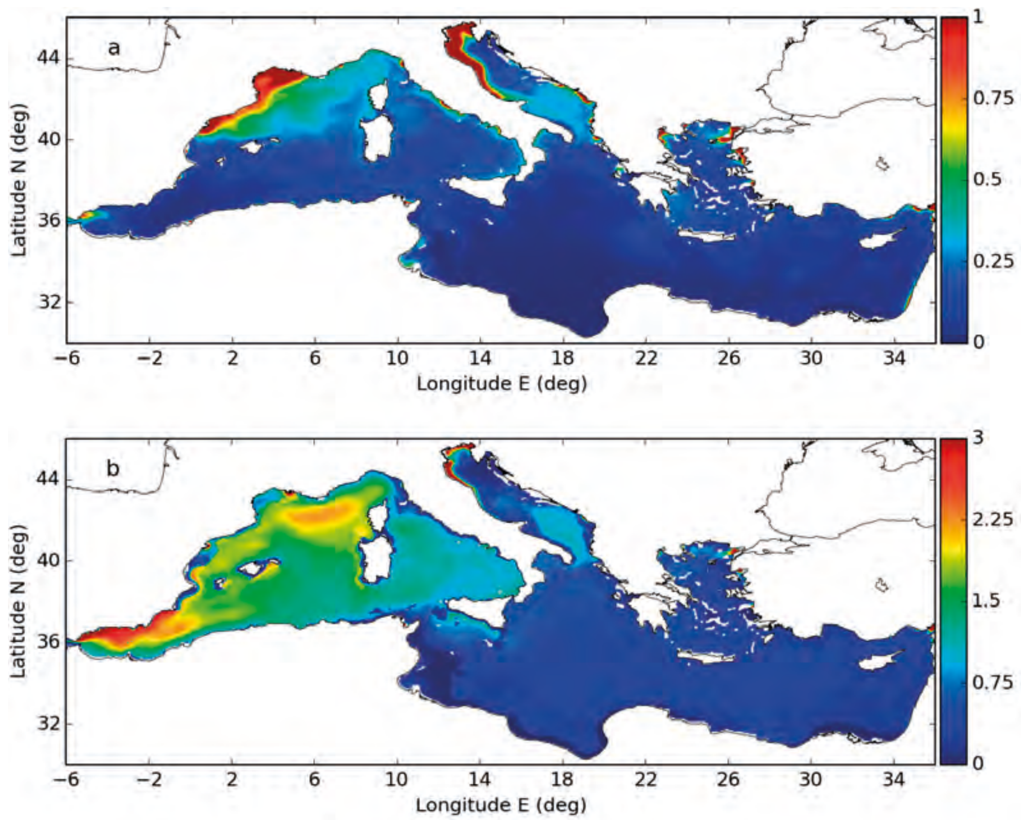


Figure 70 - Surface (a) and sub-surface (b, 0-150 m) maps of nitrate (mmol/m³) over the 2002-2014 period
(Source: Schuckmann et al. 2018)

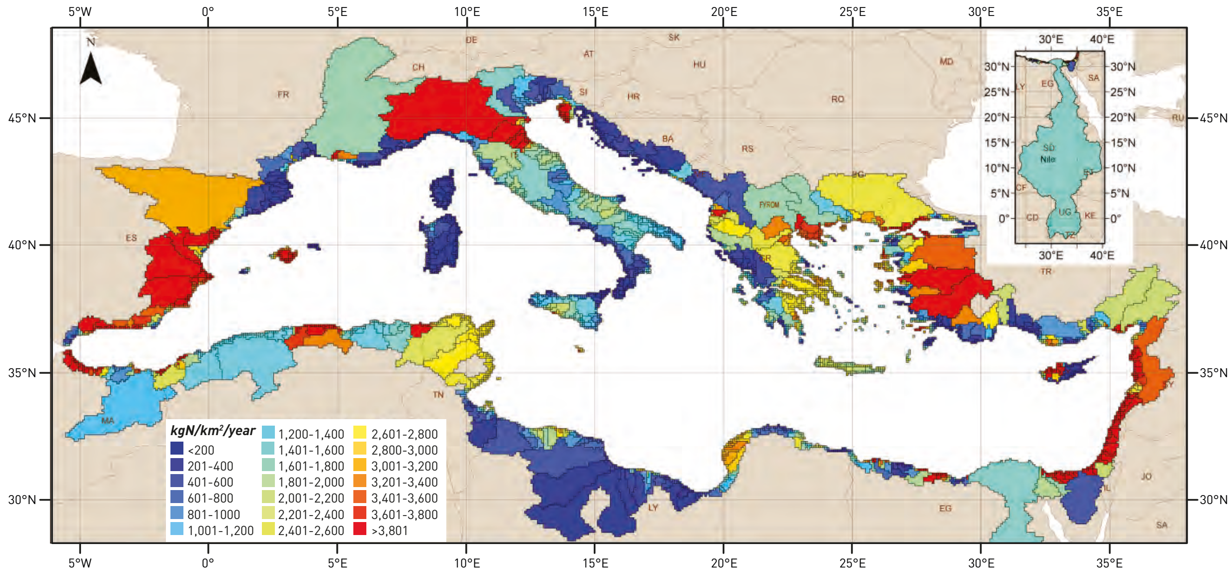


Figure 71 - Nitrogen emissions by agriculture area 2000-2010
(Source: Perseus, 2015)

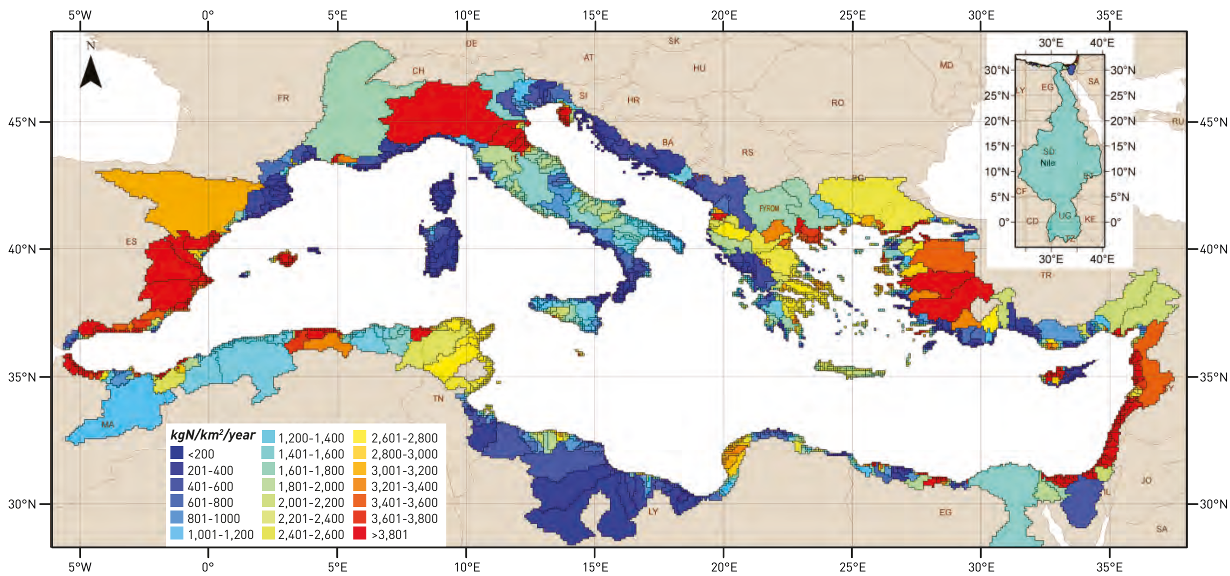


Figure 72 - Phosphorus emissions by agricultural areas in 2000s
(Source: Perseus, 2015)

The consumption of pesticides[47] in the Mediterranean basin varies largely between countries. In 2016, the average use of pesticides in kilogram per hectare of cropland was below or around the world average in most SEMCs except for Israel, Lebanon and the State of Palestine, and generally above the world average in NMCs.

Pesticides, especially if used irrationally, can lead to animal and human health problems such as the inability to reproduce normally in certain animal species, or cancer, neurological effects, diabetes, respiratory diseases, foetal diseases, and genetic disorders in humans who have been directly or indirectly exposed to certain pesticides (Andersson, Tago & Treich, 2014). Managing this type of pollution is particularly difficult because of its diffuse nature and largely unknown combined effects of multiple types of pesticides and their life cycles in the environment.

4.2.1.3 Are we moving towards a green economy?

The future sustainability of Mediterranean agriculture highly depends on its capacity to adapt to climate change and related impacts, including increased water scarcity,

[47] Pesticides are composed of insecticides, herbicides, fungicides and a number of other products (such as growth regulators).

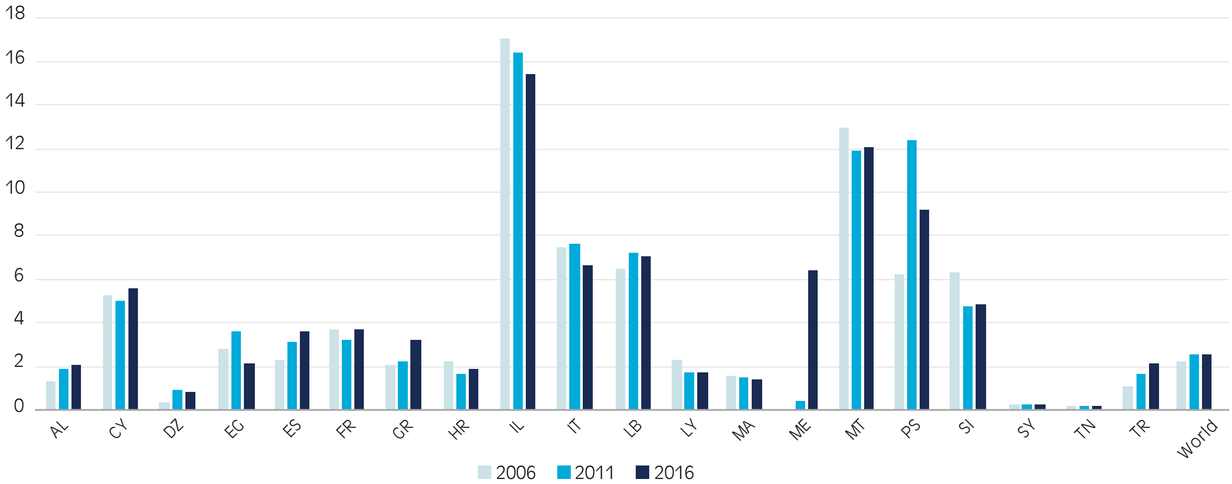


Figure 73 - Pesticide use per area of cropland in Mediterranean countries, in kg/hectare, 2006, 2011 and 2016
(Source: FAOSTAT, 2020)

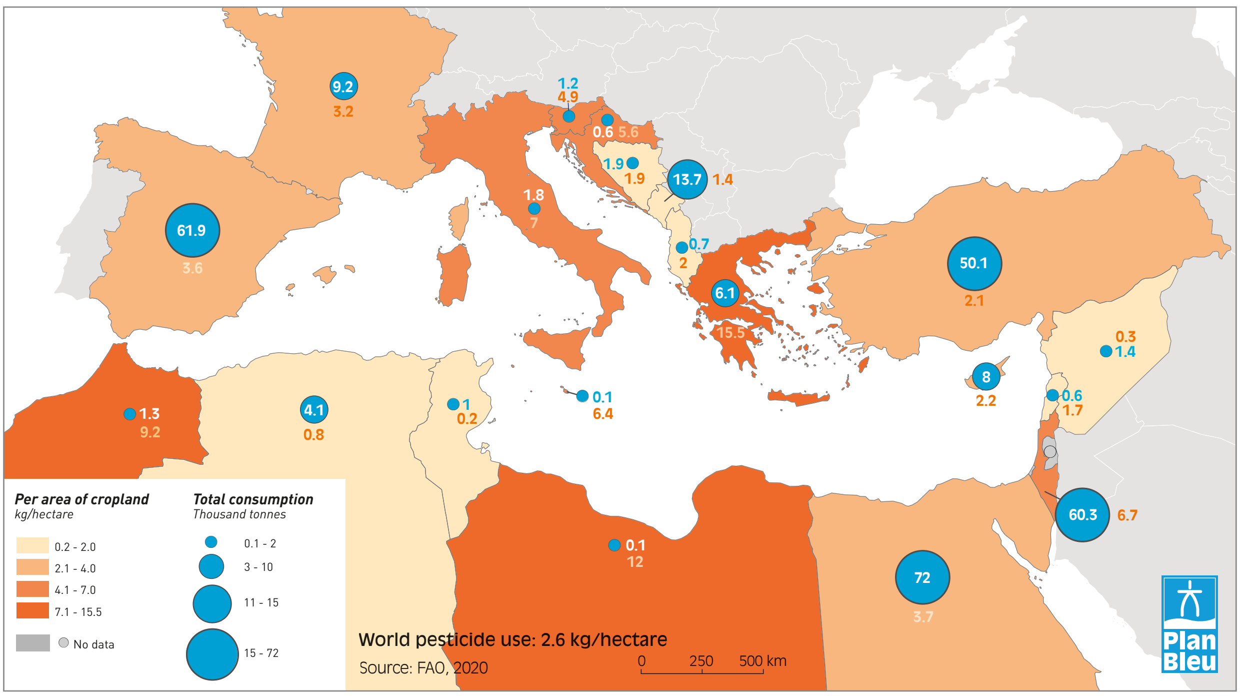


Figure 74 - Agricultural use of pesticides in Mediterranean countries, 2016
(Source: FAOSTAT, 2020)

aridity and soil degradation. Given the crucial role inherent to agriculture in providing food and - indirectly by being the highest water consuming sector - water security, which are particularly challenging in the region (see Chapter 6), the agricultural sector and the people it employs are in urgent need of solutions that provide more resilience. The implementation of integrated approaches considering the water-food-energy nexus as an interlinked system, and Integrated Water Resources Management (IWRM) could contribute to a more efficient use of resources (see Chapters 2 and 6). Responses should also include the robust management of river runoffs, and lead to a gradual reduction in the use of fertilizers and pesticides, thus preventing the release of nutrients and pollutants into the watersheds and reaching the coast. Organic farming can provide a contribution to this transition. Data from the International Center for Advanced Mediterranean Agronomic Studies (CIHEAM) shows that in non-EU CIHEAM countries (Algeria, Egypt, Lebanon, Malta, Morocco, Tunisia, Turkey, and Albania) land used in organic agriculture increased from over 174,000 hectares to over 744,000 hectares (CIHEAM, 2017). Other sustainable agricultural practices, such as agro-ecology, also have a significant potential to prevent negative impacts on the environment, or even contribute to restoring soil and store carbon.

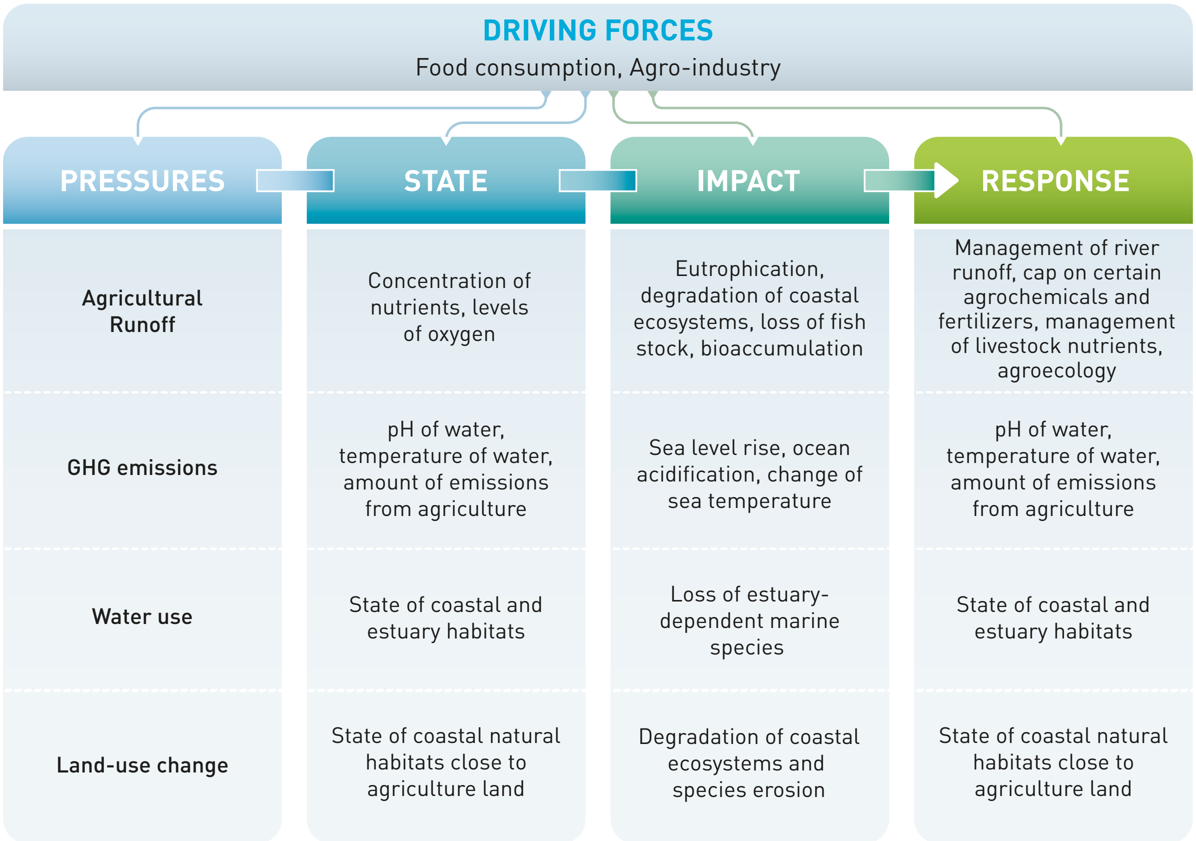


Figure 75 - Pressures exerted by agriculture on the marine and coastal environment

4.2.2 Fisheries and aquaculture

The Mediterranean has sustained important fisheries activities, including the capture of wild fish and shellfish as well as different ways of farming marine species, since ancient times. Today, industrial, semi-industrial and small-scale capture fisheries, as well as industrial and small-scale farming coexist in the region, using a large variety of techniques, fishing gear and farming mechanisms. In contrast with other major fishing areas, Mediterranean capture fisheries generally lack large mono-specific stocks, and instead exploit a variety of benthic and pelagic stocks of fish, as well as molluscs and crustaceans. Aquaculture production in the Mediterranean includes different systems and technologies, ranging from traditional activities, such as extensive aquaculture in pond or lagoon areas and small family farms cultivating mussels, to more intensive offshore finfish cage farms. Both capture fisheries and aquaculture depend on natural ecosystems; capture fisheries, in particular, depend on the status of fisheries resources, while aquaculture depends on water quality and the appropriate spatial conditions to carry out these activities. Since the Mediterranean is a semi-enclosed sea, with reduced space for marine and maritime activities, and is more susceptible to human impacts than the open oceans, both capture fisheries and aquaculture activities are particularly affected by anthropogenic impacts and are limited by space. Impacts include fishing itself, but also pollution, as well as indirect effects such as climate change and the appearance and expansion of non-indigenous species (refer to section 3.3.6)[48].

4.2.2.1 Overview of capture fisheries and aquaculture production and trends

Total production of fish and shellfish in recent years in the Mediterranean from fisheries and aquaculture amounts to approximately 2.4 million tonnes. Combined, fisheries and aquaculture provide an economic output close to USD 12 billion, including both the value at first sale and the wider economic impact along the value chain.

The sector is estimated to provide direct and indirect employment for at least one million people, including at

[48] This section summarizes information regularly provided by the General Fisheries Commission for the Mediterranean (GFCM). For capture fisheries, information is based on the report on the State of Mediterranean and Black Sea Fisheries (FAO, 2018b), while information on aquaculture comes from FishStat and the Information System for the Promotion of Aquaculture in the Mediterranean (SIPAM). Aquaculture information refers to marine species and is compiled at the level of Mediterranean countries, therefore implying that land-based production of marine species, including from other marine areas (such as the Black Sea in the case of Turkey), are included.

least a quarter of a million people directly employed on board capture fishing vessels.
This production is achieved by nearly 100,000 vessels, including official statistics and the estimated number of small boats, of which at least 83% are considered to be small-scale, and more than 30,900 fish farms, almost all of which are small- to medium-sized enterprises and family-owned farms.

Landings from capture fisheries in the Mediterranean reached their height in the 1990s and in the first decade of the 2000s, with peaks of more than one million tonnes. After that, landings started to drop, reaching a minimum of 760,000 tonnes in 2015, slightly increasing to 780,000 tonnes in 2017 *(Figure 76)*.

Italy is the main contributor in terms of landings (22%), followed by Tunisia, Algeria and Spain, respectively. Nine countries contribute to at least 5% of the total catches, together reaching nearly 90% of landings in the area *(Figure 77)*.

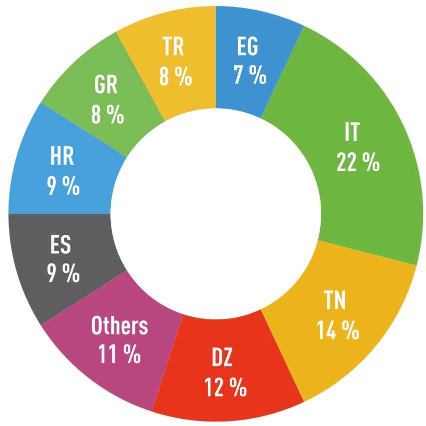


Figure 77 - Main wild capture producers (accounting for at least 5% of catches) in the Mediterranean Sea, average landings in 2014 - 2016
(Source: FAO, 2018b)

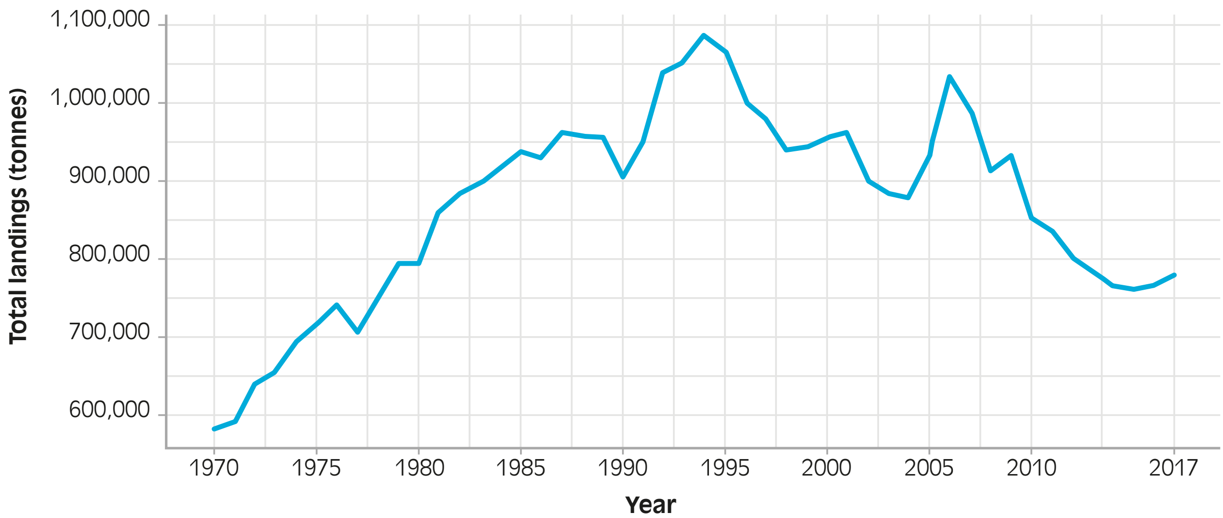


Figure 76 - Landings in the Mediterranean Sea
(Source: updated from FAO, 2018b)

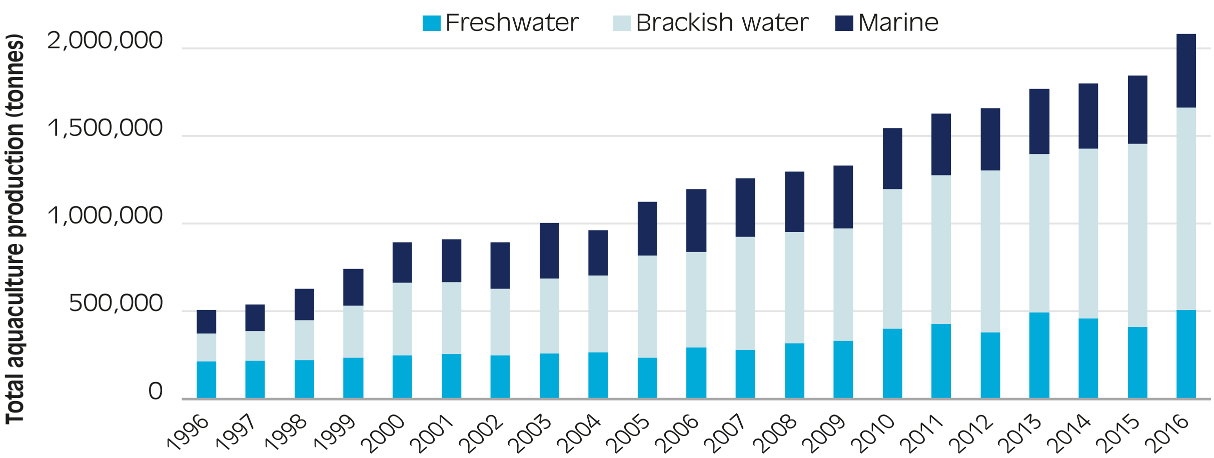


Figure 78 - Aquaculture production in Mediterranean countries, by environment
(All species and environments are included. Atlantic statistical area is excluded)
(Source: produced by GFCM based on Fishstat and SIPAM, 2019)

BOX 25

Recreational and small-scale fisheries in the Mediterranean

In Europe there are almost 9 million practitioners of recreational fishing, who generate around EUR 6 billion annually for regional economies. There are several environmental impacts associated with recreational fishing: impact on vulnerable species, disruption of trophic chains, fish welfare linked to catch-and-release, potential introduction of exotic species used as bait, potential environmental impacts of fishing gear lost or abandoned at sea, damage to sensitive habitats, etc. (Font & Lloret, 2014). Coastal, small-scale fisheries (SSFs), whether artisanal, recreational, subsistence or a combination thereof, play an important socioeconomic role across the Mediterranean countries (Lloret et al. 2018. In the EU, artisanal SSF fishers provide direct employment for around 100,000 people (around 70,000 or 84% of the 25 EU Member State fleets can be considered SSFs). Because of the small-scale nature of SSFs (smaller catches, lower impact on habitats, less annual fuel oil consumption, fewer bycatches and discards and less catch reduced to fishmeal and oil), they are often considered to have a lower ecological impact than large-scale fisheries (Lloret et al. 2018). Coastal fisheries are currently undergoing a number of changes that have been far less studied and managed than those affecting semi-industrial and industrial fisheries. The use of fishing gear that actively selects certain species, sizes and sexes, the deployment of fishing gear on certain fragile habitats, the loss of fishing gear and the use of non-native species as bait are examples of how coastal fisheries can threaten the sustainability of vulnerable coastal species and habitats in the Mediterranean (Lloret et al. 2018).

On the other hand, total aquaculture production in Mediterranean States, considering all species and all environments, has increased substantially during the last 20 years *(Figure 78)*. Production in 1996 was estimated at 509,678 tonnes, while in the last ten years production has increased from more than 1,198,000 tonnes in 2006 to more than 2,082,800 tonnes in 2016 (an increase of 73.8%, with an annual growth rate of approximately 7.4%). Considering only the production of marine species in Mediterranean countries, the production in 2016 was estimated at 1,616,041 tonnes.

This upward trend in aquaculture production has been driven primarily by increased production in Egypt and Turkey. Egypt, with a production of 1,133,439 tonnes in 2016, accounted for more than 71% of the total production of marine species (all environments included). Egypt is followed by Turkey (production of 148,730 tonnes[49]; 9.3% of total production), Greece (production of 121,154 tonnes; 7.6% of total production), Italy (production of 108,360 tonnes; 6.8% of total production), Spain (production of 17,902 tonnes; 1.1% of total production), France (production of 16,400 tonnes; 1% of total production) and Tunisia (production of 15,354 tonnes; 0.96% of total production) *(Figure 79)*.

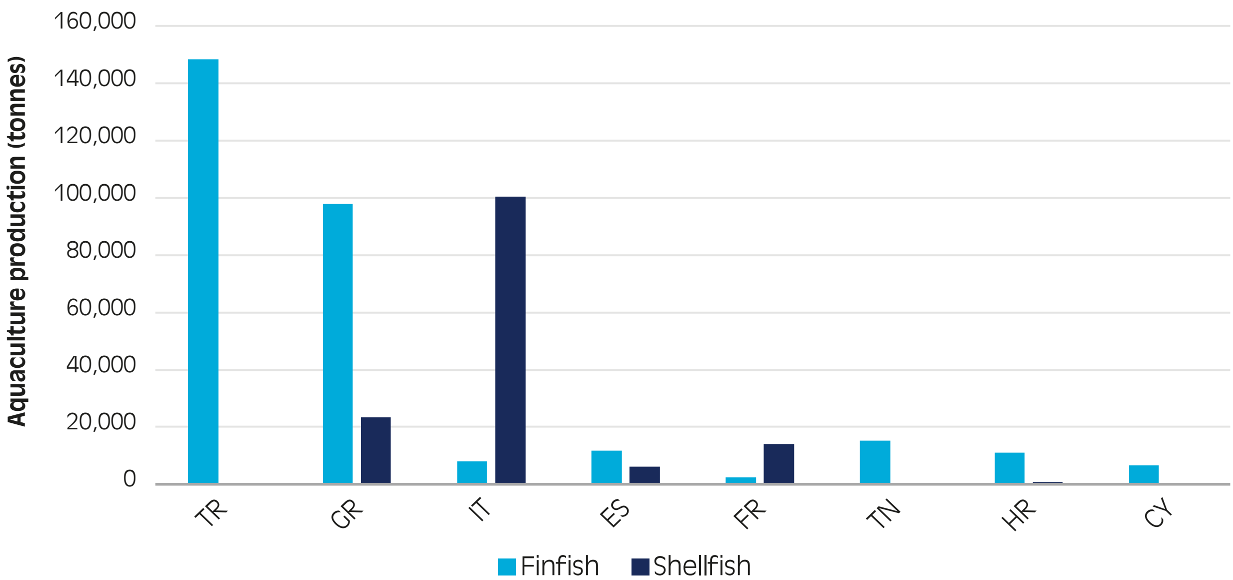


Figure 79 - Main aquaculture producers in the Mediterranean Sea in 2016, excluding Egypt
(Only marine species are included. Egypt, with a production of 1,133,439 tonnes is not shown in this graph for better readability. Black Sea and Atlantic statistical areas are excluded.[50])
(Source: produced by GFCM based on Fishstat and SIPAM, 2019)

[49-50] In 2019, Turkey registered a production of 172,492 tonnes (Turkish Ministry of Agriculture and Forestry, Fisheries Statistics 2019).

4.2.2.2 Status of resources

Eleven species each contribute to at least 1% of the total Mediterranean capture fisheries production, but all together these species only represent around 60% of catches, with a large number of other species representing the remaining 40%. Small pelagic species, in particular the sardine and the anchovy (22 and 12% respectively) are the most dominant species *(Figure 80)*.

Today, around 50% of catches in the Mediterranean and Black Sea are assessed. A considerable majority of the stocks assessed - 78%, including stocks of all priority species - are regarded as overexploited, which means that more fish are being caught than the population can naturally replace. As high as this percentage is, it has slightly decreased since 2014, when the figure was 88%. This reflects the difference made by recent management measures put in place, although it underlines the need to also make further progress.

The most seriously overexploited priority species in the Mediterranean is the European hake, which - due to its presence in most trawl fisheries - shows an average overexploitation rate 5.8 times higher than the target. Conversely, stocks which are fished within biologically sustainable limits mostly include small pelagic species (the sardine and the anchovy) and some stocks of the red mullet and the deep-water rose shrimp. Almost half (47%) of stocks in the Mediterranean show a low biomass, which may reflect the long timeframe over which they have been subject to overexploitation, diminishing their capacity to replenish.

In relation to aquaculture, more than 100 species (finfish, shellfish, crustaceans and algae) are currently cultivated within a wide range of environments and farming systems. Eight species contribute to more than 90% of overall production. Within shellfish production, the main farmed species is the European mussel *(Mytilus galloprovincialis)*, followed by the Japanese carpet shell *(Ruditapes philippinarum)* and the European oyster *(Ostrea edulis)*. Marine finfish aquaculture production is dominated by the European seabass *(Dicentrarchus labrax)* and the gilt-head seabream *(Sparus aurata)*. The production of meagre *(Argyrosomus regius)* is noteworthy among emerging marine farmed species *(Figure 81)*.

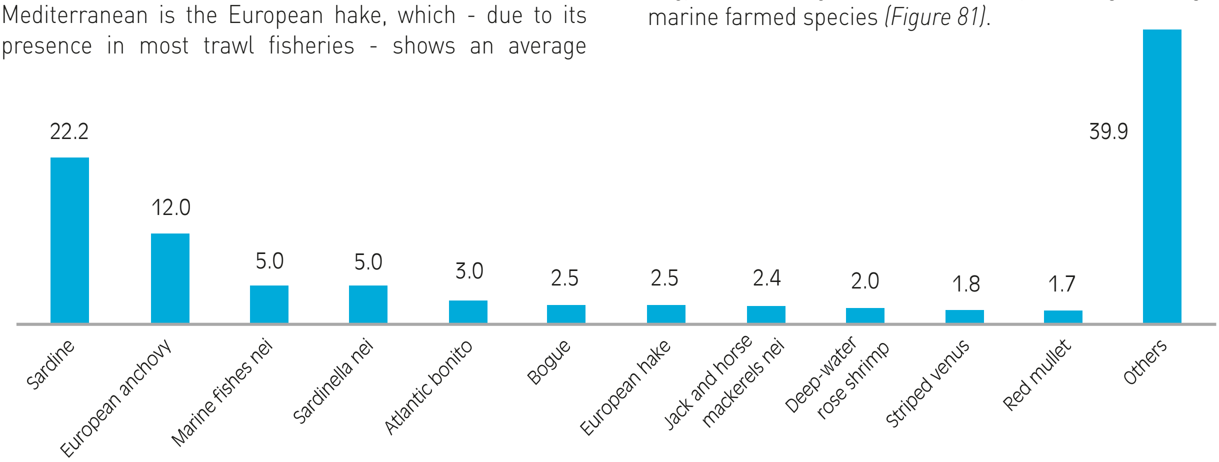


Figure 80 - Annual landings in the Mediterranean Sea by species, average values (in %) in 2014 - 2016
(Source: FAO, 2018b)

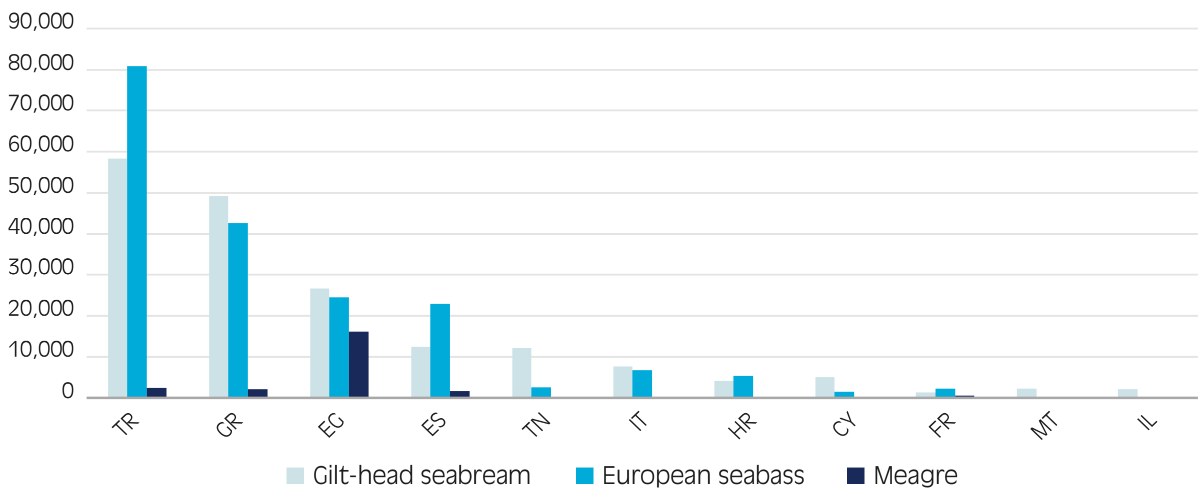


Figure 81 - Annual aquaculture production of the main marine fish species in the Mediterranean Sea, by species and country in 2016
(Source: produced by GFCM based on Fishstat and SIPAM, 2019)

4.2.2.3 Are we moving towards a green and blue economy?

Overall, the main challenge for capture fisheries and aquaculture in the Mediterranean is to provide fish for an increasing population that is also increasingly demanding fish in their diet. In fact, certain Mediterranean States are among the countries globally with a higher demand for fish protein per capita (e.g. Spain, France, Italy, Libya and Egypt; FAO, 2018b). In order to meet this demand, the fisheries and aquaculture sectors have to address different intrinsic challenges, such as the overexploitation of wild stocks and the identification of suitable places to develop aquaculture facilities, but also extrinsic challenges, such as other direct or indirect anthropogenic impacts (different kinds of pollution, habitat degradation, non-indigenous species, climate change, etc.) on the state of Mediterranean ecosystems and the environment.

Overfishing is also fuelled by unsustainable fishing techniques such as bottom trawling and discarding of unwanted fish. Bottom trawling is the least selective fishing practice and is an extensively-used practice in the Mediterranean, which leads to the destruction of benthic communities. Around 18% of the total catch may be discarded, potentially leading to overexploitation, as well as to disruptions in food webs. Non-selective fishing techniques are the main source of fish discards.
The main pressures of aquaculture are the use of wild fish for feed, which can lead to the overexploitation of the fish used for feed (Le Gouvello & Simard, 2017) and the transfer of non-indigenous species (NIS) due to the escape of fish (Sanchez-Jerez, 2013) which potentially leads to disease transfer, competition with local species or predation. These interactions of pressures are indicated in *Figure 83*.

4.3 Energy

The pollution caused by energy generation, distribution and consumption constitutes a significant challenge in the achievement of environmental objectives in the Mediterranean region. The energy mix of the region is dominated by fossil fuels, while renewable energies play a minor role. Hence, the transition to renewable energy sources is a crucial process to reduce environmental issues and threats in the Mediterranean environment.

4.3.1 Overview of the sector

Energy consumption

Mediterranean countries accounted for 7% of the world's primary energy demand in 2015, which represented 955 million tonnes of oil equivalent (Mtoe).

North Mediterranean countries account for nearly two thirds of total Mediterranean energy demand, while the South and East consume about the same, with 19% and 18%, respectively.

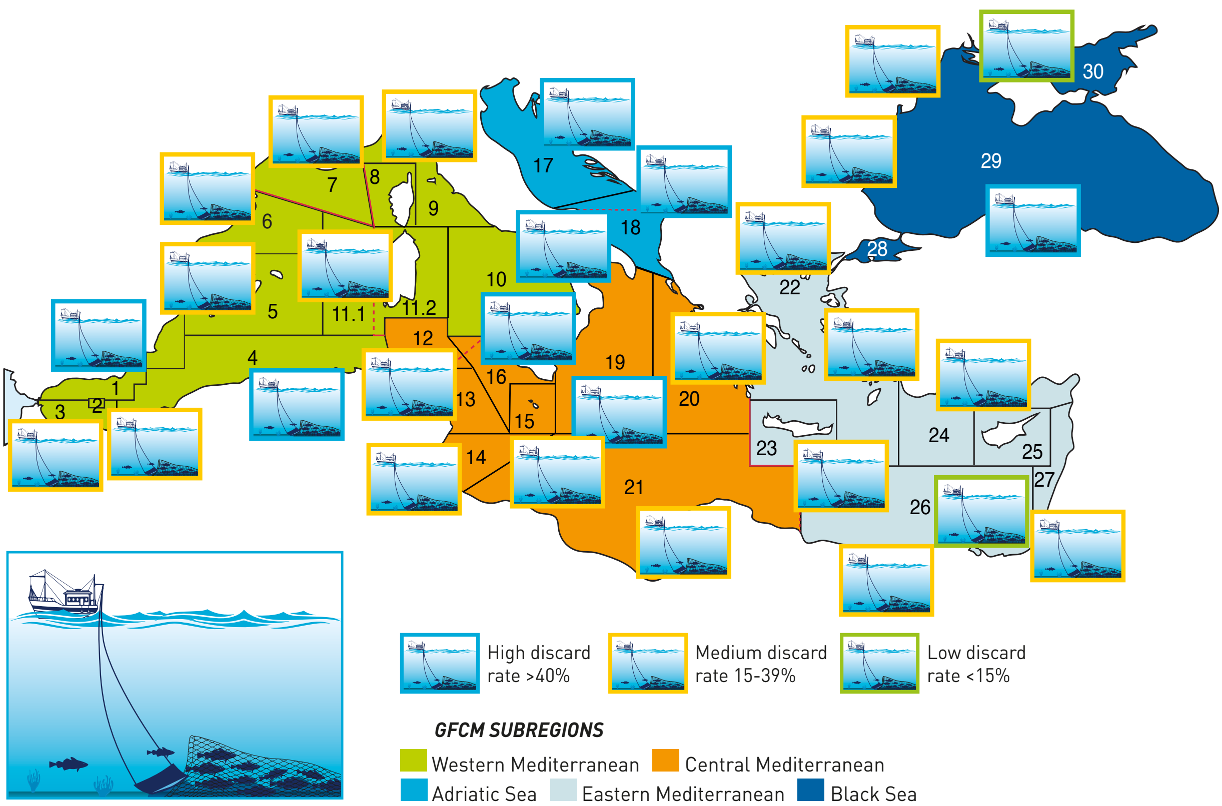


Figure 82 - Bottom trawling: discard behaviour
(Source: FAO, 2018b)

DRIVING FORCES
Demand for fish

PRESSURES	STATE	IMPACT	RESPONSE
Over-fishing	Fish stock exploited over sustainable levels	Fish stock collapse, disruption of food chain in the ecosystem	Reduce illegal fishing, ban non-selective techniques
Fish discard	Amount of discarded fish	Disruption of food chain, reduction of fish stocks, increase in benthic communities	Reduce illegal fishing, ban non-selective techniques
Bottom fishing	State of benthic ecosystems	Reduction of benthic ecosystems	Area restrictions, reduce illegal fishing, ban non-selective techniques
Wild fish for feed	Amount of fish for feed for aquaculture	Reduction of fish stocks	Limit production to non-carnivorous species
Transfer of NIS	Amount of escaped fish from the fish farms	Competition with native species, desease transfer, reduction of native fish stocks	Improvement of facilities, limit production to certain species

Figure 83 - Pressures exerted by fisheries and aquaculture on the marine environment

According to past trends and the unconditional commitments in the countries' Nationally Determined Contributions (NDCs) to the Paris Agreement (Reference Scenario), the overall energy demand in the region will increase by around 40% by 2040 (Reference Scenario). On the other hand, if the countries meet all the commitments in their NDCs (Proactive Scenario), energy demand will increase by 17% (OME, 2018) *(Figure 85)*.

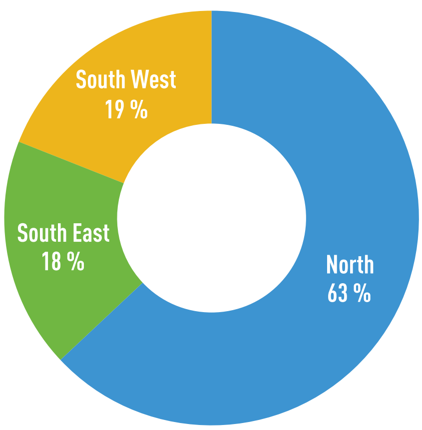


Figure 84 - Mediterranean primary energy demand by subregion, 2015
(Source: Observatoire Méditerranéen de l'Energie - OME, 2018)

The increase in energy demand is expected to be driven by Southern and Eastern Mediterranean Countries (SEMCs), which would double demand in a Reference Scenario. On the other hand, the North is expected to decrease its energy demand.

When looking at the type of fuel to be consumed in the coming decades, fossil fuels are expected to continue to clearly dominate the energy demand in both the Reference Scenario (77%) and the Proactive Scenario (67%) (OME, 2018). Most energy demand will come from transport and electricity.

Power generation trends

Total energy production has been increasing since 1990, reaching 549 Mtoe in 2015. This increase was driven mainly by the North (0.6% annual increase), followed by the South West (0.3%). On the other hand, the South East has experienced a decline in its share of production from 10% to 8% since 1990 (OME, 2018).

Regardless of the scenario, fossil fuels remain the dominant energy source in the region's primary energy mix and oil will continue to be the dominant fuel, as the region's oil demand will continue to rise, in particular for transport fuels. The production of **offshore oil and gas** was estimated at 87 Mtoe in 2011, of which 19 Mtoe were from crude oil

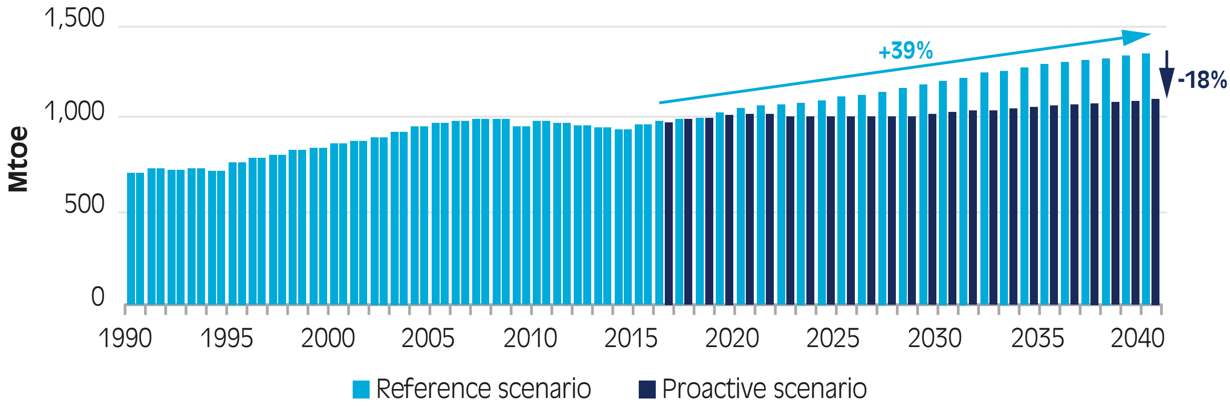


Figure 85 - Mediterranean primary energy demand by scenario, 1990-2040
(Source: OME, 2018)

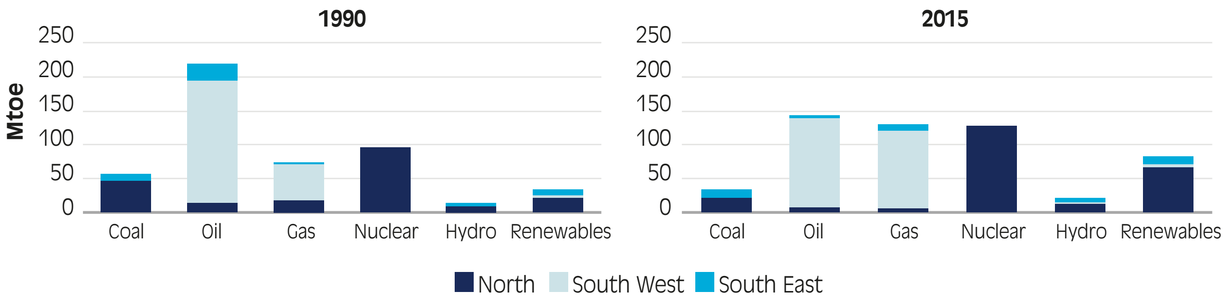


Figure 86 - Mediterranean primary energy production in 1990 and 2015
(Source: OME, 2018)

and 68 Mtoe from natural gas produced on the more than two hundred active offshore platforms in the Mediterranean. Mediterranean oil reserves represent 4.6% of global oil reserves, which are almost entirely located off the coast of Algeria, Libya, and Egypt (Piante & Ody, 2015). There are also many production areas off the coast of Greece and Turkey, and recent discoveries of major gas reserves in the Eastern Mediterranean Basin. Ongoing offshore exploration in the Eastern Mediterranean, as well as in the Nile Delta Basin and the Aegean Basin could uncover significant reserves of oil and gas that could transform the Eastern Mediterranean ecosystems and economies.

From 1990 to 2015, Northern countries decreased their share in total electricity generation in the Mediterranean from 84% to 65%. The South West and South East have both almost doubled their share to 17% and 19% respectively. In both the Mediterranean Observatory for Energy (OME) Reference Scenario and the Proactive Scenario, by 2040, the North region will produce around 50% of total electricity, while the South West and South East will both produce around 25% (OME, 2018). Currently, the North region has a varied generation mix, while the Southern Mediterranean mainly relies on natural gas, except for Turkey and Morocco, which significantly rely on coal for their electricity production (OME, 2018).

The share of non-hydro renewables is expected to grow in the energy mix, with the current policies. In the Reference Scenario, the share of renewables will expand approximately by 2.3% per year to contribute to 24% of the energy supply by 2040. In the Proactive Scenario, renewable supply would rise by 3.4% per year, accounting for 40% of energy supplied. These trends in non-hydro renewables are sustained in both Northern and Southern and Eastern Mediterranean countries *(Figure 88)* (OME, 2018).

4.3.2 Pressures on the environment

The main pressures from the energy sector on the marine and coastal environment are the release of **greenhouse gas emissions,** which derive from the production and use of energy, and from **underwater noise** and **accidental discharges,** which derive from offshore oil and gas production and the transportation of fossil fuels. See *Figure 90* for an illustrative summary of the interaction of pressures with the marine and coastal environment.

Emissions: The main greenhouse gas emitted by the energy sector is CO_2. Mediterranean countries are responsible for around 6% of the world's CO_2 emissions. Mediterranean energy-related CO_2 emissions increased from 1.575 $MtCO_2$ in 1990 to 2.013 $MtCO_2$ in 2015, of which 45% came from

BOX 26

Fossil fuels continue to be subsidized in Mediterranean countries

(Source: OECD & IEA, 2019)

Fossil-fuel subsidies undermine efforts to mitigate climate change and aggravate local pollution problems. They also represent a considerable strain on public budgets and distort the prices that inform the decisions of many producers, investors, and consumers, thereby perpetuating older technologies and energy-intensive modes of production.

Fossil fuel subsidies do not currently show a clear downward trend in Mediterranean countries. Of the ten countries for which data on fossil fuel subsidies are available, only one (France) has experienced a steady phasing-out of these subsidies over the last ten years. Most of the countries studied show an increase in fossil fuel subsidies over the same period.

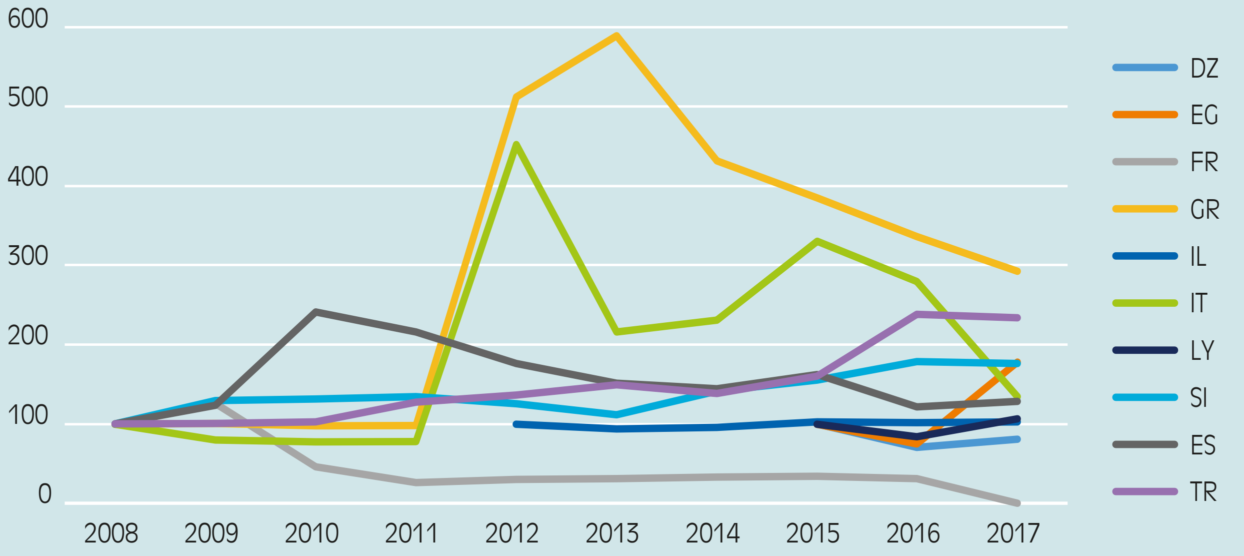


Figure 87 - Indexed evolution of government support for fossil fuels in Mediterranean countries, 2008=100

(Source: based on OECD & IEA, 2019) Notes: (i) Data available from 2015-2017 only with 2015=100 for Algeria, Egypt, Libya; (ii) Government support for fossil fuels in Israel = 0 from 2008 to 2011

In Israel, between 2008 and 2012, fossil-fuel subsidies were non-existent. They soared in 2012 upon the discovery of the Tamar Natural Gas field in the Eastern Mediterranean Basin and have been around 480 million Israeli shekels, equivalent to around Euro 120 million per year since then. Fossil-fuel support granted since 2012 is exclusively related to natural gas, including grants for the conversion of factories to natural gas and the gas agreement between the Israel Electric Corporation and Tamar Gas Field.

In Greece, fossil-fuel support rose after the 2011 Greek government-debt crisis, with a package of measures taken by the government including variable cost-recovery mechanisms for fuel expenditure. The most significant measure in terms of budget spent was a subsidy for petroleum-based small and off-grid power generators on remote Greek islands. Another measure in place is a tax refund provided for fuels used in boats for tourism in Greece.

In Italy, support for fossil-fuel consumption seems to have risen sharply since 2009, which is mainly due to a lack of data on the value of certain measures prior to 2009. Since 2012, a nominal increase in diesel tax credits for trucks and VAT reductions on electricity for domestic use can be noted. Other contributing measures that have also seen increases since 2012 are related to support for fuels in the agriculture sector as well as in air transportation and marine navigation within EU waters. Examples of measures leading to fossil-fuel support in Italy include lower rates of royalties applying to offshore production and the first 20,000 tonnes of oil produced onshore every year. A similar provision applies to natural gas for the first 25 million cubic metres extracted.

In Turkey, the 2012 new Investment Incentive Regime provides higher levels of support to coal and oil investments than to renewable-energy projects. The 2015 - 2019 Strategic Plan of the Ministry of Energy and Natural Resources identifies increased oil and gas exploration activities as a priority goal to reduce import dependency in coal, oil and gas, and to increase the use of domestic coal. Another measure in place in Turkey provides coal in kind to poor families for heating, with more than 2 million families receiving coal aid in 2017, distributed by local governments.

The weight of fossil-fuel subsidies compared to the national economy varies considerably between the surveyed countries. While they can represent up to more than 13% in Libya, around 8% in Egypt and close to 7% in Algeria, fossil-fuel subsidies represent less than 1% of national GDP in all other studied countries.

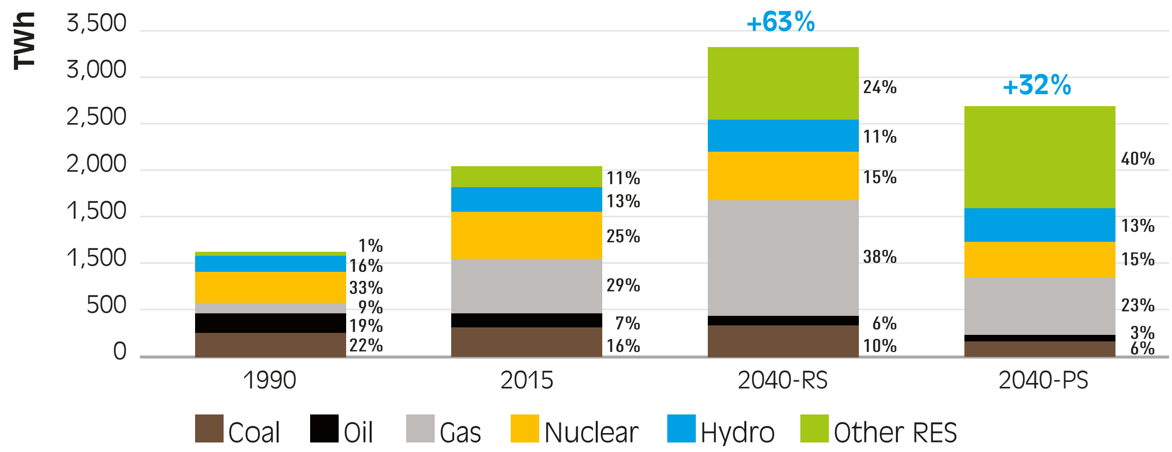


Figure 88 - Mediterranean power generation by type in 1990-2040
(Source: OME, 2018)

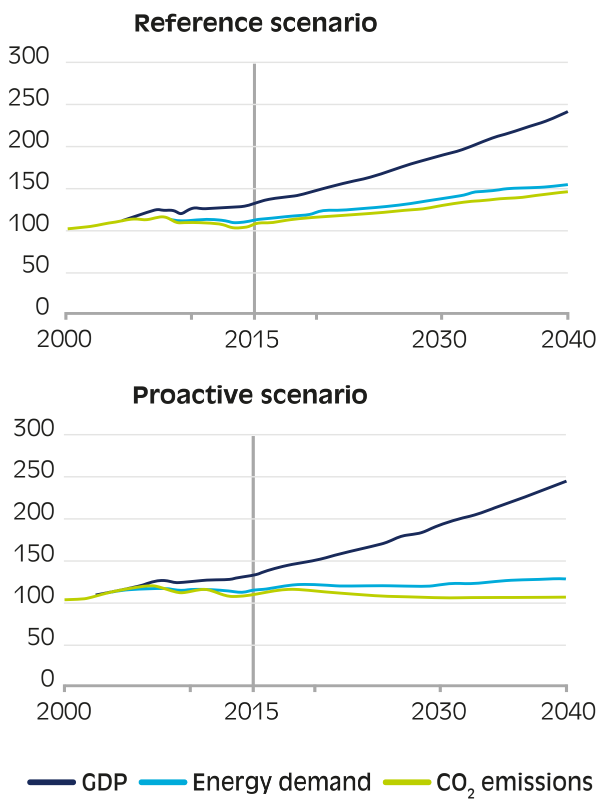


Figure 89 - CO_2 emissions in the Mediterranean region for each scenario
(Source: OME, 2018)

Northern Mediterranean countries, and 55% from Southern Mediterranean countries (OME, 2018). In the assessed scenarios for 2040, the share of CO_2 emissions from the North is expected to decrease by 9 to 13% and to increase in the South, also by 9% to 13% (OME, 2018). The energy sector is also a significant source of sulphur dioxide emissions, which exacerbates ocean acidification.

Both the current trend of CO_2 emissions from energy use and the national pledges are not in line with the temperature targets of the Paris Agreement, and emissions will greatly impact the Mediterranean environment through climate change and related impacts.

Mediterranean countries can respond by increasing the ambition of their NDCs, to fall into line with the 1.5°C target, which would significantly reduce the impacts of climate change. This would entail a rapid transformation of the energy sector towards renewable energies. Additional measures that could contribute to the reduction of greenhouse gas emissions are the adoption of an ambitious tax on greenhouse gas emissions, establishing a cap on greenhouse gas emissions, and the phasing out of fossil-fuel subsidies.

Underwater noise: The most relevant impacts of underwater noise are species' behavioural changes, such as feeding and mating, that lead to population decrease; as well as physical damage, such as the rupture of tissues and organs that can lead to the death of fish and marine mammals (Hawkins & Popper, 2016). The main responses should focus on designating restricted areas, developing more silent technology, and prohibiting noisy technologies and techniques.

Accidental discharges: The majority of spills (oil and other substances) from offshore drilling and exploration activities have been a minor source of marine pollution compared to the transport industry. The transport of oil is also part of the energy sector. From 1970 to 2009, Italy hosted most of the accidents (16), followed by Greece (5) and Spain (3) (Piante & Ody, 2015). Notably, 44% of the Mediterranean area is either contracted or designated for oil & gas exploration. Oil spills lead to the reduction of plankton, physical damage of fish stocks, marine mammals, and birds, resulting in general population decline[51]. The spillage of other chemical substances exacerbates the impacts of pollution, such as bioaccumulation and the biomagnification of ma-

[51] www.oilspillresponseproject.org/wp-content/uploads/2017/01/Impacts_on_marine_ecology_2016.pdf, pp.15, 16 and 30.

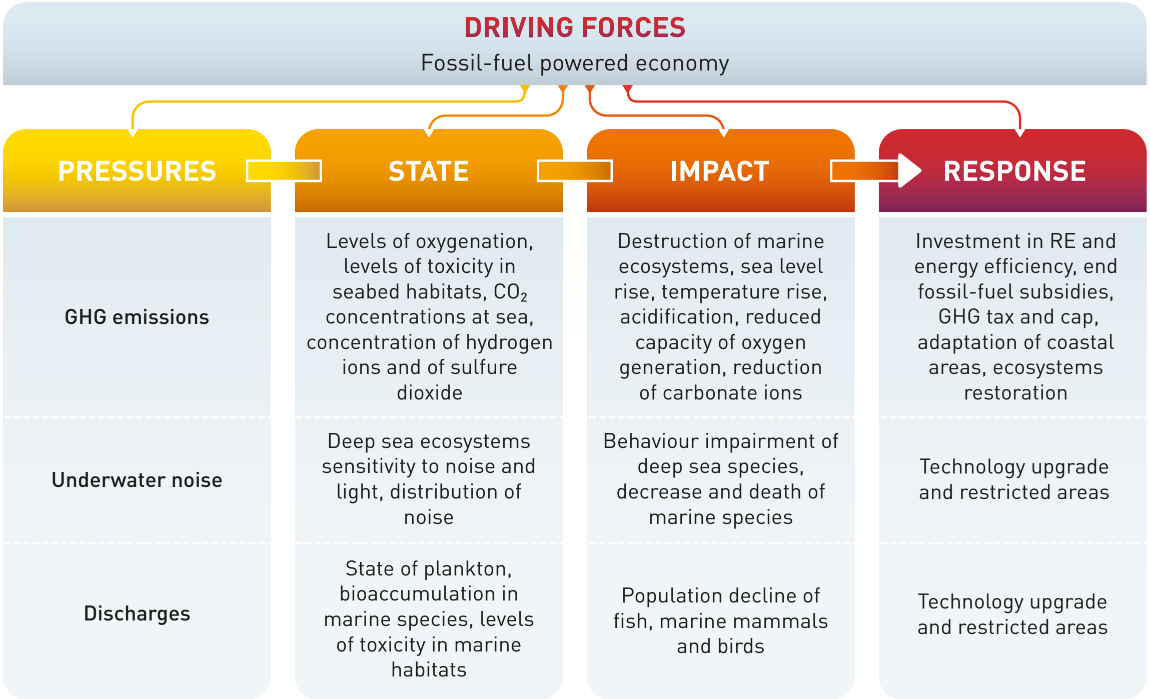


Figure 90 - Pressures exerted by the energy sector on the marine environment

rine organisms. The main regional instrument addressing offshore spillage is the Offshore Protocol of the Barcelona Convention, which entered into force in 2013. The main responses should focus on improving technology, designating restricted areas, and ensuring effective onboard pollution control facilities.

4.3.3 Dependency on the availability of natural resources and the quality of ecosystems

The Mediterranean region is overall highly dependent on the importation of fossil fuels. In 2015, the region imported 430 Mtoe of fossil fuels, which represented a 44% energy import dependency ratio. Northern Mediterranean countries import 90% of their fossil fuels, while Southern Mediterranean countries only import about 20%.

Under the Reference Scenario, where countries only achieve their unconditional NDC, countries that export fossil fuels, such as Algeria and Egypt, will have to reduce their exports to meet their domestic energy demands. In turn, importing countries, especially in the South, will have to improve their energy efficiency and increase their share of renewable energy sources. Nevertheless, in a Proactive scenario, where countries fully achieve their NDCs, in 2040 fossil fuel imports will have been reduced by more than half, reducing the fossil fuel import dependency rate to about 23% (OME, 2018).

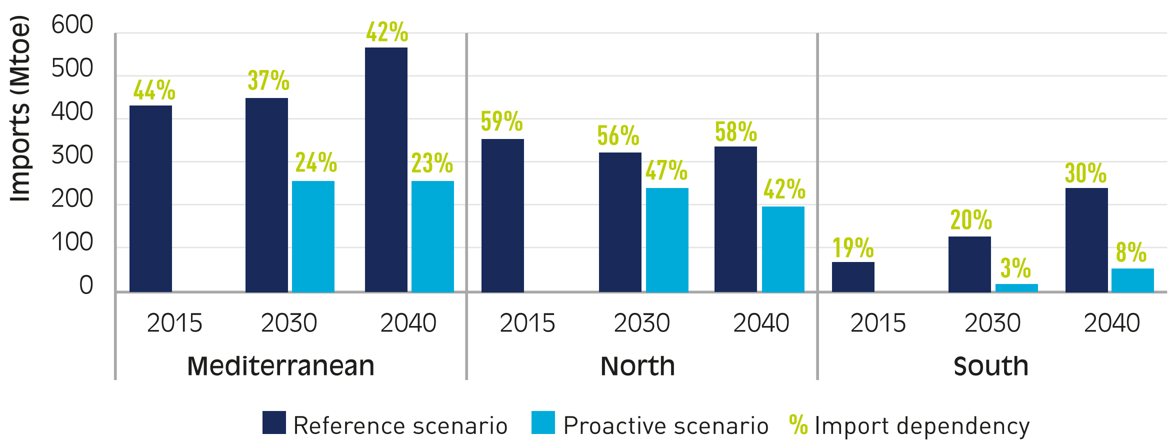


Figure 91 - Fossil fuel net trade volumes and import dependency
(Source: OME, 2018)

4.3.4 Are we moving towards a green and blue economy?

Until the early 2000s, renewable energy technologies were almost non-existent in the Mediterranean region, apart from hydropower, biomass and geothermal. Between 2000 and 2015, non-hydro renewables have more than doubled their output. Today, renewable energy technologies are mostly present in the electricity sector and the capacity is increasing faster than natural gas. Renewables currently reach 107 Mtoe, accounting for 11% of the total Mediterranean energy supply. About 80% of the region's renewable energy supply is located in the Northern countries (84 Mtoe), while the remaining 23 Mtoe are mostly in Turkey (15 Mtoe) (OME, 2018).

Therefore, there is an important margin of progress for an energy transition towards a green and blue economy is SEMCs. Indeed, the highest potential for renewable energy, especially solar power, lies in the South.

In 2040, the OME Reference Scenario would result in a renewable energy share of 34% of total energy production and the Proactive Scenario in a 52%, with NMCs clearly leading in both scenarios (OME, 2018).

Region	2015	2040	
		Reference scenario	Proactive scenario
North West	28%	52%	76%
North East	36%	36%	48%
South West	6%	15%	30%
South East	23%	23%	36%
Total Mediterranean	25%	34%	52%

Figure 92 - Renewable electricity production shares by scenario, 2015 and 2040
(Source: OME, 2018)

In any case, both scenarios fail to decarbonize Mediterranean energy consumption and to meet the goal of the Paris Agreement. For the Mediterranean to be moving towards a sustainable economy, countries would have to adopt the necessary regulatory measures to achieve ambitious targets regarding renewable energy deployment and energy efficiency that would result in meeting the goals of the Paris Agreement.

Furthermore, the decentralization and the digitalization of energy systems are crucial to boost the potential of renewable energy systems, with countries relying on a diversity of renewable energy sources that are best suited to their national environment.

Ultimately, reaching a sustainable economy greatly depends on the level of investment in the energy transition. In order to reach the OME Proactive Scenario (which still falls short of meeting the Paris Agreement), the region would have to invest over 3.3 trillion Euros in the energy system, 40% of which would go to energy efficiency measures, and 34% to power generation (OME, 2018).

BOX 27

The 2020 Renewable energy investment programme in Morocco

(Source: Moroccan Agency for Solar Energy (MASEN))

Development prospects for renewable energy in Morocco are very favourable:
- An estimated wind potential of 25,000 MW, of which nearly 6,000 MW are achievable by 2030;
- A solar potential illustrated by 3,000 hours of sunshine per year and 5 kWh/m²/day of irradiation;
- A significant hydraulic potential for micro-hydropower plants: more than 200 sites that can be exploited;
- A significant biomass potential;
- Highly-developed transit energy infrastructures;
- A legislative and institutional framework to accelerate the implementation of renewable energy development projects.

The Moroccan energy investment programme for 2020 is estimated at around USD 19 billion, which would generate some 50,000 jobs. The programme forecasts that the share of installed electrical power in renewable energy (wind, solar, and hydro) would reach 42% of the energy mix by 2020 (52% by 2030), and would also save 2.5 million tonnes of oil equivalent (toe) in fuel, representing nearly USD 1.25 billion, and avoid 9 million tonnes of CO_2 emissions per year.

4.4 Tourism

Tourism has been gradually recognized as a key economic sector within the UNEP/MAP - Barcelona Convention system with the 1980 Protocol for the Protection of the Mediterranean Sea against Pollution from Land-Based Sources and Activities identifying tourism as an economic activity to consider when setting priorities for action plans, and the 2015 Sustainable Consumption and Production (SCP) action plan setting a goal-oriented framework to promote sustainable tourism in marine and coastal protected areas in Southern Mediterranean countries, namely Algeria, Egypt, Israel, Jordan, Lebanon, Morocco, the State of Palestine, and Tunisia.

4.4.1 Overview of the sector

Over time, the Mediterranean region has developed a unique blend of maritime and coastal tourism, offering significant employment and economic wealth. The economic growth induced by tourism activities has often been to the detriment of environmental integrity and social equity. Sea-Sand-Sun (3S) dependency, cultural alteration, environmental pollution, resource depletion, climate change vulnerability, geopolitical insecurity, social instability, job precarity, are the upcoming issues that threaten the long-term sustainability of the tourism sector - and in general of the coastal communities' well-being - in the Mediterranean region. Tourism, as one of the major economic activities in Mediterranean countries, can contribute positively to local development, environmental protection and social cohesion only if it is correctly managed, monitored and supervised. Long-term strategies, multi-stakeholder collaborations and sound public policies are essential tools to promote truly sustainable tourism in the Mediterranean.

With its unique combination of mild climate, rich history and cultural heritage, exceptional natural resources and proximity to major source markets, the Mediterranean region has become the world's leading tourism destination, with around 360 million international tourist arrivals (ITAs) in Mediterranean countries, representing around 27% of total world tourists for 2017 (UNWTO, 2019). ITAs grew from 58 million in 1970 and are forecast to reach 500 million by 2030 (UNWTO, 2019). Approximately half of the 2017 arrivals -170 million - are in Mediterranean coastal areas,

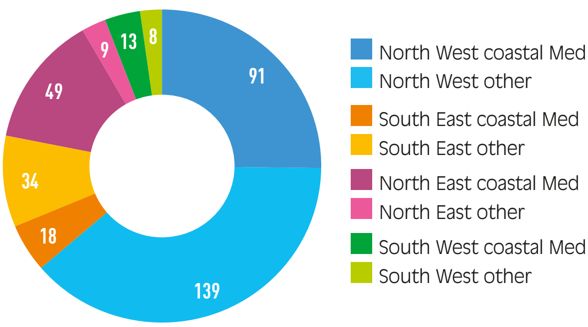


Figure 93 - Coastal Mediterranean international tourist arrivals (ITAs) and non-coastal ITAs in Mediterranean subregions, in millions of ITAs, 2017
(Source: eco-Union estimates, based on Eurostat, WTO and national sources, 2019)

aggravating the concentration of human-made pressures in coastal zones, particularly during the summer season.

The top five destinations in Mediterranean countries, receiving most of the Mediterranean countries' international tourist arrivals are France (86.9 million ITAs), Spain (81.8 million), Italy (58.3 million), Turkey (37.6 million) and Greece (27.2 million) - represented more than 82% of the region's total ITAs in 2017. The highest ten-year growth rates of ITAs have been registered in Albania (1.2 million in 2008 to 4.6 million in 2017) and Bosnia and Herzegovina (from 322,000 in 2008 to 922,000 in 2017).

Tourism is one of the most important economic sectors in the Mediterranean region, bringing high economic value, particularly for countries (or regions within countries) with limited industrial or agricultural development. As shown in *Figure 95*, the tourism sector contributes to 11.3% of total GDP[52], 11.5% of employment, 11.5% of exports and 6.4% of capital investments in the region (WTTC, 2015).

The tourism sector remains volatile and sensitive to external and internal turbulences: social conflicts and political turmoil; terrorist attacks and insecurity; economic slowdown and unemployment; and climate change and environmental degradation. Such shocks have recently led to the so-called "connected vessels effect", i.e. the fact that part of tourist flows towards destinations of Southern Mediterranean countries (seaside but also historical centres and archaeological sites) are diverted towards similar destinations in the Northern Mediterranean, considered as safer or more attractive.

Since the Arab Springs, especially in 2011, the number of international tourist arrivals decreased drastically in the countries concerned. In Egypt, this number decreased by almost 46% in 2011 and increased only slightly after 2013. In Tunisia, international arrivals dropped by more than 20% after the 2011 revolution, reversing the previous upward

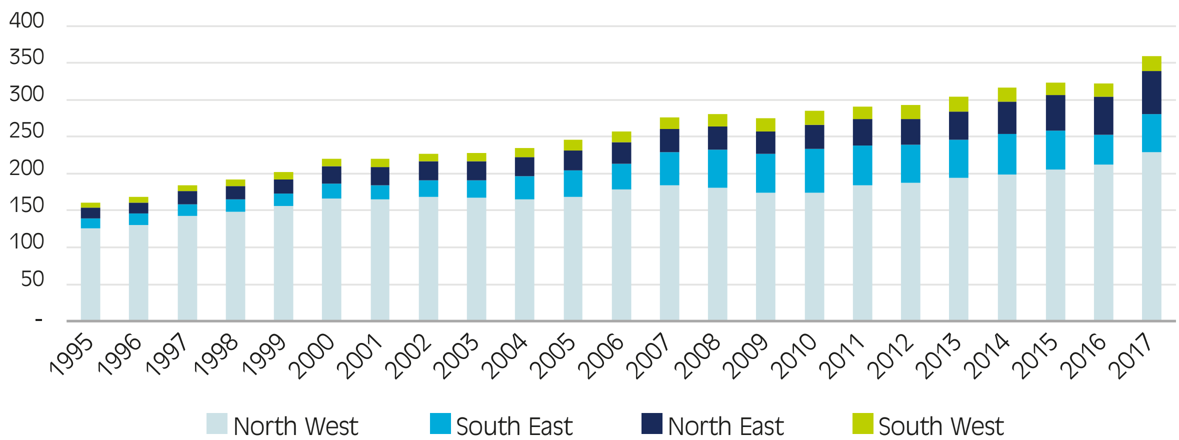


Figure 94 - Mediterranean international tourist arrivals (ITA), in millions, 1995-2017
(Source: based on UNWTO data, 2019)

[52] Taking into account direct and indirect impacts.

trend. In Turkey, the terrorist attacks and putsch attempt in 2015 and 2016 have led to a significant downturn of international tourist arrivals. In the case of Egypt, Tunisia and Turkey, previous levels of international tourism have been reached once again only just recently in 2018[53]. This change in trends might have benefited Northern countries that saw their arrivals rise in this period. For instance, in France, while the growth rate of international tourist arrivals was at - 1.2% between 2009 and 2010, the rate jumped to 38.5% the following year. Similarly, in Italy, this rate was at 3.9% between 2009 and 2010 and 24.9% between 2010 and 2011.

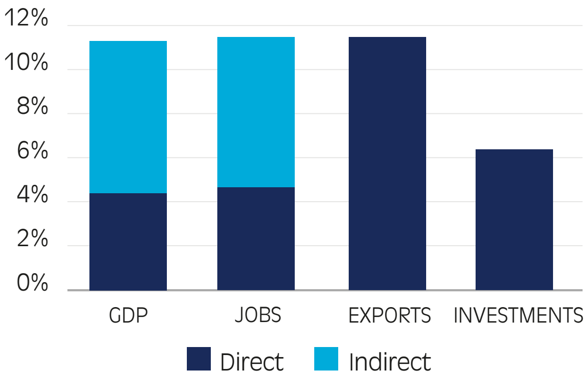


Figure 95 - Economic impact of Mediterranean tourism
(Source: Plan Bleu, 2016, based on data from WTTC, 2015)

4.4.2 Pressures on the environment

Tourism is a major consumer of natural resources: water - an extremely scarce resource in many coastal areas; food - sometimes causing pressure on the local production, leading to overfishing; electricity and cooling/heating facilities - making tourism a massive consumer of energy. Coastal tourism generates serious environmental impacts by causing marine and freshwater pollution through the discharge of sewage and the disposal of solid waste.

Tourism in the Mediterranean strongly depends on the region's natural assets, with related ecosystem services accounting for more than two thirds of the total value of ecosystem services in the Mediterranean (UNEP/MAP, 2012). This denotes that the majority of services provided by coastal and marine ecosystems are exploited for tourism purposes (BleuTourMed, 2018). Tourism supply and demand tend to be concentrated in coastal areas, which results in territorial disparities between densely-occupied coastal areas (collecting most of the economic benefits) and hinterlands where tourism activities are less developed. Climate change could create redeployments of tourist flows in space and time, thus challenging the profitability of heavy investments in coastal areas (seaside and summer tourism).

From the current state of play of tourism in the Mediterranean (Plan Bleu, 2016), it is indisputable that human-made pressures are dramatically threatening both the environmental and social sustainability of destinations as well as the economic viability of the sector. In particular, the benefits of mass tourism to local communities is highly questionable: large international operators, providing both demand (groups of international tourists) and offer (resorts, cruises, etc.), are able to extract most of the economic value generated (so-called economic leakage). Despite increasing awareness of the societal risks linked to tourism development, sustainability principles are not yet widely applied in the facilities and destination management. The key issues affecting the main pillars of sustainability related to the tourism sector, are summarized in *Figure 96.*

The main pressures of the tourism sector on the marine environment are marine litter, coastal land take, habitat degradation, air emissions, water consumption and sewage generation, and proximity to natural sensitive areas. *Figure 98* illustrates the interaction of pressures with the marine and coastal environment.

Figure 96 - Main issues of Mediterranean tourism
(Source: Plan Bleu, 2016)

[53] According to announcements by the UNWTO, but pending official reports.

BOX 28

Pressures from leisure boating

Coastal Mediterranean areas are very attractive for leisure boating. The recreational boating sector is undergoing structural changes with a general slight downturn of new boat orders at the global level and at the same time the doubling of total orders of megayachts (>60 m) between 2007 and 2014 (Boat International, 2019), of which approximately 50% sail in the Mediterranean. Recreational boating, especially the rapid growth of yachting (ships >24 m), is creating significant environmental and socioeconomic challenges, since yachts and their associated infrastructure (ports, marinas, etc.) can threaten marine fauna and habitats and cause conflicts with other sectors from recreational users to professional fishers. Increasing attention is being paid to the environmental impacts of recreational boating, raising the question of the management of boating and yachting. Of particular concern is the destructive impact of anchoring on *Posidonia* meadows, which increases with the size of the boat.

BOX 30

Tourism severely threatens the Mediterranean monk seal

The critically endangered Mediterranean monk seal needs cave and beach habitats to breed successfully. Many of such areas are exploited for tourism which has played a major role in the drastic decline and extinction of the Mediterranean monk seal in France and Corsica, Spain and the Balearic Islands, Croatia, Italy and Sardinia, and Tunisia. Without dramatic changes, the current tourism pressure will likely drive the species to extinction (WWF, 2001).

Marine litter: The pronounced seasonality of marine litter on beaches indicates that tourism is a significant source of marine litter (UNEP/MAP, 2017a) (see section below on marine litter). Tourist destinations can adopt many actions to tackle marine litter. For instance, local authorities can improve waste management systems, upgrade sewage systems, and develop guidelines for the management of their coastal litter. Regional governments can introduce dissuasive taxes, such as the Balearic Islands Sustainable Tourism Tax, which applies to all tourist accommodation facilities and invests revenue into protecting, preserving and restoring the Balearic environment (Sustainable Balearic Islands website, 2019).

BOX 29

Marine litter in coastal destinations

The results of the 2016 Blue Islands Project, an assessment of marine litter in Mallorca, Sicily, Malta, Rab, Crete, Rhodes, Mykonos and Cyprus showed a pronounced seasonality of marine litter. The study showed that July is the month with the most litter on beaches, with an average of 450,000 litter items per km^2 per day at tourist beaches, and 200,000 litter items per km^2 per day at remote beaches. The majority of litter found on beaches is formed of plastics (36.8%) and cigarette butts (30.6%). Microplastics represent 9.3% of total waste, mesoplastics (from 0.5 to 2.5 cm) account for 19.8% of the total, and macroplastics, 7.7%. The beach with the greatest amount of marine litter is Marsaxlokk beach in Malta, followed by the beaches of Torà in Mallorca, Golden Bay in Malta, Es Caragol in Mallorca, Gnejna Bay in Malta and Sunrise Beach in Cyprus (Universitat Autònoma de Barcelona, 2018).

gas emissions contribute to ocean acidification, while greenhouse gas emissions also lead to other global warming impacts on the sea, such as temperature rise and sea level rise, all of which degrade marine ecosystems. Between 2009 and 2013, tourism's global carbon footprint increased from 3.9 to 4.5 $GtCO_2$, four times more than previously estimated, accounting for around 8% of global greenhouse gas emissions (Lenzen et al. 2018). As the Mediterranean is the leading destination in the world, it therefore accounts for a significant amount of emissions. No study has estimated the amount of emissions generated by Mediterranean coastal and marine tourism. One significant source of emissions is cruise ships. For instance, in Greece, cruise ship emissions are close to non-existent in winter and peak to 800 tonnes of total emissions in August *(Figure 97)* (Papaefthimiou, Maragkogianni & Andriosopoulos, 2016).

The authorities can respond by heavily investing in (research and development for) clean transportation, promoting sustainable tourism, improving efficiency standards in the sector, as well as implementing a carbon cap and a robust carbon tax.

Water consumption: Tourism, agriculture and industry place a significant stress on freshwater resources in the Mediterranean basin (UNEP/MAP, 2017a). A tourist staying in a hotel uses, on average, one third more water per day than a local inhabitant. Water parks, golf clubs, and other tourist and recreational facilities are significant consumers of water, especially during the dry season (WWF, 2004). In consequence, the tourism sector's intensive demand for water contributes to the building of dams and reservoirs that reduce the amount of river flows to the sea. While the impacts of reduced river flows on the marine environment are not fully known, it surely has adverse impacts on marine species, which are dependent on brackish habitats. Reduced riverine flow can also lead to saltwater intrusion in estuaries and lower river systems, resulting in negative

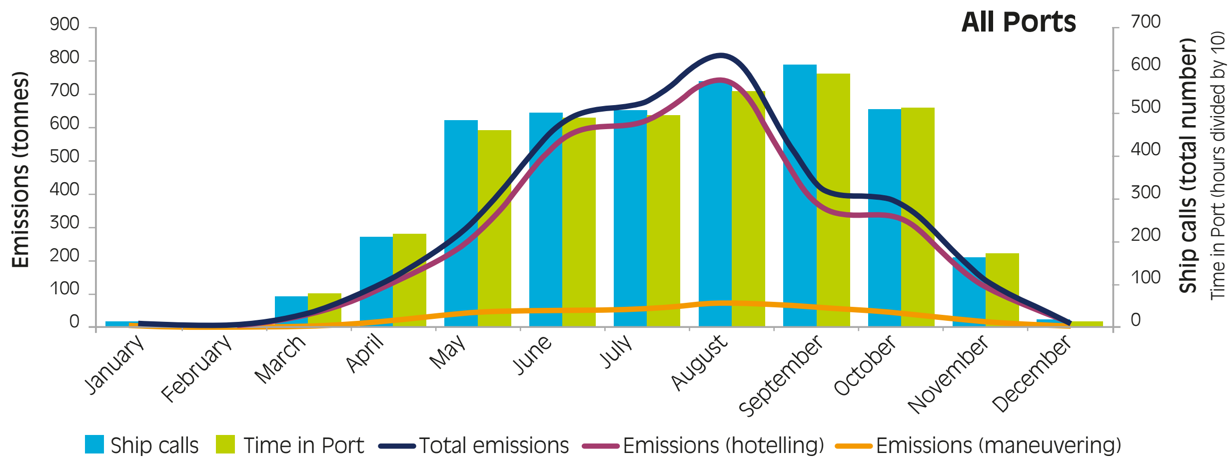


Figure 97 - Seasonal variation of cruise ships' emissions in Greek ports
(Source: Papaefthimiou, Maragkogianni & Andriosopoulos, 2016)

consequences on estuarine-dependent species and marine species dependent on reduced salinity conditions for part of their life history (FAO, 1995).
Authorities can respond by promoting sustainable tourism, restricting water-intensive practices, and implementing plans to conserve water.

Proximity to natural sensitive areas: Coastal manmade infrastructure causes irreversible damage to landscapes, habitats and biodiversity, and shoreline configuration by disrupting sediment transport (UNEP/MAP, 2017a), as well as pollution and beach erosion. 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 (UNEP/MAP, 2012). Authorities can respond by implementing coastal management plans,

DRIVING FORCES

Demand for sand, sea and sun - Extension of seasonality of coastal tourism - Demographic changes - Affordability of travel and lodging expenses

PRESSURES	STATE	IMPACT	RESPONSE
Marine litter	Amount of marine litter	Fish stock collapse, disruption of food chain in the ecosystem	Improvement of municipal waste, management of coastal areas, restriction on plastic and smoking on beaches
Coastal development	Disruption of coastal ecosystems, erosion	Disruption of coastal ecosystems, erosion	Coastal management
Air emissions	pH of water, temperature of water	Sea level rise, ocean acidification, change of sea temperature	Cap on emissions, carbon tax, clean transport, sustainable tourism, improve efficiency
Water consumption	State of coastal and estuary habitats	Loss of estuary-dependent marine species	Sustainable tourism, restrictions on water-intensive facilities
Proximity to natural sensitive areas	State of sensitive habitats close to tourism hotspots	Loss of habitat of keystone species	Coastal management

Figure 98 - Pressures exerted by tourism on the marine environment

setting minimum standards, requiring certification systems concerning water use, and developing guidelines.

4.4.3 Are we moving towards a green and blue economy?

The call for better governance
Coastal, urban and cultural tourism has increased exponentially in the past decades all over the Mediterranean region. Low-cost airlines and all-in-one packages make a short trip to sunny islands or historical sites accessible to a large number of middle-class consumers. Unfortunately, this massification comes at a cost, in particular for the local communities who feel that they are losing control of their neighbourhoods and suffering irreversible cultural or environmental damage. Recently, voters in tourist cities and regions (such as Barcelona, Paris, Rome, etc.) have elected politicians who propose to regulate tourism activities more stringently and enhance transparency and governance processes in order to increase local benefits and reduce negative environmental and social externalities.

Drawing benefit from international commitments
Mediterranean countries have recently approved global sustainability objectives, such as the Sustainable Development Goals (SDGs), the Paris Agreement on climate change (UNFCCC COP21), the Convention on Biological Diversity (CBD), as well as, under the Barcelona Convention, the Mediterranean Strategy for Sustainable Development (MSSD 2016-2025), the Regional Action Plan on Sustainable Consumption and Production in the Mediterranean (SCP AP), and the Protocol on Integrated Coastal Zone Management in the Mediterranean (ICZM Protocol). These institutional commitments strongly contribute to tackling some of the issues identified previously, but inherent societal characteristics and exponential development of the tourism sector create the need for a dedicated set of actions that could be embedded in a possible Mediterranean Strategy for Sustainable Tourism (MSST) to be approved by regional and national stakeholders including countries, the private sector, civil society and NGOs, and scientists.

Defining a shared vision and building a common strategy
Until now, each Mediterranean country has developed its own tourism strategy and set of policies to regulate and encourage the development of tourism activities. However, environmental degradation, social inequalities, lack of economic competitiveness, cultural alteration and poor governance go beyond national borders and therefore require a regional strategy shared by all neighbourhood countries. A common vision has to be shaped by all national and regional stakeholders to *"promote sustainable Mediterranean tourism in which visitors and hosts enjoy balanced, respectful and fruitful relationships and value the unique Mediterranean environmental, human and cultural heritage, while ensuring inclusive socioeconomic development, taking into account the carrying capacity of healthy natural ecosystems, and developing complementarity between various economic activities at the tourist destination level"* (Fosse & Le Tellier, 2017).

Engaging with regional stakeholders
In order to successfully implement the proposed MSST, relevant international institutions have to be involved to coordinate specific objectives, directions or actions, in particular: UNEP/MAP and its Regional Activity Centres (technical coordination), the World Tourism Organization (UNWTO) and UNESCO (thematic expertise), the Organisation for Economic Cooperation and Development (OECD) (policy knowledge), the European Union (financing mechanisms), and the Union for the Mediterranean (political support). A comprehensive, transparent and reliable monitoring system with relevant indicators also has to be built to support the implementation and follow-up of the Strategy, which should be fully integrated within the Mediterranean Strategy for Sustainable Development (MSSD 2016-2025). As the budget to implement the Strategy may be significant, it requires innovative financial instruments to attract private and alternative investments financing concrete actions, projects and activities.

4.5 Transport

Transport is an important sector in the framework of the Barcelona Convention as it facilitates mobility, trade and Mediterranean regional integration. With the continued economic development of Southern and Eastern Mediterranean countries, expanding and strengthening transport infrastructure within and between Mediterranean partner countries becomes essential, entailing the need to comply with the Barcelona Convention to regulate pollution caused by the transport sector.

4.5.1 Terrestrial transport

4.5.1.1 Overview of the sector

Transport represents the biggest share of energy use (31% in NMCs and 38% in SEMCs). Road transport accounts for more than 70% of the transport sector's energy use in Mediterranean countries, with private vehicles accounting for the highest share (Medener, 2013). Total transport energy use has increased considerably in the last decade within SEMCs compared to NMCs. However, NMCs consume more energy in transport than SEMCs. While the efficiency of transportation has improved, especially in NMCs, energy consumption remains high in this sector. In SEMCs, there is an almost total dependency on combustible fuels for transport energy. In NMCs, a mix of combustible fossil fuels, electricity and gas sources is used for transport.

Modal Share in Land Transport
Private vehicles are still the primary means of transport at the national level with a modal share exceeding 75% in NMCs. Western NMCs have the most diversified public transport systems. Buses and coaches are still predominant as public transport in most countries.

In Northern Mediterranean cities, public transport and soft modes of transport (walking, biking) are the predominant transport modes over motorized alternatives (EEA, 2013a).

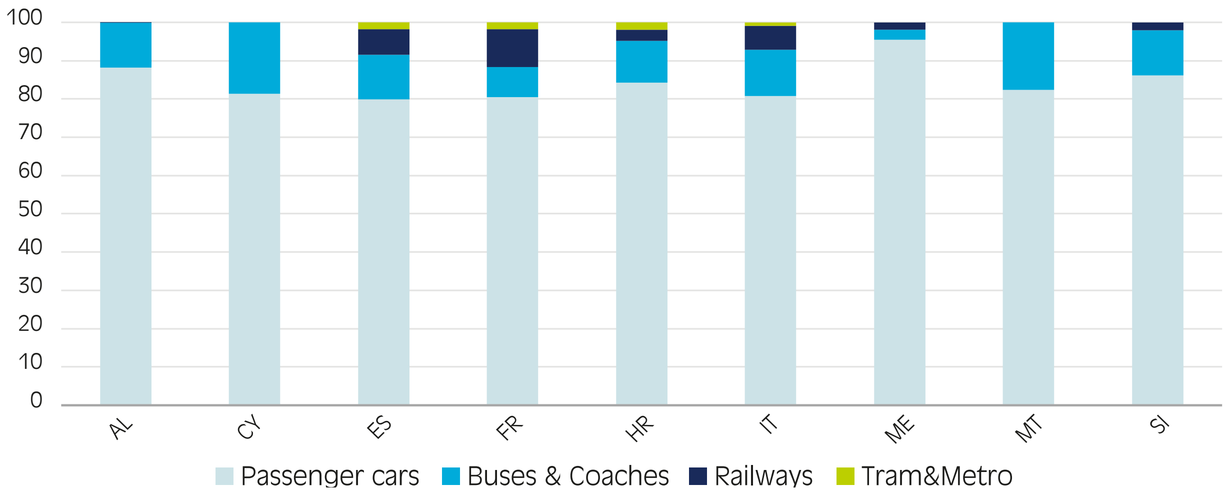


Figure 99 - Modal split of passenger transport on land in NMCs in 2015
(Source: European Commission, 2017)

While data availability on transport modes in SMCs is challenging, modal split data is provided for motorized mobility in the cities of Algiers, Beirut, Cairo and Tunis. Public transport is more developed in NMCs than in SMCs, and its further development is an important lever for reducing air pollution, traffic congestion and transport poverty. Providing incentives and better regulation to take the most-polluting vehicles out of circulation is another way to improve air quality and energy efficiency. The relevance of urban cycling as an alternative to walking, public transport and private cars is unknown.

Train Passengers and Freight

National train systems are more developed in western NMCs. In the last decade, neither the development of railways, nor the number of train passengers have changed in eastern NMCs and SEMCs. Railway transport is key for the decarbonization of transport and for reducing

BOX 31

Barcelona Mobility Strategy

In Barcelona, Spain, the modal share for public transport, walking and biking is 74%. In the last five years, the use of motorized transport has decreased and bike mobility has increased.

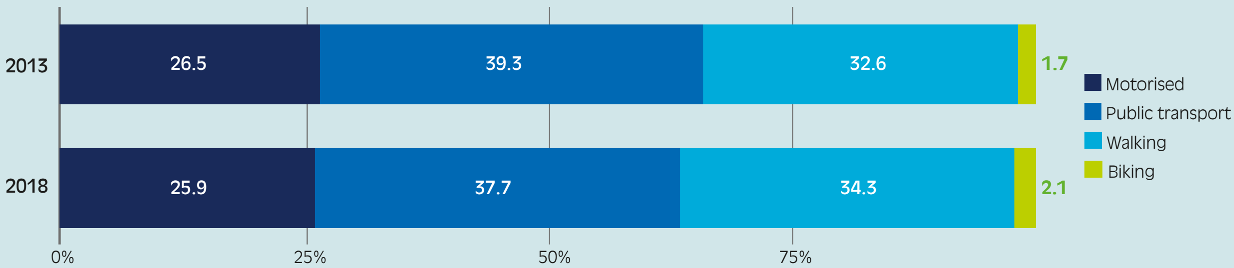


Figure 100 - Barcelona City Transport Modal Share 2013-2018
(Source: Barcelona Urban Mobility Plan 2013-2018)

The new Urban Mobility Plan (PMU 2019-2030) intends to significantly reduce motorized private vehicles, increase public space and low-emission zones, reduce private car space and increase the number of pedestrianized streets and bike lanes. In 2019, the metropolitan area will introduce an integrated public transport card, facilitating accessibility and flexible pricing. This identifies a certain number of basic traffic roads and places inside each network a wider pedestrian priority zone, where only bikes, pedestrians, residents' vehicles and urban services and emergency vehicles are allowed. It aims to establish priority areas and access controls under the UN Habitat Design for Sustainable Urban Mobility, such as to limit the transit of private vehicles. The identification of pedestrian priority zones corresponds to the routes of public transport networks.

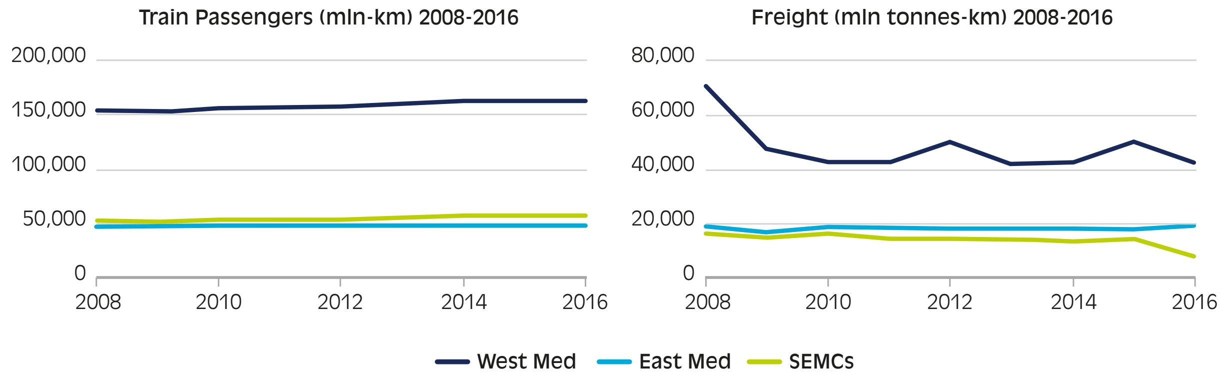


Figure 101 - Train passengers in min-km in 2008-2016 and freight in min tonne-km in 2008-2016
(Source: World Bank, 2020)

disparities between regions and within the countries. In terms of railway freight, goods transportation decreased in the North-West Mediterranean after the economic crisis and pre-crisis levels have not been recovered. In SMCs, train freight volumes declined in 2015.

Energy Use and Transport
Gasoline/Diesel are still predominant sources of energy for transport, with an increasing share of gas products, especially in NMCs. Biofuels are the second source in NMCs. Electricity, mainly used in public transport and private vehicles, is still not significant.

4.5.1.2 Environmental impacts

Motor traffic exposes people not only to physical hazards related to accidents, but also to hazardous emissions of air pollution, noise and anthropogenic heat (Mueller et al. 2017) (see Chapter 7, Health and Environment).

4.5.1.3 Are we moving towards a green economy?

In order to achieve a green land transport sector in the Mediterranean, current trends of stagnating, or even worsening, air quality, particularly in cities, need to be curbed. Major efforts are required in terms of decarbonization, depollution and energy efficiency, and need to go hand-in-hand, aiming at both meeting emission targets and health requirements.

BOX 32

Electro-mobility in Mediterranean countries

All Mediterranean countries are dependent on combustible fuels for their transportation sector. Electrical sources of energy represent a small share of energy use in transport. The share of electric transportation in NMCs is bigger and growing faster than in SEMCs (IEA, 2016). In NMCs, public transport, such as the underground and trams, are increasingly turning towards electrical sources of energy in order to reduce carbon and greenhouse gas emissions in urban areas (IEA, 2016). This shift towards electricity needs to be done carefully because shifting towards electrical sources of energy in the transport sector allows only partial decoupling. It may reduce emissions from the means of transport, but it generally generates indirect emissions due to the low share of electricity generation based on renewable energy. Although electricity generation in the Mediterranean region depends increasingly on renewable resources (hydro, wind and solar), the share of these resources in electricity generation remains low with around 25% (OME, 2018). In 2018, **EnerNETMob** (EnerNETMob, 2018), an Interreg MED-funded project, was launched in parallel to the "Sustainable Electromobility Plans" with the purpose of enabling a Mediterranean-wide network that connects cities in coastal and maritime areas with land transport. By implementing several pilot networks of Electric Vehicle Supply Equipment (EVSE), co-powered by renewable energy, EnerNETMob aims to test interurban and interregional mobility plans and land-sea intermodality using electric transport systems. It also seeks to coordinate future investments in electric transport in the Euro-Mediterranean region.

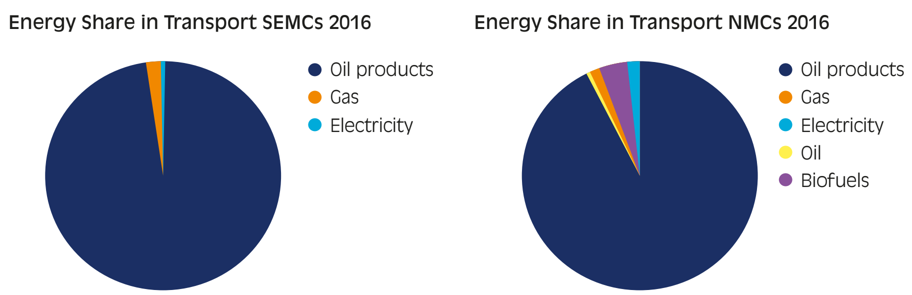


Figure 102 - Energy use and transport in 2016
(Source: IEA, 2016)

BOX 33 Social inclusiveness of public transportation in the Mediterranean

Access to transport is often subject to implicit obstacles that impede certain groups from obtaining full inclusion, especially women and young people, and particularly in rural areas. In many areas, especially in Southern Mediterranean countries, the lack of affordable, safe and reliable transportation is an impediment to women's inclusion in the labour market, making the combination of work, commuting to work and spending time on chores and childcare more difficult. These problems are amplified in rural areas, where even though transport links have been improved, the lack of transport infrastructure is still a problem, increasing the distance to market and, therefore, the isolation of some social groups. Adequate infrastructure and, in particular, access to transport and the ability to travel, are identified as essential in order to access employment and develop social relationships in remote rural areas. More particularly, in rural regions, the dispersal of a high number of small villages make traditional public transport services difficult and very expensive. In order to facilitate commuting to cities for rural inhabitants, Italy and France have created a type of territory to make sure that villages are not marginalized and can access public transport. Transportation challenges are one of the most significant barriers to youth participation in the workforce, especially for females (International Youth Foundation, 2014). The barriers to finding employment among young people depend on the relationship between transport, employment and housing, and are accentuated in rural areas, partly due to the marginality of many regions and the costs associated with spatial exclusion, such as access to education and training facilities (International Youth Foundation, 2014).

Significant levers of action in urban areas include integrated urban planning with measures to reduce traffic and avoid busy roads around schools and playgrounds, including low emission zones, more green areas, bike lanes and pedestrianization in city centres and the most congested areas, as well as public investment in (electric) public transport that is accessible to all, and the promotion of active mobility (cycling and walking). Establishing rail freight corridors, promoting the electrification of vehicles and trucks powered by renewable energy sources and the support of measures enhancing energy efficiency (potentially 15% energy savings in the Mediterranean transport sector by 2030 with a proactive scenario, OME, 2018) are other environmentally friendly solutions to decouple economic development from a high-carbon, high-pollution land transport system.

4.5.2 Aerial transport

4.5.2.1 Overview of the sector

Mediterranean Air Passenger Traffic: Disparities concerning connectivity

Commercial aviation in the Mediterranean region experienced an almost 50% increase in air passengers between 2005 and 2018, crossing the threshold of 350 million passengers. The increase in SEMCs (from 37 million passengers in 2005 to 158 million in 2018) and particularly in Turkey (from 17 million passengers in 2005 to close to 116 million in 2018) has been much stronger than in NMCs (from 155 million passengers in 2005 to 201 million in 2018). Airport infrastructure is more developed in NMCs, generating around close to 60% of air passenger traffic. Air passenger traffic within NMCs and SEMCs, especially Morocco, will keep growing over the coming years (Eurocontrol, 2017).

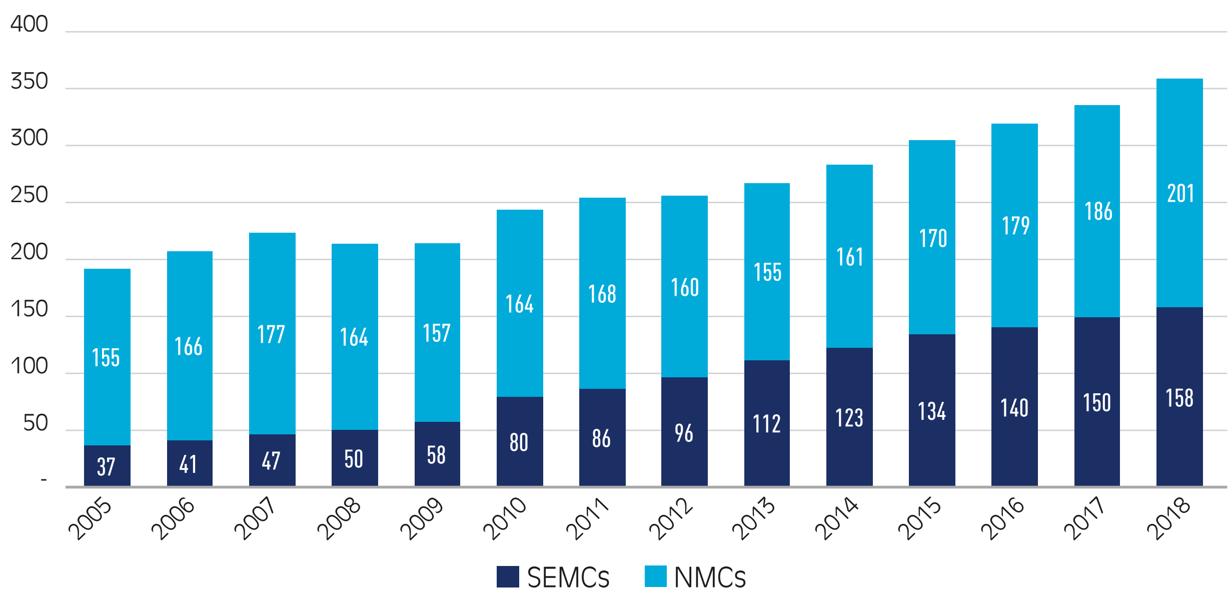


Figure 103 - Air Traffic Passengers in Mediterranean Countries 2005-2018, in million passengers
(Source: World Bank, 2019)

Figure 104 shows the striking difference between NMCs and SEMCs in terms of air passenger traffic and connectivity by key coastal airports in the Mediterranean Region. NMCs rely on an extensive network of international airports, compared to SEMCs. The Connectivity Index (Arvis & Shepherd, 2011)[54] shows that NMCs are better connected than SEMCs. The Western Mediterranean region is the most connected, followed by the Adriatic-Ionian region. Algeria, Tunisia and Turkey have the best-connected airports among SEMCs.

4.5.2.2 Environmental impacts

Aviation is responsible for an estimated 4.9% of anthropogenic global warming (Cames et al. 2013). In this context, if international aviation greenhouse gas emissions are not properly regulated, they are expected to increase by 17% (Cames et al. 2013). While aviation is not the major source of air pollution, Mediterranean cities that have a port and / or airport nearby register higher levels of greenhouse gas emissions (Dayan et al. 2017).

4.5.2.3 Are we moving towards a green economy?

Electrofuels and biofuels are potential technological solutions to decarbonize aviation, but significant electrification will probably not be possible in the coming decades, as it is too heavy and costly at this stage. To fuel 50% of European aviation in 2050 with electrofuels would require 8 million

BOX 34

Air quality near ports and airports in Spain

The air quality in coastal Mediterranean Spanish cities is considerably affected by the presence of ports and airports that can represent very large concentrations of emissions of pollutants such as NO_2, SO_2 or volatile hydrocarbons, emissions that are generally produced in metropolitan areas, although sometimes in non-urban areas.

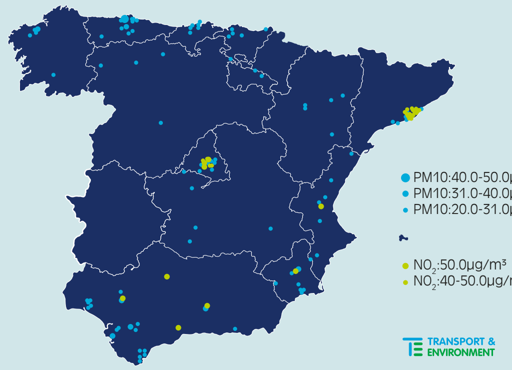


Figure 105 - PM_{10} and NO_2 emissions in Spain
(Source: Transport & Environment, 2018a, based on EEA 2015 data)

The concentration of NO_2 and PM_{10} (airborne particles) generation along Spain's Mediterranean coast corresponds to the cities where there are the biggest and busiest airports (Barcelona, Alicante, etc.).

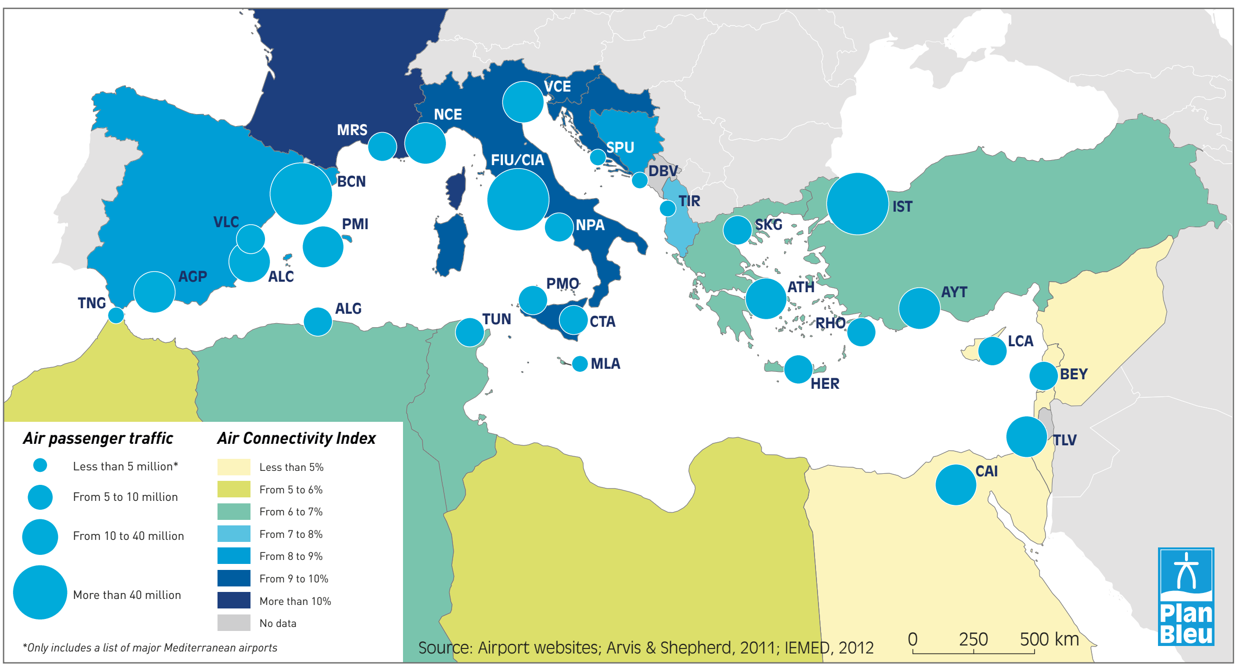


Figure 104 - Air Passenger Traffic in the Mediterranean Coast, 2017, and the national Air Connectivity Index, 2012
(Source: Airport websites; Arvis & Shepherd, 2011; IEMED, 2012)

[54] The Air Connectivity Index (ACI) measures the overall level of air service: frequency of flights, reliability, and diversity of destinations. It defines connectivity as "the importance of a country as a node within the global air transport system. A country is considered to be better connected the stronger is the overall "pull" it exerts on the rest of the network. A country's connectivity score is higher if the cost of moving to other countries in the network is relatively low. It is considered to be less well connected if the dispersion of those costs is high" (Arvis & Shepherd, 2011).

hectares of land and 33 million hectares of farmland, along with a renewable energy generation equivalent to 25% of total electricity supply in the European Union (Transport & Environment, 2018b). Its use for aviation must be considered under a conservative assessment of sustainable levels of electrification.

4.5.3 Maritime transport

4.5.3.1 Overview of the Sector

Maritime transport is the backbone of trade and economic development (80% of goods are shipped by maritime transport). Global seaborne trade volumes and demand for shipping services have been in constant - although moderate - growth since the 2008-2009 economic crisis. In 2015, for the first time, the world seaborne trade volumes exceeded 10 billion tonnes (UNCTAD, 2016). In 2017, the world fleet continued to grow (+ 3.15% in deadweight tonnage (dwt) or + 2.47% in the number of vessels) compared to 2016, but growth has been decelerating since 2011 (UNCTAD, 2017a).

The Mediterranean Sea is located at the crossroads of three major maritime crossings, namely the Strait of Gibraltar, opening into the Atlantic Ocean and the Americas; the Suez Canal, a major shipping gateway which connects to Southeast Asia via the Red Sea; and the Bosporus Strait, leading to the Black Sea and Eastern Europe / Central Asia. With its strategic location, the Mediterranean hosts an important transit lane and trans-shipment activities[56] for

BOX 35

Euro-Mediterranean Common Aviation Area (EMCAA), fuel taxation and climate mitigation

The EU is actively pursuing its policy of promoting the Euro-Mediterranean Common Aviation Area (EMCAA), based on the principle of a gradual market opening and regulatory convergence (UfM, 2013). The finalization of this agreement will enhance connectivity between Europe and South and Eastern Mediterranean countries. The NGO, Transport and Environment (T&E)[55], along with other stakeholders, such as the International Coalition for Sustainable Aviation (ICSA), to achieve ambitious targets for reduced emissions within the aviation sector, especially by removing exemptions on fuel taxation and Value Added Tax (VAT) for airlines in the EU. It builds on the 2008 agreement to include emissions from international aviation - to and from Europe - in the EU Emissions Trading System (EU ETS). The EU ETS needs to be reformed to be made more effective, especially when it comes to aviation. Increasing the rate at which the cap falls and removing the surplus which has built up are two key reforms that are being negotiated. These reforms are essential for aviation, as aircraft operators purchase allowances from this overall EU ETS. At present, the aviation sector receives 85% of its allowances for free. The T&E initiative encourages the EU to ensure that reductions in emissions from the aviation sector make a fair contribution to achieving the EU's overall 2030 climate target. This implies ending tax exemptions and subsidies and investing in low-carbon alternatives. All international flights and fuel are currently VAT-exempt based on the 1944 Chicago Convention.

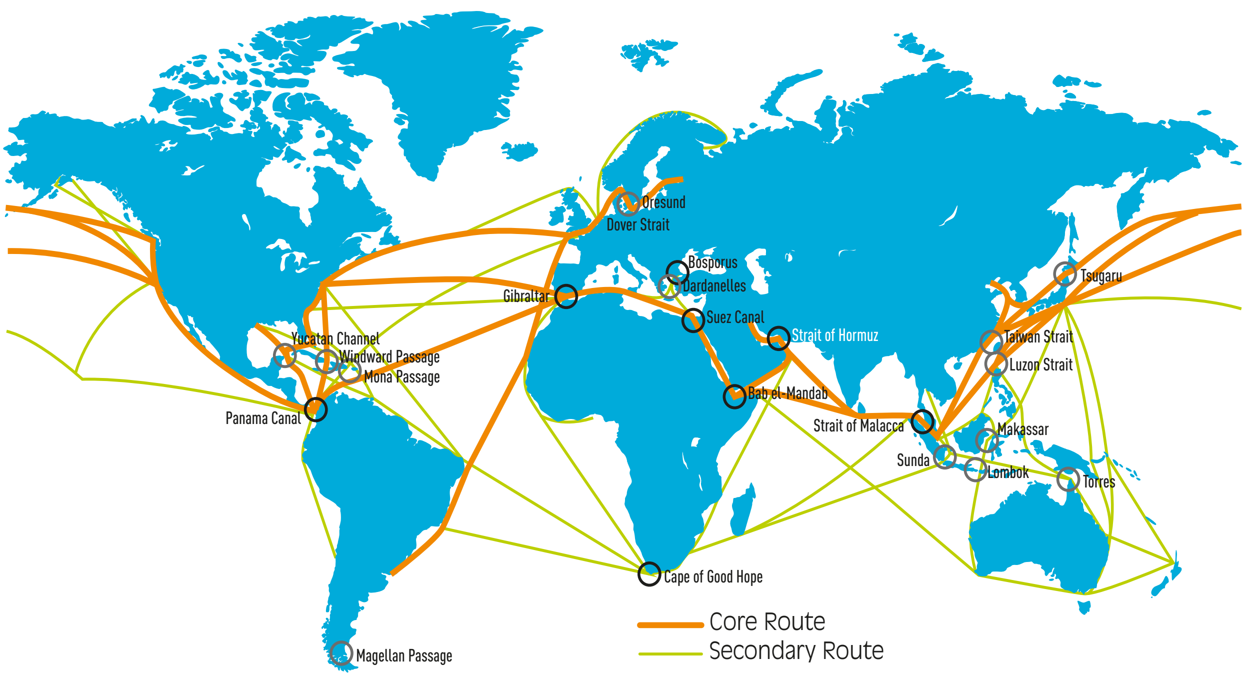


Figure 106 - Main Maritime Shipping Routes
(Source: Rodrigue, 2017)

55 https://www.transportenvironment.org/what-we-do/aviation
56 Trans-shipment is the transfer of goods (containers) from one carrier to another or from one mode to another.

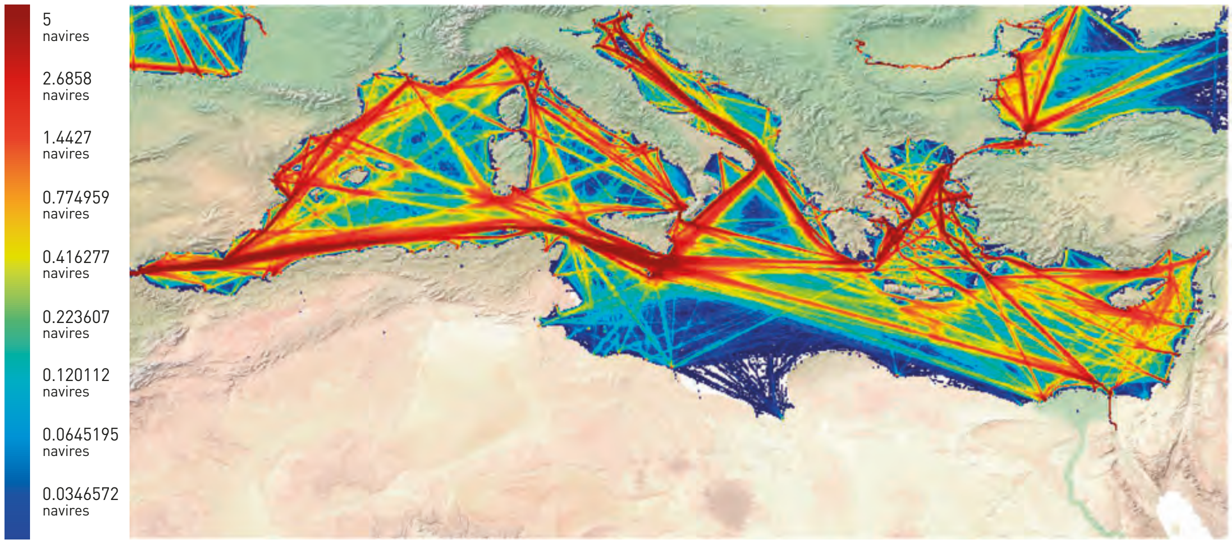


Figure 107 -Traffic density in the Mediterranean Sea Area
(Source: INERIS, 2019)

international shipping. It is also a busy traffic area due to Mediterranean seaborne traffic (movement between a Mediterranean port and a port outside the Mediterranean), and short sea shipping activities (connecting two Mediterranean ports).
In terms of connections with the rest of the world, Europe (European port calls) is by far the main shipping connection for the Mediterranean, receiving around 40-50% of total extra-Mediterranean traffic (from ports outside the Mediterranean) (Arvis et al. 2019), as shown in the *Figure 108*.

The proportion of intra-Mediterranean traffic in total Mediterranean traffic rose from 49% in 2009 to around 58% in 2016. This increase was attributable to the growth of either trans-shipment or coastal or short sea shipping (Arvis et al. 2019).

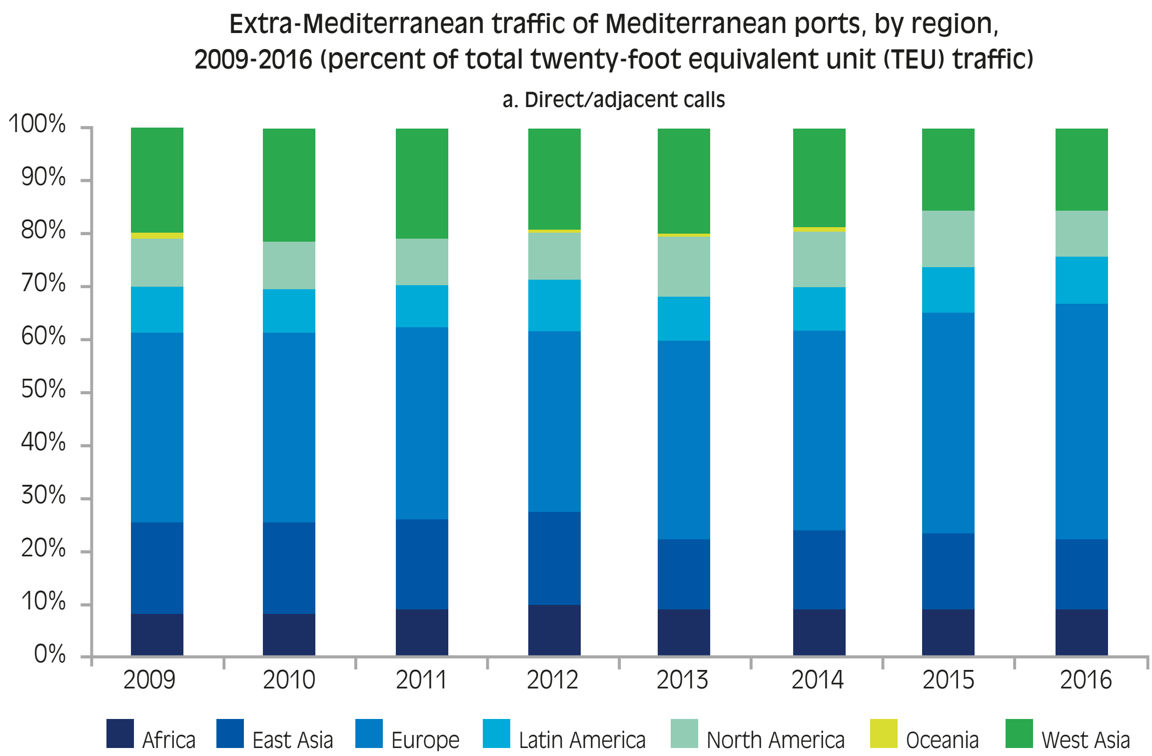


Figure 108 - Traffic density in the Mediterranean Sea Area
(Source: Arvis et al. 2019)

Oil transport: The Mediterranean is host to major oil transportation lanes, notably with oil shipments through 2 of the 6 major oil chokepoints worldwide. These are (i) the Suez Canal / SUMED Pipeline with 5.4 million barrels per day of crude oil and petroleum in 2015, equivalent to approximately 9% of the world's seaborne oil trade, and (ii) the Turkish Bosporus and Dardanelles straits with 2.4 million barrels per day of crude oil and petroleum products in 2016 (US Energy Information Administration, 2017). Together, the Suez Canal / SUMED Pipeline and the Turkish straits accounted for 13.24% of the world's seaborne oil trade in 2015.

A fast-emerging cruise industry: The Mediterranean region has seen a significant and rapid rise in cruise ship movements over the past two decades: the number of individual cruise passengers in 2017 was almost 26 million, more than double compared to 2006, with 12 million cruise passengers (MedCruise Association, 2018). Today, the region stands as the second biggest cruising region in the world (15.8% of global cruise fleet deployment in 2017 (MedCruise Association, 2018)), after the Caribbean. Because of this continuous growth, ports are facing the challenge of providing proper infrastructure to accommodate large cruise ships and upgraded facilities to be able to accommodate an ever-growing number of cruise passengers as well as to collect and dispose of related waste.

Ports accommodating more than 120,000 cruise passengers each year are considered major ports. 36 ports in the Mediterranean fall under this category, 25 of which are located in the Western Mediterranean area, 7 ports in the Adriatic and 4 ports in the Eastern Mediterranean area. Ports with fewer than 120,000 cruise passengers in 2017 include 15 Western Mediterranean ports, 11 Eastern Mediterranean ports and 6 ports located in the Adriatic (MedCruise Association, 2018).

For three years in a row, Mediterranean cruise ports hosted, on average, more than 2,000 cruise passengers per cruise call *(Figure 110)*. The increase from previous years is an indication of the continuous increase in the cruise shipping business in the Mediterranean region, but also of the increase in size of cruise vessels sailing in the Mediterranean (MedCruise Association, 2018).

BOX 36

Mediterranean countries' fleet by main ship types

(Source: UNCTAD, 2017b)

Capacity of Mediterranean coastal States' fleet (2017, in dwt)	Capacity in dwt	Mediterranean / World (~%)
Total capacity	248,304	13%
Oil tankers	92,771	17%
Bulk carriers	103,764	13%
General cargo ships	7,688	10%
Container ships	25,923	11%

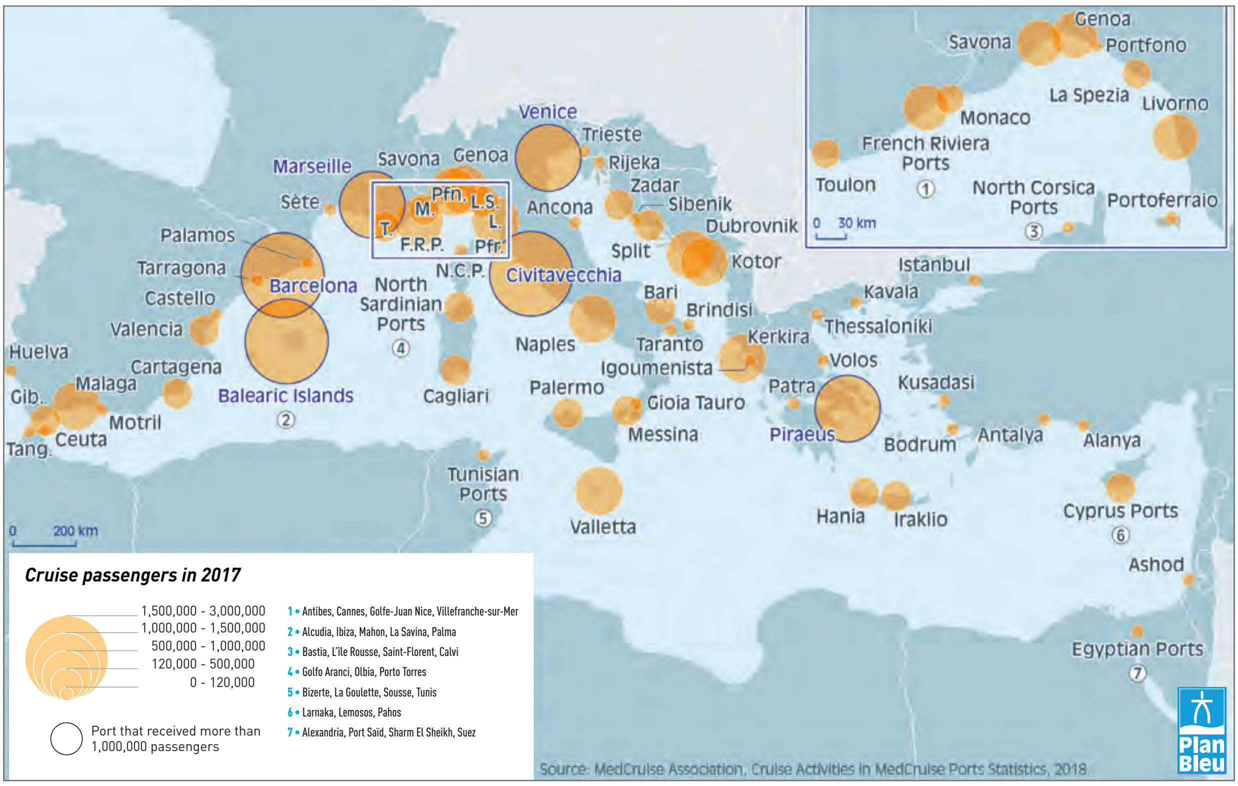


Figure 109 - Cruise passengers per cruise call in the Mediterranean, 2017
(Source: MedCruise Association, 2018)

4.5.3.2 Pressures on the environment

Increasing shipping and maritime activities are significant drivers for anthropogenic pressure on the marine environment in the Mediterranean Sea. Pressures from maritime transport essentially include: potential **accidental and illicit discharges** of oil and hazardous and noxious substances (HNS); **marine litter; water discharge and hull fouling; air emissions** from ships; **underwater noise; collisions** with marine mammals; **land take** through port infrastructure; and **anchoring.** While accidental pollution and operational oil discharges have historically been the focus and appear to be under control due to a series of technical and regulatory measures implemented over the past two decades, marine bio-invasions, air pollution from ships and marine litter are today emerging as the three more pressing environmental challenges. Recently, underwater noise and marine mammal disturbance have been the subject of increasing international attention and action. See *Figure 114* for an illustrative summary of the interaction of pressures with the marine and coastal environment.

61% resulted in a spillage of less than 1 tonne (REMPEC, 2014). In the Mediterranean, the quantities of HNS accidentally spilled considerably decreased during the 1994 - 2013 period. Since 2003, the release of HNS has become insignificant compared to the 1994 - 2002 period. According to the findings of the Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea (REMPEC), shown in *Figure 111*, the majority of incidents occurred in the Eastern Mediterranean area (REMPEC, 2014).

Oil spills and other hazardous substances lead to the reduction of plankton and physical damage to fish stocks, marine mammals and birds, resulting in general population decline[57].

For an effective response to accidental discharges, countries should agree to adopt the recommendations set forth by the International Council on Clean Transportation (ICCT), UNEP/MAP and the EEA concerning the design of new engines and vessels as well as the use of cleaner fuels and onboard pollution control facilities (Abdulla & Linden, 2008).

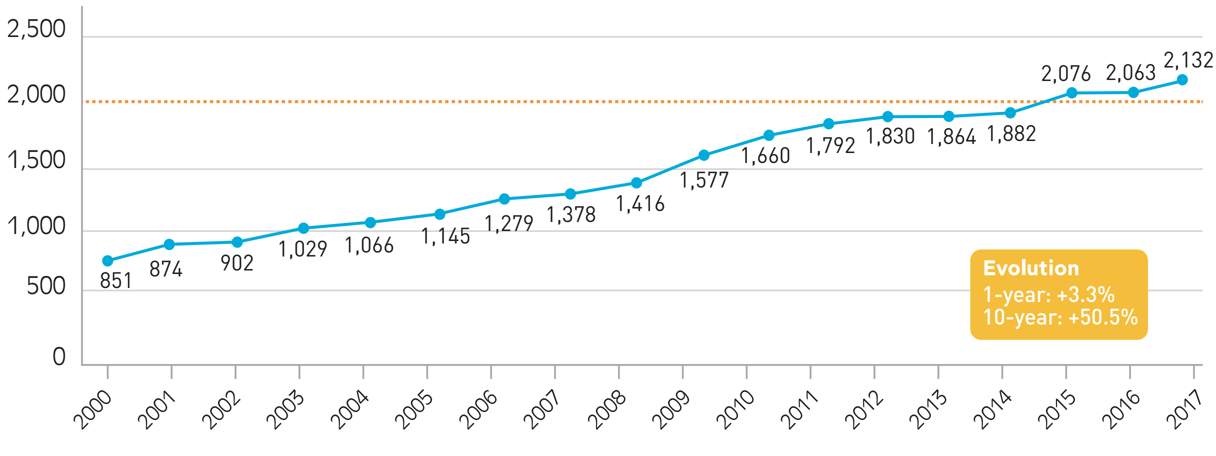


Figure 110 - Average number of cruise passengers per cruise call in the Mediterranean, 2000-2017
(Source: MedCruise Association, 2018)

Accidental and illicit discharges: Incident rates, especially incidents involving oil, have decreased globally, including in the Mediterranean, despite a steady increase in oil and other cargo volumes transported by ship. This can be attributed to the adoption and implementation of international maritime conventions addressing the safety of transportation as well as preparedness and response to accidents, following the Torrey Canyon oil pollution disaster in 1967. Between 1 January 1994 and 31 December 2013, approximately 32,000 tonnes of oil were released into the Mediterranean Sea as a result of incidents. The number of incidents involving oil spills as a proportion of the total number of incidents dropped from 56% for the 1977 - 1993 period to 40% for the 1994 - 2013 period. Of these incidents,

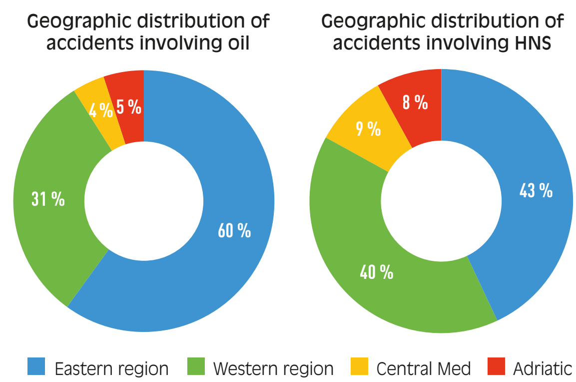


Figure 111 - Geographical distribution of accidents
(Source: REMPEC, 2014)

[57] www.oilspillresponseproject.org/wp-content/uploads/2017/01/Impacts_on_marine_ecology_2016.pdf, pp.15, 16 & 30

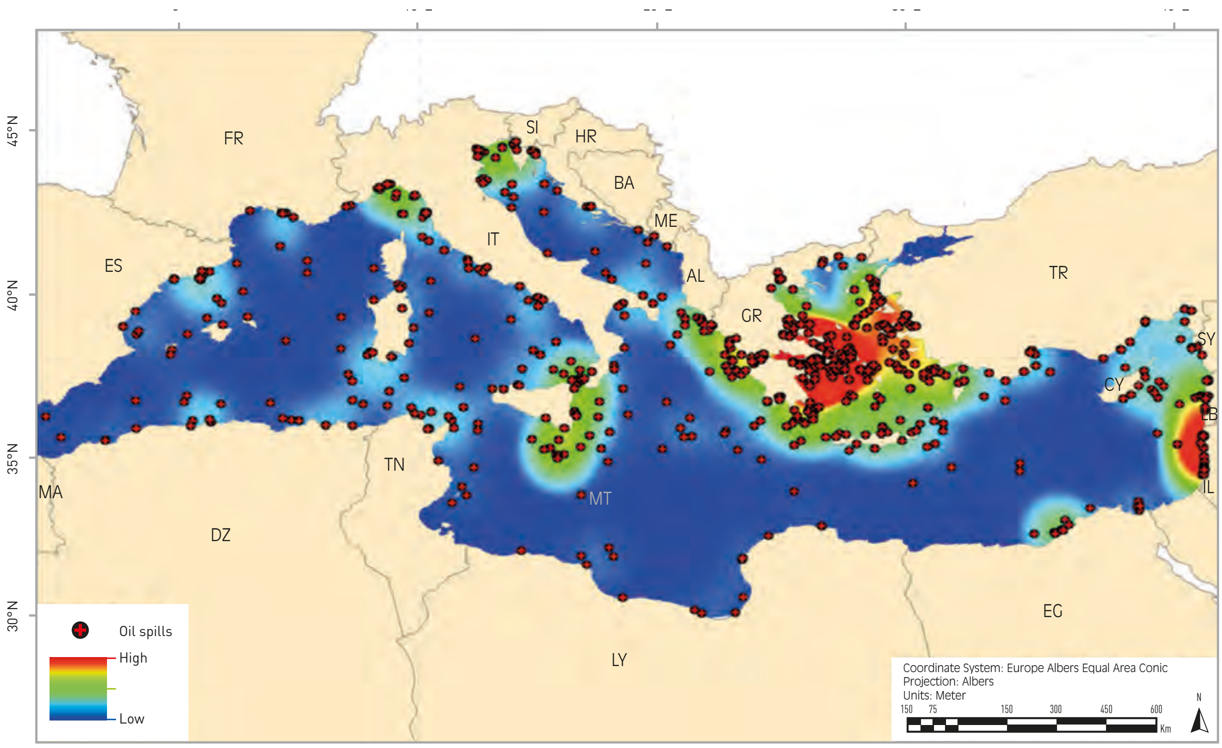


Figure 112 - Main oil spills in the Mediterranean Sea 1977-2017
(Source: Polinov, 2018 from REMPEC data)

Furthermore, sustained efforts to control illicit oil pollution discharges from ships are needed. Strict discharge regulations as well as the introduction of mandatory equipment and management procedures (required under MARPOL) have addressed operational discharges from ships, such as sewage, garbage and cargo residues. However, illicit ship pollution discharges of oily water remain an issue, although increased regional cooperation for ship surveillance, data sharing, prosecution and Port State Control have proven effective. It is expected that sustained efforts and cooperation among Mediterranean States to promote better enforcement will help minimize the occurrence of illicit ship pollution discharges.

Marine litter: Although most marine litter in the Mediterranean originates from land-based sources, commercial fishing has been recognized as a sea-based source of litter, particularly fishing gear (UNEP/MAP, 2015). Litter from fisheries, such as nets, depletes fish stocks by continuously capturing fish (ghost fishing), and can also result in the transfer of NIS. Responses should focus on introducing mandatory measures concerning onboard litter management.

Ballast water released at sea and hull fouling facilitate the transportation and proliferation of NIS, over 1,000 of which are established in the Mediterranean, with the greatest impact felt in the Eastern Mediterranean (UNEP/MAP, 2017a). NIS negatively impact the environment through predation and competition upon native species (Chapter 3). The primary responses to tackle NIS from ballast water is the 2017 IMO International Convention for the Control and Management of Ships' Ballast Water and Sediments (BWM Convention). On the other hand, the most relevant international response to reduce biofouling is the IMO voluntary GloFouling Partnerships project. Overall, responses focus on the adequate management of ballast water and the periodic maintenance of hulls.

Air emissions from ships: Shipping activities have increased significantly over the last century and, as such, are a known contributor to the global emissions of air pollutants and greenhouse gases. Ship emissions contain toxic gases and particulates like sulphur oxides (SOx) and nitrogen oxides (NOx). When released into the atmosphere, these have adverse effects on human health and cause acidification of soil and the aquatic environment, impairing the life of fauna and flora. Greenhouse gas emissions lead to ocean acidification, sea level rise and temperature rise. Greenhouse gas emissions from ships, particularly carbon dioxide (CO_2), contribute to climate change. According to the third greenhouse gas study published by the IMO in 2014, shipping accounted for 2.2% of global CO_2 emissions in 2012 (IMO, 2015). A recent study published by the International Council on Clean Transportation (ICCT) shows that shipping's contribution to global CO_2 emissions has increased slightly (2.6% in 2015) (Olmer et al. 2017). Predictions indicate that by 2050, these emissions could grow by 50 to 250%, depending on economic growth and energy developments (IMO, 2015). The ecosystems of the Mediterranean Sea are specifically vulnerable to climate change and require urgent emissions reductions. The forthcoming application of IMO global regulations establishing a sulphur cap in 2020 is expected to curb air emissions by promoting low-sulphur and alternative fuels and energy. Further responses should

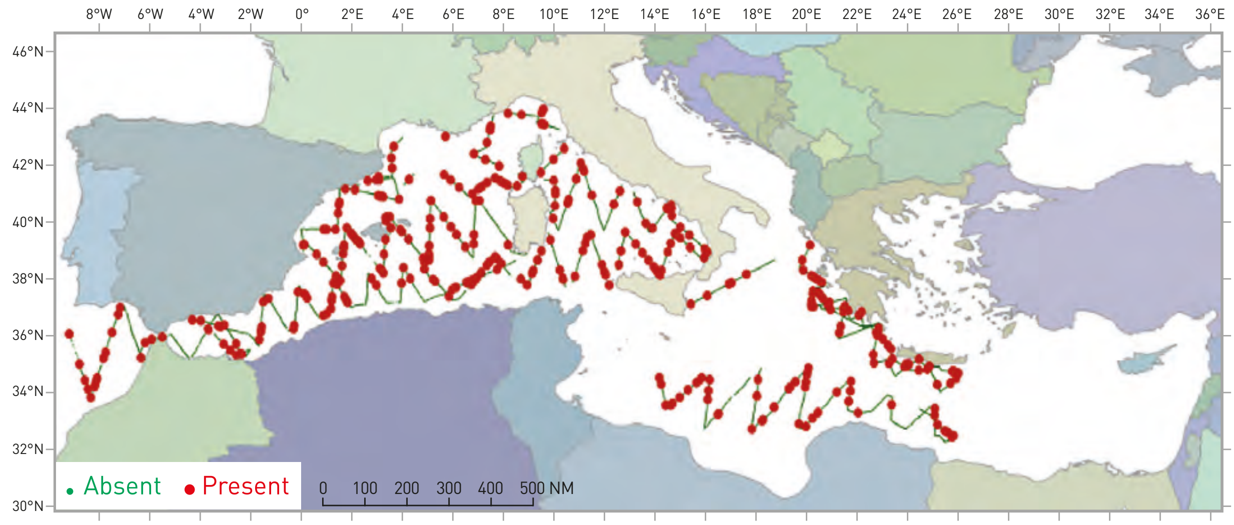


Figure 113 - Passive acoustic surveying - anthropogenic noise: shipping
(Source: ACCOBAMS, 2018)

include the adoption of ambitious emission reductions with the upscale of transport powered by renewable energies and robust carbon taxes.

Underwater noise: As sound travels four times faster in water than in air, it affects the communication, behaviour and overall health of marine species that are reliant on sound to survive, most notably cetaceans. Shipping is a significant source of underwater noise, which is mainly generated by propeller cavitation and on-board machinery (Nolet, 2017). The Mediterranean Sea is one of the world's busiest waterways and is deeply affected by underwater noise. Given the significance of shipping traffic in the Mediterranean Sea, several attempts have been made to predict or assess noise levels from vessels in the region. A recent study published by ACCOBAMS[58] has identified and mapped several areas of high anthropogenic pressure in the Mediterranean region (noise hotspots)[59], including noise from shipping and port activities (Maglio, Pavan & Castellote, 2016). Initial data from the ACCOBAMS survey illustrates that underwater noise from shipping is considerably more abundant in the Western Mediterranean, although the coast of Greece is also a significant hotspot (ACCOBAMS, 2018).

The most relevant impacts of underwater noise are behavioural changes, such as feeding and mating, which lead to population decrease; as well as physical damage, such as the rupture of tissues and organs that can lead to death (Hawkins & Popper, 2016).

Despite the fact that many agreements acknowledge the issue of underwater noise, such as the Barcelona Convention, the GFCM, and ACCOBAMS, no relevant response has led to the effective adoption of minimum standards for quieting technologies nor speed limits to reduce underwater noise.

Collisions with marine mammals: Around 220,000 vessels of over 100 tonnes cross the Mediterranean Sea every year, often navigating on autopilot day and night. Such vessels pose a significant risk of collision to marine mammals, specifically cetaceans that spend long periods of time at the surface (Panigada et al. 2006). A collision between a ship and a marine mammal can be caused directly by a ship crossing paths with a mammal in motion, but it

BOX 37

Potential impacts of underwater noise on marine animals

(Source: Hawkins & Popper, 2016)

Impact	Effects on animal
Mortality	Death due to damage from sustained noise
Injury to tissues	Injury of gas-filled organs, such as the swim bladder; internal haemorrhaging, etc.
Damage to the auditory system	Rupture of hearing organs
Masking	Masking of sounds essential for species survival
Behavioural	Interruption of feeding, schooling, spawning, migration, etc.

[58] Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic Area (ACCOBAMS).
[59] Activities considered: commercial and recreational marine traffic, harbour activities, commercial and scientific seismic surveys, oil and gas drilling activities, wind farm projects, military exercises.

DRIVING FORCES
International trade & tourism

PRESSURES	STATE	IMPACT	RESPONSE
Water discharge & hull fouling	Number of NIS, location of discharge	Predation and competition on native species	Management of discharge, maintenance of hulls
Emissions	Amount of emissions	Sea level rise, ocean acidification, change of sea temperature	Reduction of emissions, RE-powered transport, carbon tax
Underwater noise	Distribution of underwater noise	Physical damage, behaviour change, population decrease of mammals	Speed limits, monitoring, technology upgrade
Oil spills	Reduction of plankton, fish stocks, marine mammals and birds	Reduction of plankton, fish stocks, marine mammals and birds	New engine of vessels, cleaner fuels, on-board pollution control
Collisions	Number of cetaceans killed by ships	Loss of cetaceans stock	Speed limits, monitoring, relocation of routes
Anchoring	Anchoring on sensitive marine habitats	Destruction of seabed habitats	Anchoring restricted zones
Land take: ports	State of marine environment in ports	Degradation of coastal ecosystems	Green ports
Marine litter from fisheries	Marine litter from fisheries	Reduction of fish stock, NIS	Management of litter from fisheries

Figure 114 - Pressures exerted by maritime transport on the marine environment

can also be caused by underwater noise from shipping activities, acting as sound masking, which interferes with mammals' communication and echolocation (Gerstein, Blue & Forsythe, 2006; Nolet, 2017). The risk of collision between ships and marine mammals is high in some parts of the Mediterranean Sea where there is intense shipping traffic (IUCN, 2012). Areas of particular risk for collision with cetaceans are the central part of the Ligurian Sea, areas off the Provencal coasts (Alleaume & Guinet, 2011) and the southern area of the Pelagos Sanctuary, the only pelagic Marine Protected Area (MPA) for marine mammals in the Mediterranean Sea (Pennino et al. 2017). The quantitative data available shows that ship strikes killed 16% of carcasses found between 1971 and 2000 (Panigada et al. 2006). Studies also suggest that most strikes are unreported, and some indicate that ship strikes in Greece are responsible for 60% of whale deaths.[60] Hence, collisions with cetaceans can lead to a significant reduction of the cetacean population. Responses should focus on a basin-wide conservation strategy, including real-time monitoring of cetacean presence, the relocation of ferry routes, and reducing ship speed in high-density cetacean areas.

Land take due to port infrastructure: Depending on the location, construction and operation of a port, it will imply modifications to water quality, coastal hydrology, and marine and coastal ecology, leading to the degradation of coastal ecosystems due to bottom-sediment contamination. Authorities should minimize the impacts of the land-use change caused by port infrastructure by turning existing ports into green ports and building new port infrastructure based on environmental impact assessments.

Anchoring has a significant impact on keystone species present on the sea floor, such as Posidonia oceanica, and can therefore lead to the destruction of seabed habitats. As a response, some local authorities, such as Port Cros, France, have introduced anchoring restriction areas, especially in zones designated as environmentally sensitive (Abdulla & Linden, 2008).

[60] https://www.theguardian.com/environment/2018/may/27/shipping-routes-move-save-whales-greek-seas-dying-agony

4.5.3.3 Are we moving towards a green and blue economy?

Shipping and the UN Sustainable Development Goals (SDGs): Compared to road, rail and aerial modes of transportation, shipping is a low-cost, energy-efficient and safe mode of transport. As such, it has an essential role to play in achieving sustainable development and reaching the UN Sustainable Development Goals (SDGs) and targets to promote economic prosperity, while protecting the planet. IMO has established clear links between its work and the SDGs. The shipping industry has also embraced sustainable development by participating in the UN Global Compact initiative, a UN-led corporate sustainability movement in support of achieving the SDGs by 2030, and mapping opportunities in the sector to contribute to the SDGs (DNV-GL, 2017).

Ocean management: Marine Spatial Planning (MSP) provides a framework for arbitrating between competing marine human activities, including shipping, and managing their impact on the marine environment. The work achieved for the ongoing conservation and sustainable use of marine biodiversity in areas beyond national jurisdiction (BBNJ) through the development of a new legally-binding instrument under the United Nations Convention on the Law of the Sea (UNCLOS) is certainly relevant to fill in the gaps in the management and use of biodiversity beyond national jurisdiction. This work is expected to conclude in 2020.

Port reception Facilities: In the Mediterranean, ahead of the adoption of the IMO action plan to address marine plastic litter from ships in 2018, sustained work has been carried out over the past decade to address ship-generated waste. First, by prohibiting any discharge of garbage - under the International Convention for the Prevention of Pollution from Ships (MARPOL) Annex V special-status and oily waste, in accordance with MARPOL Annex I, into the Mediterranean Sea. Second, by promoting the availability of port reception facilities so that ships can dispose of their waste on shore for subsequent collection, processing, if needed, and final disposal. Third, following the adoption in 2013 of the Regional Plan on Marine Litter Management in the Mediterranean, by promoting, within the framework of the EU-funded "Marine Litter-MED" Project, the application of charges at reasonable costs or, where applicable, a No-Special-Fee system for the use of port reception facilities by ships calling at Mediterranean ports - whether or not they use port reception facilities. This is in line with the EU Directive 2000/59/EC (Directive 2000/59/EC of the European Parliament and of the Council of 27 November 2000 on port reception facilities for ship-generated waste and cargo residues) applicable to EU ports. As shown in the *Figure* below, some EU ports in Mediterranean countries use a cost recovery system, either based on administrative fees (ADM) that are partly established based on the amount of waste delivered, or a Non-System Fee that is charged to ships irrespective of their use of facilities, or direct fees that are only established based on the volumes of waste discharged.

Operational cooperation to address illicit discharges from ships in the Mediterranean: Cooperation among Mediterranean countries is key to coherently and effectively address illicit discharges from ships in the region. In recent years, joint work has included coordinated aerial surveillance operations and reporting, as well as agreeing on common methods for collecting, recording and documenting evidence. A Mediterranean Network of Law Enforcement Officials (MENELAS), relating to MARPOL within the framework of the Barcelona Convention was established in 2015 and an information system made available (http://www.menelas.org/). The challenge is to engage all Mediterranean countries in operational cooperation, which is subject to the availability of expertise and funding.

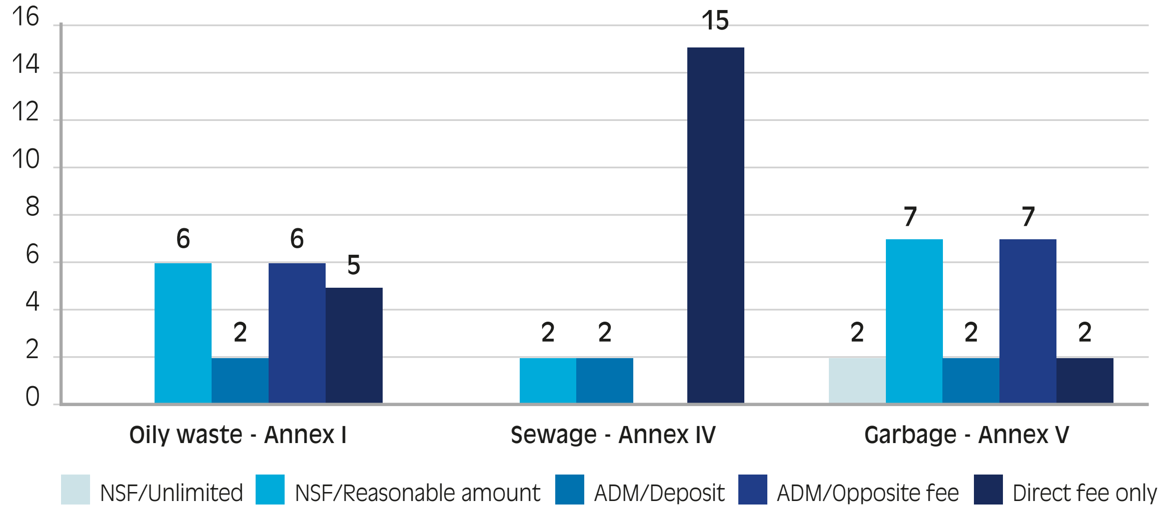


Figure 115 - Types of fee systems used in EU ports located in the Mediterranean region
(Source: UNEP/MAP, 2018)

Alternative fuel type	Potential CO_2 emission reductions
Advanced biofuels	25-100%
LNG	0-20%
Hydrogen	0-100%
Ammonia	0-100%
Fuel Cells	2-20%
Electricity	0-100%
Wind	1-32%
Solar	0-12%

Table 21 - Alternative fuels and potential energy and corresponding CO_2 emission reductions
(Source: OECD/ITF, 2018a)

Alternative fuels and energy: There are emerging promising alternative fuel and energy options for potential greenhouse gas emission reductions *(Table 21)*. Although not all of these alternatives are mature or readily available on the market, ships are increasingly looking at these, especially for new builds or retrofitting. The 2020 sulphur cap, which will reduce the permitted sulphur content in ship fuel from 3.50% to 0.50%, will increase maritime transport costs. This, in turn, will increase the attractiveness of lower-carbon ships and alternative fuel types such as LNG-powered ships.

Knowledge gaps. Integrated maritime data with a specific focus on the Mediterranean Sea remains scarce. Economic and shipping data (such as UNCTAD data or Eurostat data and other databases and data analysis) often fail to consider the Mediterranean as a whole. In most cases, Mediterranean coastal States are distributed between different geographical groups (Europe; Africa; Middle East) or are classified in groups according to their level of economic development. Another challenge is to keep databases and information systems up to date, given that maritime traffic characteristics (type of cargo transported; number, type and size of ship movements), port infrastructure developments and volumes of goods and passengers calling at ports can vary significantly over the years. There is also a gap in research and studies addressing all sources of pollution from ships and their specific impact on the Mediterranean Sea and coastal ecosystems, as defined in the Barcelona Convention. This lack of knowledge may be a challenge for shaping policy that would adequately address maritime transportation and its interaction with the marine and coastal ecosystems in the region.

4.5.4 Dependency on natural resources and quality of ecosystems

The transport sector is the second largest component in the Mediterranean Ecological Footprint after the food sector, with a share of 22% (Mancini & Galli, 2017). Transportation's footprint in the region is mostly due to the transportation of people (both private vehicles and public transport) in major Mediterranean cities. The higher a city's income level, the higher its ecological footprint, mostly due to the greater use of transportation. This explains why cities such as Tel Aviv, Athens or Barcelona have a larger per capita ecological footprint than their respective countries. In cities with lower per-capita footprints, such as Cairo and Tunis, approximately 14% of the ecological footprints are due to transportation, compared to 25% in cities with the largest values, such as Athens and Barcelona. The transport sector is also strongly dependent on public services and policies as well as personal behaviour. Countries with a well-functioning public transport network can lower the sector's resource requirements, allowing households to depend less on private cars (Mancini & Galli, 2017).

Therefore, two conflicting dynamics are taking place in Mediterranean cities (Mancini & Galli, 2017). Cities concentrating investment are able to maximize resource and energy efficiency, contributing to a lower dependency on natural resource availability and a smaller per-capita footprint. Cities also permit an increase of wealth per capita and lifestyle improvements, which increase the demand for resources, dependency on the quality of ecosystems and pressures on natural resources. In order to understand the dependency of Mediterranean cities on natural resources and the quality of ecosystems it is essential to understand the trade-offs between these two dynamics (Mancini & Galli, 2017).

Since the beginning of the 20th century, the development of different means of transportation in Mediterranean countries required and mobilized an exponential quantity of resources, leading to a growing total energy use (Brun, Blanc & Otto, 2016). As an energy intensive sector, until now, transport has depended mainly on fossil fuels and has required the massive use of natural resources at every stage of production and delivery in order to satisfy human requirements and all three types of transportation (terrestrial, aerial and maritime), with infrastructure building, cars and other transport industries, oil, petrol or gas for transport operation, etc. (Brun, Blanc & Otto, 2016).

According to estimates from the International Energy Agency (2014), by 2040, global energy demand will increase by 37% and be equally divided into four components: oil, gas, charcoal and low-carbon emission energy sources (Brun, Blanc & Otto, 2016). As transport is the second largest driver of the Mediterranean region's ecological footprint and is constantly growing in size and value, its dependency on natural resources is likely to increase if national and regional stakeholders fail to prevent an unsustainable allocation of resources. For instance, total maritime traffic is expected to grow with the future implementation of 'Motorways of the Sea', which is part of the Trans-European Transport Network, implying a considerable increase in the volume of traffic in the Euro-Mediterranean region (Brun, Blanc & Otto, 2016).

4.6 Industries and mining of non-living resources

The Barcelona Convention specifies in its 1995 version of Article 7 that "the Contracting Parties shall take all appropriate measures to prevent, abate, combat and to the fullest possible extent eliminate pollution of the Mediterranean Sea Area resulting from exploration and exploitation of the continental shelf and the seabed and its subsoil" (Amendments to the Barcelona Convention, 1995). This implies that activities by marine biotechnology industries and the mining of non-living resources represent a central challenge to sustainable development if not properly monitored and regulated. This sector also constitutes a major stake in scientific and technological cooperation (Article 11) in the Mediterranean.

4.6.1 Marine biotechnology industries

4.6.1.1 Overview of the sector

Bioprospecting is defined as *"the search for interesting and unique genes, molecules and organisms from the marine environment with features that may be of benefit for society and have value for commercial development"* (UfM, 2017). It has the potential to make a significant contribution to green growth in many industrial sectors through multiple applications in medicine, food, materials, energy and cosmetics. Since many microbial species are still unknown, bioprospecting has a huge potential, and developing this sector could help address major global challenges (UfM, 2017).

There is little statistical data on the global development of marine biotechnology industries, and even less regarding the Mediterranean region specifically (UfM, 2017). It has been estimated by the European Union that the sector may be producing a Gross Value Added (GVA) of EUR 1 billion in European waters, although there are no statistical databases that back up these estimations (UfM, 2017).

On the other hand, a report tried to define the value of bioprospecting, and estimated that the size of the European blue biotechnology sector in 2012 represented approximately EUR 302 - 754 million in revenue (Ecorys, 2014). If market growth of 6-8% per annum is maintained, revenue from this sector in Europe should reach EUR 1 billion by 2020, which would result in the creation of 10,000 jobs (Ecorys, 2014). There is no data on the economic value of the blue biotechnology market (GDP contribution) nor on public funding of R&D (UfM, 2017).

Patent claims regarding marine organisms in the Mediterranean are mainly in European countries, as shown in the following graph. Israel and Turkey are the only non-European Mediterranean countries where patents were registered during the 1991-2009 period.

Over 50% of the European patents are related to health, followed by cosmetics, genetics and food, with fewer patent claims in energy and aquaculture (Plan Bleu, 2017b). Due to the small number of patent claims, it can be assumed that this sector implies low employment, but the jobs created are probably highly qualified. Ecorys estimated that the number of employees in the Blue Biotechnology sector in Europe could range from 11,355 to 39,750 (Ecorys, 2014). These numbers are expected to grow in the next decade as the Mediterranean region has been identified as a region with high endemic potentialities, especially as the Mediterranean is rich in species with the highest potential for application (sponges, extreme microorganisms) (Ecorys, 2014).

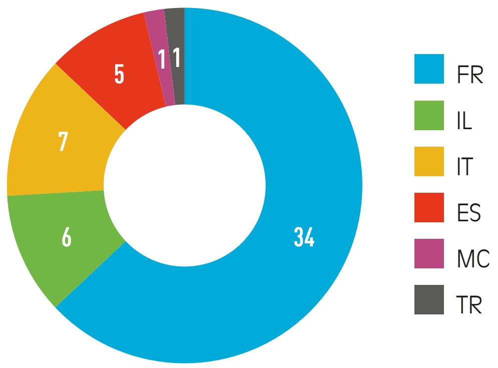


Figure 116 - Number of bioprospecting patent claims on marine organisms in Mediterranean countries
(Source: eco-union & Plan Bleu, 2017b)

4.6.1.2 Environmental impacts

Since there are very few marine resources currently extracted by the activities of biotechnology industries, the environmental impact of bioprospecting is estimated to be low (UfM, 2017). In the longer term, the potential impacts are rather unclear due to the immaturity of this sector. If bioprospecting undergoes significant development, there could be risks of biological contamination and the overexploitation of organisms in the Mediterranean Sea (UfM, 2017).

4.6.1.3 Are we moving towards a green and blue economy?

The Mediterranean Sea has considerable potentialities for bioprospecting, especially due to its diverse environments shifting from extremes such as thermal or sulphur vents and hypersaline intrusions at depths of 2000 metres or more, which are considered of great value for Blue Biotechnology (UfM, 2017). Nevertheless, the cost of prospecting in such deep environments is extremely high (UfM, 2017). To foster bioprospecting in the Mediterranean area, several channels can be explored (UfM, 2017):

- Increase coordination between academic and industry partners through common projects;
- Facilitate public investment in R&D in order to increase knowledge on the ecology of marine species and organisms;

- Develop a regulatory framework that secures intellectual property rights and monitor social and environmental impacts;
- Elaborate regional policies on marine biotechnology development.

If this sector is to develop, it should implement policies and regulations to control its activities, especially by applying the precautionary principle. This sector, if regulated, could therefore enable the achievement of SDG 14.2 *"By 2020, sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, including by strengthening their resilience, and take action for their restoration in order to achieve healthy and productive oceans"*.

4.6.2 Deep-sea mining

4.6.2.1 Overview of the sector

According to the OECD, marine and seabed mining are "the production, extraction and processing of non-living resources in seabed or seawater" (OECD, 2016). Three types of deposits containing minerals, such as copper, zinc, indium or gold, can be found in the deep sea, namely polymetallic nodules, polymetallic sulphides and cobalt-rich crusts (UfM, 2017). This type of extraction could help meet the increasing demand for minerals by capitalizing on basins and alleviating the dependency on imported mineral resources. For example, the European economy is more than 90% dependent on imported metals (UfM, 2017). Despite deep-sea mining representing an opportunity, many potential environmental issues remain unknown questioning the sustainability of such a practice.

Until now, no projects have been granted a mining license in the Mediterranean. Apart from the exploration project submitted and granted in 2007 in the Tyrrhenian Sea in Italy, there is no deep-sea activity in the Mediterranean (UfM, 2017). This slow development of deep-sea exploitation can be partially explained by low technological development in the region and the lacking regulatory system (UfM, 2017).

The Mediterranean region seems to have a rather low resource potential for deep-sea mining, attracting fewer investment projects, particularly when compared to other locations such as the Pacific Ocean (UfM, 2017). Researchers seem to remain divided about the profitability of turning to deep-sea mining in the Mediterranean and launching exploration projects. Although studies show that there is a potential for companies working in the oil & gas supply chain to turn to deep-sea mining in Italy, generating high revenue streams (Keber et al. 2017), these activities are not likely to create many jobs (UfM, 2017).

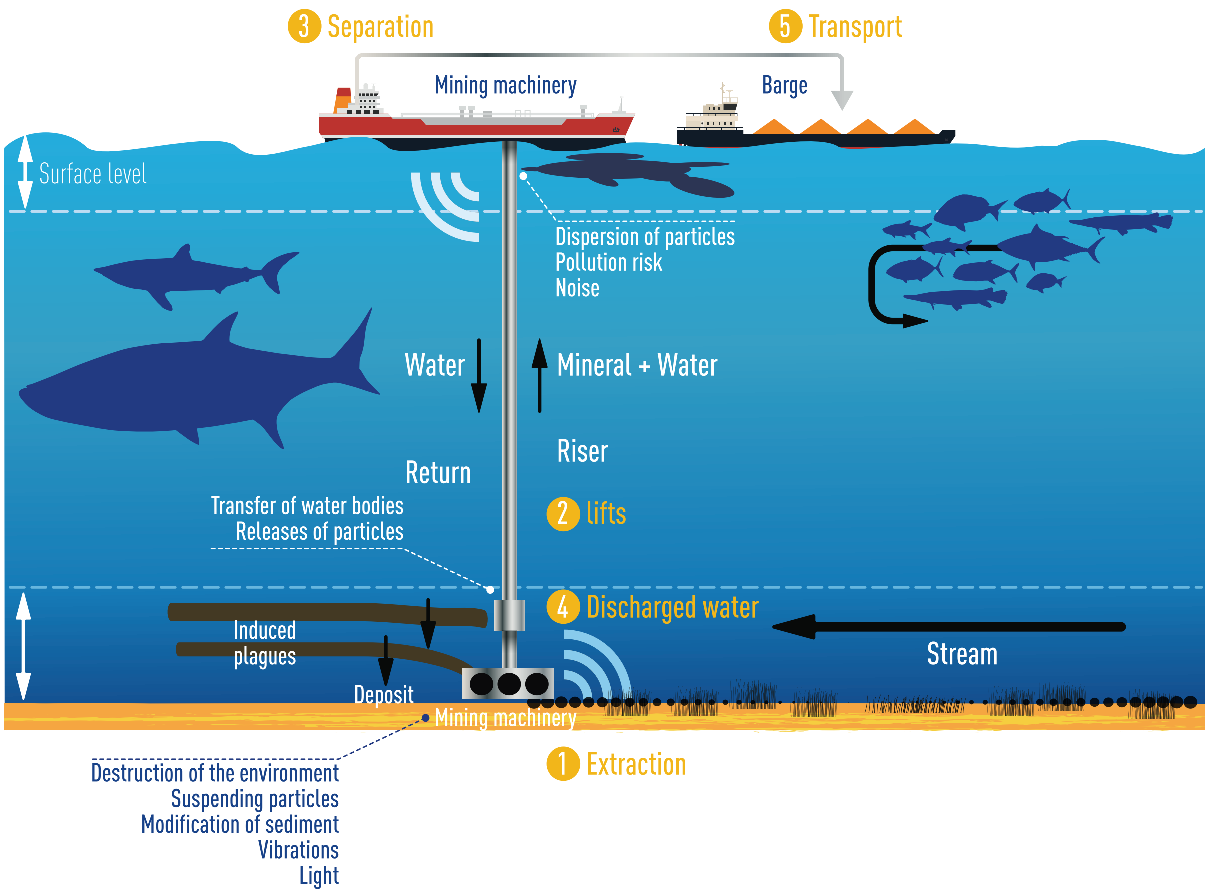


Figure 117 - Environmental impact of deep-sea mining
(Source: Navarre, Lammens & ESG Analysis, 2017)

4.6.2.2 Pressures on the environment

There is little understanding of the potential environmental and social impacts of deep-sea activities given that the state of knowledge regarding deep-water biodiversity remains very low. This is also true for knowledge about the ecosystems' faculty to recover after mining operations and the resulting disruption (UfM, 2017). Deep-sea mining could present similar challenges to offshore oil and gas exploration and production, but is likely to be less damaging to the environment than deep-sea trawling or the consequences of rising temperatures on Mediterranean ecosystems (Plan Bleu, 2017b). According to the UfM report (2017), deep-sea mining could have several harmful environmental consequences, such as *"destroying deep-sea ecosystems, stirring up potentially toxic sediment plumes, impacting species because of the noise, vibration and light induced, or through waste management"*. It could also impact local communities by disturbing fishing or tourism.
These potential harmful environmental consequences are mostly derived from the three main pressures of deep-sea mining on the marine environment: **extractive techniques, underwater noise and light,** and **water discharge.**

Extractive techniques: The different extractive techniques can change the state of seabed habitats by scattering toxic sediment plumes, leading to the destruction of fragile deep-sea ecosystems, which are essential to biogeochemical cycles (Navarre, Lammens & ESG Analysis, 2017).

Underwater noise and light: Deep-sea species have evolved in silence and complete darkness, and are therefore sensitive to noise and light. Consequently, the noise and light from deep-sea mining may result in behavioural changes in seabed species, such as the impairment of sensing food fall (the fall of organic matter that is an essential food source for deep-sea species) (Navarre, Lammens & ESG Analysis, 2017).

Water discharge: Deep-sea mining can affect the environmental state at different depths by releasing water extracted from the seabed. The pollution can thus affect species and degrade the habitats at all depths of the mining area.
Regulations for the emerging deep-sea mining activities should respond by tackling all pressures at once, for example, by designating restricted zones, best practices, as well as minimum standards of noise, light and extractive techniques.
The following *Figure* illustrates the relationship between the pressures of deep-sea mining with its driving forces, impacts, and potential responses, as described above.

4.6.2.3 Are we moving towards a green and blue economy?

From 2013 to 2016, the European Union partly funded the MIDAS[61] (Managing Impacts of Deep-seA reSource exploitation) project to explore the potentialities of deep-sea activities. Its aim was to better identify the potential environmental impacts entailed by deep-sea mining in the Mediterranean and other regions, focusing on the direct impacts caused by mining on the ecosystems on the ocean floor, as well as the impacts of sediment plumes and toxic chemicals released by mining activities (UfM, 2017).

Via this project, more information has been collected on the potential capacity of recovery of ecosystems, including species. Researchers were able to draw up a set of recommendations and essential best practices for ensuring the relative sustainability of the deep-sea mining industry (UfM, 2017). One of the main recommendations suggested the creation of conservation zones where mining activities would be prohibited. Recommendations are being translated into regulations within each European Union Member State for areas located in their Exclusive Economic Zone (UfM, 2017). These recommendations are

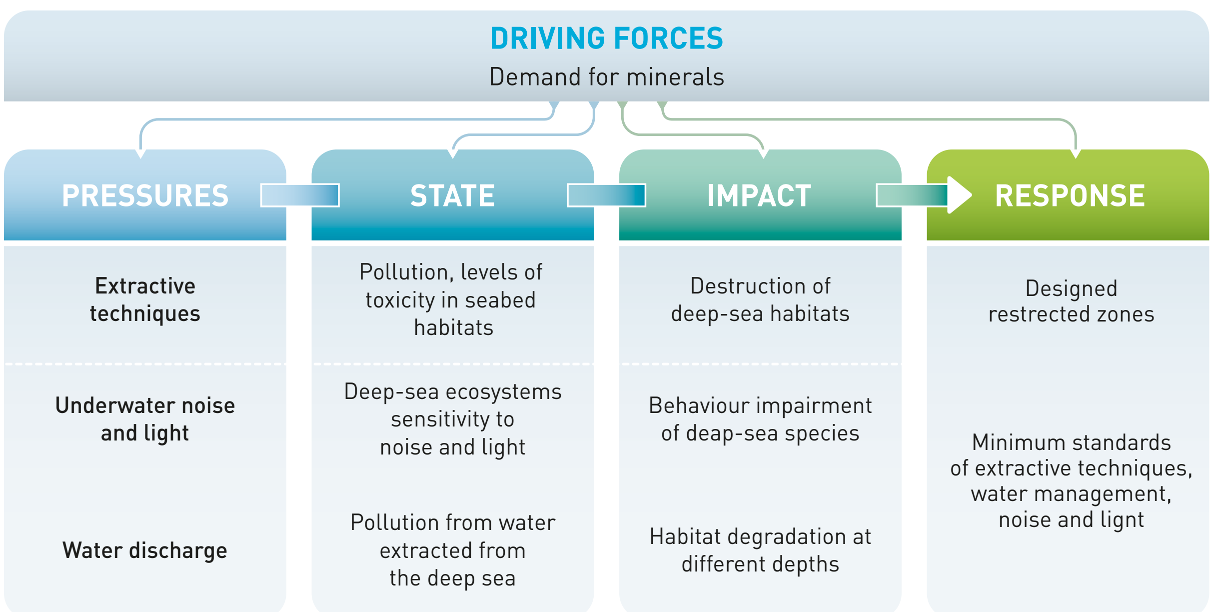


Figure 118 - Pressures exerted by deep-sea mining on the marine environment

being integrated within the regulations of the International Seabed Authority (for international waters located more than 200 miles from a State's baseline) (UfM, 2017).

4.7 Pollution

The main types of pollutants in the Mediterranean are oxygen-depleting substances, heavy metals, persistent organic pollutants (POPs), hydrocarbons, microorganisms, nutrients introduced by human activities and marine litter. The latter source of pollution is discussed in section 4.9. *Figure 119* shows pollution hot spot areas (in red) and areas of major environmental concern (in yellow) (UNEP/MAP, 2012).

Pollutants enter the Mediterranean Sea as land-based sources either via discharge points and dumping grounds (point source pollution) or from surface fluvial run-off (nonpoint source pollution). Pollutants also enter the marine and coastal environment through atmospheric deposition. Other pollutants are derived directly from marine activities such as shipping, mining, and oil and gas exploration. In recent years, emerging pollutants are raising cause for concern.

4.7.1 Eutrophication status

The offshore waters of the Mediterranean have been characterized as extremely oligotrophic with a clear gradient eastward (Turley, 1999). The highly populated coastal zone in the Mediterranean and the riverine input from a draining area of 1.5 10^6 km^2 (Ludwig et al. 2009) induce eutrophic trends in coastal areas. The main coastal areas in the Mediterranean which are historically known to be influenced by natural and anthropogenic inputs of nutrients are the Gulf of Lion, the Gulf of Gabès, the Adriatic, the North Aegean and the South-East Mediterranean. The coastal area of the South-East Mediterranean is facing eutrophic conditions, mainly caused by sewage effluents from the cities of Cairo and Alexandria. The North Aegean shows mesotrophic to eutrophic conditions that are explained by the river inputs from Northern Greece and inflow from the nutrient-rich Black Sea.

The available data shows that in areas where assessment is currently possible, key nutrient concentrations in the water column fall within ranges that are characteristic of coastal areas and in line with the main processes occurring in the specific area. The assessment based on chlorophyll a concentration in the water column showed that, with only a limited set of data for France, in the Western Mediterranean all stations in the Gulf of Lion were in a less than moderate state. Slovenia, Croatia and Montenegro were assessed in the Adriatic, with all stations showing good environmental status. Cyprus, Israel and the Mersin area in Turkey were also assessed, showing that stations in Cyprus have a good status while Israel and the Mersin area in Turkey have a moderate status (UNEP/MAP, 2017a).

Based on remote sensing, chlorophyll *a* concentrations in the Mediterranean Sea have been modelled by the European Commission's Copernicus Marine Environment and Monitoring Service. The *Figure 120* illustrates the results of this exercise, showing a remarkable East-West difference (decrease in the West and increase in the East) in the Mediterranean and an overall increasing trend of chlorophyll *a* concentrations in the Mediterranean Sea over the past twenty years.
An improvement of data availability would be required in order to establish time series of data capable of determining significant trends. Criteria for reference conditions and boundaries for key nutrients in the water column should be

Figure 119 - Pollution hot spots and areas of environmental concern on the Mediterranean coast
(Source: UNEP/MAP, 2012)

[61] MIDAS project: http://www.eu-midas.net/

determined and harmonized throughout the Mediterranean region, as well as reference conditions for coastal water type and boundaries for chlorophyll *a* concentration in the water column for the Southern Mediterranean region (UNEP/MAP, 2017a).

4.7.2 Contaminants status

The trends and levels of so-called legacy pollutants (e.g. heavy metals, persistent organic pollutants and pesticides), have decreased significantly in the most impacted areas in the Mediterranean Sea after the implementation of environmental measures, but issues remain as described below.
Assessment of key harmful contaminants measured in the relevant matrix shows that acceptable conditions exist for heavy metals (mercury, cadmium and lead) for biota (mussel and fish) in coastal surface marine waters, which are showing levels below the assessment criteria, except for lead in some mussel monitoring areas. These areas correspond to known coastal sites (hotspots). The sediment assessment for heavy metals shows an impact on the coastal benthic ecosystem, especially for total mercury, which should be further investigated and assessed against the assessment criteria, taking into consideration subregional specificities.
Data on petroleum hydrocarbons and persistent organic pollutants (POPs) from the national coastal monitoring networks reporting to the MED POL database show limited data availability with insufficient geographical coverage and quality assurance to allow for proper regional assessment, and mostly non-detected concentrations. There are still, nevertheless, point and diffuse pollution sources releasing both priority and emerging chemical contaminants into the Mediterranean.

Levels of heavy metals (cadmium, mercury, lead) in coastal waters show a more-or-less acceptable environmental status, assessed from bivalves and fish against Background Assessment Concentrations (BAC) and Environmental Assessment Criteria (EAC). For lead, 10% of stations show levels above the set EC maximum concentrations in foodstuff to protect public health for mussel samples. Concerns with regard to heavy metals are found in the coastal sediment compartment for lead and total mercury, indicating an impact from these chemicals. For total mercury, 53% of the sediment stations assessed are above the Effects Range Low value developed by the US Environmental Protection Agency as sediment quality guidelines, used to protect against potential adverse biological effects on organisms.

BOX 38 Eutrophication

Eutrophication is a process driven by the enrichment of water bodies with chemical nutrients, especially compounds of nitrogen and/or phosphorus, leading to increased growth, primary production and biomass of algae, changes in the ratio of nutrients resulting in changes in the ratio of organisms, changes in species composition, water quality degradation, including decreased transparency and oxygen depletion. The consequences of eutrophication are undesirable if they appreciably degrade ecosystem health and/or the sustainable provision of goods and services. These changes may occur due to natural processes; management becomes a concern when they can be attributed to anthropogenic sources. Water bodies are classified according to their level of nutrient loading and phytoplankton growth. Low nutrient/phytoplankton levels characterize oligotrophic water bodies; water bodies enriched in nutrients are characterized as mesotrophic; and water bodies rich in nutrients and algal biomass are characterized as eutrophic. To assess the status of eutrophication under the ecosystem approach, the UNAP/MAP Integrated Monitoring and Assessment Programme (IMAP) combines information on nutrient levels, direct effects (chlorophyll *a* concentration and water transparency) and indirect effects (oxygen concentration). Reference conditions for coastal water types and boundaries between good and moderate status were agreed and adopted in the IMAP for chlorophyll *a* in the Mediterranean, based on the influence of freshwater inputs as the main nutrient drivers.

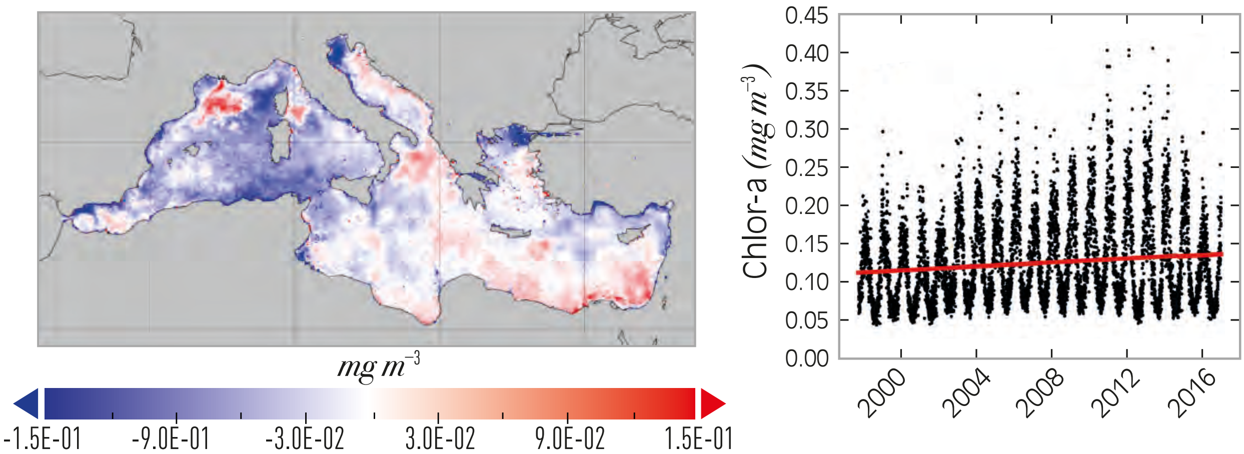


Figure 120 - Chlorophyll anomalies for 2016 compared to the 1997-2014 reference period (left) and regional time series of chlorophyll a in the Mediterranean region, 1997-2016 (right)
(Source: Schuckmann et al. 2018)

Measures and actions should focus on known hotspots associated with urban and industrial areas along the coasts of the Mediterranean Sea, and include sea-based sources, as these are also important inputs. Riverine inputs and coastal diffuse run-off also play an important role (UNEP/MAP, 2017a).

4.7.3 Industrial Pollution

The MED POL National Baseline Budget (NBB) is the reporting tool established by UNEP/MAP to detect changes, including a potential downward trend, in direct and indirect releases of pollutants into the marine environment. The main activities contributing to the emissions of pollutants are wastewater treatment plants, metal production and processing, energy production, pulp and paper processing and production, the chemical industry, intensive livestock production and aquaculture, and other activities (pre-treatment or dyeing of fibres or textiles; tanning of hides and skins; surface treatment of substances, objects or products using organic solvents; production of carbon or electrographite through incineration or graphitization; ship building, painting or paint removal).

Figure 121 shows the total aqueous effluent values per sector for the Mediterranean reported by NBB 2003, 2008, 2013 and the European Pollutant Release and Transfer Register (E-PRTR) 2013. In 2003, the major effluent values reported are from the chemical industry (74% of total industrial releases) and the food and beverage industry (11%). In 2008,

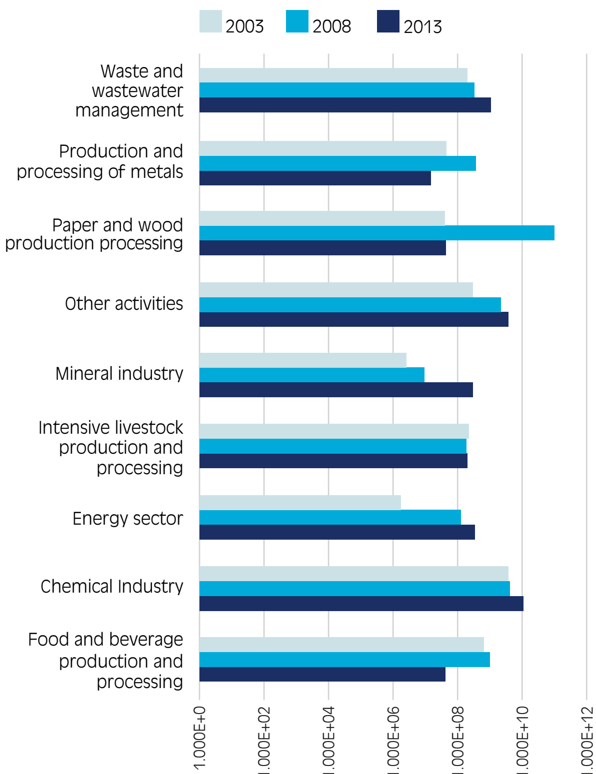


Figure 121 - Total aqueous effluent values per sector
(NBB 2003, 2008 and 2013 & E-PRTR, 2013)

the major reported sectors discharging pollutants in their effluents are the paper and wood processing industry (92%) and the chemical industry (74%). In 2013, the major liquid emissions reported are from the chemical industry (66%) and other activities (22%).

Figure 121 gives an indication that from 2003 to 2013, aqueous effluent values from waste and wastewater management, the mineral industry, the energy sector, the chemical industry and other activities show increasing trends, indicating a potential for an increasing pollution contribution from these sectors. Effluent values for the production and processing of metals, and the food and beverage sector show decreasing trends from 2003 to 2013, indicating a potential for a decreasing pollution contribution from these sectors. Between 2008 and 2013, there is an indication of a decrease in effluent values from the paper and wood production and processing sector, indicating a potential for a decreasing pollution contribution from this sector. *Figure 121* shows that values for intensive livestock products and processing remained the same between 2003 and 2013.

There are constraints and limitations associated with the National Baseline Budget (NBB) data analysis. The data presents inconsistencies between reporting years, and with other reporting systems (PRTR) methods, where used. Different criteria are used to define the geographic scope when establishing the NBB industrial inventory. While it is generally acknowledged that a large percentage of pollution received by coastal waters stems from land-based sources located in Mediterranean watersheds, which flows into the coastal zone as riverine inputs, whereas NBB data analysis is currently not systematically conducted at the watershed level, but instead by administrative zone. This introduces a significant bias into the analysis, especially where the geographical limits of watersheds do not coincide with administrative boundaries. In these cases, pollution stemming from sources located upstream beyond the administrative limits are not taken into account. Along with the lack of data validation, this somewhat hinders the identification of reliable trends, and therefore the extraction of strong conclusions and recommendations for action.

4.7.4 Emerging Pollutants

The terms "emerging contaminants" or "contaminants of emerging interest'' describes a heterogeneous set of thousands of molecules and metabolites whose presence in the environment had not been detected in the past and whose study and monitoring are relatively recent. We find these substances in personal care products (antiseptics, sun lotions, cosmetics, etc.), synthetic musk, flame retardants, additives in plastics, in pesticides and in herbicides, bisphenol A (used in plastic wrap), plasticizers such as phthalates, nanoparticles (measuring less than 100 nanometres, used in food, medicine, construction and textiles), phytoestrogens (plant-derived substances, i.e. isoflavones), perfluorocarbons (PFCs used as protective layers), pharmaceuticals (painkillers, hormones, antibiotics, antidepressants) and non-halogenated substances (carboxylic

BOX 39

Legacy pollution from industrial activities - the case of the Calanques in Marseille, France

(Source: Daumalin & Laffont-Schwob, 2016)

Located on the outskirts of the global port city that is Marseille (France), the Calanques are known as a place of natural picture-postcard beauty and became a national park in 2012, attracting thousands of tourists. The Calanques are much less known for their industrial history: for around two centuries, highly-polluting activities, mainly in the soda and lead industries, were carried out in twelve factories on this site, which continue to impact the environment and people.

The area around the former industrial sites remains contaminated from legacy pollution of the soil and living organisms, as well as marine sediments, affecting terrestrial and marine biodiversity. The contamination can also affect human health, either directly via ingestion or inhalation, or indirectly via the food web. For example, significant concentrations of lead and arsenic are found locally in soil and dust, as well as in aerial parts of edible plants colonizing the area, such as rosemary. While these concentrations are below the threshold of acute intoxication, they could be of concern for chronic exposure and cumulated exposure to a "cocktail" of contaminants. Coherent management of these sources of pollution is required, even long after the industrial activities that caused them have ceased. Local and national governments and environmental institutions therefore continue to work together to reduce legacy pollution.

BOX 40

The importance of riverine inputs of industrial contaminants to the Western Mediterranean Sea

Using the River Rhône as an example, in comparison to port contributions, urban contributions and direct industrial contributions, riverine inputs (watersheds, coastal watercourses), the river Rhône contributes 97% of the main heavy metals, with significant concentrations (Boissery, 2018).

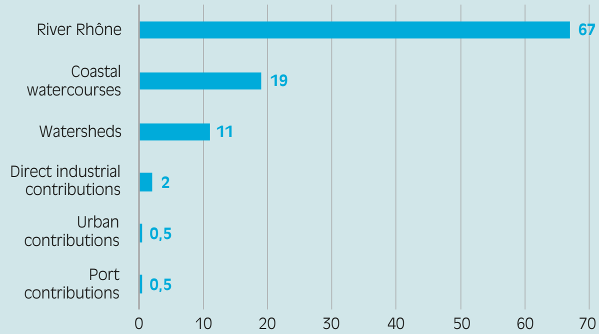


Figure 122 - Origin of heavy metal concentrations in French Mediterranean coastal waters
(Source: Boissery, 2018)

acid, formaldehyde). Few studies have analysed the effects of prolonged exposure to these substances, which can be toxic for marine organisms and humans in minute doses. The effect is not only additive but also synergistic and municipal treatment plants are currently unable to remove these substances. The study of the multitude of emerging contaminants, their interactions with the environment and human health and their treatment is extremely complex and costly, has been insufficient for a number of substances, and does not currently keep up with the pace at which new substances are being created. To date, the European Chemicals Agency has registered more than 22,000 substances (European Chemicals Agency, 2019) under the REACH regulation, compared to more than 142 million in existence worldwide (CAS, 2019).

Although depollution measures, such as wastewater treatment, are improving in their capacity to effectively treat or eliminate certain substances, it is likely that neither the technology nor financial resources will ever be sufficient to treat 100% of pollution. Therefore, pollution prevention must be a priority, involving the following:

- reduction and phasing-out of the use of known harmful substances;
- action to avoid the "creation" of new substances whenever possible and to regulate the emergence of new substances on the market with mandatory and strongly-enforced environmental and social (including health) impact assessments; and
- emergency preparedness and responsiveness for accidental pollution, natural hazards and other emergencies.

BOX 41

A best practice case study of a "switcher", resource efficiency and sustainable waste management in the State of Palestine

(Source: SCP/RAC, 2019)

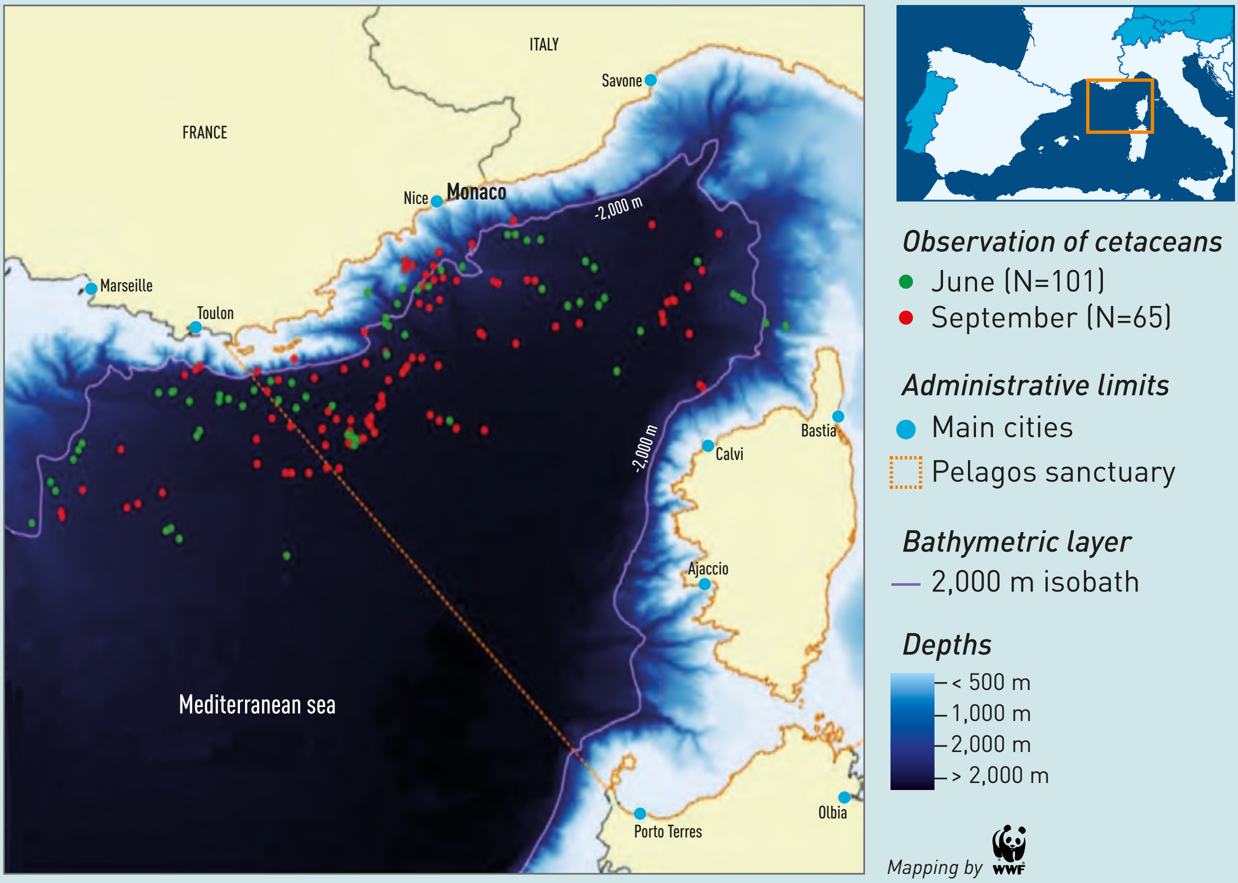
Three female Palestinian environmental engineers have invented an innovative concept of treating waste by using waste to eliminate environmental pollution from both leather tanning wastewater and stone cutting solid waste. This is an integrated treatment system that minimizes the economic losses for both industries and improves public health and the environment.

This environmentally friendly, efficient and integrated wastewater treatment unit removes chromium-containing tannery wastewater by adsorption on stone cutting solid waste particles, thus eliminating pollution from both industries. Laboratory results proved that this treatment system is 99% effective. Chromium is removed within a much shorter time frame (30 minutes) in comparison to conventional methods. This sustainable wastewater treatment solution costs three times less and saves 50% of treated wastewater for the industry, estimated at 6 cubic meters daily. Reusing the treated wastewater minimizes the running cost of the leather tanning factories and makes them more competitive. The process is also applicable in the galvanization industry to remove zinc, the dairy industry to remove organics and the lubricants industry to remove waste lubricants and grease.

The EU "SwitchMed" project provides coaching sessions to improve pitching skills in order to find potential funding and launch the project.

BOX 42 The presence of phthalates and dibromobiphenyl in the "Pelagos" Sanctuary, 2015

(Source: Boissery, 2018)



	Di Ethyl Phthalate (DEP)	Bis (2-Ethylhexyl) Phthalate (DEHP)	Dibutyl Phthalate (DBP)	Diisobutyl Phthalate (DIBP)	Di-n-Hexylphthalate (DNHP) + Benzylbutyl Phathalate (BBP)	Di Methyl Phthalate (DMP)	Bis (2-Methoxyethyl) Phthalate (DMEP)	Di-n-Octyl Phthalate (DNOP)	Di-n-Decyle Phthalate (DNDP)	Total
Order of abundance	1	2	3	4	5	6	7	8	9	
Mean	14,656	1,060	629	409	337	267	184	5	0	17,547
Standard deviation	14,747	1,390	825	497	413	359	480	15	0	15,227

4.7.5 Pollution from noise

As underwater noise is considered a major threat for cetaceans, in the 2015-2016 period, ACCOBAMS conducted a study aimed at identifying noise hotspots and areas of potential conflicts with cetacean conservation. Data was collected from activities using noise sources identified as being of primary concern for cetacean conservation (coastal and offshore activities, geophysical surveys, naval exercises, maritime traffic).

4.8 Waste

The types and amounts of waste generated and the associated management practices vary widely across Mediterranean countries. The total amount of municipal solid waste produced in Mediterranean countries in 2016 was around 184 million tonnes, i.e. an average of 370 kilograms per capita per year (about 1 kg per capita per day). In NMCs, the range of values is from 1.0 to 1.7 kg/cap./day, rising to more than 3 kg/cap./day in Monaco. In SEMCs, the amount generated is from 0.5 kg/cap./day in Morocco to 1.0 in Lebanon (the value for Israel is similar to EU countries with 1.8 kg/cap./day). In NMCs and Israel, the percentage of Food & Organic waste is between 31% and 52%, while this rate in SEMCs is higher still (from 53% in Lebanon to 70% in Libya).

Recycling rates also vary widely. In NMCs, the recycling rate is above 13%, exceeding 40% in Slovenia. Bosnia and

BOX 43 The ACCOBAMS study on underwater noise hot spots

The positions of 1,446 harbours, 228 drilling platforms for hydrocarbon exploitation, 52 wind farm projects, 830 seismic exploration areas, several military areas, and 7 million vessels were recorded in the 2015-2016 ACCOBAMS study on areas of potential conflict with cetacean conservation. The results revealed several noise hotspots overlapping with important cetacean habitats such as the Pelagos Sanctuary, the Strait of Sicily, and the upper portion of the Hellenic Trench. These results provide strong evidence of multiple stressors acting on the marine environment and of the need for urgent management and conservation actions.

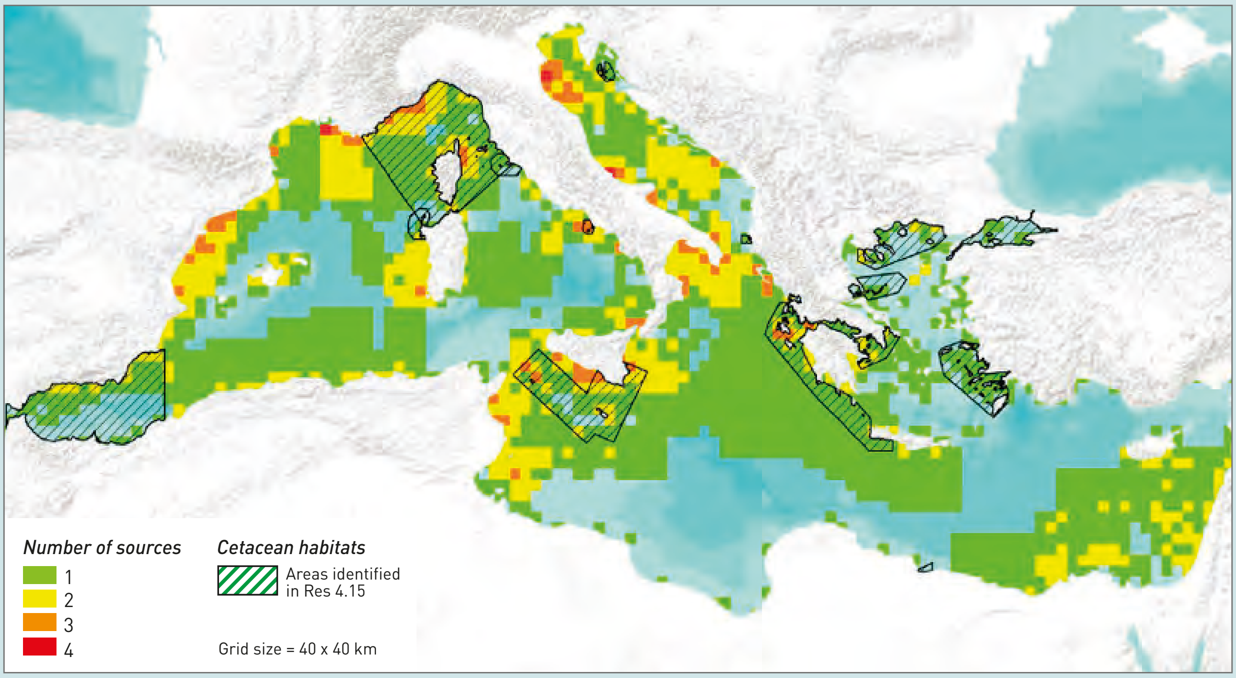


Figure 123 - Overview of the noise hot spots in the ACCOBAMS area
Overview of the noise hot spots in the ACCOBAMS area

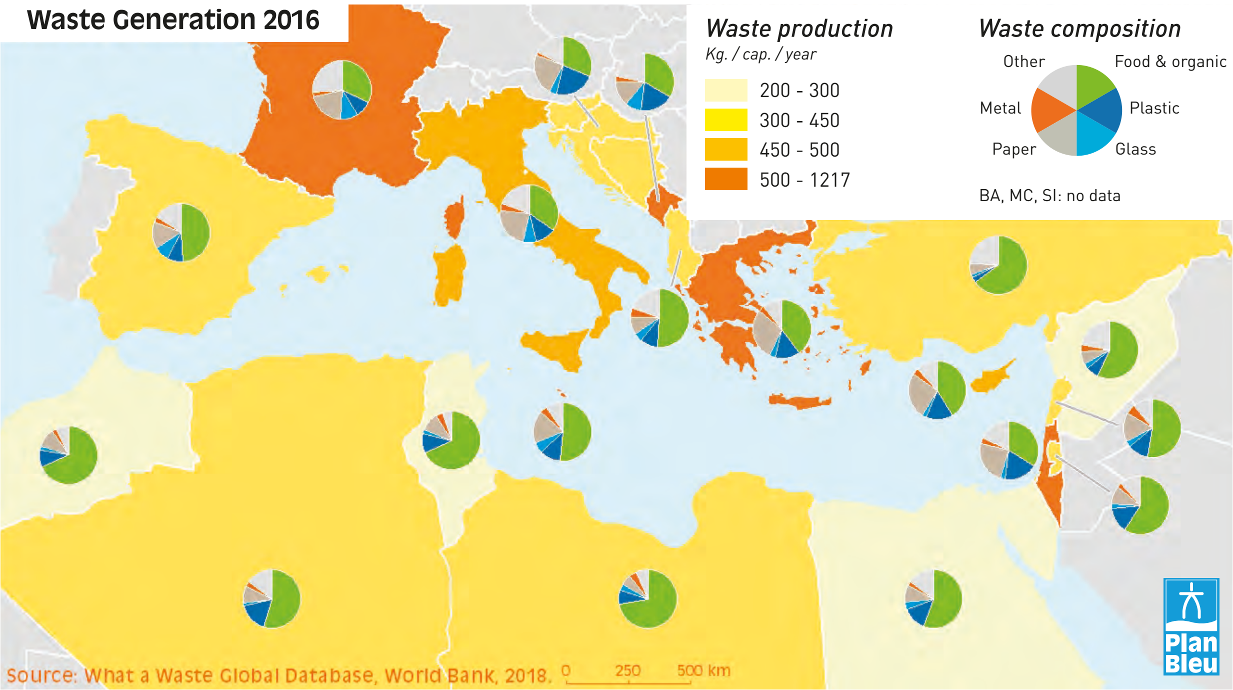


Figure 124 - Waste generation and composition in Mediterranean countries, 2016
(Source: World Bank, 2018)

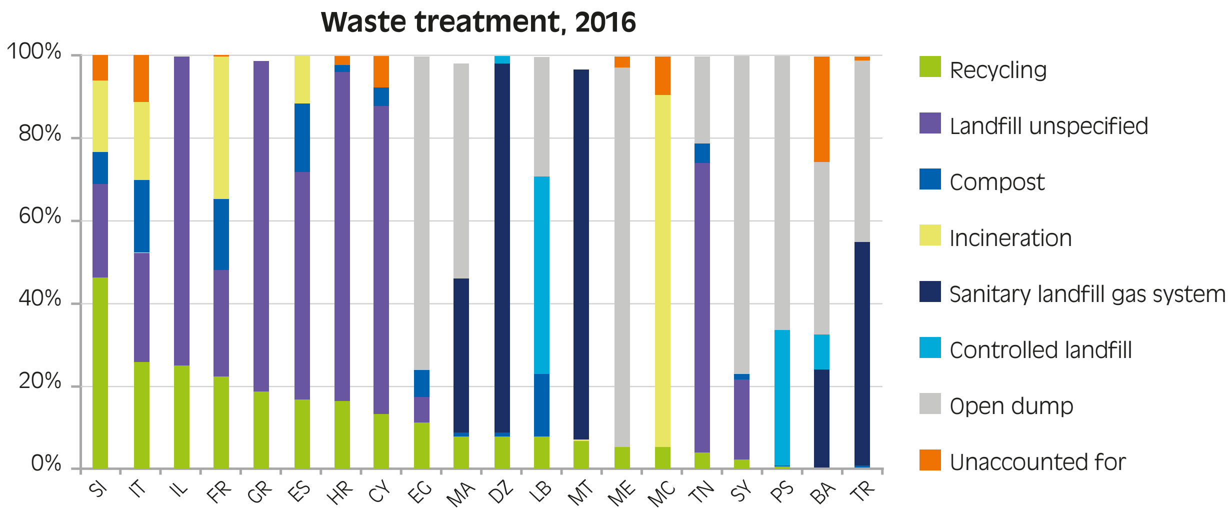


Figure 125 - Waste treatment in Mediterranean countries, 2016
(Source: World Bank, 2018)

BOX 44

Urban waste and recycling in Italy

(Source: ISPRA, 2019)

A recent national report on waste management in Italy (ISPRA, 2019) showed that per-capita waste production in Italy was 449 kilograms in 2017, around 55% of which was collected for recycling. The *Figures* below show that the absolute quantity of urban waste produced has decreased since 2010 and stagnated since 2012. At the same time, the percentage of waste collected for recycling has been growing steadily, from 34% in 2009 to 56% in 2017.

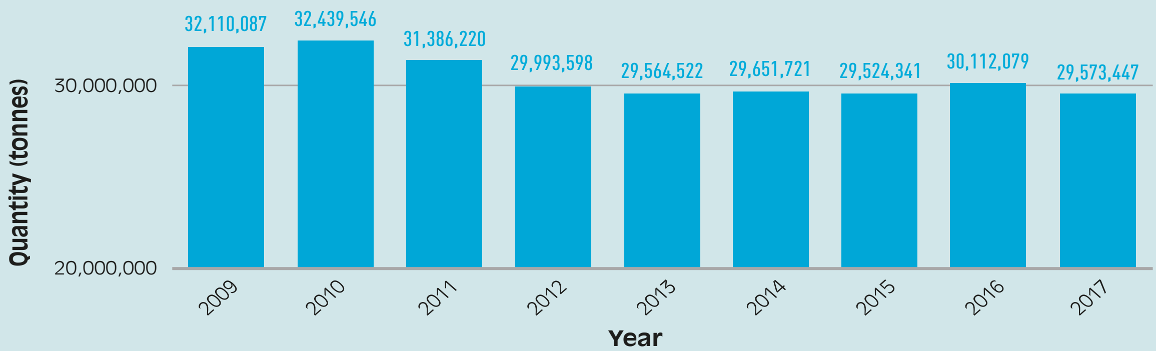


Figure 126 - Total urban waste production in tonnes in Italy, 2009-2017
(Source: ISPRA, 2019)

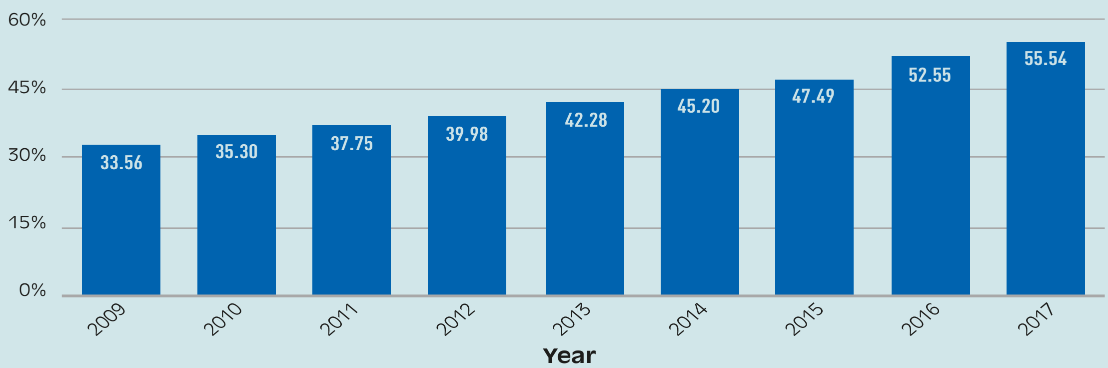


Figure 127 - Percentage of waste collected for recycling in Italy, 2009-2017
(Source: ISPRA, 2019)

Herzegovina (close to 0%) and Malta (7%) are exceptions on the northern shore. In SEMCs, Egypt has the highest recycling rate (12.5%), after Israel (25%), and the recycling rate is especially low in the Syrian Arab Republic and the State of Palestine.

4.9 Marine Litter

4.9.1 Introduction

Marine litter - any persistent, manufactured or processed solid material discarded, disposed of or abandoned in the marine environment- is globally acknowledged as a major societal challenge of our times due to its significant environmental, economic, social, political and cultural implications. The root causes of marine litter are unsustainable consumption and production patterns, coupled with deficiencies in waste management, resulting in alarming amounts of waste leaking into the oceans every day. For plastic only, the global production of resins and fibres increased from 2 million tonnes in 1950 to 380 million tonnes in 2015, i.e. an annual growth rate of 8.4% (Geyer, Jambeck & Lavender Law, 2018), while the production of resin in Europe reached 64 million tonnes in 2017 (Plastic Europe, 2018).

Global commitments have resulted from the meetings of the United Nations Environment Assembly since 2016, the Convention on Biological Diversity, recent G7 and G20 declarations, and under Target 14.1 of the Sustainable Development Goals (UN Environment, 2018a), while more than 730 tonnes of plastic are entering the Mediterranean Sea every day (UNEP/MAP, 2015). Consequently, the Regional Plan on Marine Litter Management in the Mediterranean (MLRP) was adopted in 2013 by the 18th Conference of the Parties to the Barcelona Convention

BOX 45

Plastic waste exports from EU countries

Global plastic production increased from 2 million tonnes in 1950 to 380 million tonnes in 2015 and is projected to continue to grow rapidly (WWF, 2019). The EU is responsible for 18% of this production (Barra et al. 2018) and around 40% of plastic demand is for packaging (Plastic Europe, 2018). Plastic recycling in EU countries is most successful in the first stage of the recycling value chain, i.e. collection. After collection, much of the plastic waste is exported to non-EU countries in order to deal with insufficient recycling capacities in the EU. Receiving countries use the plastic waste to foster industrial growth, which is, however, potentially linked to negative impacts on social and environmental conditions (OECD, 2018). Waste import restrictions, mainly in China and Hong Kong, have shifted European waste exports to other receiving countries and sharply reduced exported plastic waste. The country that experienced the highest increase in the amount of EU plastic waste received is Turkey. EU-originated plastic waste imported in Turkey in 2018 was 13 times the amount imported in 2015, making Turkey the number two destination for EU plastic waste exports, after Malaysia (D'Amato et al. 2019).

The United Nations Basel Convention has recently prohibited the trade of some types of plastic waste for EU countries. This further narrows prospects for trading plastic waste and requires countries to make decisive progress towards a circular economy for plastic in Europe.

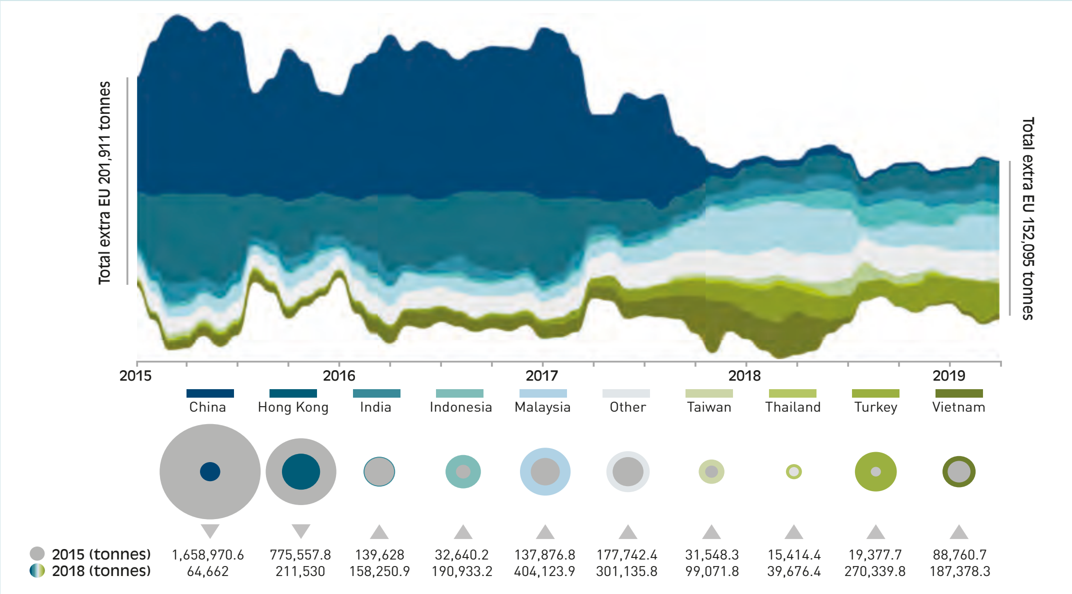


Figure 128 - Extra-EU-28 plastic waste trade by receiving country
(Source: D'Amato et al. 2019)

(COP 18). Among all Regional Seas Conventions, it is the first legally-binding instrument to reduce marine litter, an issue of high concern for the Barcelona Convention since its early years. In addition, European policies such as the EU Plastics Strategy and various directives such as the Marine Strategy Framework Directive (MSFD, 2008), the Directive on Port Reception Facilities (PRF, revised in 2019) and the Single-Use Plastics Directive (2018) provide a driving force to act on marine litter and the related impacts. Coordinated national measures and promising strategies on plastics in the circular economy also address marine litter in the Mediterranean Sea, together with the MLRP and related updated National Action Plans (Markovic & Hema, 2016).

4.9.2 Situation and evolution of marine litter in the Mediterranean

Studies on marine litter in the Mediterranean basin started in the 1990s, but more attention was given to the issue after 2010, when more data became available on the abundance and distribution of marine litter, and when the first attempts to assess trends were made, microplastics entered into the agenda and the mapping of impacts became a priority. There is no comprehensive assessment of the economic impacts of marine litter in the Mediterranean Sea, apart from an assessment of the economic impacts of marine litter in the Adriatic and Ionian Seas within the framework of the EU funded DeFishGear project (Vlachogianni, 2017), as well as limited information deriving from beach clean-up activities, the fishing industry, and research reports. The Mediterranean Sea is a closed basin, with a coastal population of about 210 million inhabitants. Mediterranean countries are the number one tourist destination in the world, with around 360 million visitors every year, and receives waste from coastal zones, as well as from many large rivers flowing through largely urbanized cities such as the Nile River that transports more than 730 tonnes of plastic into the Mediterranean Sea per year (Lebreton et al. 2017). In addition, more than 20% of global maritime traffic passes through the Mediterranean Sea. Consequently, the basin has become one of the most marine litter-affected areas in the world (UNEP/MAP, 2015). Plastics are the prevailing type, accounting for up to 95-100% of total floating marine litter, due also to the high floatability of plastics, and more than 50% of seabed marine litter. The analysis of 80 beaches conducted in 2016 (Addamo, Laroche & Hanke, 2017) indicated that only 10 types of debris, mostly single-use plastics (cutlery/trays/straws, cigarette butts, caps/lids, plastic bottles, shopping bags) represent more than 60% of the total recorded marine litter on beaches. No change was observed in the percentage of the dominant marine litter categories between 2013 and 2018 on the beaches of 8 Mediterranean countries (Ocean Conservancy, 2018). Typically, most of the litter on beaches originates from beach/recreational activities. Glass bottles and metal beverage cans disappeared from the top ten lists in non-tourist areas in recent years because of behavioural changes.

On the sea floor of the north-western basin, plastics and fishing-related items (some of which are also made of plastic) have represented the same percentage of litter for more than 20 years (UNEP/MAP, 2017a), but information still remains scarce, especially on the specific issue of abandoned, lost or otherwise discarded fishing gear (ALDFG), which may account for a large or even the largest part of marine litter items in many areas (UNEP/MAP, 2015). Particular importance is currently being paid to the emerging issues of micro- and nanoplastics and the possible release of associated Persistent Organic Pollutants (POPs) and Endocrine Disrupting Chemicals (EDCs). Concentrations of microplastics at the surface of the Mediterranean Sea are largely above 100,000 items per km² (UNEP/MAP, 2015) and, reach maximums of more than 64 million floating particles per km² (Van Der Hal, Ariel & Angel, 2017).

4.9.3 Sources and driving forces

In most Mediterranean countries, the root causes of plastic pollution are found in the increase of plastic use, unsustainable consumption patterns, ineffective/inefficient waste management and loopholes in plastic waste management. Plastic ranges from 5% (Morocco), to 14% (Israel) of the total waste generated (World Bank in UNEP/MAP, 2015). Inputs of plastics into the sea, as estimated in 2015, are at the level of over 260,000 tonnes per year or 730 tonnes per day *(Table 22)*, depending on the coastal population, which may vary depending on the country, representing more than 2% of the total inputs in the world's oceans.
At the level of Mediterranean watersheds, another study (Weiss et al. 2019) modelled plastic flows into the Mediterranean Sea, as shown in the *Figure 129*.

In some areas, up to 58% of the municipal solid waste collected is still disposed of in open dump sites. Of the millions of tonnes of plastic waste produced every year in Mediterranean countries, less than one third is recycled and plastics recycling is less than 6% (WWF, 2018). Bearing in mind the importance of wastewater as a pathway for waste leaking into the sea, a key challenge is that in the Mediterranean region, 21% of wastewater (25% in Southern Countries) undergoes only basic treatment, and less than 8% (1% in southern countries) undergoes tertiary treatment (UNEP/MAP, 2017a).

Key economic sectors in the Mediterranean, such as professional and recreational fisheries, aquaculture, tourism and shipping, also generate large amounts of litter that end up as marine litter.

4.9.4 A significant socioeconomic and ecological cost

Measuring the full economic cost of marine litter is complex due to the wide range of economic, social and environmental impacts, the range of sectors involved and impacted by marine litter and the geographic spread of those affected. Marine litter creates an economic burden on local authorities through clean-up costs, and potential loss of income and jobs from tourism, residential property values, and recreational activities. From surveys based on public

Countries	Plastic waste littered (kg/person/year)	Plastic waste littered (tonnes/day)
AL	0.5	3.5
BA	1.1	1.7
CY	1.8	4.2
DZ	1.0	47.5
EG	1.3	77.2
ES	2.0	125.6
FR	1.4	66
GR	1.5	39
HR	1.8	8
IL	2.2	39.5
IT	1.0	89.8
LB	0.7	7.3
LY	1.1	11.6
MA	0.5	25
MC	2.4	0.2
ME	1.0	0.7
MT	1.6	1.7
PS	0.5	3.8
SI	1.1	1.0
SY	1.3	12.9
TN	1.0	20.9
TR	1.5	144
Total		731

Note: UNEP/MAP calculations based on World Bank (in Jambeck et al. 2015), and Jambeck et al. 2015. Values for Egypt, France, Morocco, Spain and Turkey were estimated for the Mediterranean coast only.

Table 22 - Estimated total plastic waste littered in the 50 km Mediterranean coastal belt by country
(Adapted from UNEP/MAP, 2015).

perception of the impact of littering, significant differences were found between countries, with important implications for the importance of the estimated social costs across European countries, including from the Mediterranean region (Brouwer et al. 2017). Notwithstanding the uncertainties underlying full damage assessments, and although only addressing a fraction of the damage, financial expenditure linked to beach clean-ups is generally known. In European countries, beach cleaning may reach EUR 3,800 per tonne per year (CleanSea project, 2016), depending on clean-up methods. For floating litter, the same study indicated that removal was equal to a unit cost of EUR 2,200 per tonne per year per km². For the fishing sector, an annual economic loss of EUR 61.7 million has been estimated in European waters (WWF, 2018), with a total cost for all sectors of EUR 263 million (Arcadis, 2014). Extrapolating loss at the Mediterranean level will require more data and studies, but the costs will probably be higher considering the higher litter concentration.

The damage and associated social costs of marine litter also extend to other sectors, such as aquaculture and fishery, where litter damages nets, reduces (ghost fishing) or contaminates catches, and more broadly affects marine ecosystems. Marine litter also creates economic pressures for the shipping sector, including yachting (fouled motors, lost output and repair costs) and risks to human health, via injuries and accidents, or through the potential release of chemical substances.

The main impacts on marine organisms for which scientific certainty exists are linked to entanglement, ingestion, colonization and rafting marine organisms. Costs of damage to marine ecosystems and services, through the introduction of alien invasive species, for example, must also be considered despite a limited understanding of the detrimental impacts on the marine ecosystem structure

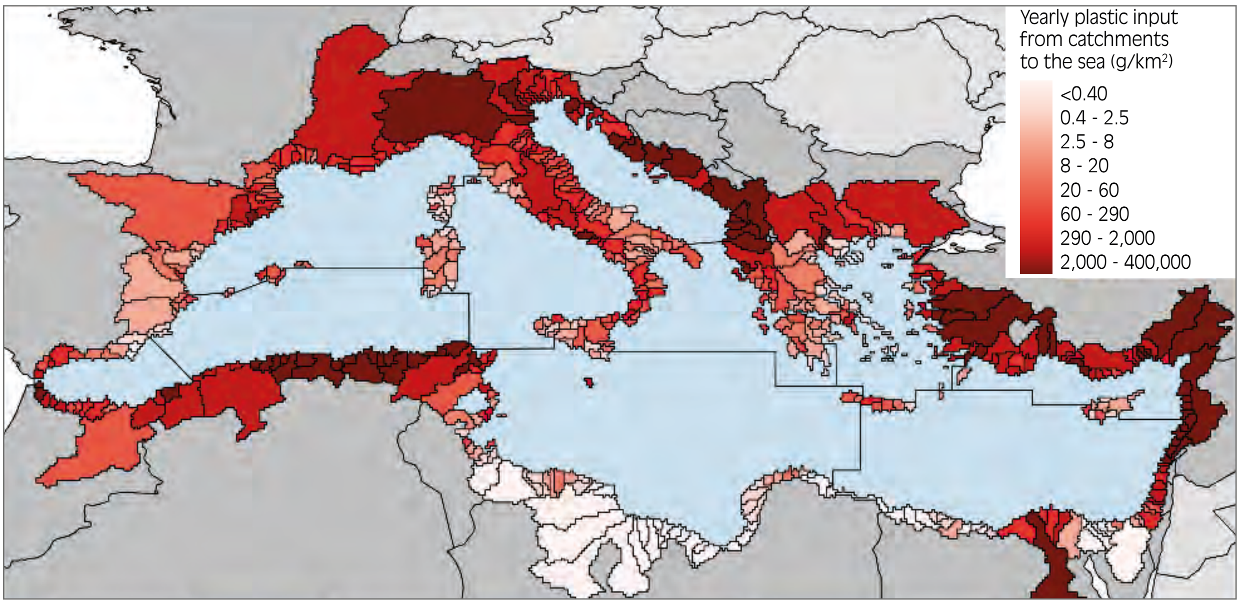


Figure 129 - Estimate of annual specific plastic flows (kg/m³) discharged by watersheds into the Mediterranean Sea
Flows calculated based on Lebreton et al. 2017
(Source: Weiss et al. 2019)

and functioning. Links to human health are not sufficiently addressed and the gaps in knowledge are even bigger when it comes to nanoplastics, which may have even greater impacts on marine ecosystems, with a possible transfer through the trophic chain (GESAMP, 2016).

4.9.5 A regional and circular economy approach as a response to marine litter in the Mediterranean region

In acknowledgement of the importance of prevention and the circular economy rather than clean-up actions, a plan for reduction measures was provided in the Regional Plan on Marine Litter Management in the Mediterranean (UNEP/MAP, 2017b), where governments committed to pass plastic reduction policies, support industry to minimize plastic packaging and redesign products, and change consumer habits. So far, the majority of Mediterranean countries have made progress towards upgrading the regulatory framework for reducing single-use plastic bags, and many of them have adopted, or are making progress towards, adopting an extended producer responsibility (EPR) approach to tackle packaging waste. In order to support such policies, pilot projects promoting alternatives to single-use plastic bags and rewards schemes for the return of packaging have been tested. The countries, supported by UNEP/MAP, have also explored and implemented fishing-for-litter schemes, as well as improved port reception facilities, including the application of charges at reasonable costs and no-special-fee systems. In addition, five Mediterranean countries have joined the #CleanSeas campaign. Policy action by sub-national authorities, industry-based solutions[62] and large-scale green economy initiatives[63] support the transition towards a more sustainable economy, promoting the transfer of environmentally-sound technologies to industry, policy changes and incentives to enable the circular economy, providing innovative and long-term solutions. The action of civil society[64] has been of great importance in this issue, not only in terms of awareness, but also for advocacy and the promotion of concrete solutions to marine litter.

Nevertheless, with only one binding quantitative target to reduce marine litter on beaches by 20% by 2024, and despite a number of pieces of legislation and international agreements, the circular economy concept will not be fully implemented (Eunomia, 2016). Typically, there are insufficient accounting and cost-recovery mechanisms in most of the countries regarding wastewater and solid waste management. Weak enforcement, insufficient waste

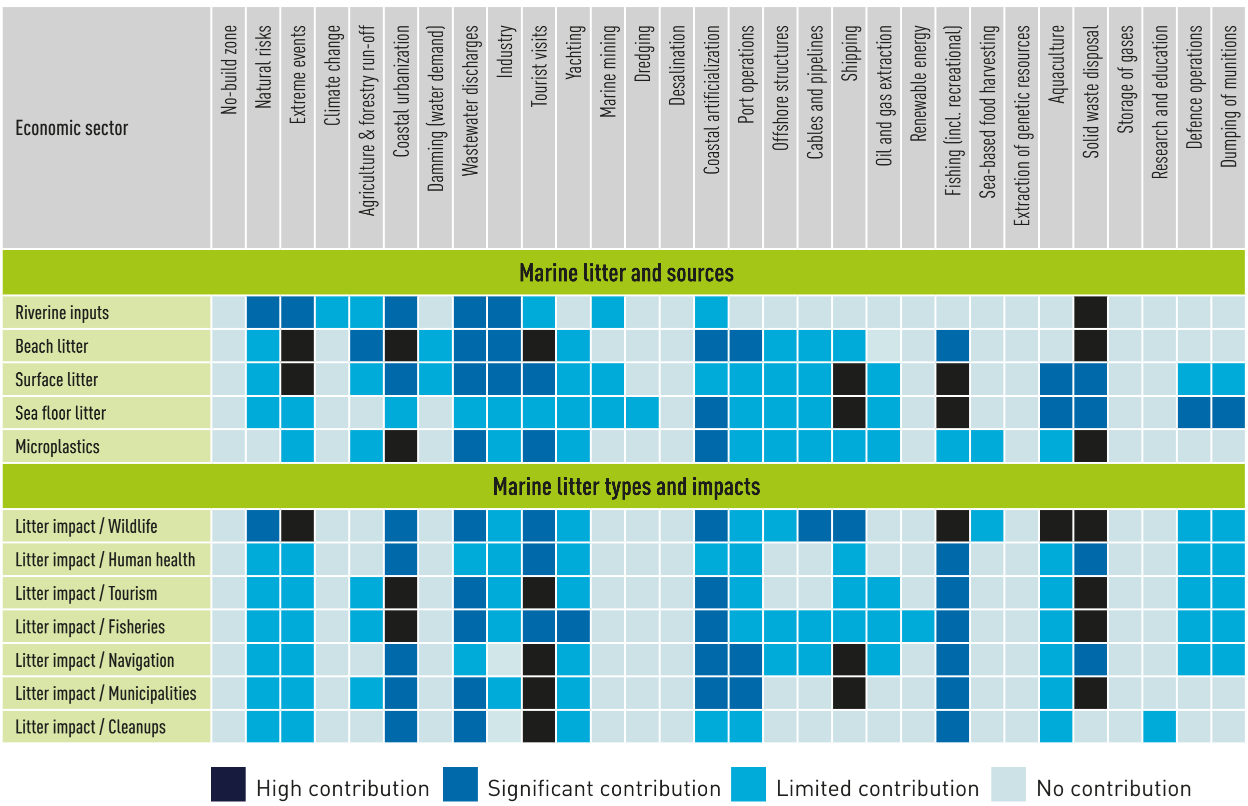


Figure 130 - Marine litter in relation to the economic sectors in the Mediterranean Sea. Sources, amounts and impacts (According to UNEP/MAP, 2015 & UN Environment, 2018a)

[62] https://www.marinelittersolutions.com
[63] https://switchmedconnect.com/en/
[64] i.e. www.breakfreefromplastic.org, mio-ecsde.org

treatment infrastructure and policies, as well as strong regional disparities between urban and rural areas, and poor stormwater management are still gaps that need to be addressed. Despite measures for the establishment of wastewater treatment systems in most agglomerations, there are still many coastal cities without wastewater treatment plants, especially in the Southern and Eastern Mediterranean. The issue of the informal economy, informal recycling networks around the basin, illegal manufacturing and black markets is a reality in some Mediterranean areas and jeopardizes solutions to marine litter, making it even clearer that the waste management schemes at a national level need to become more effective.

Single-use plastic bags have generally been addressed through bans and economic disincentives, as shown in this map. However, they are still persistent along with other iconic items such as cigarette butts.

Ship-generated waste and cargo residues can be managed through port reception facilities. In the Mediterranean, these do not yet operate optimally, especially in small harbours and marinas. Relevant legislation on port reception facilities still requires efforts to be fully implemented and/or enforced. A regional survey (UNEP/MAP, 2015) revealed some important shortcomings in the management of ALDFG, extending to insufficiently-adopted environmentally-responsible fishing practices. The most critical levers to reduce litter are objectives and actions to reduce plastic consumption, support eco-design/innovation, resource efficiency and better waste and water management, long-term efficient and viable recycling targets for municipal waste and packaging/plastic waste, greater use of policy instruments and control measures, such as bans, incentives, taxes, etc., extended producer responsibility schemes and coordination of policy investments in the waste sector (Ten Brink et al. 2018).

Socioeconomic assessments made on/of various measures at the Mediterranean level (Plan Bleu, 2017a) have demonstrated the cost-effectiveness of a Mediterranean plastic bag tax, estimated as levied at the retail level, at a cost of EUR 670 million for a 95% reduction of incremental plastic bag waste during the first year of implementation. "Fishing for litte[65]" initiatives, at a large scale, also lead to an estimated cost-effectiveness of around EUR 900 per tonne of fished litter, with reduced indirect costs to the fishing sector itself. Other measures, such as the use of port reception facilities at a reasonable cost, or the no-special-fee system, where applicable, are recommended because of their positive impacts on employment and tackling chronic pollution from ships.

Finally, in the Mediterranean Sea, adopting ambitious targets for reducing the production and consumption stages of the most important items found in the marine environment, such as single-use plastics, will largely contribute to the reduction of marine litter and its impact.

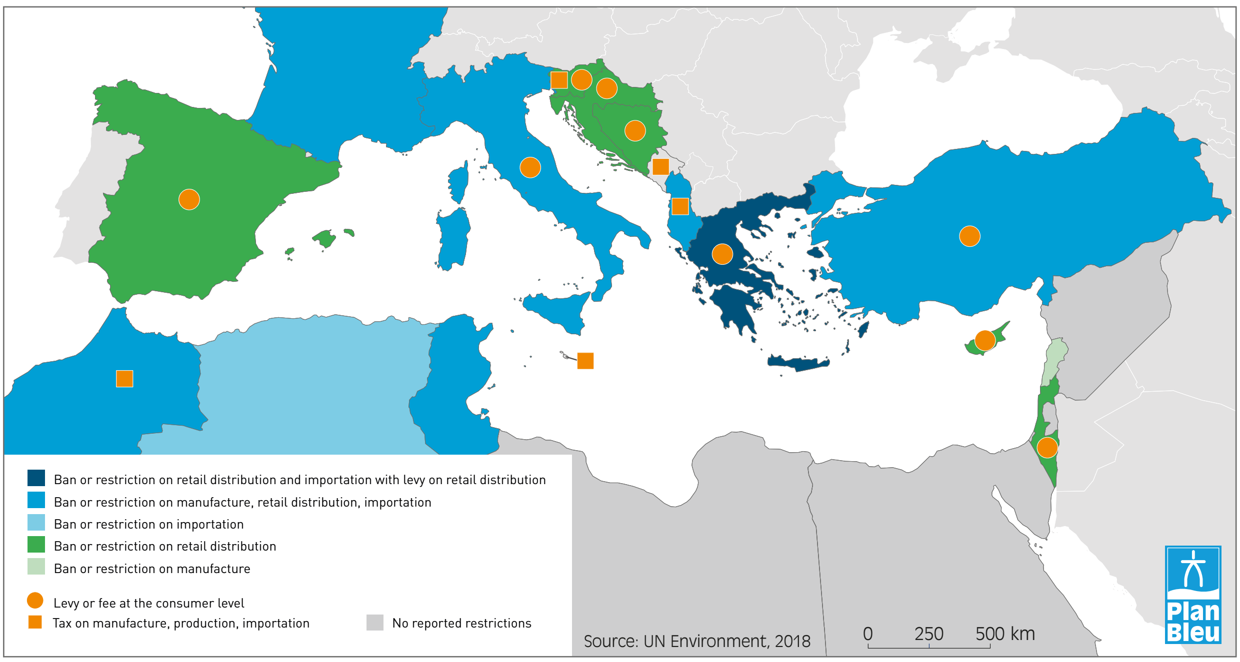


Figure 131 - Total and partial bans and taxes on the manufacture, free distribution, and importation of plastic bags

(Source: UN Environment, 2018b) Note: In Bosnia and Herzegovina, the restriction covers one of the three national administrative divisions, the Federation of Bosnia and Herzegovina (O.G. of FBiH, No. 09/14). In Lebanon, the voluntary agreement with malls has been withdrawn after publication of the source mentioned in the *Figure*. In Egypt, two governorates issued bans on plastic bags: the Red Sea Governorate (Decree no. 167 for 2019) and South Sinai Governorate (Decree no. 172 for 2019).

[65] Fishing for litter: action where participating fishing vessels collect marine litter that is caught in their nets during their normal fishing activities.

Solving the problem of marine litter is a complex task because of the diversity of the stakeholders involved, the sources, the materials, the socioeconomic aspects and the regulatory frameworks. Changes towards a more circular economy have been observed in recent years, but large gaps remain. Prior to the effective implementation of the measures required at the national level, political, environmental and operational targets must be set to drive the necessary actions. The Mediterranean region may have to face new challenges, such as the increase of plastics production, the use of new materials (bioplastics, copolymers, etc.) that may not have been produced to be environmentally relevant and may mislead consumers. The need for better understanding of the links between marine litter flows and the regional economy, as well as for coordination in establishing and implementing national programmes of measures to maximize transboundary benefits, should be continuously addressed at the regional governance level.

4.10 Responses and Priorities for Action

The economic sectors described above are based on dominant linear business models and systematic unsustainable resource consumption, generating detrimental impacts on the environment, including carbon emissions. Economic outputs are coupled with environmental degradation. Each unit of economic value added is linked to incremental resource consumption and environmental degradation, referred to as negative externalities.

Transitioning to a sustainable economy requires urgent and profound changes in both production and consumption patterns, based on environmentally responsible lifestyles and resource consumption within sustainable limits. Targeted policy mixes, including market-based instruments and behavioural insights that favour environmentally-friendly activities and disadvantage polluting ones (including by making producers accountable for the entire life cycle of their products), are needed to mitigate climate change, protect natural ecosystems and biodiversity, and promote circular economy principles within current business models, thus enabling the transition to a blue/green economy[66].

4.10.1 Transforming consumption patterns

Unsustainable consumption patterns, i.e. demand for unsustainably-produced and/or unsustainable quantities of products and services, are a key (if not the main) driver for environmental pressures. Directing demand towards products and services that are produced and consumed within the carrying capacity of ecosystems is one of the most effective levers for avoiding environmental degradation and requires profound modifications in consumers' values and behaviour. Changes in consumers' choices and behaviour require an inclusive approach that pays attention to inequalities and involves civil society in decision-making and action.

The young generations and their demands and potential for action are central to short-term and longer-term progress, including in countries with strong demographic growth. Young generations represent an opportunity to foster transformative change in consumption behaviour and economic sectors, yielding reduced resource consumption and sustainable lifestyles. Women can also play a major role in promoting sustainable household consumption and investment (e.g. in food, energy), and in entrepreneurship and economic development.

Knowledge about the attitudes of Mediterranean citizens towards the environment can guide decision-making and increase public acceptance and the effectiveness of environmental measures and policies.
In the absence of comprehensive studies about environmental attitudes in Mediterranean countries, some elements can be drawn from an EU-wide survey *(Box 46)*.

Obtaining a better understanding of the behavioural mechanisms that contribute to environmental issues, by involving disciplines such as behavioural economics, psychology and neuroscience, represents another important lever for more effective policies aimed at changing consumption patterns. Behavioural insights are a complementary tool alongside other policy instruments, such as pricing and regulation.

4.10.2 Transforming economic sectors and production patterns

Making Mediterranean **fisheries and aquaculture** sustainable requires urgent and coordinated actions. The GFCM recently launched two dedicated strategies for capture fisheries and aquaculture. In 2016, the GFCM launched the "Mid-term strategy (2017-2020) towards the sustainability of Mediterranean and Black Sea fisheries", with the aim of reversing the trend of overexploitation of commercial fish stocks and improving coastal livelihoods. The following year in 2017, the "Strategy for the sustainable development of Mediterranean and Black Sea aquaculture" was also launched, with the aim of achieving a level playing field and promoting the sector to make it more competitive, sustainable, productive, profitable and equitable. Both strategies are designed so as to contribute directly to achieving the United Nations Sustainable Development Goals, particularly Goal 14 to "Conserve and sustainably use the oceans, seas and marine resources for sustainable development"[67].

---

[65] Fishing for litter: action where participating fishing vessels collect marine litter that is caught in their nets during their normal fishing activities.

[66] The circular economy approach has already proven successful in the EU where, in a few years, it has contributed to the creation of a significant number of jobs and business opportunities (European Commission, 2019).

[67] Important advances in the implementation of both strategies include the publication of the GFCM report on the State of Mediterranean and Black Sea Fisheries (SoMFi) (FAO, 2018b) and the upcoming publication of the report on the State of Mediterranean and Black Sea Aquaculture. In 2018, the GFCM also organized the first Forum on Fisheries Science in the Mediterranean and the Black Sea (Fish Forum 2018), and launched a series of dedicated regional surveys, such as socioeconomic sample surveys, bycatch monitoring surveys and pelagic acoustic and demersal trawl surveys to assess the status of resources (for more detailed information, visit the GFCM webpage at www.fao.org/gfcm).

BOX 46

Environmental attitudes in EU Mediterranean countries

(Source: TNS political & social, 2017)

The Special Eurobarometer "Attitudes of European citizens towards the environment" gives some indications about the declared environmental preferences of European citizens.

- **Environmental protection is important to European citizens.** The study shows that 94% of responding Europeans (ranging from 99% in Cyprus to 87% in Croatia) say that the protection of the environment is important to them personally.
- **Mediterranean-EU countries are more concerned about environmental issues than the EU average.** 81% of EU respondents agree that environmental issues have a direct effect on their daily life and their health. This proportion is higher than the EU average in all surveyed EU Mediterranean countries, with 97% in Cyprus, 96% in Greece, 93% in Malta, 91% in Spain, 90% in Italy, 84% in Slovenia, 83% in France and 82% in Croatia. 74% of Europeans agree that they are worried about the impact on their health of everyday products made of plastic. This proportion is also higher in EU-Mediterranean countries than the EU average, except for France. The five EU countries where citizens worry the most about the impact of plastics on their health are all located on the Mediterranean rim. All Mediterranean-EU countries also show a high proportion (EU average of 87% or above) of respondents indicating they are worried about the impact on the environment of everyday products made of plastic. A similar picture is revealed when asking Europeans if they are worried about the impact of chemicals present in everyday products on their health: Mediterranean-EU countries reply positively more often (96-87%) than the EU average (84%), just as when asked if they are worried about the impact of chemicals present in everyday products on the environment (EU average = 90%, Mediterranean-EU countries above average (98-93%), except for Croatia (89%)).
- **Mediterranean-EU countries are particularly worried about air pollution and think that the EU level is the right scale to address this issue.** In terms of environmental issues, air pollution is considered the most important environmental issue in five Mediterranean-EU countries, followed by climate change (three Med-EU countries) and the increasing amount of waste (one Med-EU country). Mediterranean-EU countries are more numerous than the EU average (47%) to say that they perceive that air quality has deteriorated over the last 10 years: at least six in ten respondents in Cyprus (69%), Spain (68%), France (62%), Italy (61%) and Greece (60%) think that the air quality has worsened in their country. When asked about the most effective ways to address air quality, the most popular option chosen by respondents is applying stricter pollution controls on industrial and energy production activities (41%). Overall, more than six in ten respondents in the EU (62%) say that they have undertaken at least one action to reduce harmful emissions into the air over the past 2 years, and most say that air pollution can be best addressed at the EU level (versus the national or subnational level).
- **EU citizens consider that environmental action taken by all stakeholders is insufficient and that environmental legislation is a main lever to protect the environment.** The majority of respondents agree that the action taken by the different stakeholders to protect the environment is insufficient: 79% say that industries and big companies are not doing enough, 67% say this is the case for their national governments, 66% say that citizens are not doing enough, 62% say the same for the European Union, 53% for their region, and 50% for their city, town or village. When asked about effective ways to tackle environmental problems, EU respondents give strong support to measures linked to environmental legislation (higher fines for breaches, stronger enforcement and more stringent legislation), along with more investment in research and development for technological solutions.

This study is based on stated environmental preferences (what citizens say); it does not survey revealed preferences (what citizens actually do).

Field projects implemented in the region offer lessons learned with respect to crucial issues such as overfishing, as illustrated in *Box 48, Box 49* and *Box 50*. The initiatives emphasize the following: i) effective governance is crucial to conserve marine natural resources while harnessing the potential of fisheries; ii) transnational, multi-stakeholder and cross-sectoral actions, based on the "value chain approach", should be designed for generating alternative sources of income for fishermen (such as marine environment monitoring, environmental education, fishing-tourism, MPA patrolling activities, valorization of local fish products, etc.), while identifying gaps and/or bottlenecks hindering such income diversification; iii) clear mechanisms for the participation of small-scale fishermen in MPA decision-making processes should be established within the existing collaboration schemes between MPAs and fishery-related authorities; iv) technological solutions for sustainable fishing practices should be sustained while supporting auxiliary industries which give value to discards with the aim of promoting job creation and onshore investments.

Moving towards sustainable aquaculture has become an urgent issue considering the fast expansion of the sector in the Mediterranean region. Approaching aquaculture with a systemic view has led to innovative aquaculture processes, as illustrated in the *Box 51*.

Moving towards **energy** efficiency and reliance on low-carbon energy mixes is key. The energy sector too often has considerable fossil-fuel subsidies (including tax exemptions on polluting activities, such as for fuels for aviation and maritime transport), going well beyond those needed for social purposes. Its environmental impacts need to be controlled in energy facilities (at primary production, at power plants and at refining facilities). Supportive policies and adequate investments are needed to support renewable energy sources, such as wind, solar or biomass, including those in prototype form, such as marine energy *(Box 52)*.

Moving towards sustainable **tourism** requires the cooperation of multiple stakeholders and their commitment to value and preserve Mediterranean cultural and environmental heritage while ensuring the well-being of local populations. Effective governance mechanisms can determine the economic, sociocultural and environmental sustainability of tourism developments. This is why the current

BOX 47

Examples of applications of behavioural insights in different policy areas

(Source: OECD, 2017)

A recent OECD study provides a number of examples where insights from behavioural sciences have been used to design and implement measures to tackle environmental issues. Behavioural levers are mainly based on changing default settings, using social comparisons, and framing information in more understandable ways, for example:

- **Encouraging energy conservation and private investment in energy efficiency:** supplementing energy efficiency labels with estimates of lifetime running costs can encourage choosing more efficient household appliances, because consumers are sensitive to the way in which labels are presented. Providing real-time feedback on energy consumption through in-home displays, changing default options to more energy-saving settings and comparing one's own energy consumption against that of one's peers have also proven to lead to changes of behaviour.
- **Promoting the purchase of more fuel-efficient cars:** providing information about expected fuel costs over a period of multiple years, and especially comparing these costs against those of the most fuel-efficient car in the same class, can promote the purchase of more fuel-efficient models.
- **Encouraging water conservation:** statements on the water bill comparing household consumption with the average in the same neighbourhood and guidance on concrete steps to take to save water have been successful. Likewise, placing "save water" stickers next to taps has also proven to induce water savings. Using in-home displays to provide real-time feedback on hot water consumption in the shower has led to both energy and water savings in Switzerland.
- **Incentivizing more sustainable food consumption:** providing clear information about food products, including encouragements to consume imperfect-looking food products, or about the optimal quality guarantee of food products (best-before date vs. production date) can prevent food waste.
- **Promoting environmental compliance:** sending regulated entities timely reminders of their obligations, emphasizing the mandatory nature of these obligations and the consequences of not complying, have proven effective.
- **Encouraging participation in voluntary schemes:** messages underlining the environmental benefits and competitive advantages associated with voluntary environmental certification can be effective.

BOX 48

Fishermen's organizations agreements for the protection of demersal fisheries resources - case study

(Source: Plan Bleu, 2020)

The "Fishermen's Organizations Agreements for the Protection of Demersal Fisheries Resources" is a fishing sector initiative aiming at improving the conditions of demersal resources with the consequent long-term maintenance of the fishing activity that depends on it along the coast of Girona (Spain). The three main species targeted by the project *(Merluccius, Aristeus antennatus, Nephrops norvegicus)* are in different states of overfishing. The general objective is to ensure that fishing activities are environmentally, economically and socially sustainable, ensuring that living marine resources are restored and stocks maintained above levels capable of producing the Maximum Sustainable Yield (MSY). Measures have been introduced to reduce fishing efforts, increase selectivity and control access to resources. These measures were agreed by the fishermen's organizations involved and acknowledged by the competent authorities. The main management measures are: i) rules to reduce and/or restrict fishing efforts: decreasing the number of operations of fishing gear per day or per fishing ground; ii) incorporation of technical measures to improve selectivity and/or reduce environmental impact: more restrictive technical measures (type of gear, mesh size, dimension, type of otter trawl doors); iii) access control regulations: census of authorized fleet); iv) time limitation on fishing activity: temporary closure of areas to protect juveniles and reduction of total fishing time per day; v) adaptive and multi-stakeholder management: active participation of the agents involved in regulating the activity.

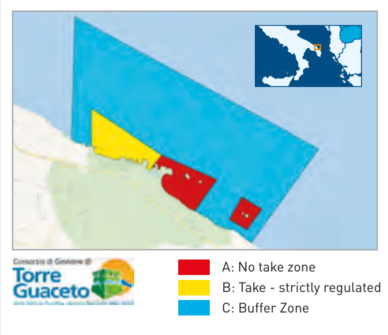
These measures aim to reduce fishing pressure to adjust the capacity of fleets to the state of the resource, and balance environmental sustainability of the fishing grounds with the best long-term economic performance. Current results include: i) improved relationships between fishermen; ii) better quality of the product sold (larger sizes, better pre-sale maintenance conditions); iii) reduction of physical impact on the ground; iv) increased biomass of harvested stocks; v) better economic efficiency; vi) involvement of the fishing sector in the decision-making process.

lack of cooperation and common understanding between different stakeholders is an issue to be addressed urgently and at different levels (e.g. through public-private cooperation initiatives). Due to the number of economic activities linked to tourism, only the inclusion and engagement of all stakeholders can reconcile contrasting visions and goals with respect to tourism developments.

Box 49

Engaging fishing communities in MPA management - Torre Guaceto Marine Protected Area (Italy) - case study

(Source: Plan Bleu, 2020)



The experience of Torre Guaceto Marine Protected Area (hereafter called TGMPA) is one of the few examples in the Mediterranean of the successful involvement of traditional fisheries within MPA management programmes. TGMPA is a stretch of coast where traditional fishermen have been working for generations. When the MPA was first enforced, fishermen felt that they had been deprived of their rights. Between 2000 and 2001, all fishing activities were banned, causing violent frictions between fishermen, MPA authorities and police bodies (e.g. coastguard). Based on an agreement and a shared vision between fishermen and the TGMPA authority - under the scientific supervision of a research institute - a regulated fishing activity was allowed as of 2005 in part of the buffer zone surrounding the two TGMPA no-take zones.

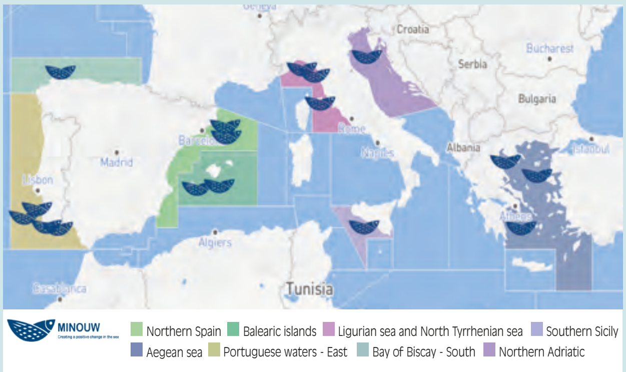
Fishermen's participation in the adaptive co-management program was proposed on a voluntary basis. Fishermen were invited to share decisions with the MPA authority about the rules to manage fishing activities, while a scientific institute supervised the monitoring programme. Fishermen who adhered to the co-management protocol (initially only seven fishing boats) were authorized to fish. The fishing effort was set up and the gear selected to limit the impact on key fish predators, juvenile stages, and benthic communities and habitats. Fishermen agreed to fish only inside part of the buffer zone using shorter trammel nets (1 kilometre long versus 2-3 kilometres) with a larger mesh (3 vs 2.4 cm), and to haul the nets only once per week. They also agreed to reduce the fishing effort if symptoms of overfishing were detected through scientific monitoring (total and per-species yields, and catch composition). The data collected showed that catches were, on average, 2-4 times higher inside the buffer zones of the TGMPA than outside. More recently, several fishermen who initially did not accept to join the program, asked to be part of it, representing an extraordinary signal of success, but also the increase of the overall fishing effort, which represents a new challenge for the management body.

The main lesson learned is that building trust with fishermen is crucial as well as agreeing collectively on objectives. Tangible results to demonstrate the benefit of the MPA management body for safeguarding local fisheries help to slowly modify the cultural approach to fishing. The continuous exchange with fishermen in TGMPA helped define a shared roadmap for enlarging the MPA and its inclusion in the Natura 2000 Network.

Box 50

MINOUW project - case study

(Source: Plan Bleu, 2020)



The "Science, Technology and Society Initiative to Minimize Unwanted Catches in European Fisheries" (MINOUW) addresses the implementation of the Landing Obligation from the scientific, technical, economic and societal perspectives. Catches of unwanted species can be large in demersal fisheries. Bottom trawling on fish nursery areas can generate large amounts of unwanted catches that are usually discarded (undersized specimens, untargeted species or over-quota catches).

MINOUW is based on a multi-stakeholder approach, whereby scientists, technicians, fishermen, producers and NGOs work together to provide the scientific and technical basis to gradually eliminate discards. Providing a diagnosis of the problem, partners develop a portfolio of solutions to be tested in the field under commercial conditions. The impact of such solutions is ranked against biological, social and economic criteria, and recommendations are made. The project shows that it is possible to decrease the production of unwanted by-catches by changing fishing procedures or adopting more selective nets in bottom trawl or set nets. New types of sorting grids specifically designed for Mediterranean trawls have proven effective. In small-scale fisheries, a guarding net fitted to the footrope of the trammel net can reduce unwanted by-catches, as well as costs. In surface longline fisheries targeting swordfish, a significant reduction in the catch rates of undersized swordfish was demonstrated. The project has also made progress in developing a Geographic Information System (GIS) tool that can identify areas with high potential of unwanted catches.

MINOUW's main lessons learned/recommendations are: i) fishermen are the stewards of marine resources and they have a direct interest in the sustainability of their activities. While some tend to be adverse to innovation imposed from outside, they are not against innovation as such; ii) fishery managers need to resist the pressure from industry for short-term profit and instead work closely with other stakeholders to ensure the resources needed for monitoring and control, capacity-building and awareness campaigns; iii) scientists and experts play a key role, namely gathering and analysing data to gain understanding of current trends, and develop innovative selective fishing gear and sustainable practices in collaboration with fishermen; iv) valorization of discards by other industries might lead to new jobs and onshore investments; v) means for enforcing the existing regulation are needed; vi) underfunded and understaffed fisheries management agencies cannot promote the implementation of the solutions proposed by MINOUW and other projects addressing the issue of overfishing. Public incentives are required to attract private investments from technological companies considering that the Mediterranean fishing industry is mainly composed of micro-enterprises with a very low investment capacity.

BOX 51 Integrated Multi-Trophic Aquaculture (IMTA)

A new approach to aquaculture attempts to address technical, environmental, market, socioeconomic and governance issues, while exploring innovative solutions, and to provide codes of practice and tools throughout the value chain with the aim of enhancing the performance of the marine fish-farming sector holistically[68]. Integrated Multi-Trophic Aquaculture (IMTA) is acknowledged as a promising, though complex, solution for the sustainable development of aquaculture. Its ecosystem approach is fully in line with the FAO Code of Conduct for Responsible Fisheries.[69] The concept of IMTA, inspired by the trophic dynamics of the natural environment, is based on farming fish together with molluscs and/or crustaceans, algae and/or aquatic plants, with the aim of improving environmental and economic yield.

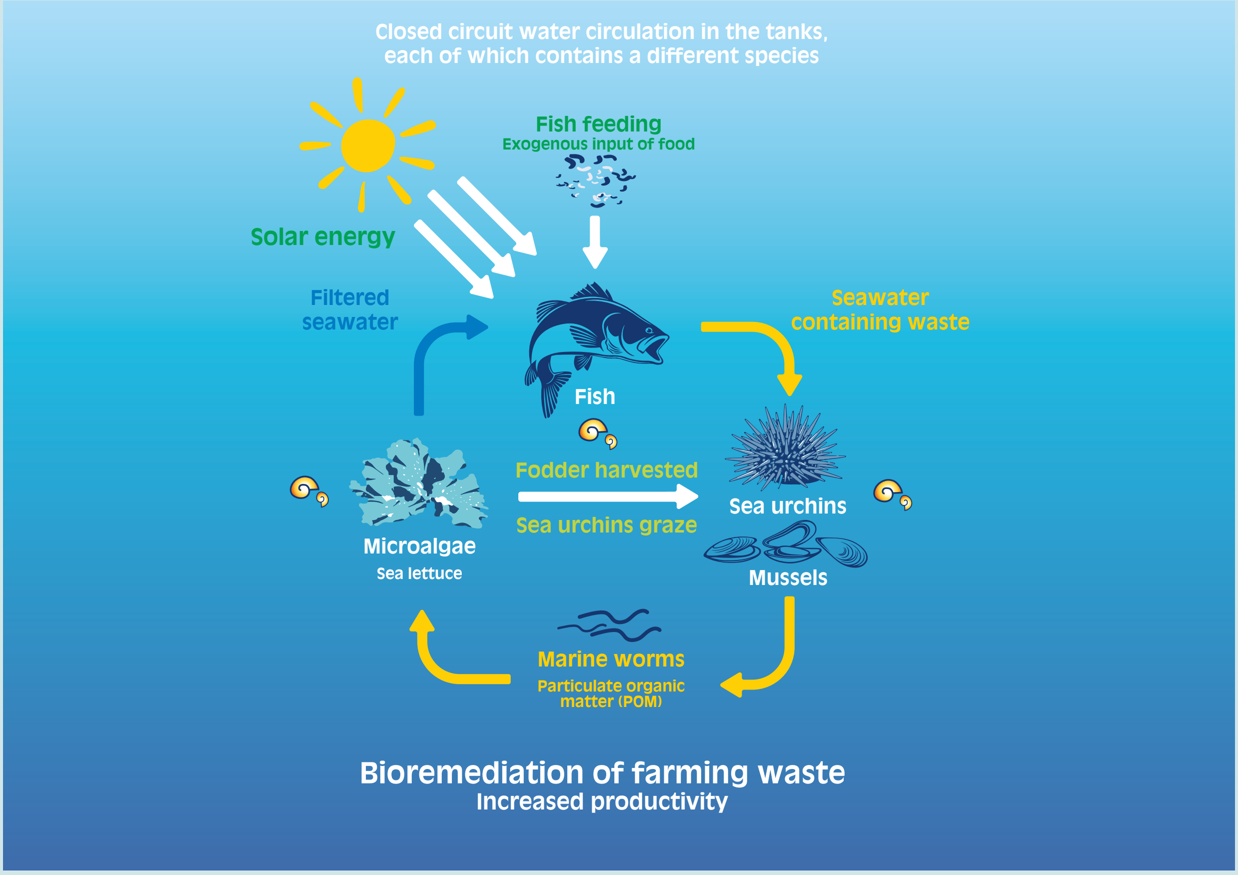


Figure 132 - Integrated Multi-Trophic Aquaculture (IMTA)
(Source: Paul Ricard Oceanographic Institute website, consulted October 2019)

The Sustainable Tourism Community under the Interreg MED programme[70], with support of the BleuTourMed project, showcased how sustainable tourism can contribute to solving crucial environmental and socioeconomic challenges. Shifting to sustainable tourism models would require: i) introducing more stringent monitoring systems when assessing the health of marine and coastal ecosystems to ensure better decision-making when it comes to preserving those ecosystems' services, which are at the foundation of most tourism developments; ii) shifting the focus of tourism policies and practices from competitiveness to sustainability in order to halt environmental and social degradation and unleash the potential of the sector to promote local and regional development through the improvement of infrastructure, the creation of decent jobs, etc.; iii) avoiding a system whereby negative externalities of tourism developments are paid by residents only, and ensuring that environmental, economic, social and cultural

[68] MedAID (Mediterranean Aquaculture Integrated Development), a four-year project, funded by the European Union in the framework of Horizon 2020, http://www.medaid-h2020.eu/

[69] The Code of Conduct for Responsible Fisheries, approved by FAO in 1995, is the framework for national and international efforts to ensure the sustainable exploitation of aquatic living resources in harmony with the environment.

[71] https://sustainable-tourism.interreg-med.eu/

BOX 52

Eco Wave Power - Gibraltar Power Station - case study

(Source: Plan Bleu, 2020)

Since 2016, Eco Wave Power (EWP), a Swedish company founded in Israel in 2011, has been operating a 100 kW wave energy array in Gibraltar. The station is the only grid-connected wave energy array in the world operating through a commercial Power Purchase Agreement (PPA)[71]. It is the initial part of an overall plan which aims to cover 15% of Gibraltar's electricity needs. So far, the results of EWP are promising: the station surpassed 15,000 grid connection hours, a new world record for wave energy, and made significant scientific progress, resulting from the tests and R&D conducted at the power station, which will assist the commercialization of wave energy worldwide.

costs are accounted for in planning and budgetary documents; iv) favouring inclusive, structured and coordinated governance that empowers citizens, strengthens destinations' resilience and reconciles social needs and the legitimate interests of the sector. With regard to the latter, there are very interesting experiences in the region, in particular the establishment of stakeholder/thematic clusters for structured private-public collaboration and cooperation.

Moving towards a **sustainable transport** sector requires paying attention to infrastructure (e.g. investment and maintenance in road, rail, port and airport facilities, and their environmental impacts), vehicles (e.g., pollution control for new and in-use vehicles, and the use of the best available technologies, transition to renewables-based electric and/or hydrogen technologies, reduction of the environmental impacts of civilian and military maritime transport with Mediterranean and non-Mediterranean flags at port and at sea), and traffic management (e.g. urban traffic police, urban public transport optimization, control of straights and canals, legal and illegal maritime transport of freight and humans).

At the Mediterranean level, tackling air pollution from **shipping** is an urgent matter since a high percentage of the air pollution in coastal towns comes from this sector. The emissions of carbon dioxide (CO_2), nitrogen oxides (NOX), sulphur dioxide (SO_2) and particulate matter (PM 2.5) from shipping occurring in European waters contribute up to 10-20% of overall worldwide shipping emissions. When considering all ship traffic from national and international shipping arriving or departing from EU ports, the contribution rises to 30% for CO_2 (EEA, 2013b). A feasibility report looking at implementing a low-emission zone for ships in the region has concluded that the benefits would outweigh the costs threefold (INERIS, 2019). The report highlights that particulate matter can be reduced by up to 20% and nitrogen dioxide (NO_2) levels even by up to 76%, leading to up to EUR 14 billion in reduced health costs and potentially saving more than 6,000 lives every year in the region. The possibility of designating the Mediterranean Sea as an Emission Control Area (ECA)[72] is an important subject of discussion among Mediterranean countries.

Industry and mining need to improve: i) their resource use in the context of a circular economy, with the reduction, reuse and recycling of waste, ii) their attention to the production and use of chemicals, their impacts on humans and the environment, and the presence of chemicals in the environment and products (e.g. traditional pollutants, endocrine disruptors, substances, etc.), and (iii) their use of best available techniques.

Having steadily increased with global production over the past fifty years, the presence and accumulation of **plastic debris** is nowadays recognized as a major environmental problem, with consequences affecting not only nature and biodiversity, but also society and human well-being.

[71] A Power Purchase Agreement (PPA) often refers to a long-term electricity supply agreement between two parties, usually between a power generator and a customer (an electricity consumer or trader). The PPA defines the conditions of the agreement, such as the amount of electricity to be supplied, negotiated prices, accounting, and penalties for non-compliance. Since it is a bilateral agreement, a PPA can take many forms and is usually tailored to the specific application. PPAs can be used to reduce market price risks, which is why they are frequently implemented by large electricity consumers to help reduce investment costs associated with planning or operating renewable energy plants.

[72] International Convention for the Prevention of Pollution from Ships (MARPOL), Protocol, Annex VI *Regulations for the Prevention of Air Pollution from Ships,* 1997.

BOX 53 DestiMED project - case study

(Source: Plan Bleu, 2020)

DestiMED brings together a network of Mediterranean partners and protected areas to collectively develop, manage, monitor and promote ecotourism in Mediterranean protected areas, to inspire transformative nature experiences and cultural exchange. DestiMED aims to: i) assess and monitor the sustainability of ecotourism products developed in Mediterranean protected areas; ii) provide capacity building and reinforce cooperation for sustainable ecotourism product development at the local and regional scales; iii) improve the regional governance of ecotourism in Mediterranean protected areas.

Among other outputs, the project developed:

- a tested methodology for measuring the environmental impacts of tourism products, the "Ecological Footprint Calculator" available online for any Destination Management Organization, and the design of various ecotourism packages tested/assessed in thirteen protected areas in six Mediterranean countries.
- a replicable governance method for ecotourism development (planning, implementing, monitoring, revising), applicable to any destination with significant natural/cultural assets. A Public-Private Partnership is in place in each of the thirteen pilot protected areas, starting from the establishment of a Local Ecotourism Cluster in each area, involving ecotourism stakeholders in the destination and the park management bodies.

BOX 54 Mitigation of impacts from maritime transport in Marine Protected Areas (MPAs)

The impact of the **maritime transport sector** is an issue for the whole Mediterranean Sea, but is particularly critical in Marine Protected Areas (MPAs). In this respect, there are clear recommendations developed within projects that aim to prevent or minimize the impact of the maritime transport sector on MPAs. The PHAROS4MPAs project provides a set of practical recommendations for regional stakeholders, including public authorities, as listed below (Randone et al. 2019).

Maritime Spatial Planning (MSP) Authorities should: i) make use of Particularly Sensitive Sea Areas (PSSAs), Areas To Be Avoided (ATBAs) and Traffic Separation Schemes (TSSs) to protect MPAs from the risks of maritime traffic accidents and reduce the chances of collisions with cetaceans; ii) use MSP processes to prevent anchoring impacts, introduce voluntary no-anchoring zones, adopt zoning plans indicating sensitive areas as well as suitable anchoring areas, include MPA boundaries and anchor-sensitive areas on nautical charts.

Ports Authorities should: i) develop joint solutions with MPAs - including monitoring, modelling and vulnerability assessments - to mitigate the impact of pollution from port operational activities; ii) work with local pilot companies to identify and implement piloting solutions in key marine areas; iii) together with the State, promote cross-border cooperation by defining agreements between national authorities and/or port authorities for navigation safety and pollution response.

States should: i) promote and actively participate in coordinated response and contingency plans for oil spills and other pollution events at the cross-border, subregional and regional levels; ii) ensure implementation of the International Convention for the Control and Management of Ships' Ballast Water and Sediments (BWM Convention), particularly through inspections and monitoring activities (Randone et al. 2019).

Public authorities can also play a major role in minimizing the cruise sector's impacts on MPAs by, for example, establishing strict limits and buffer zones regarding the minimum distance at which cruise ships are allowed to navigate, moor or stop from the borders of MPAs. This would minimize existing impacts and counterbalance the growing interest from the industry in visiting these areas. National environmental/marine authorities should also: i) promote the continuous monitoring of cruise activities, with close cooperation between MPA managers and the relevant public authorities (e.g. registration of operational data, emissions and discharges, fuel type); iii) ensure that authorization to navigate in highly sensitive natural areas is a well-informed process, with the close involvement of MPA managers to limit the risks (e.g. grounding, collisions); iv) implement speed restrictions to mitigate the collision risk. In addition, lower speeds reduce potential acoustic impacts and emissions of air pollutants; v) make use of MSP tools such as PSSAs to prevent accidents and the consequential environmental impacts (UNEP/MAP - PAP/RAC, 2019).

While waste prevention measures are likely to be more efficient than curative action, both approaches need to go hand in hand, especially given the amount of marine litter already present today in the Mediterranean Sea. Innovative responses have been put forward in the Mediterranean *(Box 55)*.

At the current stage of knowledge, even if applying all available best practices and technologies, it is not possible to eliminate all environmental impacts stemming from the economic activities described above. Such impacts can and must be mitigated. The most effective way to do so is by applying the mitigation hierarchy, that aims at (i) avoiding negative impacts as much as possible in the first place, (ii) then, if degradations cannot be avoided, to reduce them, and (iii) in a third and last step, if negative externalities can neither be avoided nor reduced, to offset them (Chapter 8, *Figure 199*). Integrating this mitigation hierarchy into the prevailing business models and production patterns will be key to achieving sustainability in the Mediterranean region.

BOX 55

Cleaning Litter by developing and Applying Innovative Methods (CLAIM) - case study

(Source: Plan Bleu, 2020)

The CLAIM project targets marine litter through the development of new technologies and approaches to clean our seas. The project will power five innovative marine cleaning technologies, and prevent litter from entering the sea at two main source points: wastewater treatment plants and river mouths. Directly after pre-filtering, a photocatalytic nano-coating device will degrade microplastics in wastewater treatment plants. Mounted on ships, a small-scale thermal treatment device (pyrolyzer) will be used to turn the litter collected into energy to power ships. At river mouths, a floating device will collect and monitor visible litter, while a CLAIM network of FerryBox systems will operate on ships in the Baltic, West & East Mediterranean, mounted with an automated seawater sampling device & passive flow-through filtering system. From a scientific point of view, CLAIM aims to develop innovative modelling tools to assess and create informative maps about visible and invisible marine plastic pollution at the basin and regional scales (Saronic Gulf, Gulf of Lion, Ligurian Sea and Belt Sea). An ecosystem approach will guide the project through the assessment of the potential benefit from proposed litter cleaning methods to ecosystem services and human well-being. New business models will enhance the economic feasibility for upscaling the innovative cleaning technologies, taking into account the existing legal and policy frameworks in the CLAIM countries, as well as acceptance of the new technologies by their end users and relevant stakeholders. The main strengths of the project are to: i) respond to one of the major environmental concerns nowadays through cost-effective, environmentally-friendly and innovative solutions; ii) positively impact society (public health) and the coastal economy (preservation of cultural/historic heritage and biodiversity); iii) introduce new business models to evaluate the cost-efficiency and feasibility of the proposed solutions within existing policy and legal frameworks based on social acceptance; iv) use technologies that are suitable for uptake and upscaling, and eventually commercialization.

5. Coastal zone dynamics and related impacts

For Mediterranean societies and the economy, the coastal strip has long been an area of concentration for development. The coasts are indeed the seat of many uses that contribute to the economic and social development of the region. Their growth, sometimes exponential, and their intensification generate many impacts that alter the invaluable natural and social capital of the Mediterranean.

For the purpose of this chapter, three issues considered as crucial are examined:

1 • Rural-urban migration and socioeconomic disparities in a climate change context;
2 • Coastal urbanization and environmental changes degrading natural capital and cultural heritage & increasing risks for populations;
3 • Booming and multiplying maritime activities challenging Good Environmental Status.

After highlighting each of them, the urgent need to create more coherent implementation of policy and management frameworks is emphasized. At the core lays the Integrated Coastal Zone Management (ICZM) Protocol (UNEP/MAP, 2008), and particularly its common regional framework and its strong links with Maritime Spatial Planning (MSP) and the Ecosystem Approach (EcAp).

5.1 Introduction: coastal areas under significant accumulated pressure

Coastal areas are among the most valued parts of the Mediterranean countries. They are highly coveted for both living and economic activities and are thus subject to significant pressures. Climate change is an additional pressure that will have a considerable impact on both the land and marine portions of coastal areas. As described in Chapter 2, it will increase extreme weather events, coastal flooding followed by accelerated coastal erosion, sea water contamination and groundwater salinization. With high-density building development and highly concentrated economic activities (including ports), the coastal fringe is particularly exposed to sea level rise and extreme coastal hazards, while sea waters are home to most of the marine fauna and flora, including fish nurseries, hosting many maritime activities, including aquaculture, fisheries, nautical tourism, bathing, diving, snorkelling, etc. On land, elevated temperatures and decreased precipitation will result in more frequent droughts and increasing risks of wildfires, water shortage and consequently food shortage.

The riparian Mediterranean countries are increasingly aware of these growing risks in coastal areas and recognize the need for regular monitoring to anticipate these adverse phenomena and adopt appropriate forms of governance and management in the short, medium and long term. In this context and to address accumulated pressures in coastal areas, a unique document has been established, the Integrated Coastal Zone Management (ICZM) Protocol (UNEP/MAP, 2008) *(Box 56)*.

BOX 56

The Protocol on Integrated Coastal Zone Management (ICZM Protocol)

(Source: UNEP/MAP, 2008)

As a response to increasing pressures and climate change threats, and at the initiative of the Priority Actions Programme Regional Activity Centre (PAP/RAC), the Contracting Parties to the Barcelona Convention agreed in 2000 to prepare a feasibility study demonstrating the need for a regional legally binding instrument for sustainable coastal development. The study was followed by an extensive 4-year consultation process with representatives of all relevant stakeholders. The Regional Forum, a number of expert working group meetings, a consultative workshop, COP 14 of the Barcelona Convention that established another working group composed of government-appointed experts, and COP 15, resulted in the signature of a Protocol on Integrated Coastal Zone Management (ICZM) in the Mediterranean (UNEP/MAP, 2008) at the Conference of the Plenipotentiaries in Madrid, Spain, in 2008. Following 6 ratifications, the ICZM Protocol entered into force in 2011. The Protocol provides a legal basis for coordinated implementation of national integrated coastal and marine management policies. By 2019, 10 countries and the EU had ratified the Protocol.

This chapter first examines the challenges to be taken up in the Mediterranean coastal zones, starting from the watershed, to the land-sea interface and the open sea. The main drivers at stake for the three abovementioned issues are reviewed, followed by priorities for action, which are then combined as integrated recommendations under the main policy and management frameworks of the Barcelona Convention, i.e. the ICZM Protocol and Maritime Spatial Planning (MSP), the Ecosystem-based Approach (EcAp), and the Regional Climate Change Adaptation Framework for the Mediterranean coastal and marine areas. These instruments and policy frameworks aim to reduce pressures on coastal areas while maintaining socially equitable, environmentally sustainable and economically viable development.

5.2 Internal migration and socioeconomic disparities

The Mediterranean region and its coastal development dynamics appear to be characterized by urbanization and "coastalization". Although percentages of built-up infrastructure and population density vary considerably along the Mediterranean, the overall continued and unabated trend towards coastal urbanization and the associated concentration of wealth production in the coastal zone to the detriment of the hinterland is particularly strong in the Mediterranean. The following section examines the issue of inducing urban sprawl, disparities across territories and landscape fragmentation.

5.2.1 Territorial unbalance and fragmentation

The loss of rural economic growth is proportional to the increased attractiveness of cities and coastal areas. This generates strong dualities and inequalities between a neglected hinterland and a coastal area undergoing rapid urbanization now affecting the entire Mediterranean coastal zone. This change continues to deeply affect watershed and land-sea interface management, although many policies have tried hard to reduce this imbalance in recent years.

5.2.1.1 Rural exodus, land abandonment and associated risks

Although the downward trend of the rural population and agriculture is generally slowing down, there are significant differences between the Mediterranean regions. For example, 14% of land is suitable for agricultural production in the Mediterranean region, with averages of 34.4% for the northern EU Mediterranean countries and only 5% for countries on the Southern and Eastern shores (Nori, 2018). In Northern Mediterranean countries, the trend towards a historic decline in rural life is a long-standing reality. The revitalization of rural areas encouraged by the second pillar of the European Union Common Agricultural Policy[73], the promotion of natural and cultural heritage in the countryside, the resistance of smallholder farming and the maintaining of agriculture on territorial bases could not reverse this downward trend in rural populations. For example, between 1961 and 2016, the rural population has halved in Spain, dropping from 42% to 20%, from 30% to 20% in France, from 44% to 21% in Greece, and from 40% to less than 30% in Italy (FAO, 2018).

It should be noted that the rurality index of Eastern European countries remained high in 2018, with rates ranging from approximately 33% in Montenegro to 40% in Albania, and even 45% in Slovenia. These rural population rates, close to those recorded in countries such as Egypt (57%), the Syrian Arab Republic (46%), Morocco (38%), Tunisia (31%) and Cyprus (33%), reveal the persistence of rural vitality in certain regions of Europe. These rurality rates are comparable to those of France, Spain, Italy or Greece in the 1970s (European Commission, Eurostat).

With nearly half a century difference compared to Northern Mediterranean countries, in recent decades, the countries of the South and East have started to experience a historic mass rural and agricultural exodus, where the population distribution between urban and rural areas has been radically changed. With the exception of Egypt (57%) and Bosnia and Herzegovina (52%), where rurality rates are above average, all Southern and Eastern Mediterranean countries now have an urbanization rate of over 50% (World Bank, 2019).

Almost all Mediterranean countries are characterized by a decline in the annual growth rate of the rural population, except for Egypt (+ 2%), the State of Palestine (+ 1.8%), Malta (+ 1%), Israel (+ 0.9%), Cyprus (+ 0.9%) and Tunisia (+ 0.2%). Rural population decline in absolute terms is an unprecedented phenomenon in countries such as Algeria (- 0.4%), or even in countries with a high rural population such as Croatia (- 1%), Montenegro (- 1%), Slovenia (- 0.5%), Albania (- 2.4%) and Turkey (- 0.5%)[74]. Egypt remains by far the country where the rural and peasant world is experiencing remarkable demographic growth. With an annual rural population growth rate of 2%, Egypt went from 35 million rural people in 1995, to about 56 million in 2017

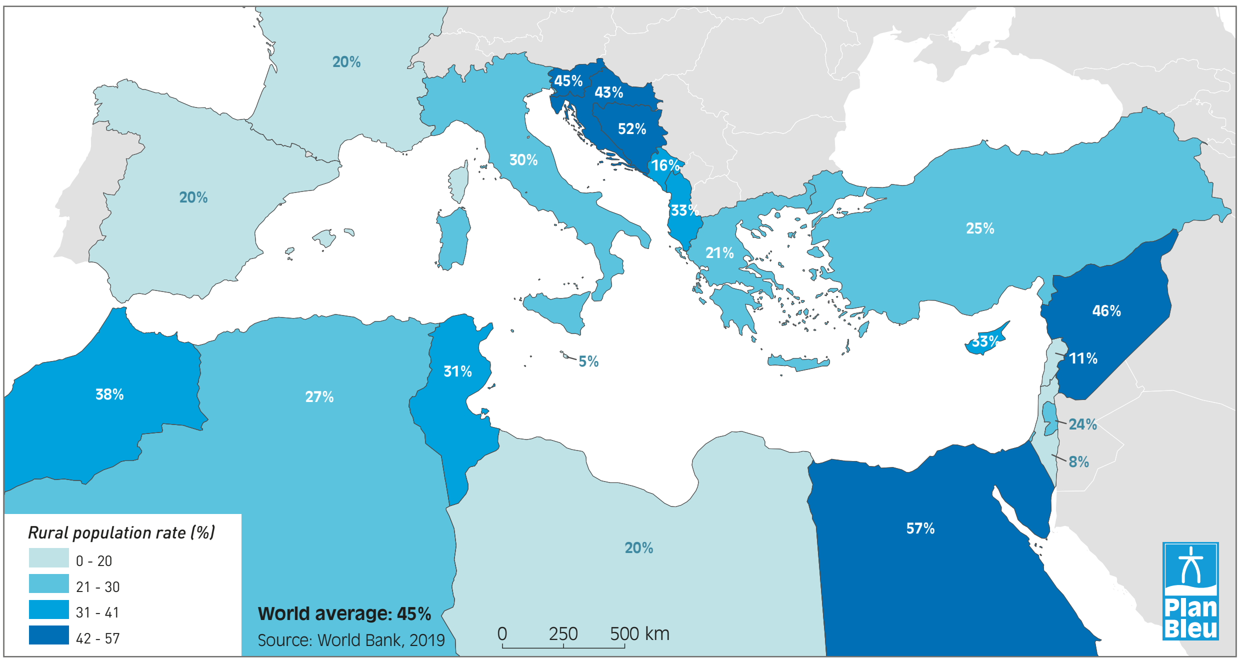


Figure 133 - Rural population in 2018
(Source: World Bank, 2019)

[73] Common Agricultural Policy (CAP) = agricultural policy of the EU implementing a system of subsidies and programmes to increase productivity, stabilize markets, etc. The second pillar of the CAP relates to rural development policy.

[74] Turkey, which in 1980 had a rural population of over 25 million, more than 56% of the population, was only 20.1 million in 2016 (25.3% of the total population).

(FAO, 2018; World Bank, 2019). The Syrian Arab Republic, which had barely 3 million rural people in 1960, had more than 7.2 million in 1995 and 9.7 million in 2016.

The agriculture labour force is older than in any other sector of the EU economy. The rates are particularly worrisome in Euro-Mediterranean countries, where agriculture is losing 2-3% of its active population per year. Today, only about 10% of farmers across the European Mediterranean are younger than 35, less than half the percentage of those aged over 65. Greece leads the group with 21.4% of its rural population in this age group, followed by Spain (21.1%), Italy (20.9%) and France (20.8%). These figures create serious concerns about an increasingly ageing population in many rural areas, as a young workforce is critical for a healthy and vital countryside. A sustainable rural world and agricultural sector need to be attractive to a young, skilled and motivated workforce, as a dynamic and productive countryside is critical to ensure food production, healthy ecosystems and territorial integration (Nori, 2018).

5.2.1.2 Housing and basic services in coastal urban areas

"By 2030, ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums", is part of the Agenda for Sustainable Development (SDG Target 11.1 expressing the need to "make cities and human settlements inclusive, safe, resilient and sustainable"). It is estimated that more than half of the global population live in cities; by 2050, two-thirds of all humanity (6.5 billion people) will be urban (UNDP, 2019). This represents a real challenge in the Mediterranean coastal region, where housing is influenced by specific social, economic and environmental characteristics such as rapid rural to urban migration, mass tourism, land ownership status and changing climate conditions.

Rapid and ever increasing growth of cities in coastal areas as a result of rising populations and increasing migration is linked to the establishment and expansion of informal settlements, defined as "residential areas where 1) inhabitants have no security of tenure vis-à-vis the land or dwellings they inhabit, with modalities ranging from squatting to informal rental housing, 2) the neighbourhoods usually lack, or are cut off from, basic services and city infrastructure and 3) the housing may not comply with current planning and building regulations, and is often situated in geographically and environmentally hazardous areas" (UN-Habitat, 2015).

Data on the proportion of urban populations living in slum areas (characterized by areas with limited access to drinking water, sanitation, durable housing and sufficient living area, measured at the national level) is available for only 8 out of 22 Mediterranean countries *(Figure 134)*, indicating the difficulty of monitoring the achievement of SDG Target 11.1.

According to UN-Habitat data, the proportion of urban inhabitants living in slums tends to decrease in most documented Southern and Eastern Mediterranean countries significantly faster than the global average. However, the latest available data shows that a large percentage of the urban population in some of the Southern and Eastern Mediterranean countries lives in informal settlements, namely in Lebanon (53%), Libya (35%), the Syrian Arab Republic (19%), Algeria (12%), Morocco (13%), Turkey (12%), Egypt (11%) and Tunisia (8%). People living in informal settlements are prone to disease exposure,

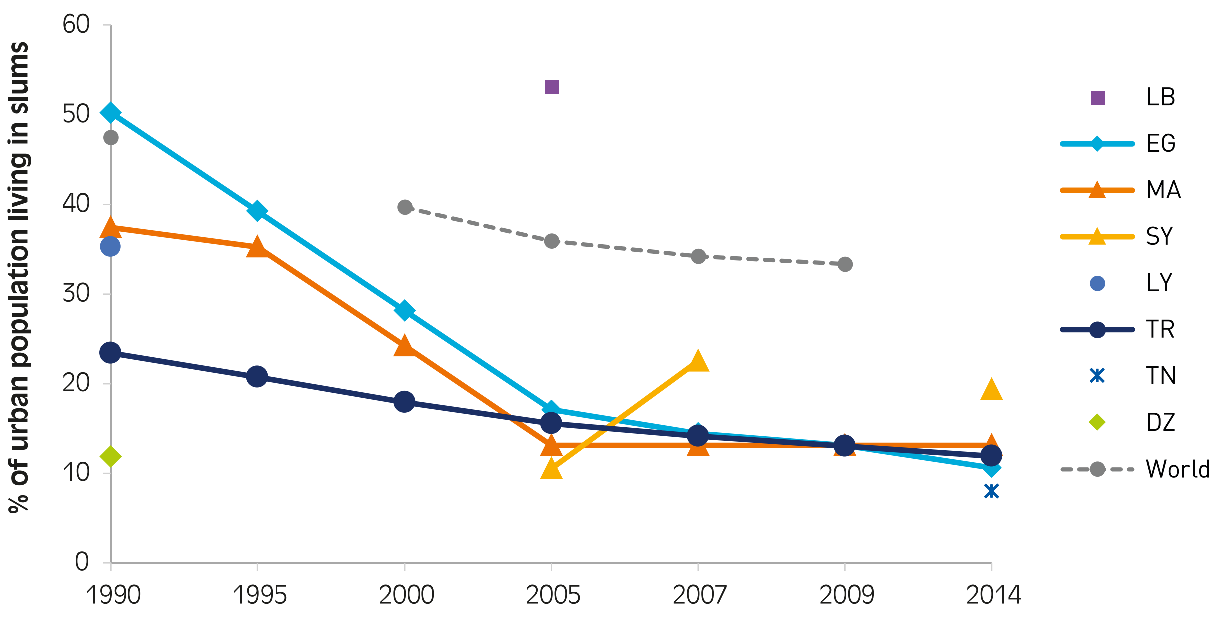


Figure 134 - Percentage of urban population living in slum areas in Egypt (EG), Lebanon (LB), Morocco (MA), Syrian Arab Republic (SY), Tunisia (TN), Turkey (TR) Algeria (DZ) and Libya (LY), compared to global trend
(Sources: UN-Habitat, 2016; World Bank, 2019)

due to a lack of drinking water and sanitation services, are more susceptible to coastal risks and have a limited financial capacity to recover from disaster.

Besides the issue of informal settlements, the housing market in costal Mediterranean cities, at least in the Northern countries, suffers from an imbalance between supply and demand of dwellings; due to a large number of seasonally vacant properties (secondary/holiday homes), low availability of assets, high market prices, prominent tourism facilities, strict rent regulation and tenant protection and a strong "family homeownership culture" (Gentili & Hoekstra, 2018). The cost of housing in relation to the total household disposable income indicates an overburden[75] in Greece, Spain and Italy (European Commission, Eurostat). Although there is limited data available on their living conditions, there are thousands of homeless people in Spain, France, Greece and Italy (OECD, 2015).

Besides cities, rural areas in the Mediterranean region have been evolving as a function of agricultural activity and rural to urban migration. In general, poverty in rural regions is more prominent than in urban areas (higher % of the population), and access to major services (e.g. transport, education, health) is more limited due to remoteness, leading to deprivation and social exclusion.

5.2.1.3 Urban mobility

Urban mobility defines all the movements of people in their daily activities (work, shopping and leisure) in an urban space. Urban Mobility continues to be a great challenge in the Mediterranean region as highlighted in the Urban Mobility Forum (UMF-II) "Efficient Urban Transport for Sustainable Cities" (Cairo, Egypt, 2017). During the Forum, multiple players underlined various urban mobility weaknesses, particularly in the Mediterranean. UMF-II conclusions called for the development of Local Mobility Strategies, including immediate soft solutions to mitigate current urban threats by identifying cities specific mobility hurdles.

Urban mobility is currently a latent and persistent environmental and management challenge in Mediterranean cities, regardless of the size of cities, geographical context, population, urban planning patterns or socioeconomic indexes. Living conditions/standards in Mediterranean cities are deteriorating due to a continued increase in mobility and the inability to properly manage common challenges such as traffic congestion, alarming air pollution indicators, lack of public urban transport systems and increased dependency on individual vehicles, the negative impacts of seasonal demands, inefficient parking and monitoring systems, etc.

During the 2008 economic crisis, CO_2 emissions from use of private cars decreased in most of the Northern Mediterranean cities. This effect is attributed to the combined impact of sustainable mobility policies from the previous decade and the decrease in urban mobility during the recession. With economies recovering, statistics tend to return to previous levels and mobility scenarios are potentially mitigated in cities, mainly in the Northern Mediterranean, that have adopted the most radical transformations in promoting soft mobility modes, multimodal approaches, etc.

In most of the EU Mediterranean cities, Sustainable Urban Mobility Plans are developed and periodically revised, resulting in the implementation of sustainable mobility actions. Most of the Southern cities, on the other hand, are in the initial phases of Urban Mobility Planning, and mobility measures remain insufficient or inefficient, due to the large-scale solutions required in the face of rapid urbanization, and the lack of skills and economic resources in local governments for implementing such large-scale projects or initiating public-private partnerships.

The World Business Council for Sustainable Development (WBCSD) provides an online tool (http://www.wbcsdsmp.org) that allows cities to analyse their sustainable urban mobility performance, identify solutions, map their solutions and provide information documents to support stakeholder communication in the city.

In Mediterranean cities, a more consistent Mediterranean regional strategy is required to implement urban mobility planning and actions. While the current Interreg MED programme (EU territorial cooperation programme limited to the European Mediterranean and Instrument for Pre-accession Assistance (IPA) countries[76]) includes a strategy on low-carbon mobility, this is not the case of the ENI CBC Med Programme (Cross-border cooperation in the Mediterranean Sea Basin). Sharing good practices, capitalizing on previous experiences and enhancing cooperation on sustainable urban mobility are necessary across the Mediterranean in order to bridge the gap.

After reviewing the state and impacts of population migration and their related socioeconomic disparities, the following sections give some solutions and how they could be implemented.

5.2.2 Networks of cities

This section examines formal and informal networking initiatives in the Mediterranean that promote cooperation among Mediterranean cities with a focus on sustainable urban development, effective delivery of urban services, and effective urban governance and management systems.

[75] Percentage of the population living in a household where the total cost of housing (net of housing benefits) is 40% or more of total household disposable income (net of housing benefits) and presented by degree of urbanization.

[76] The IPA beneficiary countries are divided into two categories:
- EU candidate countries (Turkey, Albania, Montenegro, Serbia and the Republic of North Macedonia) are eligible for all five components of IPA;
- Potential candidate countries in the Western Balkans (Bosnia and Herzegovina, Kosovo under UN Security Council Resolution 1244/99) are eligible only for the first two components.

BOX 57

From mobility to smart mobility in Koper (Slovenia): a user-oriented approach in a multi-operator context

With the support of the Interreg MED Programme, the Municipality of Koper implements a user-oriented approach to give citizens real-time information to optimize their travel.

The Municipality is upgrading the existing Transport Information Centre to better monitor and manage urban mobility, but also to provide useful information to citizens. Users can access this information via web and mobile applications but also on LED displays on bus stops, multimodal hubs and streets.

The Municipality of Koper is able to provide information for all transport modes (traffic congestion, urban & suburban Public Transport tracking, parking lot fill rate, etc.), via the installation of (i) bus trackers, (ii) sensors for counting traffic (vehicles, pedestrians and cyclists), (iii) parking lot occupancy counters, (iv) data centralization by the Transport Information Centre, and dissemination through an integrated application and information panels. With this new service, it is now easier to plan a trip using Public Transport or to find a free parking space. By reducing congestion and facilitating the use of public transport, the program is expected to have a positive environmental impact.

BOX 58

Sfax developed the first Sustainable Urban Mobility Plan (SUMP) of Tunisia: the Sfax Tramway, a sustainable large-scale project

Sfax could be considered as a southern city with considerable experience in Urban Mobility planning as it developed a local transport plan (PDU) in 2002 and updated it together with a Nationally Appropriate Mitigation Action (NAMA) in 2017. The actions' implementation rates are very low, but important large-scale projects are underway. The Sfax tramway network was defined by the preliminary study carried out in 2014, entitled "feasibility of an ecologically viable public transport system with bus lanes in the agglomeration of Sfax". The network selected for 2030 features 70 km of track organized into five lines: two 33.5 km tram lines with 20 trains and three 36.5 km Bus Rapid Transit (BRT) lines.

The Traveller Information System monitors waiting times in real time. It consolidates the information for tramway users and managers. Calculations for the multi-modal outlook for the study show that the multi-modal scenario should improve, increasing public transport use from 6% in 2018 to 25% in 2030

Such initiatives are crucial for building a culture of cooperation and strengthening cities' capacities to cope with similar problems, by exchanging, sharing and transferring technical know-how, expertise and experience. However, these kinds of networks face the challenge of discontinuity in their work due to their dependency on project funding.
Although no precise quantitative data exists regarding networking among Mediterranean cities, this section highlights relationships among coastal cities from all shores of the Mediterranean through their participation in networking initiatives. Their operating methods and organizational structure can be very different, which could have an impact on the continuity and stability of their work. This analysis includes different formats of networking initiatives, from formal well-run associations of cities, to informal networks of cities or networking platforms with ad hoc membership. It also includes networks with exclusive membership from Mediterranean cities, international networks with a regional Mediterranean focus, or international networks that include the participation of Mediterranean cities, although there is no concrete geographical focus on the Mediterranean region.

A review of the major active networks in the Mediterranean shows that they are relatively recent, some of them stemming from the Euro-Mediterranean Partnership or Barcelona process:

- **MedCities** is a Mediterranean network created in Barcelona in 1991 that promotes the creation of City Development Strategies and the implementation of urban projects. Currently it has 57 members from 17 countries.
- **Euromed** was created in 2000 to encourage local authorities to engage with the Euro-Mediterranean partnership. The Euromed Cities Network currently includes 150 cities across 27 countries, including 18 Mediterranean countries, with 46 Mediterranean cities participating in 2019.
- **Forum of Adriatic and Ionian Cities** was created in 1999 on the initiative of the Municipality of Ancona and ANCI (Italian National Association of Municipalities). It brings together around 60 cities from the 7 countries of the Adriatic-Ionian Basin.
- **Network of Associations of Local Authorities of South-East Europe (NALAS).** The Network was created in 2001 and brings together 14 Associations which represent roughly 9000 local authorities, directly elected by more than 80 million citizens.

Other international political networks with a concrete focus on the Euro-Med region include:

- **The Euro-Mediterranean Regional and Local Assembly (ARLEM)** is an assembly of local and regional representatives from the European Union and its Mediterranean partners, set up in 2010 by the European Committee of the Regions (CoR). It allows elected representatives from the three shores of the Mediterranean Sea to represent their local and regional authorities politically, including with the EU and the

Union for the Mediterranean (UfM), to maintain political dialogue and to promote interregional cooperation.
- **United Cities and Local Governments (UCLG)** is an international network of local governments with a decentralized structure. Until recently, UCLG had a specific Mediterranean branch, the loss of which has brought fragmentation with regards to Mediterranean policies between UCLG MEWA (Middle East-West Asia) and UCLGA (Africa).

Finally, initiatives to facilitate networking and bilateral cooperation with a geographical focus include **Programme CoMun, and CAT-MED.**

Besides networks focusing on the region, Mediterranean cities are active in some international and European networks, including those focused on environmental issues, like the **Covenant of Mayors and Mayors Adapt, C40 cities, 100 Resilient Cities, CIVITAS.**

The sustainability of such networks to guarantee the continuity of their actions is a big challenge. Independently of project funding, these networks should continue exchanging, sharing and transferring technical expertise and experience among stakeholders from all shores of the Mediterranean. An inspiring example for an integrated approach to urban development in the Mediterranean is URBACT (a European exchange and learning programme promoting sustainable urban development) supported by the European Regional Development Fund (ERDF). From 2000 to 2015, it enabled cities to work together and develop integrated solutions to common urban challenges.

5.2.3 Rehabilitating historic urban centres

In many cases, poorly planned and implemented urban growth has led to a deterioration of urban quality, and destruction of urban heritage, threatening the identity and local culture of communities and the sense of place in cities.

Urban heritage, including its tangible and intangible components, constitutes a key resource in enhancing the liveability of urban areas, and fosters economic development and social cohesion in a changing global environment. To achieve both the protection of world heritage within urban areas and sustainable development, UNESCO proposed an integrated approach to urban development, conceptualized in the *Recommendation on the Historic Urban Landscape* adopted in 2011 by its General Conference (UNESCO, 2011). This recommendation provides guidelines to integrate built environment conservation policies and practices into the wider goals of urban development that respects the inherited values and traditions of different cultural contexts. This approach is part of UNESCO's contribution to the implementation of the United Nations 2030 Agenda, which entered into force in January 2016, and particularly to SDG 11 on making cities and human settlements inclusive, safe, resilient and sustainable, and directly to SDG Target 11.4 to strengthen efforts to protect and preserve the world's cultural and natural heritage.

BOX 59

Revitalization of the Kasbah of Algiers

The Kasbah of Algiers is an outstanding example of a historic city having had extensive influence on town planning in the western part of the Mediterranean and in sub-Saharan Africa. In this living environment where nearly 50,000 people reside, traditional houses, palaces, hammams, mosques and various souks are still conserved, bearing witness to all the cultural influences that have spread throughout the country, including Punic, Numidian, Roman, Berber and Ottoman culture.

The conservation of this site, included on the World Heritage list in 1992, is impacted by challenging factors, such as densification and population changes, complex land tenure, lifestyle disruption, lack of housing maintenance leading to increased insalubrity, etc., resulting in serious deterioration of the urban fabric, of public space and infrastructure. In order to implement the UNESCO 2011 Recommendation on the Historic Urban Landscape and define an integrated and coordinated approach to the management and rehabilitation of the urban fabric, as well as the revitalization of its socioeconomic structures, an international meeting was organized by UNESCO's World Heritage Centre, in collaboration with the Algerian Ministry of Culture, in January 2018. The recommendations of the meeting stressed the need to coordinate the efforts of all stakeholders, including local populations, involved in the conservation of the site, and the importance of fostering and supporting the development of projects that galvanize economic and social development in order to create growing clusters that lead to mixed uses and social diversity, with an important component centred on training and job creation. This meeting launched a new dynamic in the conservation of the city supported by decision makers, and has been closely monitored by UNESCO. These approaches focus on building resilient communities in the city and support adaptation to climate related risks through the enhanced use of local resources and local knowledge particular to the place.

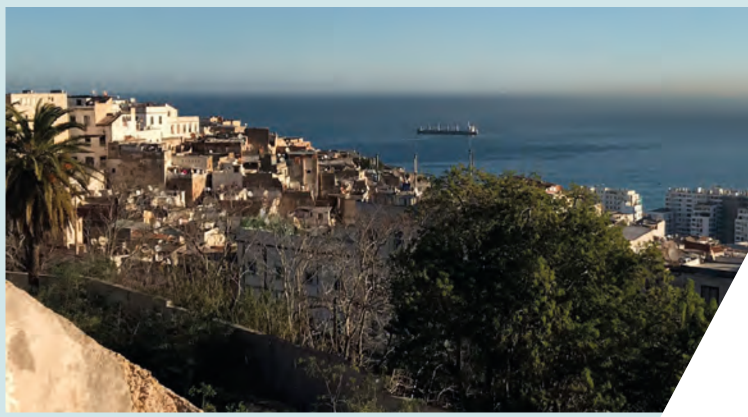


Figure 135 - Kasbah of Algiers
(© UNESCO / Youmna Tabet)

The starting point for the development of Sustainable Urban Development strategies is the conservation of cultural heritage. Without effective conservation action, the legacy of the past can rapidly be lost, as is happening in many urban contexts characterized by intensive and rapid development, with the loss of connection between communities and the built environment in which they live. Promoting the revitalization of downtowns and the conservation and adaptive reuse of their cultural heritage assets can improve the liveability and living conditions for poor communities. Culture-led redevelopment of urban areas and public spaces helps to preserve the social fabric, improve economic returns and increase competitiveness, giving impetus to a diversity of intangible cultural heritage practices, as well as other creative expressions, thereby creating sustainable urban spaces. In addition, a vibrant urban life can differentiate a city from competing locations, branding it nationally and internationally, thus helping it attract investments. Heritage-based urban revitalization and sustainable tourism are powerful economic sectors that can generate green employment, stimulate local development and foster creativity.

The urban morphology of medinas and their types of dwellings make social, generational, and functional diversity possible. As a dense and compact city, the medina is a low polluted pedestrian area and represents an urban ecosystem that could serve as an example for the future sustainability of cities. The urban heritage of medinas is a key element of urban citizenship in the Arab world, and can be a real strength that promotes social cohesion in times of economic, social and cultural restructuring. Pedestrian streets and public spaces are valuable as civic spaces for dialogue and social inclusion, helping to reduce violence and foster cohesion and promote a culture of peace. Finally, having a proper understanding of traditional building practices, materials, and technology can be a powerful tool to enhance the resilience of cities facing threats of disasters linked to climate change.

5.2.4 Planning alternatives to metropolization

The main urban areas benefit from most of the world's demographic and economic growth. In the Mediterranean, this is often the case for port cities. In recent decades, the city has grown and is organized on the larger territorial scale of the metropolis. Generally, the most noble and profitable segments of cities are spreading in the form of a coastal urban continuum, through a multitude of public and private initiatives. Others are relegated elsewhere, further inland and often landlocked. In this context, tourism promotion has a major effect by accelerating the urbanization of the coastline, with a seasonal effect that is difficult to manage in terms of urban metabolism. This structure therefore does not meet environmental requirements in the face of climate change, nor the needs of social coherence. An alternative to this model would be to organize metropolitan areas in an interconnection between the big city, intermediate cities, villages and the countryside according to economic and cultural complementarities and social solidarity. This spatial model of urban and economic archipelagos is designed as a set of links, roads, and interdependencies existing or to be created between dense urban areas, nodes, or intersections that structure the metropolitan whole and give it life and function. In this form of metropolization, nothing is empty. The countryside is not a void, it is the nourishing space of the metropolis and the mountain that formed an urban boundary can become a metropolitan park, or a biodiversity reserve.

Inventing these new metropolitan registers thus becomes a major challenge in the fight against intense coastal development, and requires tangible and intangible investments, as well as renewed territorial narratives.

5.2.5 Regional planning and territorial cohesion

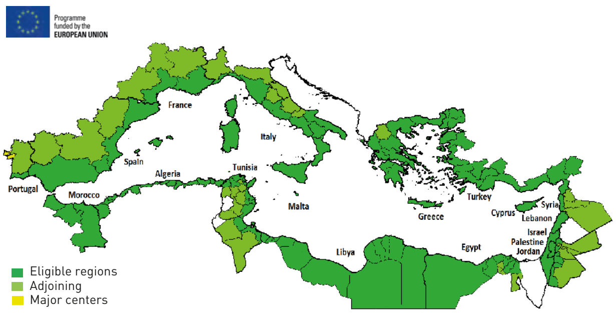
International discussion in recent years has highlighted the centrality of the territory in the sustainable development process (UN, 2015). At the European and national levels, territorial development policies are now considered essential to achieving smart, sustainable and inclusive growth (European Commission, 2010). This leads to a new dimension of cohesion, in which the EU's policy places strong emphasis on the current legislative framework: the territorial-cohesion dimension. The concept of territorial cohesion builds on the European Spatial Development Perspective (ESDP) and on the Guiding principles for sustainable spatial development of the European continent (Council of Europe, 2000). It adds to the concept of economic and social cohesion by adapting the fundamental EU goal of balanced and sustainable development into a territorial setting. The Lisbon Treaty (2007) identified territorial cohesion as an objective of the European Union, strengthening the role of regional and local actors in European territorial policy, and granting them the status of real partners (EU, 2007).

Immediately afterward, The Green Paper on Territorial Cohesion (CEC, 2008) placed the definition up for debate, underlining the importance of "putting sustainable development at the heart of policy design", overcoming differences in density, distance and division (CEC, 2008).

Despite the emphasis placed on regions[77] and cities as a new level of strategic planning, the debate on models and approaches to territorial cohesion and sustainable development over the last few decades has encountered considerable difficulties. While Mediterranean regions are usually regarded as "weak" and "peripheral"[78], there are basic difficulties in defining them only according to a spatial logic based on the twofold criteria of inclusion or exclusion. Clearly, some regions of the Mediterranean still face economic, social, and environmental problems due to a range of factors that can be sectoral, structural and transactional (IEMed, 2017). On the other hand, despite the importance of quantitative indicators, intangible, cultural and human values are needed to describe the complexity of Mediterranean territorial system, because data and statistics only partially explore the underlying sociocultural and political dynamics. For example, the centrality of the cultural landscape connotation created by the Mediterranean lifestyle, understood as an interaction between nature and humanity, is seen in the UNESCO

[77] In this paragraph the term "region" is used to designate sub-national rather than supranational geographic entities.

[78] *"The core/periphery division according to flows within the world-system can be defined in line with two basic assumptions: core areas are integrated while periphery mainly exchange with (specific) core countries; core areas control the capital and the technology"* (Grasland & Van Hamme, 2010).



ENICBCMED 2014-2020
COOPERATION AREA

Interreg MED 2014-2020
COOPERATION AREA

Figure 136 - Maps of the Cooperation Areas (EC, 2015). Left: eligible regions of the 14 countries participating in the ENI CBC Med 2014-2020 Programme. Right: 57 regions divided among 10 EU Member States and 3 countries from the Instrument for Pre-Accession Assistance (IPA) participating in MED Cooperation Programme 2014-2020

recognition of the Mediterranean Diet as an Intangible Cultural Heritage of Humanity[79]. In the last decade, cities in the Mediterranean region have partially regained their cultural role as a bridge between Europe, Africa and the Middle East. In addition, the Mediterranean's internationally recognized niche in tourism, culture and major events management consolidate the socioeconomic power of cities (IEMed, 2017). In this perspective of territorial cohesion, Euro-Mediterranean regions are strategically interested in promoting a change of paradigm in Europe, cooperating with the Mediterranean Partner Countries in order to stop being considered "external" to the EU and thereby reducing the gap between lagging regions through the achievement of a sustainable development. The promotion of a common territorial framework in the Mediterranean is needed to reconcile the different approaches between the two shores, with priority focused on strategic sectors, such as the enhancement of environmental and cultural heritage and tourism, energy efficiency, education, quality employment, mobility networks, research and innovation, and urban and rural sustainable development (EU, 2011).

Another concern about the "coastalization" of urban development should be the increasing number of deep-water ports. Port developments marked by the development of containerization and the race for mega-ships require the creation of new deep-water transhipment ports, which have numerous impacts on the quality of the coastline. For Mediterranean territories, capturing these flows of goods is becoming a major challenge that requires colossal investments. The efficiency of these new ports is dependent on their integration into a logistics and-industrial system, hence their development close to economic activity zones. Without a Mediterranean strategy, competition will intensify, and ecological considerations will again be difficult. Another approach could be based on alliances between national and international ports, in direct dialogue with private transporters. Should we consider, for each country, work worth several billion euros to open access to ships with a capacity of 18 to 20 thousand TEU and thousands of trucks, or substitute it for a strategy of specializations/complementarities between the various ports in the Mediterranean? The European notion of "motorways of the sea", i.e. a service from ports to ports, could be debated at the Mediterranean level, for example if Tunis and the Port of Genoa were to be connected.

5.2.6 Promoting traditional knowledge, skills and crafts

In the Mediterranean region, people have always had to face resource scarcity, environmental unpredictability and climate variability. These conditions have enabled appropriate knowledge to be acquired at the local level to deal with adversity, manage ecosystems, carry out technical, artistic architectural works, and create urban complexes universally recognized for their beauty and harmony. Traditional techniques, skills and know-how exist for water catchment and distribution, soil protection, recycling, optimal use of building materials and energy, etc. With emigration and the dramatic transfer from traditional habitats into new urban agglomerations, the rapid abandonment of the agricultural sector by large segments of the population and the superficial belief in the absolute superiority of modern technology, this knowledge is not preserved or passed on and needs to be re-discovered.

Traditional knowledge cannot be reduced to a list of mere isolated technical solutions capable of solving a specific problem. Using traditional knowledge today means reinterpreting the logic of tradition: the multi-functionality, the interpenetration of technical, ethical and aesthetic values, the use of resources in cycles, each activity building in another one without waste.

[79] In 2010, the Mediterranean Diet was included on the Representative List of Intangible Cultural Heritage of Humanity, involving Italy, Spain, Greece, Morocco, and from 2013, Cyprus, Croatia, Portugal.

Some traditional techniques are re-discovered, more particularly in sustainable agriculture, water and soil management. Traditional knowledge is also an important factor in coastal fisheries, with artisanal fisheries holding rich ecological knowledge about the marine ecosystems, and sustainable ways of exploiting them through traditional crafts and gears. Traditional techniques are often adapted to an economy efficient in resources. Others continue to persist. Local knowledge is an economic factor in different production sectors where it is transferred through generations. Situations where tradition persists, and its role in society and the economy is consolidated and stabilized, exist in the most technologically advanced countries and sectors. The values of tradition, manufacturing practices and craftsmen's skills are the basis on which the great added value of major economic production is founded for many modern countries *(Box 60)*.

5.3 Coastal urbanization and environmental changes

The Mediterranean is the most densely populated closed sea in the world. The total population of the Mediterranean countries grew from 276 million in 1970 (UNDESA, 2010) to 512 million in 2018 (UNDESA, 2019). It is predicted to grow by an additional 182 million inhabitants by 2050 (UNDESA, 2019). In 2019, the percentage of built-up areas has reached an astounding rate. The coastal strip is becoming increasingly populated and built up and concentrates most of the major cities, many transport routes (roads, ports, airports), as well as industrial and energy infrastructure. This concentration is intensifying year after year and generates more pollution and disturbance leading to environmental degradation and increased risks for coastal populations and infrastructure. Besides these pressures in

BOX 60

Re-discovering traditional knowledge to solve current issues: a few examples

AGRICULTURE

Prehistoric traditional techniques, used to build the Mediterranean agricultural landscape, are being revived in agriculture as best practices to replenish soils, save water and combat hydrogeological instability and desertification.

- Drainage ditches are a technique that spread across the Apulia district of Daunia 6,000 years ago, when Neolithic communities built more than 3,000 villages surrounded by trenches in the shape of a crescent. The ditches met environmental needs by draining water and drying some areas to be tilled during the wet season, and by working as drinking troughs for cattle, humus collection and water reserves during the dry season. After this practice has been replaced by mechanized agriculture, these Mediterranean coastal areas now suffer terrible flooding in winter and extreme drought in summer.
- In southern Italy, practices such as grassing and sowing on "hard soil" are being successfully experimented. The first consists in making the grass grow under orchards and in olive groves to form a protective cover and avoid ploughing, which causes erosion. The second consists in sowing wheat over unploughed soil. This technique protects soils and reduces costs. It is most advantageous during droughts as rowing ears of wheat remain shorter and need less water and chemical fertilizer.
- The practice of setting cisterns full of water or calcareous masses close to plants to provide irrigation is being revived. These innovative traditional techniques are used for reforestation, allowing each single shrub to be supplied with the quantity of water it needs for its initial growth.
- Drainage tunnels are underground tunnels that have spread across arid areas for 3,000 years to supply oases with water, and are still working today. They absorb the right quantity of water for the replenishment of the environment itself. This solution could be re-introduced into coastal areas as an alternative to the excavation of wells which lower the groundwater and deeply perforate the soil, thus causing pollution and soil salinization.

WATER COLLECTION

The atmospheric water condensed inside caves or mounds of stones and dry limestone walls were used by all ancient societies. Authentic aerial wells, atmospheric condensers producing water from vapour, are used in coastal areas to capture evaporation from the sea. Today water turbines are engineered. They produce water from atmospheric moisture using the principles of ancient techniques.

PRODUCTION AND LANDSCAPE

Typical food production such as oil, cheese and wine protect both the aesthetic and environmental quality of the landscape. The growing dissemination of organically controlled agricultural productions and meats shows increasing interest in traditional husbandry and breeding techniques.

URBAN SETTLEMENT

Several innovative traditional techniques can be used in cities to drastically reduce water and energy consumption. Roof-gardens are being reintroduced, covering the terraces of modern buildings and houses with plants. These gardens keep optimal climatic conditions inside the houses, harvest water and become an area for entertainment and relaxation. Micro-solutions for city neighbourhoods and houses represent a large innovative sector in waste recycling. Mini-composters to be placed inside the gardens or in common areas can absorb organic waste and supply gardens with humus. A water compost machine is a device set beneath the toilet bowl, which directly transforms waste into compost. Biomass mini-reactors transform waste into kitchen gases. Bigger plants for heating the whole house have been also developed.

ARCHITECTURE

In restoration and urban regeneration, traditional skills and crafts are essential for protecting the aesthetic and functional qualities of the architecture. A wide range of products, materials and know-how are necessary for heritage architecture. The aesthetic aspects that we appreciate in ancient towns, the beauty of the natural materials, the comfort of the buildings and spaces, and the organic relationship with the landscape are due to the intrinsic qualities of traditional techniques and the search for synergy and harmony ingrained in local practices. In this field, many businesses are now reintroducing market materials and processes derived from tradition, such as lime, natural clay and pozzolana, both for renovations and new constructions.

coastal areas, natural hazards such as storms and flooding add to the overall challenge. As their frequency, occurrence and intensity increase, they pose a real threat and weaken the resilience of ecosystems, human populations and coastal infrastructure. In this context of increasing environmental changes, including climate change threats, a strong landscape and ecosystem protection policies are needed.

5.3.1 Land use and artificialization

5.3.1.1 Landscape diversity

Landscapes are outcome of natural processes combined with human actions. The concept of landscape includes three dimensions: the physical space (or area), its management as a "territory", and finally its emotional and cultural aspects. Coastal areas are a dynamic and fundamental part of human activities, which have shaped rich and enormously varied landscapes over the centuries. Mediterranean coasts are also naturally varied and therefore create a fascinating and diverse combination of human and natural landscapes.

Human settlements have been influenced by Mediterranean natural characteristics for thousands of years. The frequent low energy conditions and long periods of calm weather (as well as predictable seasonal patterns) has favoured human settlement in and around the coast, taking advantage of sheltered marine environments even if natural ports were not immediately present. Frequently calm waters in closed bays or navigable estuaries facilitated the first settlers in basing cities in the Mediterranean. The major milestones of Mediterranean Ancient civilization, under the dominant role of sea trade and coastal activity, can be traced to many sites where conditions were favourable. The number of ancient cities that used the accessible Mediterranean Sea in locations that are not immediately suitable for port activities is overwhelming.

From a marine perspective, Mediterranean coastal landscapes are characterized by beaches, rocky shores and some organic coasts, all subject to relatively low energy regime from wave action, combined with a microtidal range that makes this sea behave as a large lake in some of its morphodynamics. Energy input is dominated by locally generated sea waves that are typically short-crested and steep with short periods. This promotes wave energy dissipation on narrow surf zones which, combined with an almost tideless sea level variation, represent a highly active longshore drift that moves considerable quantities of sediment around input points such as river mouths.

Terrigenous inputs of sediment are key to the existence of beaches and dune systems. The latitude along which the Mediterranean sits means that there is no evidence of glaciation during the last cold phases of our planet, and therefore the large deposits that ice caps and glaciers can generate when interglacial phases occur are not found in the Mediterranean. Mediterranean coasts are thus dependent on sediment from rivers and lack other sources of sediment dominant in higher and lower latitudes. The interaction between land and marine systems is thus very active, constant and fragile, as a lack of sediment input rapidly causes erosive trends. Large sedimentary deposits are not available on the (narrow and steep) continental shelf, nor in dune systems. This, combined with a generally steep shelf and hinterlands makes the coastal sedimentary system highly vulnerable to modifications both natural (i.e. high energy, low frequency events) and of human origin.

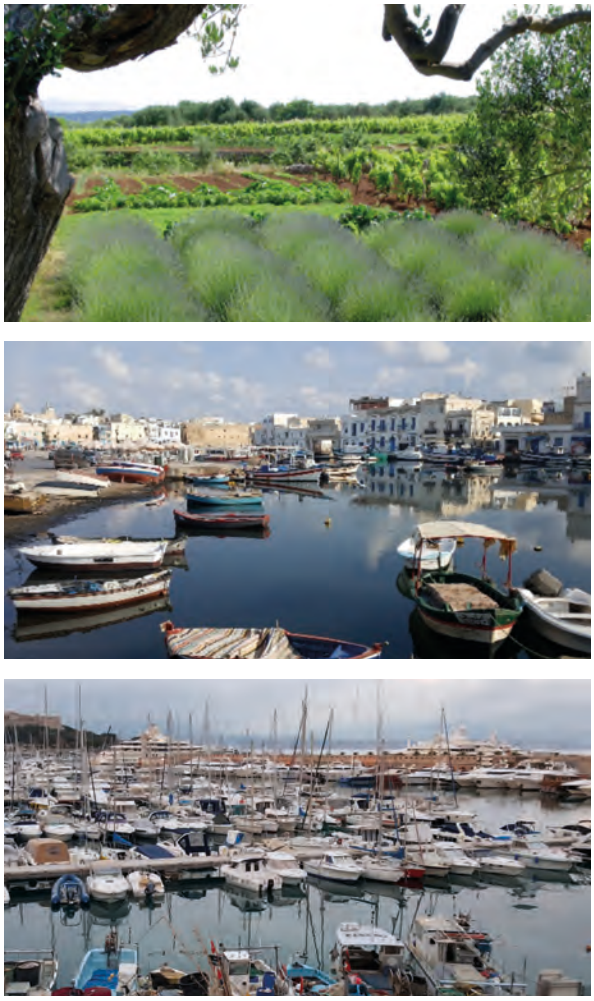


Figure 137 - Mediterranean agricultural landscape, traditional port in Tunisia and modern port in Antibes

5.3.1.2 Mediterranean island specificities

"The Mediterranean is (...) a very rich field of investigation for the study and the understanding of island facts, and a ground for specific actions for island protection and development strategies" (Brigand, 1991). In 2019, this observation, made in 1991, is still relevant, and particularly for small islands, on which many local, national and international actors are working to preserve, act and promote exceptional territories. Mediterranean islands are excellent experimental laboratories. Conservation operations tested on the islands can then be extended to all the shores of the Mediterranean.

The Mediterranean Sea has around 15,000 islets and islands, two of which are island states (Malta and Cyprus). Several "large" island entities (Balearic Islands, Sicily, and Sardinia) have autonomy status whilst Corsica has a special status distinct from other metropolitan territorial authorities in France. Finally, a large majority of small islands, whether inhabited or uninhabited, have varying administrative situations while remaining under the control of a continental authority.

In total, islands represent around 19,000 km of coastline, i.e. more than 41% of the Mediterranean coastline (Emmanouilidou, 2015). However, islands only represent 4% (in terms of land area) of the whole Mediterranean Sea basin (Kolodny & Edisud, 1974). In thirty years (1987-2018), the total permanent population of these islands increased by 1 million, from 10 million (of which three quarters live in the Western Mediterranean) to 11 million.

Representing more than 85% of the Mediterranean island territories, small islands with an area under 1,000 ha make up particular and remarkable entities of the Mediterranean heritage with diverse and multiple characteristics (geographical, ecological, socioeconomic, political, etc.). From an ecological standpoint, although small islands remain "poor" territories compared to the coastal fringe in terms of number of species or populations, they provide a refuge for flora and fauna often threatened on the continent, as for example with populations of seabirds which are now found almost exclusively on small islands. The isolation resulting from insularity has also led some species to evolve genetically, especially to adapt to island constraints, and is therefore at the origin of endemism. These small islands are thus considered as important and valuable assets in terms of biodiversity within the Mediterranean biodiversity hotspot.

In terms of human history, small islands have also played a key role in the evolution of human settlements across the Mediterranean since prehistoric times. They are places for surveillance or maritime navigation (e.g. lighthouses, semaphores), military territories (e.g. forts), places of trade and commerce, or areas of isolation (e.g. prisons, hospitals, religious communities, quarantine areas). Mobility has influenced the landscape and resource availability of small islands. Since the 1960s, most of the small Mediterranean islands have been witnessing a reversal of migration and mobility trends (Bernardi-Tahir, 2016), marked by the return of former island emigrants or the arrival of new immigrants. With residents looking for a better quality of life, small islands offer a strong economic interest, especially through the development of (eco)tourism activities. Islands also remain a source of opportunities in the fisheries and agriculture sectors (although the latter activity remains mostly on the decline).

Pressures on small islands are often directly or indirectly linked to human action: introduction of alien or invasive species, overexploitation of resources, pollution, fragmentation of habitats, climate change, etc. "The causes of the fragility of the environment in the islands are numerous and interdependent. To specific ecological characteristics, can be added: the small size of the space, the age and density of the human population, and the concentration of economic activities" (Brigand, 1991).

Given the attractiveness of these territories, it is essential for all public and private island stakeholders to be involved in the process of co-developing projects for sustainable territories. What is the best way to regulate the uses and limit the impacts of human activities? How should visitor flows be regulated and managed? What kind of energy should be chosen? How can water resources be better managed? How can waste be reduced and treated? Setting up multi-thematic local committees (island or archipelago) is a concrete way to study all the issues of a territory, to study the various possible solutions and to facilitate shared decision-making in order to work collectively towards proper conservation of the island environment and its natural balance.

Since the end of the 20th century, there has been a trend towards the designation of island or island protected areas on both shores of the Mediterranean, with varying protection statuses, such as the Habibas Islands Nature Reserve in Algeria or the Palm islands in Lebanon, Zembra-Zembretta National Park in Tunisia (also UNESCO's Man and the Biosphere Programme) or Port-Cros in France, and the Marine Protected Area of Tavolara in Sardinia. Excluding the Pelagos Sanctuary, almost half of the 35 Specially Protected Areas of Mediterranean Importance (SPAMI) include small islands.

Beyond actions at the local level, many international initiatives have focused on the need to conserve small islands. The Mediterranean Sustainable Small Islands Initiative (Initiative PIM: Petites Iles en Méditerranée, PIM) is part of an international cooperation process that provides institutional and technical assistance for the management of island sites of less than 1000 hectares. The MedIsWet project, which aims to implement Resolution XII.14 of the Ramsar Convention, works to strengthen the conservation of wetlands in Mediterranean islands by improving knowledge on these territories and setting up local advocacy at the international level. The SMILO (Small Islands Organisation) programme works with many Mediterranean islands to develop operational solutions to improve water, energy, waste, biodiversity and landscape management through pilot actions, and promote dialogue and the certification of best practices. Finally, Article 12 of the ICZM Mediterranean Protocol establishes an obligation for the Contracting Parties to provide "special protection to islands, including small islands". This article encourages "environmentally friendly activities...[and taking]... special measures to ensure the participation of inhabitants in the protection of coastal ecosystems based on their local customs and know-how" and asks the Contracting Parties to "take into account the specific characteristics of the island environment and the necessity to ensure interaction among islands in national coastal strategies, plans and

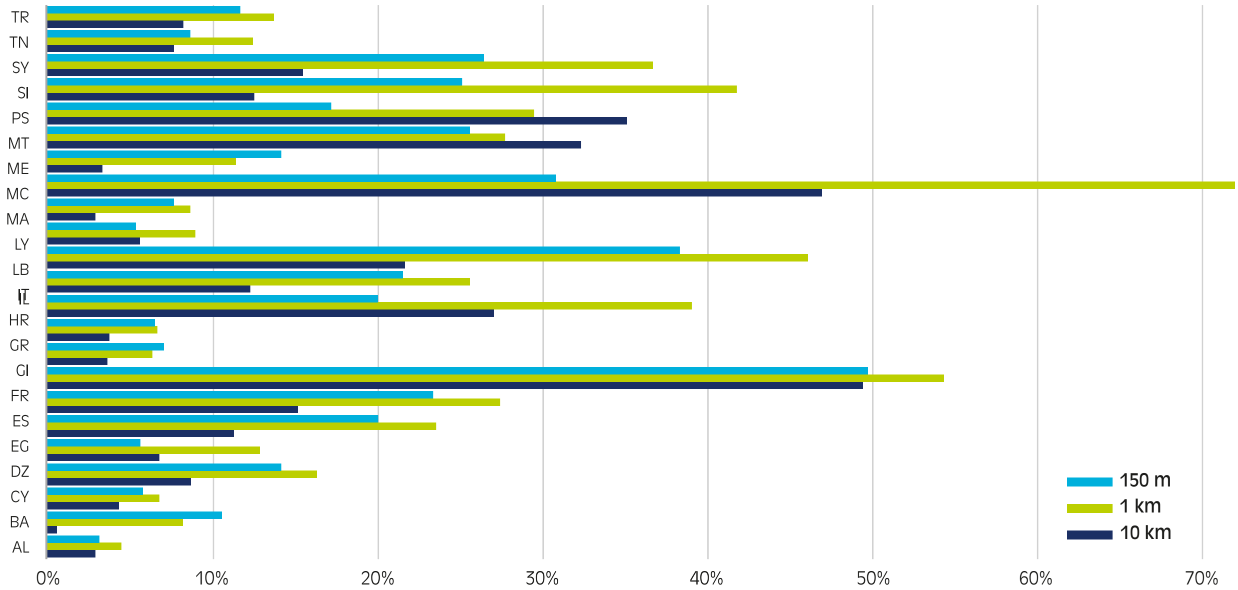


Figure 138 - Percent of built-up area per coastal belt as of 2015
(Source: UNEP-GRID, 2017)

programmes and management instruments, particularly in the fields of transport, tourism, fishing, waste and water" (ICZM Protocol, UNEP, 2008). It thus constitutes a pioneering tool in the reflection towards the emergence of a legal framework specific to the Mediterranean islands, which, in the long term, would reconcile human activities and environmental protection (see Section 5.4.5) on these exceptional micro-territories.

5.3.1.3 Coastal attractiveness and urban sprawl

One out of three Mediterranean inhabitants lives in a coastal area[81]. The coastal population share ranges from 5% in Slovenia to 100% in island countries (Cyprus, Malta) and Monaco. Coastal urbanization is also driven by tourism, with the Mediterranean region hosting more than 360 million international tourist arrivals (ITAs) per year, representing about 27% of world tourism in 2016 (UNWTO, 2019), largely concentrated in coastal zones and the summer months.

In 2017, the United Nations Environment Programme Global Resource Information Database (UNEP-GRID) prepared an analysis for PAP/RAC on the built-up area in coastal zones of Mediterranean countries between 1975 and 2015 (UNEP-GRID, 2017). For the first time, the coastal urbanization along northern and south-eastern shores of the Mediterranean was assessed using a single method. A set of data processed from the Landsat collection, more precisely the Global Human Settlement Layer (GHSL), was

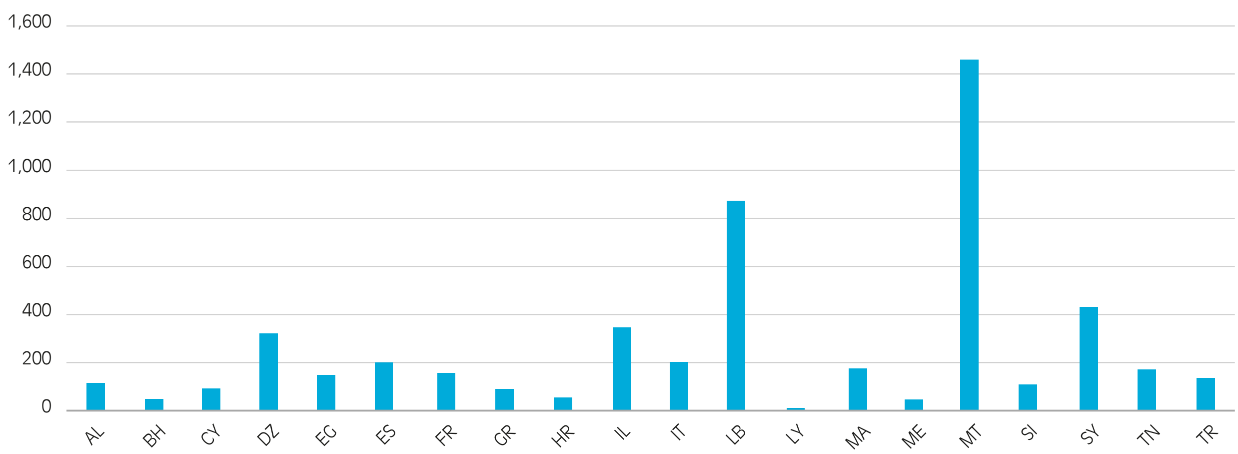


Figure 139 - Inhabitants per square kilometre in coastal regions, 2008-2017
(Source: UNEP-GRID, 2017)

[80] Plan Bleu computations, national sources (referring to NUTS 3 or equivalent).

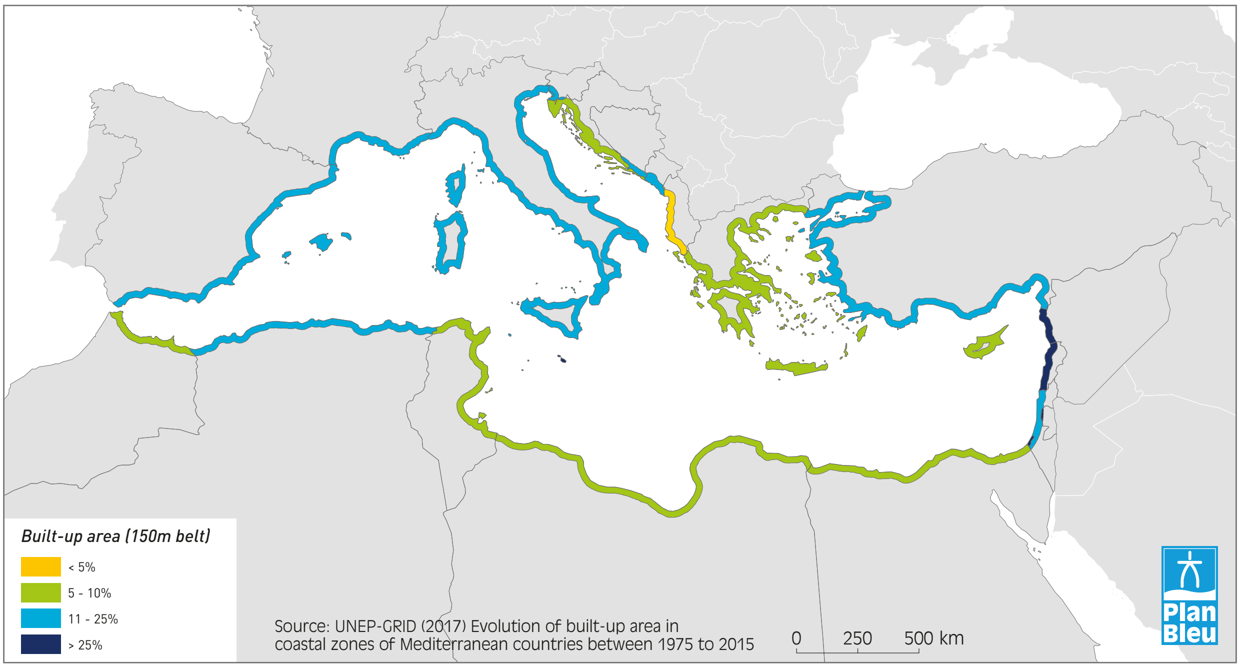


Figure 140 - Built-up area in the 150 m coastal belt in the Mediterranean, 2015
(Source: UNEP-GRID, 2017)

provided by the European Commission's Joint Research Centre (JRC). Data on built-up areas was calculated for three coastal belt widths of 150 m, 1 km and of 10 km. In addition to built-up areas, the report assessed the land take, i.e. urbanization on previously undeveloped land.

Values illustrating the situation today along the Mediterranean coasts are the percentage of the built-up area in coastal zone as of 2015, and the total land take, from 1975 to 2015, taking into account the value trends *(Figure 138)*. For all countries, the highest percentage of built-up area is within the first kilometre, except for the State of Palestine and Malta (both small in terms of area and population) where the highest percentage is within the 10-kilometre zone.

Population density varies considerably along the Mediterranean coasts. *Figure 139* presents the data collected by Plan Bleu for the period 2008-2017.[81] Besides Monaco and the State of Palestine, Malta, Lebanon, the Syrian Arab Republic, Israel, and Algeria have the highest density of inhabitants per km² in Mediterranean coastal regions.

Another factor to be considered when analysing coastal urbanization along the Mediterranean is the length of the coast of a particular country. The countries with the longest coasts are Greece, Italy and Croatia. Greece alone accounts for 33% of the Mediterranean coast, but half of its coast belongs to numerous islands and only a small part of these islands is inhabited. In addition, although it has rather low population density in the coastal zone, they still make up 85% of the total population. Croatia's coast accounts for 13% of the Mediterranean coastline, but around 70% of the entire Croatian coast belongs to numerous islands, with, again, a rather small share of inhabited islands. Italy also has a high share of island coastline, but most of it belongs to the two largest Mediterranean islands (Sardinia and Sicily), which are bigger than some Mediterranean states, such as Cyprus or Malta. Other countries with a significant share of the Mediterranean coastline are Turkey (11%), Spain (6%), Libya (4%), France (4%), Tunisia (3%), Algeria (3%) and Egypt (2%). Some of these countries also have a considerable share of island coastline, but mostly far less than Greece and Croatia.

With a visitor capacity of 14 million people on 4% of its territory, the metropolitan French coastline is subject to very strong demographic and tourist pressure, leading to very high levels of artificialization. The Mediterranean coast does not escape this observation. With 2.8 million residents in 2005, the Mediterranean façade is experiencing a certain saturation of its coastal zone. With 554 inhabitants/km², the density of coastal municipalities is five times higher than the national average (Ministère de la Transition Ecologique et Solidaire, France, 2019).

The lowest density of the coastal built-up area in 2015 was mostly found within the 10-kilometre coastal zone, in the following countries: Bosnia and Herzegovina (0.6%), Morocco (2.8%), Montenegro (3.3%), Greece (3.5%), Croatia (3.6%), Albania (3.7%) and Cyprus (4.2%). Most of these countries are also the countries with the biggest difference in the percentage of a built-up area within 10 km compared with the 150 m coastal belt. Bosnia and Herzegovina and

[81] Monaco and State of Palestine are excluded since their density is 15 and 5 times higher than Malta, disrupting the graph.

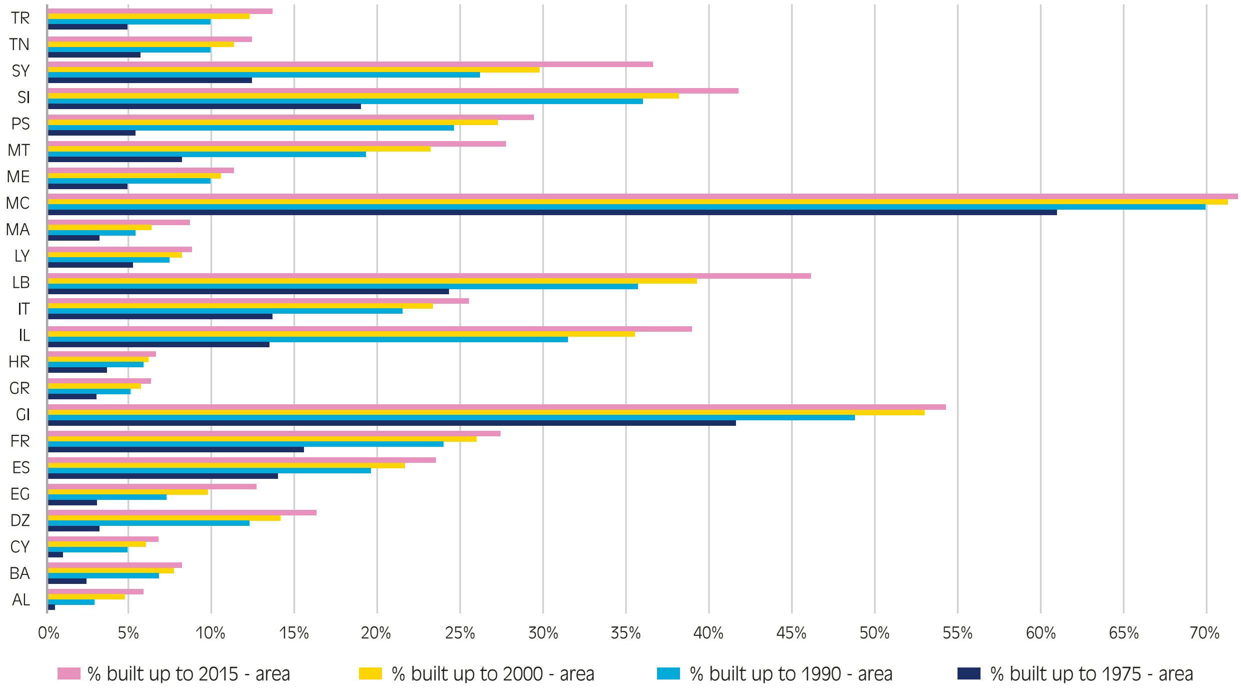


Figure 141 - Percentage of built-up areas per coastal belt 1 km from coastline
(Source: UNEP-GRID, 2017)

Greece are the only countries in the Mediterranean where the percentage of built-up area within the 150 m belt is higher than in the 1st kilometre. This is particularly significant for Greece, since it alone holds 33% of all Mediterranean coastline.

The historical trends of built-up areas within the first kilometre from the coastline is presented in *Figure 141*. Besides Monaco and Gibraltar, which are rather specific, countries with the highest percentage of built-up areas within the first kilometre from the coastline are Lebanon, Slovenia, Israel, the Syrian Arab Republic and Malta. It is interesting to note the differences between the population density in coastal regions and the percentages of the built-up areas.

On the coast, the "tourism/coastline" and "energy/hydrocarbons" nexus drive economic development. As an example, the growth of tourism, which is very often geared towards the development of seaside mass tourism, has generated many development plans and programmes which, combined with the development of transport infrastructure, have greatly contributed to coastal artificialization. For a long time, industrial investment (refining, petrochemicals, iron and steel industry, etc.) was considered a priority by public authorities, resulting in highly concentrated areas, often corresponding to extensive industrial/port areas on the North shore, but is also increasingly becoming the case on the southern shore of the Mediterranean.

5.3.2 Land-sea interactions

Land-sea interactions (LSIs) and related processes are a central issue of the United Nations Environment Programme/Mediterranean Action Plan (UNEP/MAP) 3rd Mid-Term Strategy 2016-2021, and correspond to the first objective of the Mediterranean sustainable development strategy (MSSD) and the Sustainable Development Goals 14 (Life below water) and 15 (Life on Land), strictly interconnected through LSIs.

Land-sea interactions were always the focus of ICZM (Ramieri et al. 2018). Its activities in the past were focused predominantly (although not exclusively) on the land part of the coastal system. By the adoption of the ICZM Protocol, inclusion of the territorial sea in ICZM has become compulsory. Marine Spatial Planning (MSP) on the other hand, does not extend its remit further inland than the high-water mark, although it has to take land-sea interactions into consideration as well. Both ICZM and MSP need a full range of processes and links among themselves to be effective. MSP faces more uncertainties, since we still know less about the sea than about the land where we live, and it is a more complex issue given that it has to take into account three levels/dimensions (surface, water column, and sea bed), the time factor being important for both ICZM and MSP.

5.3.2.1 Natural processes and human activities

The interactions between the terrestrial and marine areas of the coastal zone typically occur as the result of natural processes and the impacts of human activities. Natural processes are mainly related to the flow of water and movement of organisms between terrestrial, freshwater and marine ecosystems. These processes can occur in areas where two realms and their processes are intermixed or between two realms which are not adjacent. Intertidal zones or mangrove habitats are examples of interfaces

SEA-LAND INTERACTION

Economic activities / natural phenomena at "sea" interacting with "land"

SPECIFIC HUMAN ACTIVITIES

- Aquaculture in seawater
- Fishing
- Mining activities from seabed (including sand and marine aggregates mining)
- Industry (systems, including offshore desalination, CO_2 capture and storage)
- Energy industry (offshore /oil and gas energy, offshore renewable energy (wind, waves, surge))
- Infrastructure (ports, civil works of marine / coastal engineering /artificial reefs, breakwaters, etc./)
- Submarine cables and pipelines
- Maritime activities in general, including dredging and storage of materials
- Maritime transport (maritime traffic, commercial, including ferries)
- Tourism and cruise boats
- Recreation and sports
- Biotechnology
- Marine Protected Areas (MPA), Biological Protection Zones (BPZ) (and area-based management tools in general)
- Defence and security

GENERAL HUMAN ACTIVITIES

- Waste (marine litter)

NATURAL

- Extreme events (storms, heavy tides, tsunami)
- Sea level rise (global and local)
- Risks to coastal areas (coastal erosion, marine flooding and saline intrusion)
- Algae bloom
- Volcanic and tectonic activities

LAND-SEA INTERACTION

Economic activities / natural phenomena on "land" interacting with "the sea"

SPECIFIC HUMAN ACTIVITIES

- Coastal and lagoon aquaculture
- River and lagoon fishing
- Natural resource use (water abstraction, removal of aggregates /quarries)
- Farming and livestock farming
- Industry (food, manufacturing, on-shore plants, including desalination plants, CO_2 capture and storage)
- Energy industry (onshore energy -,oil and gas, onshore renewable energy - wind, sun, geothermal)
- Infrastructure (river ports, including dredging activities, engineering work, including dams, bridges, remediation activities, railways and roads). Port activity
- Transports (river transport, road and rail transport)
- Tourism, sports and recreation activities (i.e. bathing stations, tourism facilities)
- Biotechnology
- Natural Protected Areas (Nature reserves, National Parks, Regional Parks, etc., on-shore or with offshore boundaries)
- Defence and security

GENERAL HUMAN ACTIVITIES

- Urban plants (including pollution of water bodies that collect waste water)
- Waste
- Service networks (i.e. sewage systems)

NATURAL

- Soil erosion (leaching, wind action)
- Natural subsidence
- Hydrogeological instability (including landslides)
- Transport of river sediments
- Flooding
- Volcanic and tectonic activities

Figure 142 - Conceptualization of Land-Sea Interactions
(Source: CAMP Italy Project, 2017)

where a number of land-sea ecological processes are intermixed, such as energy and nutrient exchange or trapping of sediments and alike. Connections can be well-established paths (like river input) or can diffuse (movement of organisms between breeding and feeding areas). The direction of the ecological process can be seaward or landward, depending on specific natural processes and human activities *(Figure 142)*.

Similarly, human activities might have interactions across the coastal border that work in both directions, land toward sea and sea toward land. Most of the activities that take place in the marine environment also have a terrestrial component or connection, requiring ground support installations. At the same time, some land uses (for example, coastal tourism, water-front, port facilities), also extend their domain to the sea *(Box 61)*.

Coastal human activities furthermore generate waste and marine litter has become an issue of particular concern (refer to chapter 4, section 9 Marine Litter).

5.3.2.2 Booming maritime activities

In addition to the "coastalization" phenomena, the "maritimization" of human activities is now under fast development. This requires the extension of integrated coastal zone management towards offshore waters (Maritime Spatial planning or MSP), whilst the land-sea interface area remains essential for the development of maritime activities, especially ports and related infrastructure. The development of a blue economy has become possible with the availability of technological development at sea (beyond 3 and 12 nautical miles). At the same time, it is worth noting that this new economic "El Dorado" adds pressures to an already heavily impacted coastal zone and comes with conflicts between activities (Piante & Ody, 2015). It is therefore essential to connect the integrated management approaches for water resources, the coastal area, and the open sea.

In fact, significant increases in maritime activities have already caused relevant consequences on land and future trends of the sectors are expected to create additional impacts. For example, hydrocarbon exploration projects and associated drilling activities have become increasingly common in the Mediterranean in recent years, and several new gas pipelines, such as the Trans-Adriatic Pipeline or the projected pipeline between Cyprus and Greece, are planned to respond to the need for an increased gas supply to Europe. Also, shipping is expected to increase in the Mediterranean basin, both in the number of routes and traffic intensity, also linked to the doubling of the Suez Canal. Particularly, a significant increase in tanker traffic is expected in the Eastern Mediterranean Sea due to new export routes for crude oil from the Caspian region, the development of new pipelines bypassing the Bosphorus, and the expansion of current pipeline capacity. Oil transport is set to rise to 750 Mt by 2025, with 6,700 tankers/ year likely to navigate, unless the implementation of renewable energy policies succeeds in scaling down this scenario. Currently, marine renewable energy, including offshore wind, wave, tide-current and thermal gradient energies, is in the early stages of development in the Mediterranean Sea (Piante & Ody, 2015). More particularly, the offshore wind sector is expected to grow in the coming decades. This will be made possible by new developments in floating platform construction adapted to deep offshore sites which are particularly relevant to the deep waters of the Mediterranean Sea. Predicted production of electricity by

BOX 61

Trends of activities with a strong connection with coastal infrastructure

Maritime transport and ports: It is expected that shipping in the Mediterranean basin will increase in the coming years, both in number of routes and traffic intensity. This will intensify the activity and development of ports, the number of which currently stands at over 600 commercial ports and terminals, almost half of which are located in Greece and Italy. Development includes passenger transport that will continue to grow at an annual rate of 10%, driven by trends in tourism development, and particularly cruise tourism.

Tourism: international arrivals in the Mediterranean Sea region correspond to one third of the world's international tourism. Half of these arrivals are in coastal areas. Including the fast-growing cruise tourism sector, around 26 million passengers went through Mediterranean ports in 2017 (MedCruise Association, 2018). Coastal tourism is expected to maintain an upward trend over the next 15 years. International tourist arrivals in the Mediterranean are expected to significantly increase to reach 500 million arrivals in Mediterranean region.

Fisheries and aquaculture: In the Mediterranean and Black Seas, capture fisheries production declined from 1.4 million tonnes to about 1.2 million tonnes from 1993 to 2013 (FAO, 2015), as most fishing stocks are overexploited (Colloca et al. 2013) and declining (Vasilakopulos, Maravelias & Tserpes, 2014). About 78% of scientifically assessed stocks in the Mediterranean and Black Sea are overexploited (FAO, 2018). It should be noted that total recreational fishing catches in some coastal areas can represent between 10% and 50% of the total catches of small-scale fishing (excluding trawls and seines) and that the corresponding fishing effort is likely to increase in correlation with the expected coastal population increase and the development of the coastal tourism sector.

Aquaculture production in the region on the other hand increased from 0.9 million tons in 1993 to 2.3 million tonnes in 2013, an increase of over 160% and an average annual growth rate of 5%. Aquaculture production forecasts in the EU Mediterranean countries expect production to more than double between 2010 and 2030, from 280,000 tonnes to 600,000 tonnes (Piante & Ody, 2015).

offshore wind farms could reach 12 gigawatts (GW) in 2030 in the Mediterranean countries of the EU. Fast growth rates in cruise tourism have been observed in recent years and this sector is likely to continue to increase significantly in the future, driven by growing European market demand.

5.3.3 Increase in coastal risks

5.3.3.1 Natural and human-induced risks: climate change

The human-induced stresses on the communities, ecosystems, economic activities and infrastructure in the coastal zones of the Mediterranean are expected to be amplified under climate change. As detailed in Chapter 2, changes in the Mediterranean climate and their impacts are already being observed.

The main climate-related risk for Mediterranean coastal zones is sea level rise and associated hazards. Current estimates of future sea level rise show a relatively wide range from 0.43 m to 2.5 m by 2100, depending on scenarios and projection methodology (refer to chapter 2).

The region's coastal systems and low-lying areas (including beach tourism) are expected to be subject to submergence and erosion due to increased sea level rise and sea flood surges. Already overexploited coastal aquifers would become increasingly threatened by saline intrusion due to rising sea levels. Additional climate-related impacts include increased land degradation rates, and more frequent recurrence of droughts, floods and other extreme climate events. To face these risks, maintaining or restoring wetlands, dunes or salt marshes are efficient nature-based solutions.

The IPCC report "Global Warming of 1.5°C" report (IPCC, 2018) revealed huge risks for coastal zones, next to warm-water coral, and Arctic systems. 1.5°C is the most ambitious goal of the Paris agreement, originally included at the request of small island nations. Due to the high urbanization of Mediterranean coasts, it might be understood as a desirable, if not critical goal for the entire Mediterranean region, making coastal populations major advocates for mitigation and adaptation.

5.3.3.2 Coastal erosion

A significant portion of Mediterranean beaches experience severe erosion, threatening coastal settlement, communication lines, and cultural and natural sites. Beach erosion is the expression of a sediment deficit affecting the coast, and any action reducing sediment input or increasing output could induce beach erosion. Updated and reliable data on this phenomenon only cover a few areas, but this process needs to be better understood and monitored with shared methodologies to allow comparative studies among riparian countries. This will help to acquire high-level knowledge of the processes at play in this unique environment, where not all the theories, models and solutions valid elsewhere can be applied.

Most of the coasts accreted due to deforestation and pasture expansion after the sea level stabilized around 6000 BC. Ancient Greek and Roman authors portrayed the Mediterranean Basin as a barren area, where soil was washed away by run-off; valley siltation, coastal expansion, and harbour abandonment were also described (Hughes & Thirgood, 1982).

All phases of human development are accompanied by coastal degradation, always correlated with chronicles of intense deforestation, whereas demographic decline (fall of the Roman Empire, Black Death) triggered agriculture abandonment and beach erosion (Pranzini, 2018).

BOX 62

The future of the Mediterranean Sea ecosystem: putting changes into synergy

The Mediterranean Sea is considered as a mini-ocean that responds quickly to climate change, as a proxy to understand global phenomena. In the last decades, the Mediterranean Sea ecosystems have undergone a series of changes that altered their features in a dramatic way, although we do not fully understand their synergy effects. These observed modifications are as follows (Boero, 2015):

- Tropicalization: non-indigenous species with an affinity to warm water become increasingly established.
- Meridionalization: species that usually thrive in the southern part of the basin migrate northwards, adding to tropical species in changing northern biota.
- Impairment of cold-water dynamics: the Eastern Mediterranean Transient current showed that, in a period of global warming, natural mechanisms might fail to renew deep Mediterranean waters, with vast consequences on Mediterranean Sea ecosystems.
- Changes in the phenology of species: reproductive patterns are modified by different thermal conditions; warm-water species have greater opportunities to grow and thrive than cold-water species.
- Species extinction: cold-water species will be pushed into deeper waters. Their surface populations having already suffered severe mass mortalities. The risk of extinction cannot be ignored but species also might adapt to the new conditions.
- Less fish, more jellyfish and jellyfish eaters: the fish-jellyfish transition is observed in many seas of the world, as well as in the Mediterranean.
- Habitat destruction: the cumulative effects of direct (e.g. building maritime infrastructure) and indirect (e.g. pollution) impacts from human activities greatly contribute to habitat destruction.

BOX 63

DIVA method implementation and local coastal plan in Šibenik-Knin County (Croatia)

In 2015, a Dynamic Interactive Vulnerability Assessment (DIVA) of the costs of sea level rise was conducted for Croatia (UNEP/MAP/PAP, 2015). Usually this kind of assessment is based on population projections. In this case, the assessment also took into consideration census data on housing, as well as future construction as foreseen by spatial planning. Results showed significantly higher costs from those obtained when population projections alone were taken into account. Finally, a separate study was carried out for the coastal County of Šibenik-Knin (Dale & Markandya, 2015). The aim was to compare costs from the DIVA assessment with the expected impacts of climate change on the following sectors: tourism, agriculture, fisheries and aquaculture, water management, manufacturing, maritime transport, ports, energy, health, forest fires and cultural heritage. The assessment showed that the greatest potential impacts will be reflected in the damage to coastal assets. This means that primary residents, owners of secondary houses and tourism facilities located in the low-lying coastal zone will be particularly affected. Although economic indicators for the County of Šibenik-Knin are not very strong, these results represent an important finding. Both studies confirm the assumption that the Mediterranean's commitment to coastal tourism makes it additionally vulnerable.

Land use changes, including abandonment of traditional villages and activities on the slopes, followed by reforestation, combined with reducing soil erosion are the main driving factors triggering coastal erosion in the last century on the northern shore. In addition, infrastructure, in particular roads and highways, commonly built along the coastline often prevent sediment material from reaching the shores. Additional factors on the north and predominant on the south are dam construction, river bed quarrying and land reclamation.

Interruption of longshore transport by commercial and recreational harbours disturbs the balance of the coastal sediment budget, making for massive accretions in updrift sectors, but inducing extended downdrift erosion. Mega-ships require deeper water ports, with structures extending far offshore and impacting a longer coastal sector. Pleasure crafts follow a similar trend and marinas conform to meet this profitable market demand. Also, traditional shore protection structures, when effective, cause uneven sediment distribution and often favour offshore dispersion. Absolute sea level rise has been a minor factor in beach erosion during the last century along the Mediterranean coast, but the acceleration of this process will gradually make it become the main contributor to coastal reshaping. When erosion started to hit Mediterranean beaches, much of the coast was uninhabited, both for sanitary and military reasons, and many of the few settlements were on rocky coasts. Further coastal colonization (urban, industrial, tourism) reduced coastal resilience. In addition, shore protection structures were implemented, making the system even less able to naturally adapt to the changing forcing factors.

Coastal erosion is mostly addressed via hard shore protection structures. Although these structures are quite recent elements of the Mediterranean coastal landscape, in some areas of the northern side, they are now an almost dominant feature. Seawalls, revetments, or refilling are used to stabilize the shoreline with poor results in maintaining beaches. Series of groynes and detached breakwaters are present along the coast of many countries facing the Mediterranean Sea, ranging from some 15 km in Egypt and in Lebanon, up to over 200 elements for several tens of kilometres in European countries. Both cause rip currents to form with strong risks for bathers. Casualties are more frequent in these cases than on unprotected beaches.

Soil erosion on the southern Mediterranean shore will probably increase in the form of desertification induced by climate change, but many dams for water and energy production prevent sediment supply to the coast. In addition, commercial harbours and marinas, the latter resulting from recent tourism development, interact with sediment longshore transport, triggering erosion even in coastal cells where the overall sediment budget is positive. To reduce the impact of groynes and detached breakwater on landscapes, facilitate water circulation, along several Mediterranean coasts, these elements are lowered below the sea level, and new ones constructed as submerged structures. Artificial reefs have been proposed to protect the coast and increase biodiversity, but their effectiveness and stability have not been fully demonstrated. The same applies for beach dewatering, which uses devices to drain the swash zone and facilitate run-up water infiltration, thus reducing backwash energy which moves sediment to the nearshore.

To address the beach sediment deficit, artificial nourishments have been implemented since the 1950s, firstly with quarried materials (in river-beds, alluvial plains and crushed rock), and later with continental shelf sediment. This activity increased in the 1990s and was accompanied by an increase in vessel capacity and deep dredging possibilities, down to 130 m. This is very cost-effective for large projects, but mobilization and demobilization costs are extremely high for small nourishment. Sediment bypassing to reduce harbour impact on longshore transport is a type of land-to-land nourishment now possible with high performance systems and is therefore the most promising option for the future.

Many beaches, and their related economies, have been saved through beach nourishment with large-scale (e.g. Spain) and small-scale (e.g. Malta) projects, and this approach has become synonymous with soft shore protection, although its environmental impact is still under discussion, both in the source areas and on the fill beach. More generally speaking, the presence of extended beds of

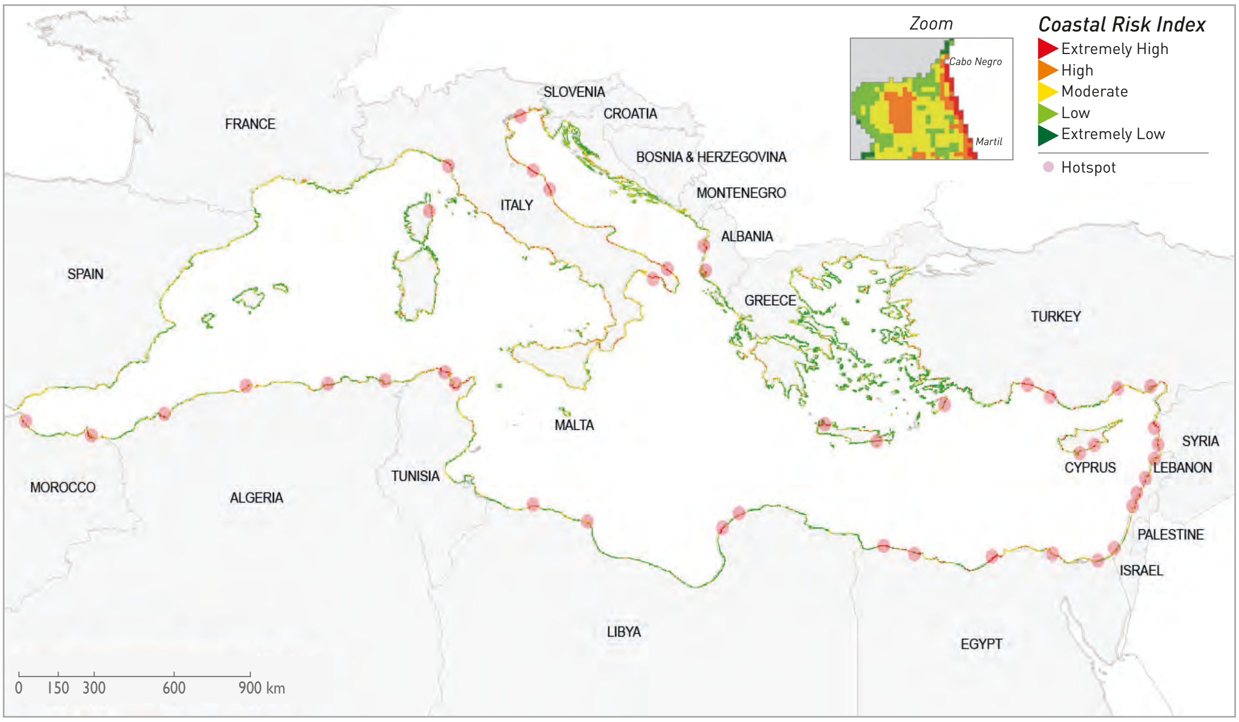


Figure 143 - Regional risk assessment map for the Mediterranean based on the CRI-Med method

Posidonia oceanica and the many protected areas require very careful use of this method.

Following the above assessment of continued extension of built-up areas and subsequent degradation of natural and cultural capital at the land-sea interface, including associated risks in a context of climate change, some priorities for action are proposed in the following section as a response to these ever-increasing pressures.

5.3.4 Land-use regulations and planning

5.3.4.1 Setback zoning and "spatial recomposition"

Risks related to climate change impacts are among the current most important coastal. *Figure 143* shows a regional risk assessment map for the Mediterranean developed using the Coastal Risk Index (CRI)-Med method. This integrated method was developed in 2015 and implemented to assess risk and vulnerability to the physical and socioeconomic impacts of climate variability and change in the Mediterranean with the aim of identifying coastal hot-spots (Satta et al. 2015). *Figure 143* shows the Mediterranean coastal hotspots based on the aggregation of 19 variables (representing climatic and non-climatic forcing) and 3 sub-indices (hazard, vulnerability and risk). A coastal hazard zone is first defined according to the Article 8 of the ICZM protocol, then the 19 variables are calculated and weighted.

Actions have to be taken to protect people and infrastructure. This can be done through coastal planning and land-use regulations, including coastal setbacks, central to any ICZM policy. In this respect, Article 8-2 of the ICZM Protocol lays down the establishment of a 100-metre zone from the highest winter waterline where construction is not allowed in Mediterranean coastal areas *(Box 64)*. Coastal setbacks are a prescribed distance to a coastal feature, such as a line of permanent vegetation, within which all or certain types of development are prohibited (Cambers, 1998). A setback area should be a minimum distance from the shoreline for new buildings or infrastructure facilities, or may be determined from a minimum elevation above sea level. Setback areas are proving to be a tool that meets many different policy objectives, such as biodiversity protection, maintaining ecosystem services, preserving cultural and natural assets and traditional landscapes and climate change adaptation (Rochette et al. 2010). These buffer zones provide a disaster risk reduction tool, and are a low-cost alternative and effective method for minimizing property damage due to coastal flooding and erosion. They are also a proactive adaptation option to sea level rise in undeveloped areas or areas proposed for future development. Coastal setbacks are commonly used in many countries around the Mediterranean, as part of their coastal regulations. To be more effective, this planning tool should be "tailored" to the local context through an inclusive process that matches the anthropogenic and climate change issues with the technical capabilities and capacity of the coastal community. Even in countries where these areas exist, the regulation is only rarely respected.

Preserving natural coastal areas through land interventions is an effective and inexpensive way to mitigate and adapt to the effects of climate change. "Spatial recomposition" is both an opportunity and a challenge for coastal municipalities and inter-municipalities. This concept is part of a long-term risk management approach and

BOX 64 Coastal setback provision according to the ICZM Protocol (Article 8-2)

Under the ICZM Protocol the Parties:

(a) Shall establish in coastal zones, as from the highest winter waterline, a zone where construction is not allowed. Taking into account, inter alia, the areas directly and negatively affected by climate change and natural risks, this zone may not be less than 100 metres in width, subject to the provisions of subparagraph (b) below. Stricter national measures determining this width shall continue to apply.
(b) May adapt, in a manner consistent with the objectives and principles of this Protocol, the provisions mentioned above:
  1) for projects of public interest;
  2) in areas having particular geographical or other local constraints, especially related to population density or social needs, where individual housing, urbanization or development are provided for by national legal instruments;
(c) Shall notify to the Organization their national legal instruments providing for the above adaptations.

opens up opportunities to preserve natural areas made up of land including previously built grounds which could in the future be "deconstructed". To do this, natural space management stakeholders can participate in relocation operations by becoming direct owners of certain threatened natural complexes with built elements. Ownership may be transferred to the State if submerged land is incorporated into the public maritime domain. Amicable acquisition and expropriation mechanisms also allow this type of action to be taken as a preventive measure.

A new land acquisition mechanism has recently been proposed in France (Lambert, 2013). The MAReL method *(Méthode d'Anticipation du Recul sur les Littoraux)* spreads buildings abandonment measures over time and creates a new legal concept: the coastal public domain, which would be added to the existing maritime public domain. This method "is based on anticipating tomorrow's shoreline, through the delimitation of submerged areas by 2100, which are not yet part of the maritime public domain at present.
The zones thereby identified would constitute a 'coastal public domain' (DPL) or 'coastal common heritage' (PCL) on which new rules of law could be envisaged" (Doze, 2016). The gradual loss of ownership would make it possible to deconstruct the properties in danger and to provide the necessary space for the natural movements of the coastline.

BOX 65 Strategic retreat before disaster, example of a protection and adaptation strategy for marine and coastal ecosystems in a context of climate change (*"Lido du grand et petit Travers"* on the Languedoc coast, France)

The Languedoc coastline, formed of low and sandy areas, is very sensitive to erosion, a phenomenon that is aggravated by the effects of climate change. An experiment to replenish the beach and reduce erosion, by adding sand extracted offshore, was carried out in 2005 and temporarily increased the width of the beach and created a sub-marine dune to break the swell. A more ambitious project meeting more environmentally friendly expectations was implemented in 2015, combining adaptation to climate change, renaturing an ecologically rich site and maintaining beach visitor numbers.

The site in question is the *"Lido du grand et petit Travers"*. It is a site of great environmental value, owned by the Conservatoire du littoral (except for the beach), with strong landscape interest (70% of community habitats), and part of the area is under protection measures (northern part included in the classified Natura 2000 Étang de l'Or site and special protection area (Birds Directive)). This site is very busy throughout the year and faces difficulties accommodating people (parking, intense traffic in the summer and trampled dunes).

After ten years of studies (2002-2015) and consultations, a charter and a compromise document (not consensus document) were issued in 2006 and 2010 respectively, and served as a basis for the development programme. These documents were produced through:
- the creation of a steering committee in 2003, bringing together the local authorities of the Hérault department, the municipalities of Maugio-Carnon and La Grande Motte, as well as the Conservatoire du Littoral and the State;
- and a project group from 2008 to 2011 involving all stakeholders, including associations, business owners, users, etc.

The total cost of this development amounts to €5 M, supported mainly by the State, the Region, and the ERDF (63%), as well as the Hérault Department (17%), the Conservatoire du littoral (10%), the Pays de l'Or Agglomeration and the municipalities of Maugio-Carnon and La Grande Motte (5%).
22 major actions were implemented, for example, the reinforced protection of the coastline, better hydraulic management of the site, the restoration of natural continuity with the Étang de l'Or, the removal of the RD59 departmental road (a first in France!), the creation of large car parks behind the dune and access to the beach via boardwalks, as well as the creation of a bike path and interpretive trails.

The success of this project, which could be replicated in the Mediterranean, was made possible by:
- the availability of scientific studies over time;
- convictions shared at all levels, the establishment of an extensive consultation process and a "project" team;
- the alliance between a co-developed adaptation strategy, clearly identified societal challenges, as well as financial and political support;
- continuous technical follow-up of the actions carried out under the initiative.

This method therefore appears as an opportunity for ICZM. To date, the theory has been taken up within the framework of Camadapt, an adaptation project in French Camargue (Allouche & Nicolas, 2014). This new public domain could then benefit from differentiated management depending on the zone: Natura 2000, coastal green and blue corridor, coastal management agency (e.g. Conservatoire du Littoral in France), integral reserves or reversible agricultural activities. However, unavoidable legal principles can be put forward to challenge the applicability of this method: the principle of equality and retroactivity of the law. To circumvent the obstacle of retroactivity, this method could apply mainly to the most recent acquisitions.

5.3.4.2 Nature-based Solutions and green infrastructure

The concept of Nature-based Solutions (NbS) was recommended by practitioners (in particular the International Union for Conservation of Nature, IUCN) and quickly thereafter by the European Commission (Eggermont et al. 2015). IUCN defines NbS as "Actions to protect, sustainably manage and restore natural or modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits". For example, building oyster reefs in coastal areas can provide a nature-based solution to coastal erosion and storm surges, while also filtering contaminated seawater, fostering biodiversity, and supporting local fisheries.

Nature-based Solutions can be implemented alone or in an integrated manner with other solutions to societal challenges (e.g. technological and engineering solutions like green infrastructure). Science and practice are clear that protection or restoration of natural habitats can be a cost-effective approach that can be combined with infrastructure approaches for protecting communities and infrastructure from coastal hazards. However, the disconnection between the state of science and practice has left a gap in guidance for implementing habitat-based solutions for coastal protection (Moser, Williams & Boesch, 2012).

In a first analysis undertaken by IUCN-Med, consulting several databases such as Naturvation, OPPLA, EKLIPSE, ICLEI,[82] which provides examples of the multiple benefits delivered by Nature-based Solutions in cities, compiled 77 case studies from 15 Mediterranean countries, covering societal challenges such as climate change, water management, coastal resilience, green space management, air quality, urban regeneration, etc. These include the Trees Master Plan in Barcelona, the Grow green initiative in Valencia, urban agriculture in the Greater Cairo region, green roofs in Athens, VISA VERT in Marseille, the BIO.FOR. POLIS[83] project to increase biodiversity and the ecosystem and social services of forests in the Naples-Caserta metro-

BOX 66

Green roofs in Athens, Greece

"Constitution Square (Syntagma Square), considered the most important square of modern Athens from both a historical and social point of view, is located at the epicentre of commercial activity and Greek politics and is situated opposite the Greek Parliament. The Greek Ministry of Finance installed this green roof on the Treasury in Constitution Square in Athens. The so-called *"oikostegi"* (Greek *oiko*, pronounced eeko, meaning ecological building, and *stegi*, pronounced staygee, meaning roof/abode/shelter) was inaugurated in September, 2008. The main motivation for this installation was to provide a research roof to study the thermodynamic impact of a green roof in hot Athens.

Studies on the thermodynamics of the roof in September 2008 concluded that the thermal performance of the building was significantly affected by the installation. In further studies, in August 2009, energy savings of 50% were observed for air conditioning in the floor directly below the installation. The ten-floor building has a total floor space of 1.4 hectares. The *oikostegi* covers 650 m^2, equalling 52% of the roof space and 8% of the total floor space. Despite this, energy savings totalling 5,630 Euros per annum were recorded, which translates to a 9% saving in air conditioning and a 4% saving in heating bills for the whole building. An additional observation and conclusion of the study was that the thermodynamic performance of the *oikostegi* had improved as biomass was added over the 12 months between the first and second study. This suggests that further improvements will be observed as the biomass increases further. The study also stated that while measurements were taken by thermal cameras, a plethora of birds and beneficial insects were observed on the roof, ranging from robin redbreasts, yellow hammers, coal tits, and sparrows to kestrels hovering high above eyeing up the smaller birds. Many species of pollinators have been seen, such as honey bees, swallowtail and monarch butterflies, also dragonflies and ladybirds. Obviously, this was not the case before installation. Finally, the study suggested that both the micro-climate and biodiversity of Constitution Square, in Athens, Greece had been improved by the *oikostegi*.

Athens, and Greece as a whole, is a seismic hot spot, so one of the main limitations of this installation was the acceptable load. The wet weight of the build-up is under 50 kg/m^2. The light weight was achieved by incorporating a number of strategies, including shallow substrate depth (less than 10 cm) and lightweight substrates. While high water storage capacity would be a benefit for roofs in dry Athens, weight considerations prevented this from being viable.

In addition, summer irrigation was considered to be undesirable so the plant palette was also limited. Mainly local species were selected so that they could survive the harsh conditions of this particular roof." (Greenroofs website[84])

[82] NATURVATION website, 2020, consulted at https://naturvation.eu/; OPPLA website, 2020, consulted at https://oppla.eu/; EKLIPSE website, 2020, consulted at http://www.eklipse-mechanism.eu/nbs_report; ICLEI website, 2020, consulted at https://resilientcities2018.iclei.org/

[83] Barcelona Trees Master Plan website, 2020, consulted at https://ajuntament.barcelona.cat/ecologiaurbana/en/what-we-do-and-why/urban-greenery-and-biodiversity/tree-master-plan; Grow Green Initiative website, 2020, consulted at http://growgreenproject.eu/city-actions/; urban agriculture in Greater Cairo website, 2020, consulted at https://www.weadapt.org/placemarks/maps/view/31826?utm_content=buffere4d44&utm_medium=social&utm_source=twitter.com&utm_campaign=buffer; Greenroofs website, 2019, The Hellenic Treasury – Constitution Square, consulted at https://www.greenroofs.com/projects/the-hellenic-treasury-constitution-square/; Visa Vert website, 2020, Consulted at https://www.marseille.fr/environnement/nature-en-ville/vegetalisation-des-rues; Bio.For.Polis website, 2020, consulted at https://www.esperienzeconilsud.it/bioforpolis/

[84] Greenroofs website, 2019, The Hellenic Treasury – Constitution Square, consulted at https://www.greenroofs.com/projects/the-hellenic-treasury-constitution-square/

politan area, and a project funded by Project Identification Phase of the Urban Projects Finance Initiative (UPFI) on sustainable urban development in Sfax Taparura (Tunisia)[85]. In most cases of this preliminary study, NbS act as open innovation drivers for cities, engaging multiple stakeholders and generating benefits that bridge social and economic interests in the relevant cities.
Green infrastructure is also inspired by nature-based solutions. Green infrastructure, as opposed to grey infrastructure, is the living infrastructure in cities used for "ecology-based management of water, food, air and energy in towns and cities. One of the best examples is the development of green roofs.

5.3.5 Coastal land-use and environmental taxes

Land policy is one of the tools for implementing land-based territorial planning. It plays a key role in land-use planning policies by determining the current and future uses and ownership of land. It defines the principles and rules of property rights on the land and its natural resources, as well as the legal frameworks for access and use, the validation, and transfer of these rights. It is also a relevant tool to limit environmental degradation associated with urbanization and the use of coastal areas for the development of human activities. Finally, it allows for the creation of spaces supporting Nature-based Solutions.
Beyond natural areas of high environmental quality, which are subject to regulatory preservation measures, land policy makes it possible to intervene in territories that are less rich in biodiversity but useful in the context of networks (green and blue infrastructure) or within the framework of risk prevention measures (flood expansion zones, submersion zones, etc.) and can also adapt to the acquisition of ordinary unbuilt properties (e.g. agricultural zone, wasteland, ordinary nature, etc.) that are useful for achieving these objectives.

In order to implement management policies for the coastal area through land protection, there are various instruments, measures and legal tools, the most specific of which are detailed below. The various land policy tools described below must be applied in coordination with land-use planning.
In addition, some instruments have a purely financial purpose. They are set up to generate financial resources for public budgets, where the aim is for all or part of the funds raised to be redistributed to finance the preservation of coastal zones in the framework of affected areas. Other tax measures have a more strategic objective related to practices. They are put in place to influence the behaviour of people and economic players by introducing incentive or dissuasive instruments. "Deterrent taxes" aim to greatly reduce the pressure related to an activity, without prohibiting the activity. Conversely, "incentive taxes" aim to support stakeholders in a process to change practices that would be more favourable for the sustainable management of coastal areas.

Land acquisition	Within the framework of the protocol relating to the integrated management of Mediterranean coastal zones, it is important to facilitate amicable acquisition procedures, by pre-emption, by donation of land, and by expropriation if necessary, in favour of public or private bodies responsible for the sustainable conservation of the coastal area. If the coastal area is already public property, it remains important to give a status to the sensitive coastal areas, by allocation of land to organizations dedicated to conservation or by documents on land-use management.
Land concession	This allows an owner to grant the management of a site to a beneficiary so that he / she can carry out the management measures himself for a fee. It also allows a State or the municipalities to provisionally authorize private occupation on their public property. It is considered a concession when it comes to fulfilling a public service mission. This practice also makes it possible to raise funds via the royalty, which can be reinvested in the preservation of the coastal zones, and also makes it possible to envisage non-permanent occupation on spaces potentially subject to risks of submersion or erosion in the perspective of their non-sustainable tourism or economic valuation.
Dismemberment of ownership right	When bare ownership (right to own the property, to transform it or destroy it) and usufruct (right to use the property or to collect the income) are exercised by different people, it is referred to as the dismemberment of the right of ownership. The goal is to get an owner to abandon the construction or destruction of certain landscape elements in exchange for compensation (financial or otherwise). There are several types of dismemberment practices, including easement, which is an obligation imposed on the land owner for the benefit of the owner of another land. There are environmental easements whose objective is the legal defence of a space, considered landscape or natural habitat, to prevent its artificialization or construction.
Land Stewardship	This tool is halfway between land concession and dismemberment. It is a strategy that, with the help of civil society, associates landowners and users with the conservation of nature and landscapes. It helps to preserve, manage and even restore the environment through voluntary agreements between landowners / users and management bodies. In the Mediterranean, this tool is used in Catalonia where there is a network for the stewardship of the territory[86]. There are three levels of the stewardship agreement: Management Support, Management Transfer, and Transfer of Ownership.

Table 23 - Legal tools for the protection of coastal areas

[85] Sfax Taparura website, 2020, consulted at http://upfi-med.eib.org/en/projects/project-for-the-development-of-the-taparura-seafront-in-sfax/
[86] Xarxa de Custodià del Territori (XCT).

Mediterranean examples of redistribution practices that finance ICZM actions include:

- The implementation of a tax on building construction works, which is then redistributed to local public institutions to implement land policies to preserve the coastline[87].
- The allocation of fees on sea fishing licenses or the tourist tax for stays in tourism accommodation establishments to the local government budget[88].

BOX 67

Integrated Coastal Zone Management (ICZM)

ICZM is defined as a *"dynamic process for the sustainable management and use of coastal zones, taking into account at the same time the fragility of coastal ecosystems and landscapes, the diversity of activities and uses, their interactions, the maritime orientation of certain activities and uses and their impact on both the marine and land parts"* (ICZM Protocol, Art 2, Lett. f).

5.4 Enhancing the coherent implementation of policy and management frameworks

Noting the difficulties in several riparian countries to implement a national coastal policy, the entry into force of the Protocol on Integrated Coastal Zone Management (24th March 2011) is a major step forward, with particular emphasis on: (1) the need to strengthen the legal and operational aspects, (2) the creation of coastal laws and agencies, (3) the mobilization of civil society and, (4) the implementation of regional planning and development policies.

Maritime Spatial Planning (MSP) and the ongoing implementation of the Ecosystem Approach (EcAp) have consolidated and extended the ICZM approach to the open sea, thereby ensuring the land-coastal zone-sea continuum. To strengthen the coherence of the various approaches and methods in line with the ICZM Protocol, a Common Regional Framework for ICZM has been developed and adopted at COP21 in 2019. At the heart of this integrated approach, taking cumulative impacts into account is the main operational requirement related to the implementation of the Ecosystem Approach (EcAp) in the Mediterranean (11 ecological objectives), in the same way as the Marine Strategy Framework Directive (MSFD) applied by the Mediterranean EU member countries.

At a local scale, more operational cooperation in coastal management has been developing since the 1990s and gaining momentum since 2005 vis the ICZM implementation tools (including the Coastal Area Management Programmes (CAMP) in many countries) and other tools that remain to be replicated and promoted. International donors, Regional Activity Centres such as Plan Bleu (PB/RAC) and the Priority Actions Program (PAP/RAC), as well as coastal agencies, work to this end by jointly developing projects between the Contracting Parties of the Barcelona Convention, thereby encouraging partnerships at different levels of governance to exchange experiences and practices.

5.4.1 Effective implementation of the ICZM Protocol

Since the 1990s ICZM has proven to be the most appropriate operational tool in achieving sustainable development in coastal areas, complementing other methods and approaches. Ecosystems extend across the interface of land and sea, but policies relating to the protection of marine biodiversity are often delivered separately from those for the land. The proper application of the ecosystem-based approach helps cross this policy divide between land and sea. The ecosystem approach, along with the SDGs, provides some of the major goals to be delivered operationally through ICZM. Finally, ICZM provides the context to deal effectively with important global problems, such as adaptation to the impacts of climate change. With such a range of sectoral priorities and policies, combined with the large number of delivery agencies and governance bodies, the risk of duplication or even conflict is obvious, and the need for integration is stronger than ever. Therefore, advancement of integration at all levels remains a key objective, with the emphasis on building synergies and avoiding overlapping, conflicts or wasting resources.

Integrated Coastal Zone Management (ICZM) and Marine Spatial Planning (MSP) offer valuable coherent and sustainable solutions to the problems and obstacles identified and described in previous sections. Both disciplines address the two major types of conflicts that occur in coastal and marine areas:

- conflicts between human uses and the coastal and open sea environment (user-environment conflicts), which in some countries are the predominant type; and
- conflicts among human uses (user-user conflicts) claiming the same space or natural resources and seeking profit - in most of the cases, at the expenses of the environment.

ICZM and MSP both apply the precautionary principle, being not only concerned with mitigating conflicts between ongoing activities but are designed to avoid such conflicts by anticipating future developments. Being adaptive, flexible and dynamic from the outset in the planning process makes it possible to deal with the uncertainty related to the future evolution of coastal and marine area, including the uncertainty of climate change effects. These characteristics enable practitioners to adjust management policy and practices to meet new goals or to support local solutions within an overall comprehensive regulatory framework. Strategies and policies at all levels should integrate major global issues such as climate change and ocean health. While the first one is to be tackled through

[87] French example of the *taxe départementale des espaces naturels sensibles.*
[88] These last two examples of taxes are applied in Morocco.

an integrated approach to adaptation and mitigation, the health of oceans is to be managed through the ecosystem approach and marine spatial planning.

5.4.2 Coordinating MSP, EcAp, and climate adaptation and mitigation

The ICZM Protocol, which entered into force in 2011, was a ground-breaking achievement, an innovation in international law. Built on nearly three decades of solid experience and achievements, including local pilot actions, thematic strategies and cooperation, the ICZM Protocol put the Mediterranean at the global forefront in sustainable coastal management. Support for Mediterranean countries to implement the ICZM Protocol is provided by the PAP/RAC. This support includes on-the-ground actions, capacity-building and awareness-raising across the Mediterranean.

However, times, and policies, are constantly evolving. The demands and pressures on our environment, particularly on the coast, continue apace. The need for evolving and adaptive responses to meet these demands requires the continuous development of innovative methodologies.

In the 20th Century ICZM was a pioneer in fighting for sustainable coastal development, and its methodology has stood the test of time. New challenges, such as climate change, the advent of MSP and other approaches has led to the need for what one commentator calls a new, "ICZM 2.0" (Shipman, 2012) - an overarching policy framework that operates as the nexus between multiple policies and programmes and across the interface of land and sea - ensuring harmony between policies and programmes and the agencies that deliver them, rather than duplication or even conflict.

Fortunately, and uniquely, the ICZM Protocol for the Mediterranean provides that nexus, having both the holistic methodology and the agreement between the Contracting Parties that can bring these various policies and approaches into a coherent and sustainable whole - so that the whole is greater than the sum of the parts. The ICZM Protocol provides a much-needed over-arching umbrella under which MSP, EcAp, climate adaptation and mitigation, disaster risk reduction and other policies and tools can be delivered in harmony - both for the coastal and marine ecosystems, and across national boundaries, in order to achieve the SDGs.

The past decades have witnessed rapid developments in our ability to access and exploit marine spaces, and the value of MSP as a policy tool to manage these developments is recognized internationally. On the European side of the Mediterranean, countries are required under the Maritime Spatial Planning Directive of 2014 to prepare maritime spatial plans for the marine waters covered by their sovereignty or jurisdiction. In 2017 the Contracting Parties agreed to the introduction of MSP into the delivery of the Barcelona Convention and the ICZM Protocol. A Common Regional Framework has been adopted in 2019 to steer this.

BOX 68 How to define new governance initiatives

- The creation of a permanent collaborative platform, a kind of sub-basin multi-stakeholders commission on sustainable development;
- Launching joint or coordinated calls for proposals;
- Improving the role of existing networks as capacity builders;
- Deploying cross-cutting actions in the programmes' preparatory phases, benefiting from existing initiatives with the same purpose;
- Starting discussion on common strategic planning at the subregional scale in the port and maritime transport sectors.

The objective is to introduce MSP as the main tool/process for the implementation of ICZM in the marine part of the coastal zone and specifically for planning and managing maritime human activities according to MAP ecosystem approach-based goals and objectives. The Common Regional Framework allows for harmonization of the regional action plans and instruments, as well as national and cross-border strategies and plans. Its objective is coherence, and achieving this requires alignment/integration of the different approaches, methodologies and tools applied on land and at sea, notably ICZM, MSP, ecosystem approach and climate action. The links between the first three approaches are shown below, demonstrating how ICZM can function as the central pillar - bringing MSP and the ecosystem approach together for coastal management.

BOX 69 Maritime Spatial Planning (MSP)

MSP is defined as *"a cross-sectoral coordination and decision-making tool enabling public authorities and stakeholders to apply an integrated, policy-based, transboundary approach to the ecosystem-based regulation, management and protection of marine environments, considering the competition in seas for maritime transport, oil and gas development, offshore renewable energy, offshore aquaculture, oil and gas mining, fisheries, sand and gravel mining, tourism and recreation, waste disposal and the other issues like marine conservation and military defence issues; and to analyse and allocate the spatial and temporal distribution of human activities in marine areas for achieving ecological, economic and social objectives that have been specified through both technical and political processes"* (Regional Framework for ICZM).

ICZM will therefore continue to deliver this coherence through tools and instruments that already have a certain "history and tradition" of use by the Contracting Parties, while others still need to be developed, explained, tested and verified. To achieve this, UNEP/MAP will provide assistance to the Contracting Parties for the implementation of the ICZM Protocol through, for example:

- Guidance for consistent and complementary implementation of ICZM and MSP, particularly addressing Land Sea Interactions in the light of climate change;
- Tailoring existing methods and tools and developing new

ones to operationalize the Ecosystem Approach concepts, as well as SDGs, within ICZM and MSP, and
- Developing additional coastal indicators to complement existing ones, predominantly marine-oriented Ecosystem Approach indicators, to better reflect the interaction between terrestrial and marine ecosystems, habitats and species, and to reduce pressures from economic activities that exceed the carrying capacity.

Although MSP is not expressly mentioned in the ICZM Protocol, the geographical scope and the definition of the coastal zone given in Art. 3 of the Protocol includes both the land and sea. Planning should therefore be equally applied consistently, even if it is delivered by different authorities, or even different states.

Appropriate policy, and institutional and legal frameworks are needed to successfully implement ICZM and MSP. Other governance functions such as enforcement mechanisms, scientific expertise and technological tools and methods, information/education, consultation and participation processes, monitoring and evaluation, are all needed to create an enabling environment for successful implementation.

Partnerships are essential for forging collaboration, from different responsible agencies to regional collaboration needed to address complicated widely relevant transboundary environmental challenges. Scientific knowledge, including the availability of reliable data, information and tools is essential to wisely orient policy and management decisions, especially in times of scientific and/or political uncertainty. An example from France, is the role of the National Observatory of the Sea and Coast *(Observatoire national de la mer et du littoral, ONML)*, whose main missions are to provide information, from raw to more elaborate data (key figures, data sheets and mapping tool) to understand and analyse the central themes at stake on the sea and coast. These productions directly support decision makers. The recent report (2019 edition) on the environment in France (Ministère de la Transition Ecologique et Solidaire, 2019) is based on this information. The role of cross-sectoral coordination, especially existing platforms and coordination mechanisms for coastal zones, MSP, disaster risk reduction and adaptation to climate change, could be a good starting point in Mediterranean countries.

The effective implementation of the Protocol will require strong social engagement involving civil society and individual citizens in the coastal zone, as well as different government institutions. To achieve this, a good communication strategy that utilizes innovative communication methods needs to be developed to raise public awareness, strengthen multi-sectoral participation and promote open and transparent access to information and decision-making processes. Making ICZM and MSP programmes visible improves inter-institutional cooperation and collective responsibility in meeting programme goals and objectives. At the local level, an effective communication mechanism will strengthen local stakeholders' acceptance and help them take ownership. Finally, well-informed stakeholders throughout the process provide a strong political base and serve as the champions and driving force for ICZM and MSP implementation. It is of great importance to identify the right level of involvement to get the maximum results.

There is a need to promote public-private sector partnerships by creating favourable environmental investment policies that encourage private sector investments. Policy enhancement and capacity-building efforts at the national level will be very useful in mobilizing financing, not only from the private sector, but also from bilateral organizations or multilateral financing institutions. Climate proofing for development should be applied to mainstream efforts and contribute to effectiveness, where appropriate, and combine capacity-building, monitoring, funding, and other mechanisms for climate change adaptation with those for coastal and marine management, thus making best possible use of available resources.

The implementation of ICZM and MSP is a long process, which, while providing tangible economic and social benefits for coastal communities, needs permanent and operating funds from the onset. Securing funding through different economic or land-policy instruments is of key importance to be able to implement efficient management of the coastal and marine area in question.

The EU-funded MSP projects SIMWESTMED and SUPREME, showed that, in spite of existing international agreements (like in the SIMWESTMED area: Pelagos, RAMOGE, Bonifacio Straight) covering the respective large marine ecosystems, transboundary issues are still difficult and politically delicate to manage. The challenge is to develop an incremental approach by strengthening and creating networks of local forums, projects/initiatives, institutions, and platforms with constant dialogue and adjustments between the various sides involved in the transboundary area.

Going in this direction means that rather than an "ecoregion", SIMWESTMED, like SUPREME areas, should be considered as "seascapes", the definition of which relies as much on strategic criteria as it does on biogeographic and ecological criteria (Bensted-Smith & Kirkman, 2009). However, before getting the countries and regions down to work and jointly improve their maritime activities planning and management, the first step is to make them recognize that the seascape they share is underpinned by clear ecological and social connectivity. The issue at stake should therefore, and first of all, be to improve management in specific thematic areas (more particularly in coordinating their respective IMAP/MSFD action plans) and geographic (MPA network) areas. As it has been shown, starting in a relatively neutral domain, i.e. environment assessment and conservation, may lead to a progressive extension to other relevant stakeholders and sectors.

As promoted by Regional Activity Centre for Specially Protected Areas (SPA/RAC), the need to integrate Marine Protected Areas (MPAs) and Other Effective Area-Based Conservation Measures (OECMs) into the wider seascape has never been more urgent because of the synergies and negative feedback loops between fragmentation and climate

change. From an ecological perspective, fragmentation impairs the ability of species to adapt to the rapidly shifting habitat patterns and environmental processes that result from climate change, further weakening resilience, and increasing the likelihood of trophic web shifting. From a social standpoint, fragmentation of initiatives and organizations impairs the ability of local stakeholders and decision makers to communicate with each other and to upscale their vision so that it better reflects the scales at which ecosystems are evolving and the extent of the cumulated impacts of human activities on these ecosystems.
Like ICZM, MSP should be a multi-scale learning and incremental approach which, at least in the case of the SIM-WESTMED area, could be supported by the establishment of a regional-scale programme that would be considered as a WESTMED submacro-region.

5.4.3 Enhancing existing legal and institutional capacities

Planning has always been an important part of ICZM. The various interests and activities in the coastal zone, associated with land-use conflicts, could only be harmonized and solved through a systemic approach and by timely and strategic planning and by putting local sustainable development plans and policies at the heart of international policy design. The planning process is covered by several guidelines published by PAP/RAC and described in detail on its online ICZM Platform. The ICZM Protocol for the Mediterranean invites countries to prepare national ICZM strategies, plans and programmes. Coastal plans may be self-standing or integrated in other plans. Particular importance lies in integrating coastal with water-related

BOX 70

Coastal Area Management Programme (CAMP)

CAMPs are designed to implement practical coastal management projects in selected Mediterranean coastal areas, applying Integrated Coastal Zone Management (ICZM) as a major tool. The objectives of CAMPs are:

- to facilitate the local implementation of the ICZM Protocol in a particular country;
- to develop strategies and procedures for sustainable development in project areas;
- to identify and apply relevant methods and tools;
- to contribute to capacity-building at the local, national and regional levels; and
- to secure wider use of the results in the region.

Major outputs of CAMP projects include Diagnostic Analysis (Feasibility Study), Technical Specifications for individual activities of the project, project database and GIS, systemic sustainability analysis, participatory programme, follow-up Proposals and urgent investment portfolios. Results are presented at high level of government in the host country.

CAMP projects which did not claim to find immediate solutions to coastal zone governance in many southern Mediterranean countries have generally had the merit of identifying the inconsistencies in the public instruments and the technical insufficiencies in the management of these fragile areas of high economic, social and cultural value. CAMPs have been a real tool for promoting ICZM in these countries, especially among policymakers, but also with non-institutional stakeholders and the scientific community. In all the countries where a CAMP project has been implemented, dynamics have been set in motion, which unfortunately has not been systematically maintained after the end of the project, except in certain cases. In the future, the new generation of CAMP projects could have a subregional dimension that considers cross-border aspects with a multidimensional approach, where socioeconomic aspects and hybrid issues will be complemented.

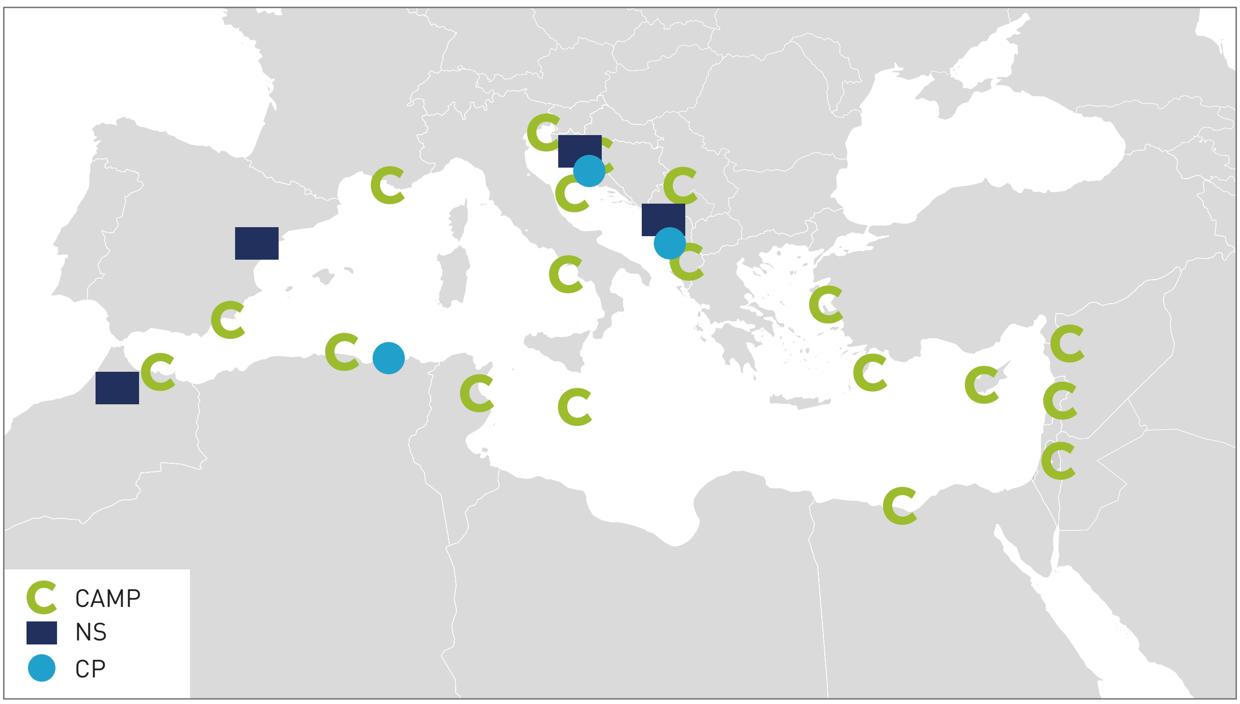


Figure 144 - Locations of CAMPs (in all countries except Libya and Monaco), national strategies (NS) in Morocco, Spain, Montenegro and Croatia and coastal plans (CP) in Algeria, Montenegro and Croatia), in 2019

plans, as well as adaptation and shoreline management plans. Finally, maritime spatial plans, in particular their "land-sea interactions" analysis, are an integral part of ICZM.

UNEP/MAP launched its Coastal Area Management Programme (CAMP) in the mid-1980s *(Box 70)* and by 2019 almost all Mediterranean countries had a CAMP. Several countries have also adopted national ICZM strategies and plans. *Figure 144* shows locations of these projects, strategies and plans.

A national strategy should serve to reconcile conflicting uses through a joint vision, goals and measurable targets, as well as ways to achieve them. The preparation process is an opportunity to coordinate different interests, find comprehensive solutions to interlinked issues and to lead coastal development in a forward looking and proactive manner towards achievement of the SDGs.

Since numerous coastal issues are managed at the local level, coastal plans are another indispensable sustainable coastal development tool. As coastal communities and ecosystems are seriously threatened in many areas of the Mediterranean and due to the effects of present and future human encroachment on the coast, local authorities are faced with the increasingly complex task of balancing development and managing coastal risks, especially coastal erosion and flooding. Reducing natural and anthropogenic stressors can therefore help decision makers foster coastal resilience to overall change. Examples of Coastal Plans that follow the ICZM Protocol are the Coastal Plan for the Šibenik-Knin County (Croatia), the Reghaia Coastal Plan (Algeria) and the Buna-Bojana Transboundary Integrated Resources Management Plan (Albania-Montenegro), with support from the PAP/RAC. While the first plan focused on adaptation to climate change, the last is an example of a plan integrated with water resource management and was developed in partnership with the Mediterranean Regional Water Partnership of the inter-governmental organization Global Water Partnership (GWP) and the UNESCO Intergovernmental Hydrological Programme (IHP).

Just like the ICZM plan, a maritime spatial plan should provide a common vision and consistent direction, setting out shared principles, goals, and objectives for the area and define what these priorities mean in time and space. MSP cannot be delivered on its own. To effectively implement MSP, many complex interactions across land and sea should be taken into account. These Land-Sea Interactions (LSIs) actually lie at the very heart of ICZM. It is that very place where all interactions occur, where the terrestrial and marine portions of the coastal zone meet and where results of the natural processes and the impacts of human activities create the highest number of conflicts and issues to be resolved and harmonized. It is therefore essential to plan and manage these interactions in an integrated way. Despite this, spatial planning of land and sea is often divided by both legislation and practice.

Although the ICZM Protocol does not expressly include the concept or the definition of LSI, this can be indirectly derived from Article 2 through the interpretation of the given definitions of "coastal zone" and "integrated coastal zone management". Furthermore, the coastal zone is *"the geomorphologic area either side of the seashore in which the interaction between the marine and land parts occurs in the form of complex ecological and resource systems made up of biotic and abiotic components coexisting and interacting with human communities and relevant socioeconomic activities"* (Art 2.e). The analysis of the interactions between land and marine components of the coast is therefore a key element of the ICZM process and includes ecological processes that cross the coastline delimitation, interactions among land and sea-based socioeconomic activities and between human communities.

One example of the integration of the planning process for the coastal zone is the Croatian decree on preparation of the national strategy on management of the marine environment and coastal zone. Based on this decree, the Croatian Strategy for Marine Environment and the Coastal zone was prepared as a joint answer to the ICZM Protocol and to the EU MSFD. This strategy was prepared for the Croatian part of the Adriatic Sea, from the outer limits of the Republic of Croatia's jurisdiction to the landward outer limit of the competent coastal units.

Among the ICZM-related planning instruments, shoreline management plans are focused on finding solutions that primarily address coastal erosion and marine flooding. For these types of plans, a sedimentary cell approach must be followed and local problems should not be addressed without a full-scale analysis.

Regardless of the name and main focus of the plan, the fact is that planning in coastal zones should address major identified threats. Due to the extent of climate change impacts that coastal zones around Mediterranean are already experiencing, adaptation should be a central focus of any coastal planning. An integrated planning approach ensures systemic analysis of issues the area is facing, identifying their root causes and designing comprehensive, integrated policy solutions.

Despite existing legislation and institutional capacities through various tools and instruments (programmes/plans/strategies, etc.), stronger political support is still needed to ensure full implementation and compliance. At the land-sea interface, ensuring more balanced coastal development and management requires better assessment of the complex interactions that take place in ecosystems, though economic pressure for short-term profitability is still a serious obstacle. In fact, there are still many constructions that largely encroach on the coast, including marine areas, as well as many illegal and ill-practices, such as fishing or dumping at sea that are also serious problems. Multiple stakeholders need to be made fully aware in order to achieve radical changes in terms of behaviour and practices to stop and urgently reverse the continuing degradation of coastal areas.

Also, regulatory efficiency is still a problem for many

Southern Mediterranean countries, where legislation has not been fully put in place (lack of implementing legislation and national standards) as they cannot find adequate frameworks for their effective implementation. ICZM suffers globally in most of the countries on the southern shores of the Mediterranean where CAMP projects have been driven by UNEP/MAP, due to the deficit in capitalization and underutilization of human resources formed by processes implemented in these projects. This situation is related, particularly, to a gap between the perceptions developed by the ICZM concept and preparation at the administrative level, as well as the institutional arrangements existing in these countries. In addition, the public policy evaluation processes for marine and coastal areas have largely shown the continuing need for capacity-building at all levels in Southern Mediterranean countries, particularly in administrations and the scientific community.

In some of the Northern Mediterranean countries, despite the extension of many protection mechanisms for natural areas and species, the status of aquatic and marine ecosystems remains a matter of concern. This is the case

Countries	Status of the ICZM Protocol	National coastal law[89]	National ICZM strategy	National ICZM strategy
Albania	**Entered into force** (24.03.2011)	Partially, but Law on ratification of the ICZM Protocol is a constituent part of the national legal system.	No.	No specific agency.
Algeria	Signature (21.01.2008)	A coastal law has been approved.	National ICZM Strategy according to the Protocol principles prepared in 2015.	Yes. Algeria's *"Commissariat du Littoral National* (CNL)".
Bosnia and Herzegovina	No.	Different issues covered under different laws.	No.	No specific agency.
Cyprus	No.	No coastal law has been approved.	No.	No information available at the time of publication.
Croatia	**Entered into force** 28.02.2013	No single coastal law, but different issues covered within different laws. Spatial development law recognizes protected coastal zones. Law on ratification of the ICZM Protocol is a constituent part of the national legal system.	Croatia responded to the EU Marine Strategy Framework Directive and ICZM Protocol with one Strategy. A programme of measures was adopted by the Government, but the "Strategy for the Management of the Marine Environment and the Coastal Zone" is still under the process of adoption.	No.
Egypt	No.	A coastal law has been approved.	Proposed within the GEF MedProgramme.	No information available at the time of publication.
France	**Entered into force** 28.02.2013	A coastal law has been approved	"Blue Book: a national strategy for the seas and oceans", which sets out the national strategic directions for the sea and coastline, was adopted in 2009	Yes. *"Le Conservatoire de l'espace littoral et des rivages lacustres"* established in 1975. The Conservatoire is able to benefit from transfer of public properties, donations or free transfers or payment.
Greece	Signature (21.01.2008)	No coastal law has been approved.	Under preparation.	No specific agency. A Green Fund is envisaged according to a law of 2010 with an integrated funding system for all types of environmental actions. Various categories of financial resources will feed into the Green Fund, including "green" taxes, fines from the legalization of unauthorized buildings, fines for environmental damage or violations, etc.
Israel	**Entered into force** (02.03.2016)	A coastal law has been approved.	In 2019: a national land use plan for the coast exists and has been recently updated, and an MSP has been prepared which is in its last stages of approval.	Yes. The Lands Administration manages 93% of land outside the urban areas in the coastal zone. The beach zone is identified under the Lands Law as public property.
Italy	Signature (21.01.2008)	Under preparation.	No.	At the regional level. The Coastal Conservatory of Sardinia, a new agency of the Sardinia Region, can acquire coastal territories when human impacts are threatening the integrity of the area, and when the uses of the area are generating conflicts.
Lebanon	**Entered into force** (31.08.2017)	Under preparation	Applied within the GEF project	No
Libya	No	No single law, but different aspects covered within different laws.	No	No
Malta	**Entered into force** (10.05.2019)	Different issues are covered by different laws.	A national policy framework for ICZM is embedded in the national land and marine spatial planning document: Strategic Plan for Environment and Development.	No information available at the time of publication.
Monaco	Signature (21.01.2008)	No coastal law has been approved.	No.	No information available at the time of publication.

The table follows next page

[89] The question regarding ICZM legislation and coastal legislation should be divided to enable the identification of ICZM-specific legislation from general coastal laws (Brian Shipman & Sylvain Petit, PAP/RAC. Final global results of the ICZM stock-taking, 2014).

Countries	Status of the ICZM Protocol	National coastal law[89]	National ICZM strategy	National ICZM strategy
Montenegro	**Entered into force** (08.02.2012)	Different coastal issues covered by different laws. Law on ratification of the ICZM Protocol is a constituent part of the national legal system.	National ICZM Strategy adopted by Parliament in 2015.	No specific agency.
Morocco	**Entered into force** 21.10.2012	Coastal law has been approved.	National Strategy for the Coast under preparation by the Ministry of Territorial Planning.	No specific agency. But has several land acquisition mechanisms such as expropriation for public utility, decommissioning of the public domain, and the acquisition mechanism for the construction by the State. However, the use of these acquisition mechanisms is constrained by fiscal issues, and lengthy administrative and judicial proceedings.
Slovenia	**Entered into force** 24.03.2011	Under preparation.	Under preparation.	No information available at the time of publication.
Spain	**Entered into force** 24.03.2011	A coastal law has been approved	In 2007, the Ministry of the Environment and Rural and Marine Affairs (Ministerio de Medio Ambiente Medio Rural y Marino) coordinated the development of the Estrategia para la Sostenibilidad de la Costa (Strategy for a sustainable coast).	Yes. The Shore Act (1988) gives national administrative competence for acquisition and easements.
Syrian Arab Republic	**Entered into force** 24.03.2011	No coastal law has been approved.	No.	No.
Tunisia	Signature (21.01.2008)	There is no specific coastal law, but there are several laws related to coasts.	National ICZM Strategy under development by APAL in partnership with UNDP.	Yes. The law establishing APAL (Coastline Protection and Development Agency) empowers APAL to control building on the coast by acquisition or expropriation by the state. A diagnosis of sensitive coastal areas threatened by urbanization identified 18 areas to be acquired by APAL.
Turkey	No	A coastal law has been approved	Partially completed.	Within the Ministry of Environment and Urbanism, the General Directorate for Spatial Planning has been assigned to conduct the studies on integrated coastal zone management and planning. In the Ministry, there is a specific unit responsible for ICZM plans.
European Union	**Entered into force** 24.03.2011			

Table 24 - Status of ICZM Protocol, national coastal laws, national ICZM strategies and national coastal agencies in Mediterranean countries
(Source: Original research for this publication by PAP/RAC and Plan Bleu, 2019[90])

of French ecosystems, which still face many pressures, including the artificialization of land and the fragmentation of natural environments, which continue at an alarming rate despite the measures put in place to control them. Due to its attractiveness, the French coast is particularly affected by this phenomenon (Ministère de la Transition Ecologique et Solidaire, France, 2019).

Table 24 shows an overview of the status of the ICZM Protocol, national coastal laws, national ICZM strategies and national coastal agencies.

5.4.4 A common regional framework for ICZM

The Common Regional Framework (CRF) for ICZM is a strategic instrument intended to facilitate the implementation of the ICZM Protocol, providing guidance mainly for the regional (Mediterranean) and subregional (four Mediterranean subregions, according to EcAp) levels, based on a flexible approach that can be replicated at lower geographical levels (national, sub-national) towards the achievement of EcAp Ecological Objectives (EO), taking into consideration the other Protocols and related key documents, in light of relevant international instruments.

The proposed methodological guidance at the Barcelona Convention COP 21, December 2019 (Decision IG.24/5), is based on three major phases *(Figure 145)*:

- **Phase A** - Elaboration of a matrix of interactions between the EcAp EOs and the economic activities and natural and cultural elements that have great relevance for the coastal areas, according to the main elements of the ICZM Protocol.
- **Phase B** - Detailed analysis of the provisions of the main relevant documents of the UNEP/MAP - Barcelona Convention system related to key interactions between EcAp EOs and ICZM elements. The analysis is performed by clusters of EOs, as in the MAP Quality Status Report: 1. Biodiversi-

[89] The question regarding ICZM legislation and coastal legislation should be divided to enable the identification of ICZM-specific legislation from general coastal laws (Brian Shipman & Sylvain Petit, PAP/RAC. Final global results of the ICZM stock-taking, 2014).
[90] Based on Preparatory documents for the MedProgramme Child project 2.1; ICZM Protocol /Reporting questionnaire, 2016; Final global results of the ICZM stocktaking: http://www.vliz.be/projects/pegaso/images/stories/WP2/D2.2A_Final%20global%20results%20of%20the%20stock-taking.pdf

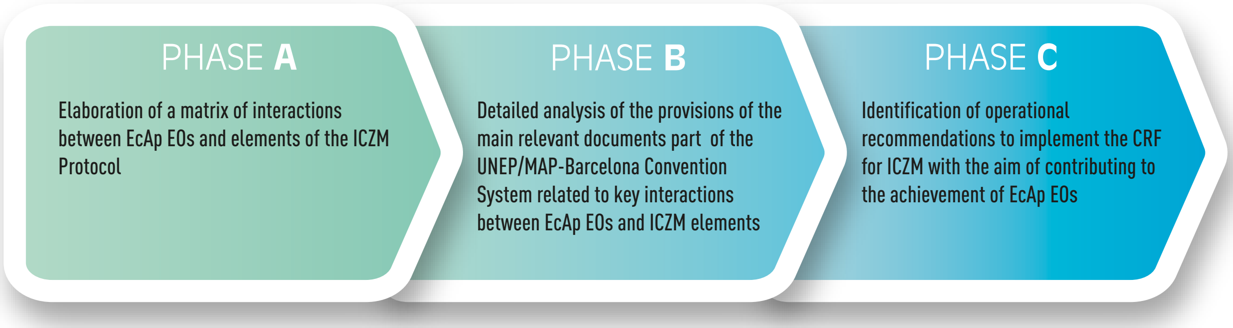


Figure 145 - Phases of methodological guidance

ty, 2. Fisheries, 3. Coast and Hydrography, 4. Pollution and Litter (UNEP/MAP, 2017).

• **Phase C -** Identification of operational recommendations to implement the CRF for ICZM with the aim of contributing to the achievement of EcAp EOs and Good Environmental Status (GES), coherently with other instruments of the UNEP/MAP - Barcelona Convention system.

The proposed methodology aims to ultimately identify (in Phase C) a set of operational recommendations, if needed and as appropriate, which will be calibrated to the specific geographic and temporal context, as well as to the cumulative impact integration rules, and regularly updated.

Considering that the CRF for ICZM should be seen and managed as a practical instrument within the UNEP/MAP - Barcelona Convention system and the other connected instruments, a specific interactive IT platform should be set up in the future, as an operational tool to support the implementation of the process. Integrated into an already existing system, the platform would provide access to decision makers and relevant institutions to:

- Find and download all relevant material, documentation, data and information;
- Upload requested information and data;
- Use specially designed tools (e.g. evaluation matrices, indicators, etc.);
- Periodically update the information and data entered.

In parallel with this approach, it is worth mentioning the other ongoing efforts for the multi-scale and transdisciplinary networking of ICZM-like initiatives, including MPAs and OECMs.

5.4.5 Managing beyond the divide between conservation and development

Besides Chapter 17, Agenda 21 also contains two separate chapters on the Conservation of Biological Diversity (Chapter 15), and Protection of Quality and Supply of Freshwater (Chapter 18), which has led to separate groups and institutions focusing on biodiversity conservation or freshwater issues and the promotion of integrated water resources management (IWRM). The emphasis placed on the titles of these three chapters did not help in fully integrating them. Yet, the quantity and quality of freshwater inflow into coastal areas is critically important for maintaining seawater quality and marine biodiversity, as well as the function of coastal wetlands and estuaries. According to the latest inventory available in 2015, 51.4% of 179 coastal water bodies have good or very good ecological status and 39 of these water bodies are in poor or bad condition and are mostly Mediterranean lagoons, with a high density east of the Hérault and Camargue. However, the campaign to modernize wastewater treatment plants initiated during the 2000s and the evolution of certain agricultural practices are contributing to the improvement of the quality of river water, especially in terms of the presence of organic matter (nitrates, phosphates). Thus, in 2018, 98.9% of the 1,834 bathing sites at sea in metropolitan France have at least sufficient quality, which places France in the European average. Of the 28 sites with poor quality, the Mediterranean coast is particularly affected with 11 sites (some Mediterranean lagoons are still subject to eutrophication phenomena and episodes of phytoplankton proliferation with diatom blooms) (Ministère de la Transition Ecologique et Solidaire, France, 2019).

Therefore, the challenge is to ensure that biodiversity conservation, ICZM and freshwater issues become more integrated and mutually supportive. In addition to national policies, this should be the task of Regional Seas Programmes such as UNEP/MAP, which is the first to have an ICZM Protocol, a legally binding document between Mediterranean riparian countries.

To paraphrase the goals and approaches of ICZM and biodiversity conservation, the aim of ICZM is to "promote the people, while trying to preserve the place", and the aim of biodiversity conservation is to "preserve the place, while engaging the people" (Best, 2003). ICZM places an emphasis on the people, and ICZM practitioners usually function as impartial, neutral brokers for communities and various users, whereas conservation practitioners typically advocate for the environment. Coastal practitioners must ensure that communities learn about and understand the term biodiversity in an inclusive and positive manner, and as an integral component of both environmental and human health. The publication of the Millennium Ecosystem Assessment report (Millennium Ecosystem Assessment, 2005) significantly facilitated this task in proposing a scheme connecting biodiversity with ecosystem goods and services, the spinal cord of the ecosystem-based approach, as defined throughout the twelve principles contained into the Convention on Biodiversity.

Therefore, responsible management of any marine area should integrate ICZM and the Ecosystem Approach (EcAp), and apply the same principles from the coast to the offshore waters with the help of MSP. ICZM is a multi-scale (nested) ecosystem-based approach to managing defined coastal and marine areas, whether they are protected or not, considered complex and dynamic interconnected systems that encompass many interactions between people and ecosystems, and must be managed as an interconnected whole.

Very much in the spirit of Aichi Target N°11[91], it includes any area-based management initiative fostering integrated management in a defined area, including community-based management, co-management, integrated coastal management and its maritime spatial planning extension, and the management of Coastal and Marine Protected Areas (CMPAs).

By working together in a strategic way, ICZM/MSP and biodiversity conservation practitioners can mutually support efforts to promote conservation of coastal resources and their habitats and the well-being of the people who depend upon them *(Table 25)*. Mutual efforts should be directed not only within and around CMPAs, but also beyond CMPAs for greater impact, following a nested governance approach, at local, national, regional and international scales.

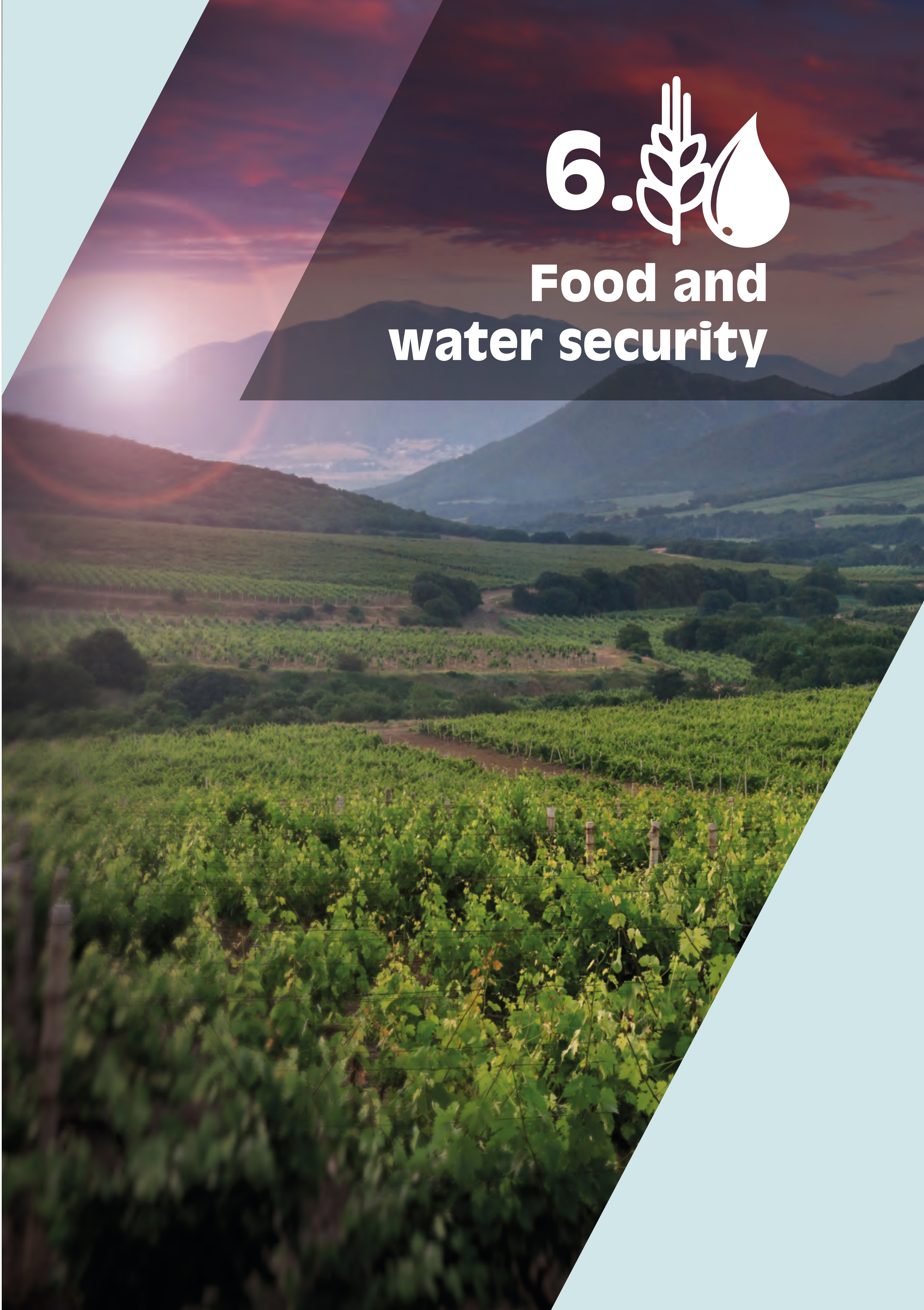
In the spirit of the WWF and IUCN Guide for quick evaluation of management in Mediterranean MPAs (Tempesta & Otero, 2012), where integrated management is recommended, a rapid assessment of coastal and marine management initiatives, following the principles and processes of the ICZM approach, has been recently developed and proposed to the Barcelona Convention COP 21 (December 2019). Developing a set of common assessment criteria should help both categories (CMPA and ICZM) of practitioners to identify themselves to the same community, thereby creating the enabling conditions for the networking of management initiatives following a nested governance approach.

Theme	ICZM/MSP	Biodiversity conservation
Focus	Emphasis on development: promote the people, preserve the place.	Emphasis on conservation: preserve the place, engage the people.
Goals	Improve the governance process, economy, health, social well-being, and environmental quality to maintain ecosystem productivity.	Conserve biological diversity and ecosystem function.
Public role	Neutral brokers.	Environmental advocates.
Site selection and project design	Development and issue-based approach (i.e., decentralization, strengthen local communities and authorities.	Global biodiversity assessments and threats-based approach.
Site-based approaches and strengths	Emphasis on governance process helps establish legal, decision-making and enabling frameworks across local, sub-national and national scales; establishing strong national integrated coastal management policies, frameworks and institutions that support local efforts and reduce external threats to MPAs.	Emphasis on establishing and strengthening management schemes in MPAs; land acquisition, concessions and debt-for-nature swaps; target critical marine biodiversity and ecosystems (habitats) in need of immediate protection; international funds and resources.
International approaches and strengths	Promote international awareness of the need for integrated approaches to coastal management and capacity-building; mainstream ICM into development plans.	Change global trade policies and transform businesses; reduce threats from global economic drivers, such as unsustainable fishing and tourism; strengthen international conventions.
Scaling-up approaches and trends	Coastal watershed and basin-scale management; establish strong national ICZM policies, frameworks and institutions; use local government units to replicate efforts; establish authorities to integrate across land and marine resources.	Establish functionally-connected networks of MPAs; Eco-regional and seascape approaches to biodiversity threats.

Table 25 - Integrating the strength of Integrated Coastal and Ocean Management (ICOM) and biodiversity conservation (Adapted from Best, 2003)

[91] By 2020, at least 17 per cent of terrestrial and inland water areas, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services are conserved through effectively and equitably managed, ecologically representative and well-connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes.

6. Food and water security



Food security and water security in the Mediterranean are intrinsically linked and are facing similar challenges. Food security is threatened mainly by the high dependency of Mediterranean countries on food imports, making them vulnerable to external pressures such as volatile food prices. From a nutritional standpoint, the number of overweight and obese people has increased as a result of the traditional Mediterranean diet being abandoned. Water security has degenerated due to the deterioration of internal freshwater resources, both in terms of water quantity and quality, with a high dependency on external water resources, higher regional water footprints than the global average, increasing scarcity of renewable water resources, an increased number and capacity of dams exerting pressure on freshwater ecosystems, and a growing risk of conflicts between water users and countries. Access to water and sanitation remains a major challenge in the region. Territorial divisions separating coastal urban and remote rural areas are growing stronger, making isolated populations such as smallholder farmers particularly at risk of food and water insecurity. With climate change, precipitation is expected to decrease and temperatures to rise in the region, which will affect water supply (and thereby energy and food supply). It will also directly affect soil moisture and crop growth, thereby further increasing irrigation water needs.

There are clear but difficult to measure interactions between the water, energy and agricultural sectors, as they are all interdependent, which calls for integrated policies and management. Agriculture being the largest water user in the region, further efforts need to be made to promote the use of non-conventional water resources. The conservation and restoration of Mediterranean agro-ecosystems is key to ensuring sustainable development. This requires better management of continuing arable land loss, land use intensification, and soil erosion and salinization. Integrated Water Resources Management and Water Demand Management (WDM) provide guidelines for achieving better water efficiency and reducing conflicts between users.

6.1 Introduction

Water, energy and food are essential to human well-being, poverty reduction and sustainable development. These strategic resources share many similar characteristics: i) billions of people do not have safe access to them; ii) global demand is rapidly growing; iii) all are 'global goods' that involve international trade with global implications; iv) their supply and demand vary geographically and across time; v) and all operate in heavily regulated markets (Bazilian et al. 2011; FAO, 2014a,b). Several of the UN Sustainable Development Goals (SDGs) focus on food and water security, in particular SDG 1, no poverty; SDG 2, zero hunger; SDG 6 clean water and sanitation; and SDG 15, which concerns the protection and sustainable use of terrestrial ecosystems, highlighting the fact that food and water security are an essential component of sustainable and inclusive development.

Food security[92] exists when all people have, at all times, physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life (World Health Summit, 1996). The nutritional dimension is an integral part of food security (Committee on Food Security, 2009). This broadly accepted definition underpins the second Sustainable Development Goal of the 2030 Agenda to "end hunger, achieve food security and improved nutrition, and promote sustainable agriculture".

The status of food security and challenges vary across Mediterranean countries. At the regional level, **food availability** is dependent on imports, with a regional agricultural trade deficit of USD 36.6 billion in 2017 (WTO, 2017). Only France and Spain produce an agricultural surplus. Mediterranean countries account for one-third of global cereal imports, for only 7% of the global population. Import dependency ratios for cereals in the Mediterranean (import over consumption ratio) are very high (86% in Lebanon, 72% in Algeria, 60% in Tunisia, 42% in Egypt) (FAO et al. 2018). Importing countries are thus very sensitive to the volatility of international prices, and were strongly hit by the food crisis of 2007-2008. Egypt and Algeria are among the world largest cereal importers.

Beyond food availability, **access to food** depends on multiple factors, including purchasing power and the state of infrastructure. In many Mediterranean areas, territorial divisions separate well-served coastal urban areas and remote rural areas, especially in the mountain ranges, where economic activity is often stricken and chronic food insecurity can exist.

From a **nutritional** standpoint, increasing overweight and obesity rates are reaching an alarming level in all Mediterranean countries (e.g. 30% of adults in Eastern Mediterranean countries are obese), and a high prevalence of anaemia affects women of childbearing age.

Factors that may affect food security in the region include dependency on imports, political instability and conflicts, global warming, and erosion of natural resources (soil, biodiversity). Rising water insecurity is a key factor because water and food are closely linked.

Water security is defined as the capacity of a population to safeguard sustainable access to adequate quantities of acceptable quality water for sustaining livelihoods, human well-being, and socioeconomic development, for ensuring protection against water-borne pollution and water-related disasters, and for preserving ecosystems in a climate of peace and political stability (UN-Water,

[92] Data on global food security from: FAO, IFAD, WHO, WFP and UNICEF, 2017. The State of Food Security and Nutrition in the World, 2017. Building resilience for peace and food security, Rome, FAO.

2013). Water resources are unevenly distributed across the Mediterranean basin, with critical limitations in southern countries, which hold only 10% of the total renewable water resources in the region. Six Mediterranean countries experience absolute water scarcity (less than 500 m^3 per capita per year) and another five are under the water scarcity threshold of 1000 m^3 per capita per year (FAO, 2016a). Most Northern Mediterranean countries (NMCs) are water-secure with over 1,700 m^3 per capita per year.
In North Africa and the Middle East, shared aquifers are the largest source of freshwater (Aureli, Ganoulis & Margat, 2008). Satisfying the simultaneous needs for high quality drinking water and high demand for irrigation water is a particularly complex problem. Water scarcity causes tensions and potential conflicts between groundwater users and land owners, and between countries. Tensions are exacerbated by increasing water demand for irrigated agriculture in a context of demographic growth. In numerous areas in the Mediterranean, groundwater quality is also under threat from pollution, sea water intrusion and overexploitation.

As pre-existing water scarcity in the Mediterranean region is being aggravated by population growth, urbanization, growing food and energy demands, pollution, and climate change, ensuring water security will require inclusive approaches and coordinated cross-sector solutions. The **Water-Energy-Food Nexus** has emerged as a useful concept to describe and address the complex and interdependent nature of these three resources *(Figure 146),* on which we depend to achieve a range of social, economic and environmental goals (FAO, 2014b).

Since water, food and energy are interconnected resources, policies designed for one component often impact and sometimes negatively affect others. Water plays a role in energy production (e.g. for powering hydroelectric plants, cooling fossil-fuel and nuclear plants, growing biofuels, in emerging technologies such as fracking for oil and gas, and

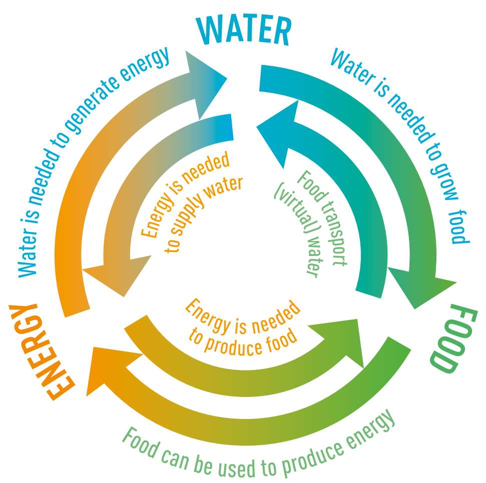


Figure 146 - The Water-Energy-Food Nexus
(Source: UN-Water, 2013 - adapted from IBM, 2009)

concentrated solar power). Energy is required to process and distribute water, treat wastewater, pump groundwater, and desalinate sea water. Water is the keystone for the entire agrifood supply chain, while intensified agriculture impacts water quality. Energy is also an essential input across the agrifood supply chain, from pumping to processing and transportation.

Non-conventional water resources such as wastewater recycling and reuse, rainwater and storm water capture, and desalination, are expected to be increasingly used in the forthcoming decades to meet growing demands. **Desalination** is a key Nexus interlinkage with energy consumed to increase water supply. The production of desalinated seawater in the Middle East and North Africa (MENA) region is projected to be thirteen times higher in 2040 than 2014. Currently, desalination for municipal use is already gaining importance on islands and in coastal cities with limited water resources. In absolute terms, the Mediterranean's largest producers of freshwater through desalination are Algeria (615 million m^3/year), Egypt (200 million m^3/year), Israel (140 million m^3/year), and Italy and Spain (both 100 million m^3/year) (FAO, 2016b). In relative terms, Malta is the desalination leader, with more than half of its drinking water supply produced via desalination.

Positive experiences in the region show that **wastewater** can be safely recycled to be used in irrigation and managed aquifer recharge, especially in coastal aquifers, to prevent salt water intrusion. Water recycling is a typical example of a Nexus interlinkage. Water recycling not only contributes to water and food security goals, it can also be achieved at zero-net energy use by capturing and reusing wastewater treatment by-products, such as biogas and sludge for energy generation, thus reducing emissions from the water sector and overall energy demand. However, around 80% of the MENA region's wastewater is still being discharged into the environment without being reused (World Bank, 2018).

Agriculture accounts for two-thirds of the increase in water withdrawals in the Mediterranean basin. Growing water scarcity in the southern and eastern Mediterranean is expected to have significant negative impacts on **food production** and to affect the types of crops grown. Specifically, the production of wheat and other grains is projected to suffer most from water availability constraints. The cost of producing crops is expected to rise as groundwater levels drop and the costs of pumping deeper increase. The availability of water for agriculture will likely face further constraints due to competition with demand from urban areas and the industrial sector. Growing water scarcity and the resulting decline in agricultural production are also expected to accelerate migration, especially in the most agriculture-dependent economies, and increase food trade.

In the MENA countries, groundwater pumping, water transfer and wastewater treatment are some of the most energy-intensive activities. Pumping for irrigation and drainage consumes around 6% of all electricity and diesel used in the MENA region (World Bank, 2018).

In Albania and Montenegro, **hydropower** is the dominant source of electricity generation (with 100% and 59% of electricity produced domestically respectively), while in Bosnia and Herzegovina, hydropower represents about a third of energy production. In both Montenegro and Bosnia and Herzegovina, the rest of the domestic electricity generation comes exclusively from coal (IEA statistics). All countries in the EU or in the EU accession process have adopted renewable energy targets for 2020 (e.g. 38% for Albania, 40% for Bosnia and Herzegovina and 33% for Montenegro; all three countries are expected to meet these targets). In 2018, the 16th Ministerial Council of the Western Balkan countries recognized the need to establish targets on energy efficiency, renewable energy sources and greenhouse gas emissions. However, there is a clear possibility that to meet these targets, countries will rely disproportionately on expanding their hydropower capacities, a development that may pose environmental risks for some of the healthiest and most pristine waterways in Europe. Hundreds of new hydro plants, mainly of a micro scale (<10 MW), have been announced and are at various stages of planning[93].

Without proper planning, river dams - including those intended to produce hydropower - can have significant impacts on the longitudinal river continuum for biota and sediments. This can potentially lead to a loss of ecological integrity, and serious river degradation processes downstream of dams (channel incision) down to the coastal zone, resulting in coastal erosion and deterioration of deltaic and marine ecosystems. Such impacts do not only affect the environment; coastal tourism may suffer as well. Countries that rely heavily on hydropower may face reduced generation and higher prices in the event of protracted drought.

All the interconnections described above justify considering a Water-Energy-Food Nexus as the relevant approach to plan for and manage sustainability transitions in the Mediterranean. Taking into account water-energy-food interactions can help reduce trade-offs and generate benefits that outweigh the costs associated with stronger integration across sectors. Such gains should encourage governments, private sector and civil society to take on coordination efforts.

6.2 Water resources and water security

6.2.1 Precipitation and soil moisture

The Mediterranean climate is generally characterized by mild and wet winters, and dry, hot summers. Precipitation strongly differs between subregions, especially in winter. Long-term average precipitation[94] ranges from 33 mm per year in Egypt to 1,325 mm per year in Slovenia, i.e. 40 times more (*Table 26* and *Figure 147*), with a clear North/South divide. Variations within countries are particularly associated with the orography of continental regions, with higher precipitation in mountainous areas than plains[95].

Precipitation over the Mediterranean region is critical to the availability of water resources. It provides the water

Countries	Precipitation (mm)	Countries	Precipitation (mm)
North		South	
Albania	981	**Algeria**	83
Bosnia and Herzegovina	1,072	**Egypt**	33
Croatia	1,066	**Libya**	44
Cyprus	468	**Morocco**	315
France	841	**Tunisia**	271
Greece	649	East	
Italy	927	**Israel**	258
Malta	428	**Lebanon**	565
Montenegro	1,135	**State of Palestine**	413
Portugal	839	**Syrian Arab Republic**	289
Slovenia	1,326	**Turkey**	568
Spain	610		

Table 26 - Long-term average annual precipitation by country, 1961-2015
(Source: World Bank, 2016[96])

[93] According to their National Renewable Energy Action Plans for 2020, compared to 2016, Albania plans to increase its hydro capacity from 1,838 Megawatt (MW) to 2,324 MW, Bosnia and Herzegovina from 2,180 MW to 2,700 MW and Montenegro from 674 MW to 826 MW.
[94] From 1961–2015.
[95] Maximum precipitation levels are recorded over the Alps and Dinaric Alps with over 1,500 mm per year. Minimum precipitation levels are recorded over the Southern Mediterranean with high precipitation in the Atlas Mountains in Algeria and Morocco.
[96] Calculated as the average annual precipitation between 1961 and 2015.

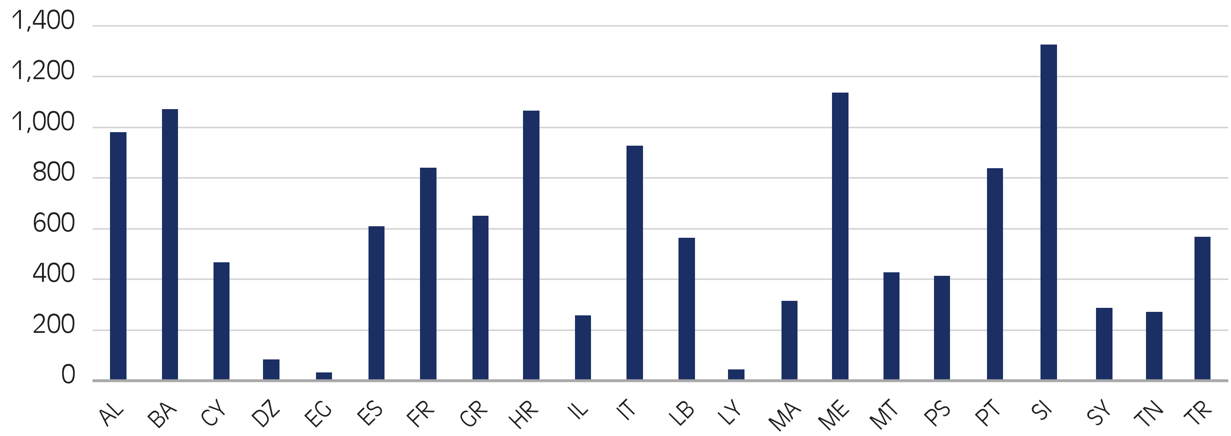


Figure 147 - Long-term average annual precipitation by country (1961-2015)
(Source: World Bank, 2016)

that flows in rivers and infiltrates to recharge groundwater (blue water), as well as the water that is stored in the soil as soil moisture (green water). The latter controls the exchange of energy and water between land surfaces and the atmosphere, which impacts rainfall-runoff processes. Thus, soil moisture is vital for the ecosystem and agricultural outputs (food security). In the Southern and Eastern Mediterranean, soil moisture is very low due to low precipitation and high temperatures, limiting the possibility of rainfed agriculture. Since precipitation is considerably less than potential evaporation in these parts of the Mediterranean region, any future decrease in precipitation will often cause a decrease in soil moisture.

The Mediterranean region has been recognized as one of most vulnerable regions to climate change, including projected decreases of precipitation and increases of evapotranspiration.

6.2.2 Freshwater availability

The ten largest Mediterranean river basins are the Nile (Egypt), Rhone (France), Ebro (Spain), Po (Italia), Moulouya (Morocco), Meric/Evros (Greece, Turkey), Chelif (Algeria), Büyük Menderes (Turkey), Axios/Vardar (Greece) and Orontes/Asi (Turkey). River inflow into the Mediterranean represents approximately 340 km^3 (Montreuil & Ludwig, 2013). A general decline in water discharge from rivers in the last 50 years has been observed. This decline results from the impact of multiple stressors, namely decreasing precipitation, an increasing number of reservoirs and increasing irrigated areas.

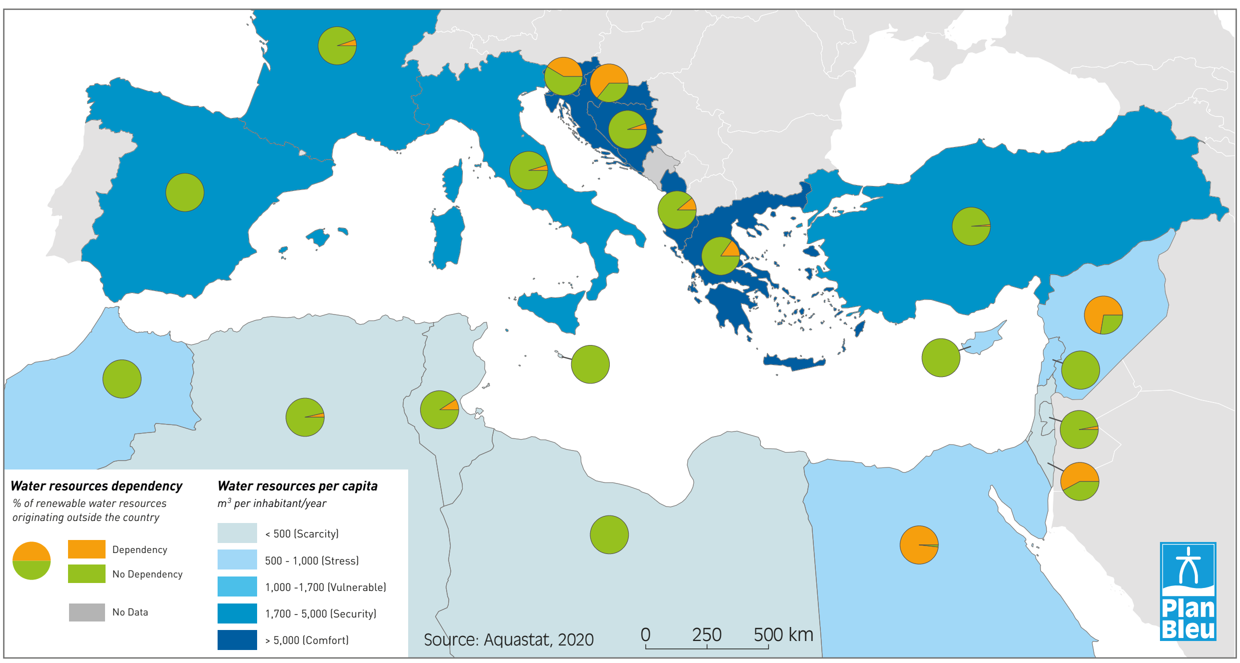


Figure 148 - Total renewable water resources per capita in the Mediterranean, 2017
(Source: FAO, 2020)

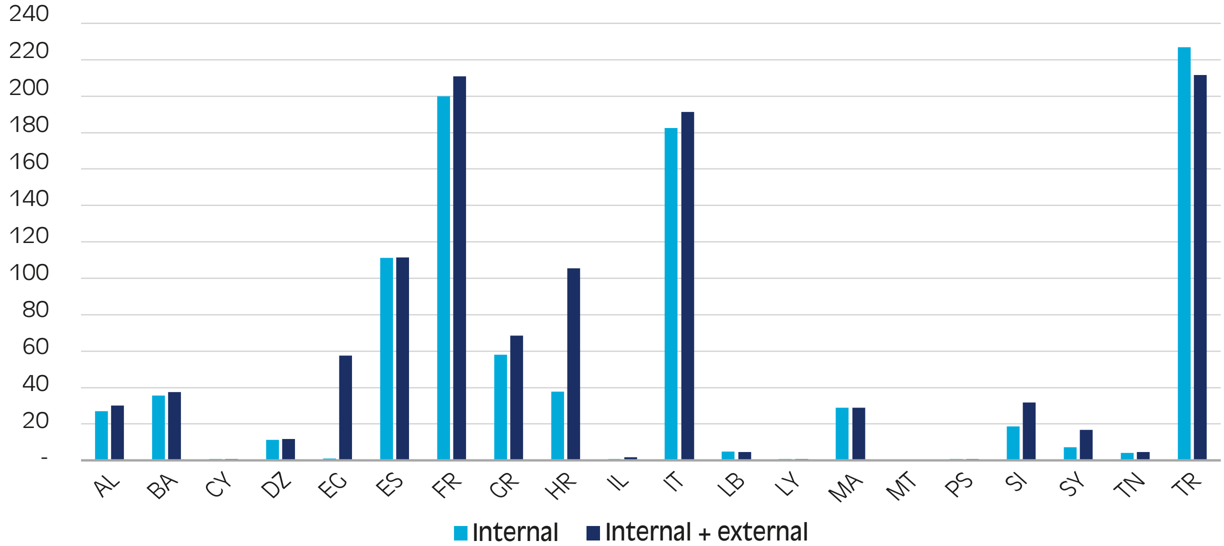


Figure 149 - Internal and external total renewable water resources in the Mediterranean (109 m³/year), 2017
(Source: FAO, 2020) - Note: No data for MC and ME.

6.2.2.1 Total Renewable Water Resources

Total Renewable Water Resources (TRWR[97]) are unevenly distributed across Mediterranean subregions: 67% are located in the North, 10% in the South, and 23% in the East, over 20.5% are in Turkey (FAO, 2016a). These heterogeneities are further emphasized by uneven population growth, as population is stagnating in the water rich North and continues to grow in the water poor South *(Figure 148)*. With less than 500 m³ per capita per year, Algeria, Israel, Libya, Malta, the State of Palestine and Tunisia face absolute water scarcity. With more than 500 m³ but less than 1,000 m³ per capita per year, Cyprus, Egypt, Lebanon, Morocco and the Syrian Arab Republic are water scarce (FAO, 2016a). Most of the NMC population is water-secure, with some countries considered as living in the comfort of water abundance, such as the Balkans.

Figure 149 shows the total renewable water resources (i.e. the sum of internal and external resources), which can mask the dependency of some countries on external water resources, i.e. water originating from outside of their borders. For instance, Egypt depends on external water for 98% of its freshwater resources, the Syrian Arab Republic

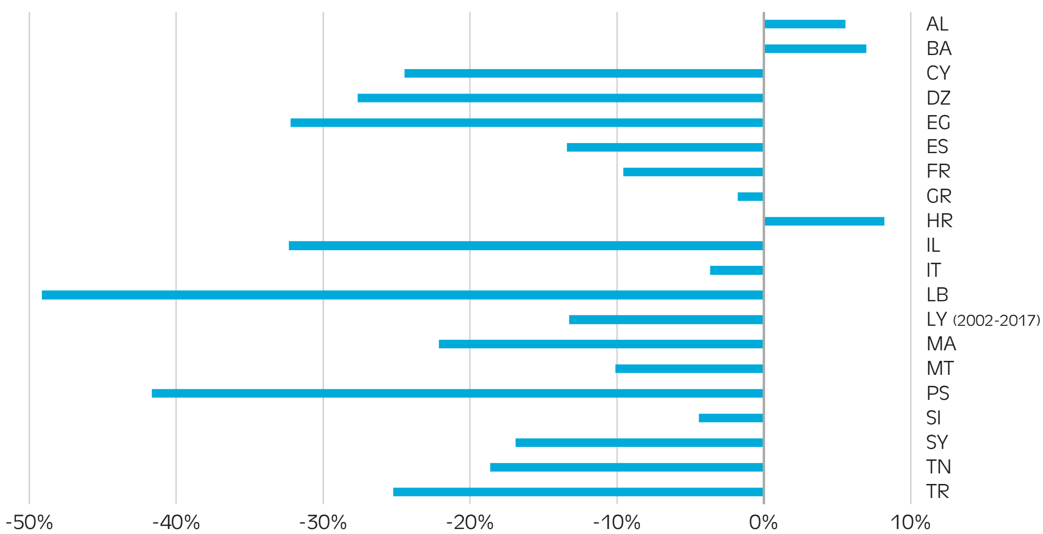


Figure 150 - Changes to internal renewable water resources per capita between 1997 and 2017, variations in %
(Source: FAO, 2020) - Note: No data for MC and ME.

[97] Total Renewable Water Resources (TRWR) is defined as the sum of internal renewable water resources (IRWR) and external renewable water resources (ERWR). It corresponds to the maximum theoretical yearly amount of water available for a country at a given moment. Source: AQUASTAT, Glossary (FAO, 2016a).

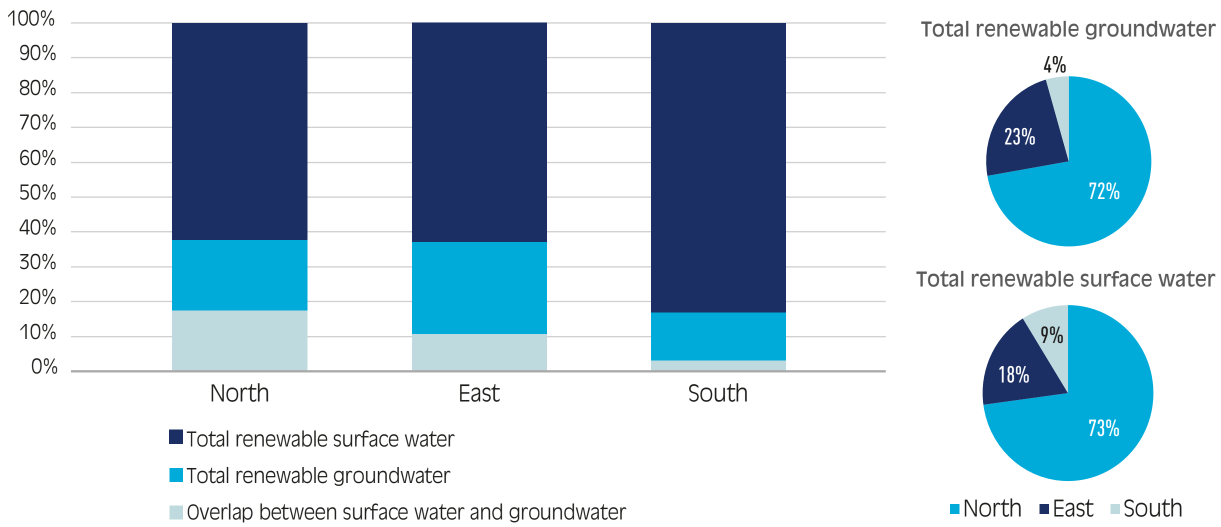


Figure 151 - Surface and Groundwater Renewable Water Resources by subregion, 2017
(Source: FAO, 2020[98])

for 58% and Israel for 58% *(Figure 149)*. Total renewable water resources in the Mediterranean Region amount to 1,127 km^3 (FAO, 2020).

The water resources of Mediterranean countries have deteriorated. Internal freshwater resources (IRWR) per capita decreased by 29% between 1997 and 2014. The most affected countries are Lebanon (- 45%) and the State of Palestine (-37%). In the Balkan countries, the IRWR per capita increased on average by 5% between 1997 and 2014, while they decreased by 4% on average in the European Union.

6.2.2.2 Surface water and groundwater

Mediterranean countries are highly dependent on both surface and groundwater resources, and both are affected by unsustainable consumption patterns and over-abstraction. Excessive groundwater abstraction for irrigation is leading to rapid aquifer depletion (Dalin et al. 2017), threatening the sustainability of food production, and inducing significant environmental damage, such as land subsidence and seawater intrusion (Calò et al. 2017; Custodio, 2018). It also contributes to the major cross-border challenges affecting the Mediterranean region (UNEP/MAP & UNESCO-IHP, 2015).

In terms of Mediterranean groundwater resources, 72% are located in the North, 23% in the Middle East and only 5% in the South. For surface water, 73% is located in the North, 18% in the East and 9% in the South *(Figure 151)*. In the southern subregion, surface water represents 85% of water resources, and up to 97% in Egypt (*Figure 151* and *Figure 152*).

Algeria, Morocco and Tunisia rely on both surface and groundwater for their freshwater withdrawals. Malta relies entirely on groundwater. Groundwater accounts for over or around 70% of freshwater withdrawals for Croatia, Cyprus, Libya and Tunisia. Most islands in the subregion use all renewable groundwater and over-abstract their resources at an increasing cost as the water table goes down. Some islands are even dependent on expensive transportation of water from the mainland to deal with structural shortages (Greek islands, Croatian islands) or during droughts (MED-EUWI WG, 2007). In the eastern subregion, the State of Palestine and Israel rely mostly on groundwater, while the other countries rely on both surface and groundwater resources. Unsustainable consumption and over-abstraction of surface and groundwater resources already contribute to water shortages and threaten long-term sustainable development.

As a consequence of irrigation, aquifers with declining groundwater levels are common in the Mediterranean region, in particular in the southern and eastern subregions and some northern areas. Custodio et al (2016) cite examples in Spain, such as the 300 m decline in the Crevillente aquifer (province of Alicante) in 30 years or in the extreme case of Libya, ranked by Wada, van Beek & Bierkens (2012) as the Mediterranean country with the most rapid groundwater depletion. Overexploitation associated with irrigated agriculture may also lead to groundwater pollution and seawater intrusion in coastal areas. In addition, tourism has expanded considerably in the Mediterranean since the 1960s and weighs heavily on groundwater. Tourism induces high additional demand in coastal areas during peak seasons that in most cases coincide with the dry season. This can put a considerable strain on available water resources

[98] The 'overlap' represents the part of the renewable freshwater resources common to both surface and groundwater.

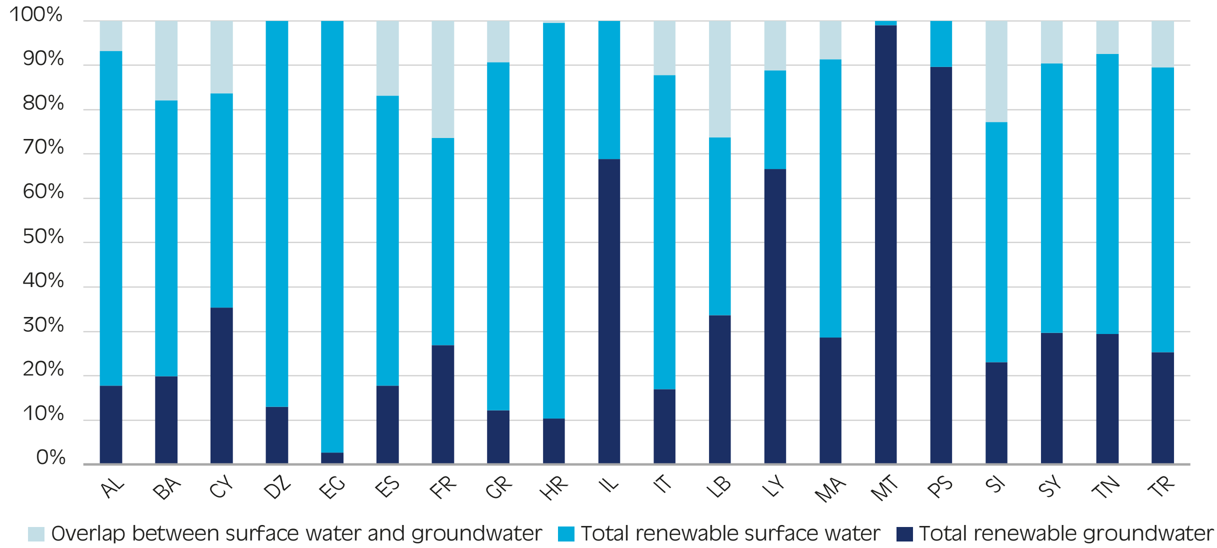


Figure 152 -Surface and Groundwater Renewable Water Resources by country, in % of total renewable water resources, 2017
(Source: FAO, 2020)

as well as wastewater infrastructure (Gössling et al. 2012). Most of the aquifers in the region are transboundary, such as the large Saharan aquifers shared between Algeria, Libya and Tunisia, and between Egypt and Libya *(Figure 153)*.

The North-Western Sahara aquifer system has a renewal rate of only 40% of the withdrawals (Goncalvès et al. 2013), indicating high vulnerability of the oasis systems that depend on it. Some of these aquifers are deep (in particular Algeria, Egypt and Libya) with substantial water resources but this water is not renewable. *Figure 153* shows the critical aquifers in the region with very low recharge. Sustainable use of these aquifers is essential to protect this valuable resource.

6.2.2.3 Climate change influence on freshwater availability

Water availability in the Mediterranean Basin is expected to further decline in the coming decades as a consequence of (i) decreased precipitation, (ii) rising temperatures, and (iii) population growth, especially in the countries already short in water supply. Water quality is also expected to decrease due to pollution and salt intrusion in coastal areas. Both phenomena may increase conflicts over freshwater use. Overall, there is a high level of certainty that a 1.5°C to 2°C increase in global warming will cause strong increases in dryness and decrease water availability in the Mediterranean and southern Europe.

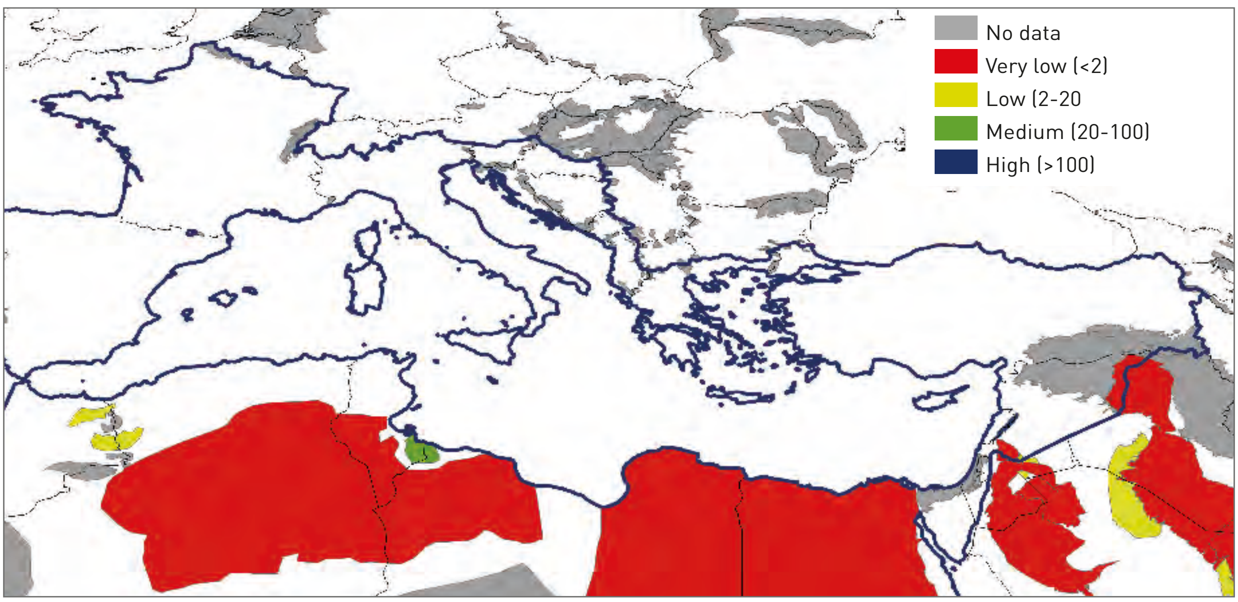


Figure 153 - Transboundary aquifers (Source: layer extracted from IGRAC-UNESCO-IHP, 2015) and mean annual groundwater recharge (mm/year)
(Source: layer extracted from UNESCO-IGRAC, 2016)

Compared to 1960-1990, annual precipitation is projected to decrease in 2040-2070 by around 15% in Southern Mediterranean countries and the Middle East (García-Ruiz et al. 2011), while this decrease is expected to be around 10% in South Italy, Greece and Southern Turkey. It is projected that Southern and Eastern Mediterranean Countries (SEMCs), as well as southern Spain, will experience a decrease in winter precipitation, the highest decrease in the Mediterranean region.

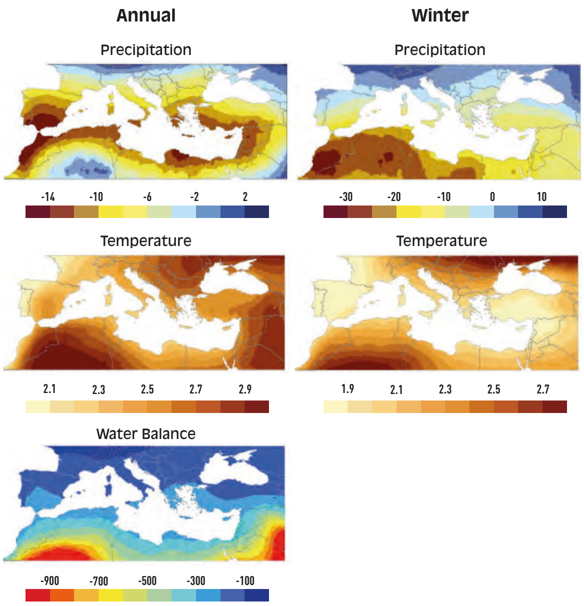


Figure 154 - Mean annual and winter climate changes precipitation (P, %), temperature (T, °C) and water balance (P–T, mm) projected for the Mediterranean region between 2040 and 2070 in comparison to 1960-1990 by nine general circulation models.
(Source: García-Ruiz et al. 2011)

Due to climate change (enhanced evapotranspiration and reduced rainfall), freshwater availability is likely to decrease substantially (by 2 to 15% for 2°C warming), among the most significant decreases in the world (Jiménez Cisneros et al. 2014; Gudmundsson & Seneviratne, 2016; Gudmundsson, Seneviratne & Zhang, 2017). The IPCC 1.5°C special report projects for the Mediterranean a mean decrease of 10% per °C in precipitation minus evapotranspiration budget but with high uncertainty. With an 18% reduction in TRWR availability in Crete under a +2°C scenario, only 6% is due to the precipitation reduction and 12% to the evapotranspiration increase (Koutroulis et al. 2016). In Greece and Turkey, water availability may fall below 1000 m³ per capita and per year for the first time in 2030 (Ludwig et al. 2010). In South-Eastern Spain and on the southern shores, water availability may drop to below 500 m³ per capita per year[99]. Particularly in the Middle East and Near East, people are expected to become newly exposed to chronic water shortages even if warming is under 2°C. Significant increases are also expected in the length of meteorological dry spells (Kovats et al. 2014; Schleussner et al. 2016) and droughts (Tsanais et al. 2011). Impacts on wheat and barley production are expected to hit hardest in the Syrian Arab Republic and neighbouring countries. The importance of covering environmental flow requirements for assuring the healthy functioning of aquatic ecosystems means that certain amount of water will need to be maintained in the systems, further limiting availability for human uses (Hermoso & Clavero, 2011).

Under climate change scenarios, river flow is generally reduced, particularly in the Southern and Eastern Mediterranean, where water is in critically short supply (Forzieri et al. 2014). As a result of decreased precipitation, low river flows are projected to decrease in the Mediterranean under 1.5°C of global warming (Marx et al. 2018), with associated significant decreases in high flows and floods (Thober et al. 2018). The seasonality of stream flows is highly likely to change, with earlier declines of high flows from snow melt in spring, intensified low flows in summer and g reater and more irregular discharges in winter (Garcia-Ruiz et al. 2011).

Water levels in lakes and reservoirs will likely decline. For example, the largest Mediterranean lake, Lake Beyşehir in Turkey, may dry out by the 2040s if its outflow regime is not modified (Bucak et al. 2017).

Further challenges to water availability and quality in coastal areas will likely arise from salt water intrusion driven by enhanced extraction and sea level rise, and increasing water pollution on the Southern and Eastern shores (Ludwig et al. 2010) from new industries, urban sprawl, tourism development, migration and population growth. Groundwater recharging will be diminished, affecting most of the region. Water requirements for irrigation in the Mediterranean region are projected to increase by between 4 and 18% by the end of the century due to climate change alone (for 2°C and 5°C warming, respectively). Population growth, and increased demand, may increase these numbers to between 22 and 74% (Fader et al. 2016).

6.2.3 Status and trends of water use and demand: breakdown by sector and categories of users, efficiency of water use

6.2.3.1 Water demand

The socioeconomic development of the Mediterranean region is highly dependent on water availability. Substantial pressure on finite water resources is induced by a rapidly growing population and urbanization requiring an increase in agricultural, energy and industrial outputs.

[99] The 'overlap' represents the part of the renewable freshwater resources common to both surface and groundwater.

Demand in Mediterranean watersheds. While watershed (i.e. catchment area) data is crucial in the Mediterranean, no recent data is available on this geographical scale for the entire region. Total water demand[100] in Mediterranean watersheds was last estimated at 119.5 billion m³/year (according to Margat & Treyer, 2004 and Milano et al. 2012). Irrigated agriculture was the most water demanding sector with 66 billion m³/year (55%), mainly for the production of cereals, vegetables and citrus. The other main sectors were the energy and domestic sector, with water demand accounting for 21.8 billion m³/year (19%) and 19.5 billion m³/year (16%), respectively. Water demand for industries not connected to the municipal water network amounted to 12.2 billion m³/year (10%). Significant differences in the proportion of water demand existed between catchment areas. Water demand for irrigation purposes represents more than half of the total water demand for all catchment areas, except in France and Italy, where water demand for energy and industrial purposes prevail, and in Slovenia and Croatia, where domestic water demands prevail.

Water demand can also vary significantly throughout the year. During summer, irrigation water demand increases due to hot and dry weather conditions and maximum phenological stage (Collet et al. 2013). Water demand from the domestic sector also increases as a result of tourism activities. For example, in riparian areas, domestic water demand can double in summer in la Costa Brava (Spain) or Côte d'Azur (France) compared to winter water demand (Plan Bleu, 2011).

Withdrawal[101] in Mediterranean countries. In Mediterranean countries, total water withdrawal from all sectors is 290 billion m³ per year (FAO, 2019a), but distribution is uneven between the three main sectors: irrigated agriculture, industry and services *(Figure 155)*.

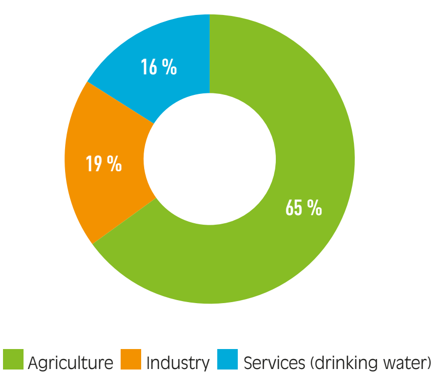


Figure 155 - Distribution of total water withdrawals between the three main sectors of water use in the Mediterranean region
(Source: FAO Aquastat, 2018)

In the North, 51% of water withdrawals are used for agriculture. The agricultural sector represents a greater proportion of water withdrawals in the South and East with 84% and 81% of the total freshwater withdrawals (blue water), respectively.

This finding emphasizes the importance of rainfall agriculture (using green water[102]), which is not developed enough and could be further valued in the semi-arid and arid zones. Improved efficiency of rainfall agriculture by conserving water and soil would increase the rainwater storage capacity of the soil and thus limit the need to irrigate, while limiting erosion and silting downstream.

By 2050, under a business-as-usual water-use scenario, water withdrawals are projected to double or even triple in catchment areas in the Southern and Eastern Mediterranean due to population growth, expansion of irrigated areas and increasing crop water needs resulting from warmer and drier conditions (Milano et al. 2012). In addition, crops on new irrigated land (mainly maize and alfalfa) have higher water needs than traditional Mediterranean crops (cereals, olives, grapes). In the Northern Mediterranean, agricultural water demands for irrigation are projected to increase mainly in the Ebro catchment area (Spain) and in Greece due to warmer and drier conditions affecting crop water needs (Milano et al. 2012). Domestic water demand in the Northern Mediterranean should remain constant or decrease as population is projected to stabilize in the medium term.

6.2.3.2 Water stress

Level of water stress (SDG indicator 6.4.2) refers to freshwater withdrawals as a proportion of available freshwater resources, taking into account environmental water requirements (the minimum amount of water required to maintain freshwater and estuarine ecosystems and their functioning included in the calculation).

The renewable freshwater resources of the Mediterranean region amount to 1,123 billion m³ per year (FAO, 2015). 84% of average long-term flows are generated by precipitation within the countries, and 16% is from water entering the countries, considering flows reserved for upstream and downstream by agreements or treaties. Total freshwater withdrawals, defined by the volume of freshwater extracted from rivers, lakes, or aquifers for the needs of agriculture, industry and municipalities, is evaluated at 290 billion m³ per year (FAO, 2015). Exploitation is therefore estimated at 37%, which remains well below the 70% threshold indicating severe water stress and potential water shortage. The level of water stress differs across countries with three groups:

[100] Water demand means total withdrawals from resources (95% of the total, including leakage during pipage and usage) and non-conventional sources (desalination, reuse of treated wastewater, etc.).
[101] Water withdrawal describes the total amount of water withdrawn from a surface water or groundwater source. Measurements of this withdrawn water help evaluate demand from domestic, industrial and agricultural users. Water consumption is the portion of the withdrawn water permanently lost from its source.
[102] Green water is the soil moisture from precipitation, used by plants via evapotranspiration.

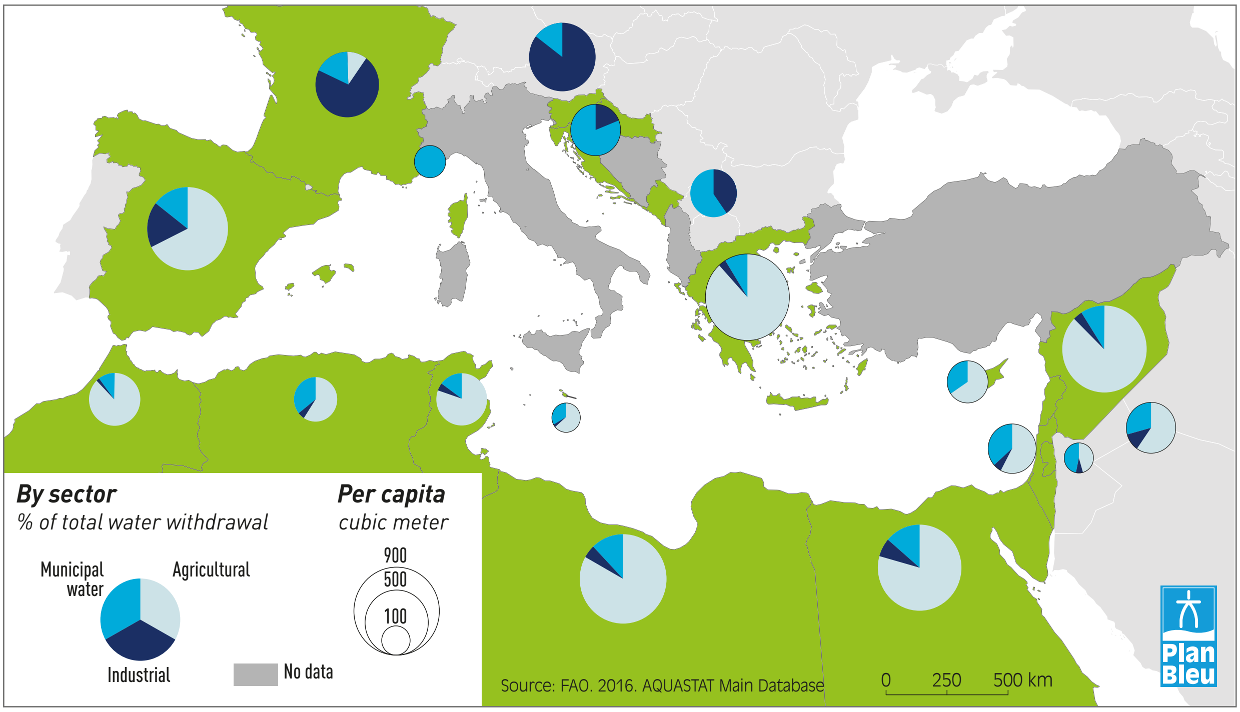


Figure 156 - Water withdrawal by sector and per capita in Mediterranean countries in 2016
(Source: FAO Aquastat, 2019)

- Algeria, Egypt, Israel, Libya, the Syrian Arab Republic and Tunisia exploit more than 80% of their available renewable water resources and their level of water stress tends towards serious water shortage;
- Cyprus, Lebanon, Malta, Morocco, Spain and the State of Palestine with exploitation approaching 50% form a group of countries with a risk of water shortage in the future;
- Albania, Bosnia and Herzegovina, Croatia, France, Greece, Italy, Slovenia and Turkey exploit less than 30% of their available renewable water resources, with local (sub-national) disparities.

A regional-scale investigation was conducted for the Mediterranean basin (Milano et al. 2013a). It highlighted that 112 million people experience water shortage conditions. The most vulnerable regions are Southern Spain, Libya, Tunisia, and the South-Eastern Mediterranean (Israel, Lebanon, State of Palestine and Syrian Arab Republic). By 2050, 236 million people are expected to be living under water shortage. If water use efficiency objectives set by the 2005 Mediterranean Strategy for Sustainable Development are met, the number of people living under high to severe water stress could be trimmed down to 228 million. Severe

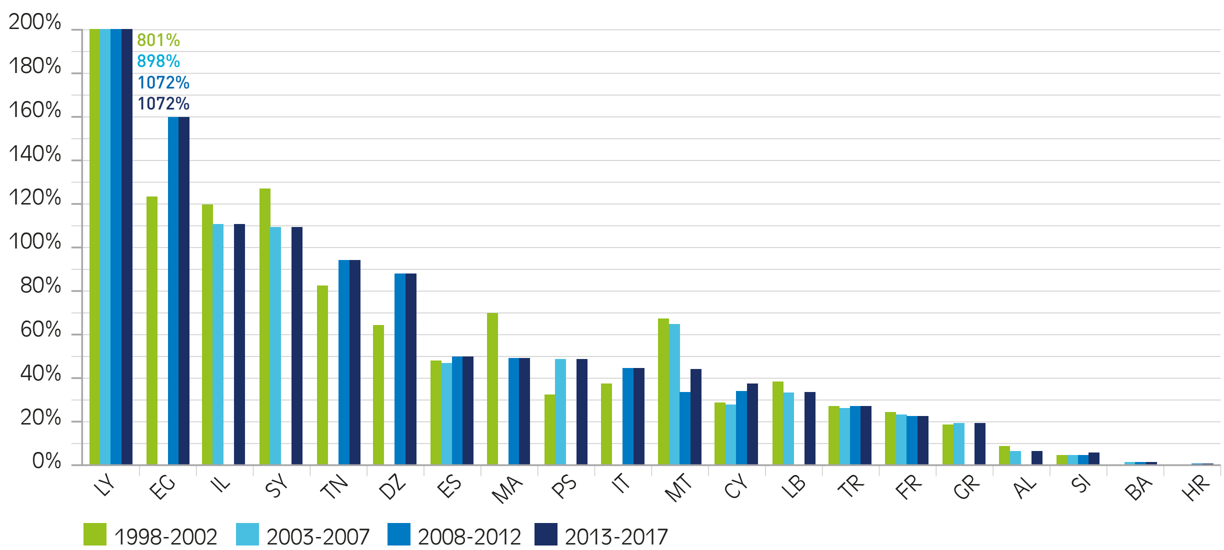
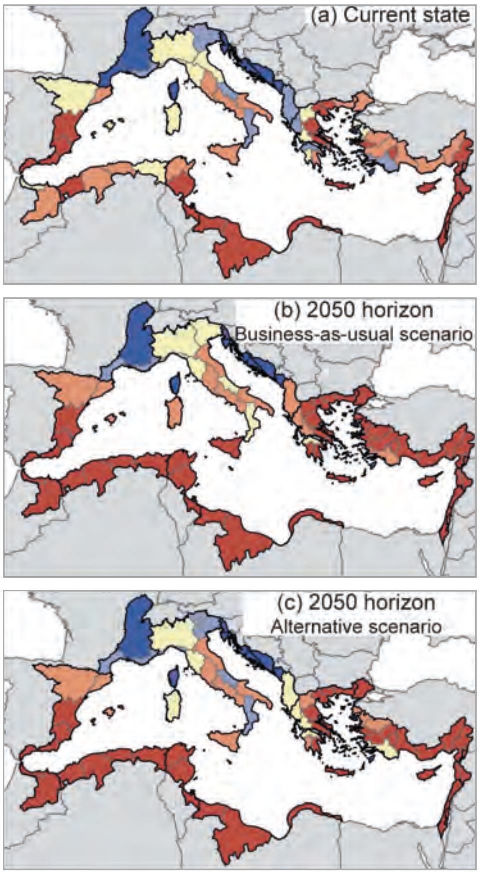


Figure 157 - Freshwater withdrawal as a proportion of available freshwater resources in Mediterranean countries
(Source: FAO and UNSTATS, 2018)

water stress situations could be mitigated in Albania, Greece and Turkey but efficiency improvements alone would not be able to reduce water stress in Spain and the Southern Mediterranean.

Differences may also occur within countries depending on multiple factors such as the level of development, population density, the availability of conventional and non-conventional water resources, general climate conditions, and spatial and seasonal variability.



Water stress index

- <10% (No water stress)
- 10%-20% (Low water stress)
- 20%-40% (Moderate water stress)
- 40%-80%(High water stress)
- >80% (Very high water stress)

Figure 158 - Water stress changes in the Mediterranean
Current water stress over the Mediterranean basin (a) and changes by 2050 according to a business-as-usual scenario (b) and an alternative scenario (c).
(Source: Milano et al. 2013a; Milano et al. 2013b)

6.2.3.3 Water Efficiency

SDG 6 "Clean Water and Sanitation" emphasizes the need to ensure more efficient and sustainable water management. Target 6.4 encourages a substantial increase in water-use efficiency across all sectors and sustainable withdrawals and supply of freshwater to address water scarcity and reduce the number of people suffering from it. Water-use efficiency (SDG indicator 6.4.1) is defined as the value added by quantity of water withdrawn, expressed as USD /m^3 for a given sector[103]. In the Mediterranean, estimations range between USD 3 /m^3 and USD 185 /m^3 (FAOSTAT, 2018). As this is a new indicator, it is impossible to define a specific target for its value. But the indicator should, at least, follow the same path as the country's economic growth.

Economic efficiency is also unevenly distributed among sectors. In the Mediterranean, irrigated agriculture uses 189 billion m^3, or 65% of total water demand (global average: 69% (FAO, 2016b)), considered as the most water-consuming sector. Water use efficiency in this sector is typically much lower than in the industrial and services sector. In Europe, for example, water use efficiency of the agricultural sector is around 50 times lower than in the industrial and 70 times lower than in the services sector. A general rule of thumb leads to lower agricultural water use efficiency in countries with lower GDP per capita and higher contribution of agriculture to GDP and to total water use (Rossi, Biancalani & Chocholata, 2019). Therefore, similar, or even more divergent rates of agricultural water use efficiency compared to other sectors' water use efficiency can be expected in the Mediterranean. Considerable water losses undermine water efficiency in the agricultural sector, which calls for modernization of irrigation systems and awareness raising programmes on water saving practices for farmers.

6.2.3.4 Environmental flows

River runoff throughout the Mediterranean basin and water discharge of specific quantity, timing and quality into the Mediterranean Sea support nutriment, sediment and carbon flows which are essential for coastal and marine ecosystems. Environmental flows, or environmental water requirements, describe "the quantity, timing, and quality of

[103] The indicator is calculated as the sum of the value added of three sectors: irrigated agriculture, industries and services; weighted according to the proportion of water withdrawn by each sector compared to total withdrawals. Only runoff water (blue water) is taken into account when calculating the indicator. Agricultural production generated by rainfed agriculture in particular should be subtracted from the overall sectoral value added.
$WUE = Awe \times PA + Iwe \times PI + Swe \times PS$
WUE = Water-use efficiency
Awe = Efficiency of water used in irrigated agriculture [Value added of irrigated agriculture in USD/ quantity of freshwater used in m^3]
Iwe = Efficiency of water used in industries [USD/ m^3]
Swe = Efficiency of water used in services [USD/ m^3]
PA = Proportion of water withdrawn by the agricultural sector over total withdrawal
PI = Proportion of water withdrawn by the industrial sector over total withdrawal
PS = Proportion of water withdrawn by the services sector over total withdrawal

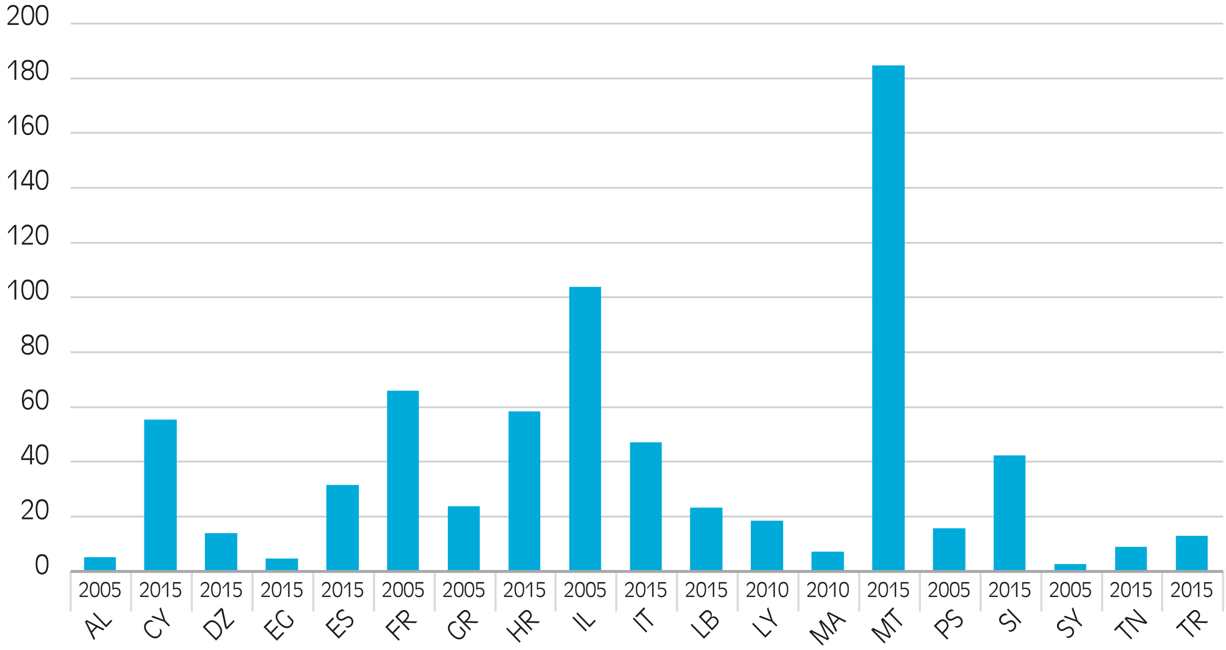


Figure 159 - Water use efficiency calculated for the Mediterranean countries, no data for BA, MC, ME
(Source: FAOSTAT, 2019)

freshwater flows and levels necessary to sustain aquatic ecosystems which, in turn, support human cultures, economies, sustainable livelihoods, and well-being" (Arthington et al. 2018). Environmental flows (EF) are increasingly recognized as a key component of River Basin Management Plans and Water Allocation Plans. FAO recently launched new guidelines for incorporating environmental flows into SDG indicator 6.4.2 "level of water stress" to help countries improve water management by ensuring a sustainable water supply that meets the needs of people, agriculture, energy, industry and the environment within the limits of availability (FAO, 2019).

In EU Mediterranean countries, EF are monitored under the EU Water Framework Directive 2015, and defined as a "flow regime consistent with the achievement of the environmental objectives of a water body" (i.e. good ecological status for natural water bodies; good ecological potential for heavily modified and artificial water bodies, and good quantitative and chemical status for groundwater bodies) (de Jalón et al. 2017).

Reservoir dams are designed to regulate river flow and provide continuous irrigation. Mediterranean dams mainly serve irrigation and hydroelectricity generation. There are 398 dams identified in the Mediterranean basin (Plan Bleu calculations based on the Global Reservoir and Dam Database (GRanD) v1.3, Lehner et al. 2011). Twenty-four were built between 2009 and 2016, mostly in Turkey (more than half) and Algeria. The High Aswan dam in Egypt has by far the largest reservoir surface area (5,385 km^2), and is followed by the Miorina Dam in Italy (208 km^2), Nechma Dam in Tunisia (87 km^2) and the Catalan and Kremasta Dams in Turkey and Greece respectively (62 km^2). The Ermenek Dam in Turkey and Vajont Dam in Italy are the highest in height.

The increase in the number and capacity of dams in Mediterranean countries *(Figure 160)*, as well as changing land covers, and increasing pollution, have considerable impacts on downstream ecosystems and the services they provide. Flow regulation infrastructures affecting land-sea interactions (especially ecological connectivity) are often related to agricultural developments, energy, and water supply, therefore requiring integrated management.

Water demand in coastal areas of the Mediterranean region is largely met by water transfers from the hinterland of the Mediterranean basin. For example, in France, canals transport water from the Rhone and Durance basins to large coastal cities like Marseille. Other transfers, from outside to within the Mediterranean basin support Mediterranean coastal population and activities (e.g. the Tagus in Spain, from Jordan to Israel, from the Atlantic basin to Morocco and from the aquifers of the Sahara to Libya). These transfers have a significant impact on neighbouring ecosystems.

Over the past three decades, despite geographical disparities, Mediterranean countries as a whole have experienced strong population growth accompanied by a substantial increase in cultivated area (around 1.6% average annual increase between 1992 and 2015) and open water areas (approximately 12.3% between 1984 and 2015). The latter seems to correlate with the number and capacity of water infrastructure, especially dams for agriculture (Pekel et al. 2016). The vast majority of this infrastructure is related to agricultural projects. There is therefore a link

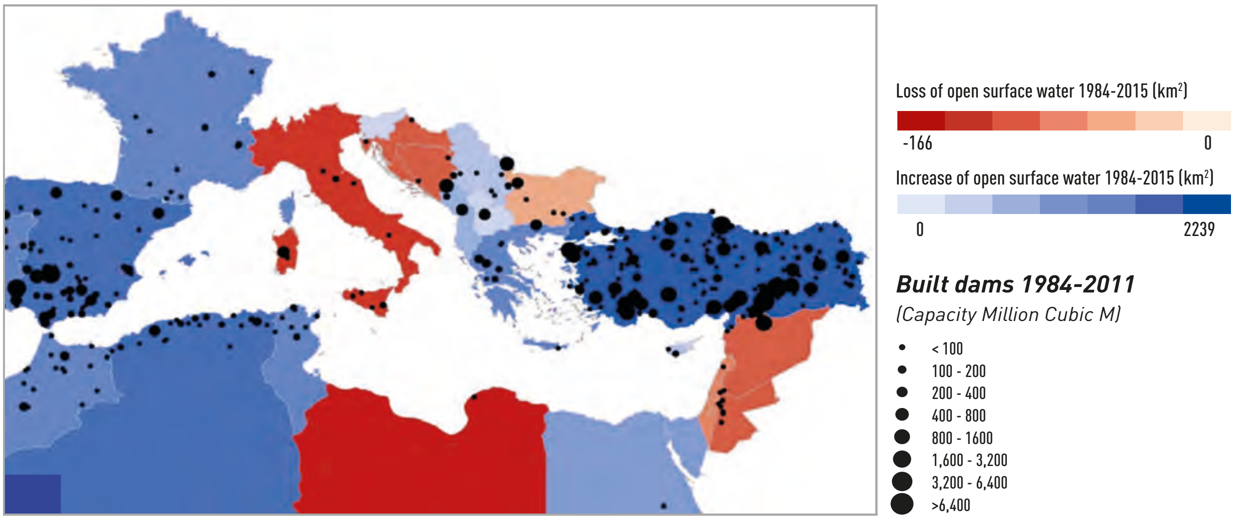


Figure 160 - Loss and increase of open surface water area and number and capacity of dams
(Source: Global Surface Water Explorer (European Commission, 2019) and Global Reservoirs and Dams database (Global Water System Project, 2019))

between agriculture, the development of surface water infrastructure, water dynamics and natural wetlands, many of which directly depend on inflow from upstream freshwater bodies. This profoundly modifies and alters ecological processes and in certain cases, could lead, to their gradual drying up or even complete disappearance. It is therefore recommended that the agricultural development models of Mediterranean countries be partially or entirely re-examined, so that agriculture, a key economic sector, does not enter into conflict with the conservation of natural wetlands and the services they provide (surface water purification, groundwater recharge, flood regulation, drought mitigation, biodiversity conservation, etc.).

6.2.3.5 Water footprint in the Mediterranean

In the Mediterranean region, trade in raw materials and manufactured products induces virtual water transfers that impact water resource management at different scales. According to the Water Footprint Network, the water footprint[104] has three components: green, blue and grey (Hoekstra, Chapagain & Mekonnen, 2011). The blue water footprint refers to the consumption of blue water resources[105]. The green water footprint is the volume of green water[106] consumed. The grey water footprint is an indicator of the degree of freshwater pollution and is defined as the volume of freshwater required to assimilate the load of pollutants based on existing ambient water quality standards. The national water footprint includes two components: the part of the footprint that falls inside the country (internal water footprint) and the part of the footprint that presses on other countries in the world (external water footprint). The distinction refers to the appropriation of domestic water resources versus the appropriation of foreign water resources through the goods and services consumed.

Mediterranean people use lots of water for drinking, cooking and washing, but even more for producing food, paper, cotton clothes, etc. In the Mediterranean region, when the water footprint and available water resources are compared among countries, two situations emerge:

- One group, mostly composed of NMCs, has a water footprint that is smaller than available water resources[107];
- In a second group, especially the SEMCs, the water footprint exceeds available water resources[108].

[104] The water footprint is an indicator of freshwater use that looks at both direct and indirect water use of a consumer or producer. The water footprint of an individual, community or business is defined as the total volume of freshwater used to produce the goods and services consumed by the individual or community or produced by the business. Water use is measured in terms of water volumes consumed (evaporated or incorporated into a product) and/or polluted per unit of time. A water footprint can be calculated for a particular product, for any well-defined group of consumers (for example, an individual, family, village, city, province, state or nation) or producers (for example, a public organization, private enterprise or economic sector). The water footprint is a geographically explicit indicator, showing not only volumes of water use and pollution, but also the locations. (Source: Water Footprint network).
Generally, we can define three major factors that determine the water footprint of a country:
- The first is the overall volume of consumption. This is directly related to the wealth of a country;
- A second factor is the lifestyle of the inhabitants: a diet rich in meat significantly increases the footprint of a country. The consumption of industrial goods also accounts for a large part in the ranking;
- The third factor is the climate. In hot climates, evaporation and water use for agriculture is particularly high.

[105] Fresh surface and groundwater, i.e., the water in freshwater lakes, rivers and aquifers.

[106] The precipitation on land that does not run off or recharge the groundwater but is stored in the soil or temporarily stays on top of the soil or vegetation..

[107] Turkey, France, Italy, Spain, Croatia, Albania, Bosnia and Herzegovina, Slovenia.

[108] Egypt, Morocco, Syrian Arab Republic, Algeria, Lebanon, Tunisia, Israel, Cyprus, Libya, Montenegro.

BOX 71

Environmental flows for the Jucar River Basin in Spain

Water is a scarce resource in many Spanish regions, including in the Jucar River Basin (Valencia). The general objective of the River Basin Management Plans (RBMPs) is to achieve fair sharing among water users while ensuring water preservation and improving water quality. Through a variety of laws and texts, Spanish legislation identifies environmental flows as a primary restriction before any water abstraction or use, and underlines the necessity to assign environmental flows (E-flows) in the RBMP.

The case of Jucar River Basin Environmental flow (E-flow) control

The Jucar River Basin Authority (JRBA) applied an E-flow assessment methodology for the first time with the publication of the Public Order of 13 August 1999. Since then, one of the basic components of E-flows, i.e. the minimum flow, has been assigned and approved in the RBMP. The first minimum flow values were determined for the first planning cycle (2009 - 2014). Other components of the E-flows were assessed and approved (e.g. maximum flows) for the first and second planning cycles (2015 - 2021). However, while some of the E-flow studies have improved the E-Flows with the aim of improving ecological conditions, some locations suffered a reduction of E-flows below 10% across the river basin.

So far, minimum flow values have been assigned to 39 and 61 out of 314 water bodies, to be obtained during the 1st and 2nd hydrological planning cycles, respectively. *Figure 161* shows the proportion of water bodies where monitoring systems (in general gauging stations) were not in place (no data) during the 1st cycle against the 61 controlled during the 2nd cycle; and the percentage of the minimum flow value compared to its Mean Annual Flow (MAF) in water bodies regularly monitored, for the first and second planning cycles.

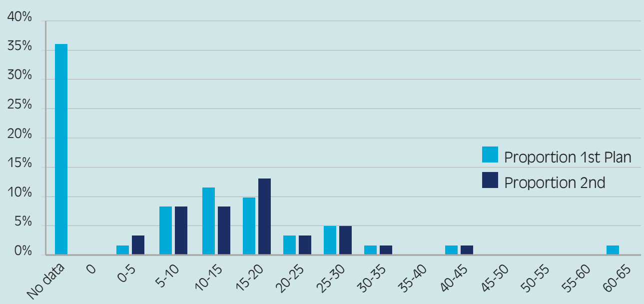


Figure 161 - Proportion of minimum flow values compared to the natural mean annual flow (MAF)
1st and 2nd Hydrological Planning Cycles are compared.

According to the JRBA reports, both 1st and 2nd cycles apply hydrological and habitat suitability methods to obtain minimum flows intended to sustain the habitat of the aquatic and riparian endemic species. There is no doubt that progress has been made in the assessment and implementation of some components of Environmental Flows in the Jucar River Basin for the last decade. Some fundamental components such as spates or high flows to facilitate fish migration, and the recruitment of native riparian vegetation, as well as the limitation of maximum flows in regular dam operations, are challenges where significant improvements are necessary. Furthermore, considerable efforts still need to be made by the JRBA because the percentage of water bodies without regular flow monitoring is still very high (253 out of 314).

Figure 161 shows the proportion of water bodies where the minimum flow in the 10-15% range has decreased by the 2nd period from 11% down to 8%, while the proportion in the 15-20% range has increased. From a historical perspective, the number of sites with minimum flows below 10% has slightly increased, which suggests that the improvement of the ecological status in some areas has been overlooked for prioritizing other water uses.

Jucar river basin E-flow related indicators

Besides the minimum flow values, three other components of the E-flows must be considered in Spain under the legal framework of hydrological planning: the maximum flows in regular operation or management (Qmax), the limitation to the rate of change, and the high flows or small floods; in addition, temporal variability should be considered for the four components. *Figure 162* shows the percentage of water bodies where maximum flows and ratio of change were approved, the percentage of water bodies where minimum flow is controlled; and the percentage of water bodies where minimum flow was achieved.

Minimum flow is legally approved in an incremental number of water bodies (up to 61%). Two other components, i.e. the maximum flow and rate of change began to be monitored in the 2nd cycle, in a relatively small percentage of the water bodies. From the total number where the minimum flow is applied, 19% are being monitored for accomplishment, from which 54% actually achieve the minimum flow.

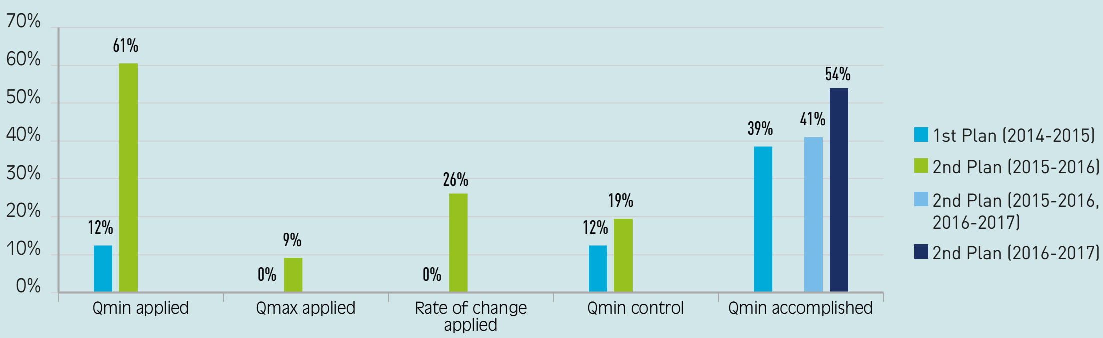


Figure 162 - Comparison of five indicators for legal forcing and accomplishment of environmental flows in the Jucar River Basin
for the 1st vs. 2nd cycle of hydrological planning. Percentage (%) of water bodies where minimum flow is approved, and similar % for maximum flow (Qmax) and rate of change. And, % of water bodies with E-flow gauging, and of water bodies where minimum flow was actually achieved.

BOX 72 Compatibility potential between agriculture and tourism development

Among the many impacts that climate change can have on the economy, the impact on tourism activities is one of the most important. Climate conditions are obviously crucial in determining tourism destination choices, so any change in climate conditions will have consequences in terms of the number of incoming/outgoing tourists, tourism revenue, consumption patterns, income and welfare.

In Roson & Sartori (2014), the economic impact of variations in tourism flows for some Mediterranean countries, possibly induced by climate change, and their implications for water consumption, were assessed. Some studies indicate that climate change will make the Mediterranean a more attractive tourist destination in the spring and autumn, especially for beach tourism. As it is well known that the per capita water consumption of an average tourist is far higher than that of a local, it can be concluded that increased tourism activity would bring about higher pressure on scarce water resources.

This is not necessarily the case, when tourism is considered in the broader framework of structural adjustments of the economic system. More incoming tourists will increase income and welfare, but this phenomenon will also induce a change in the productive structure, with a decline in agriculture and manufacturing, partially compensated by an expansion of service industries.

The reduction in agricultural production is especially relevant, because agriculture accounts for about two-thirds of total water consumption in the Mediterranean, meaning that even a modest decline in agriculture could more than compensate for the increased demand from tourists. However, not all water savings obtained in agriculture could be redirected to supply water for tourists. Much of the water used in agriculture is "green water", embedded into the soil moisture, and typically related to rainfed agriculture. Water used for irrigation, which could potentially be transferred to other uses, including tourism, is defined instead as "blue water".

The likelihood of reductions in total water consumption is assessed by considering several parameters in the calculation model as random variables, so that the results are expressed as probabilities. Results showed that there would be a 92% likelihood that water savings exceed extra demand from tourism in Spain, which means that this would be a quite likely event, and possible in France (60%). On the other hand, net savings are quite unlikely in Croatia (18%), Italy (13%) and Malta (18%).

Interestingly, the countries in which net savings are foreseen are also the most arid. This is not a coincidence as relatively arid countries rely more on irrigation in agriculture, so any decline in agricultural production would free surface water, which then becomes available for the tourism industry or other uses.

These results should therefore be interpreted in terms of "potential of compatibility" between agriculture and tourism development, suggesting that compatibility is possible and can be achieved through specific policies aimed at making water demand (by both agriculture and tourism) more evenly spread over time and space. For example, tourism development policies should be geared towards making tourism flows more continuous over the year, reducing seasonal peaks (thereby reinforcing the effect induced by climate change itself). They should also avoid further development in overexploited areas. One way to provide efficient access is to allow water trading where feasible in terms of engineering.

The average water footprint of the Mediterranean countries (1,859 m³/capita/year) is higher than the global average (1,385 m³/capita/year) (Mekonnen & Hoekstra, 2011).

Figure 163 shows that in the range of relatively large water footprints per capita there are both industrialized and developing countries. The latter generally have large water footprints not because of their relatively large consumption - although relatively large meat consumption can play a role - but because of their low water/productivity rates, i.e. large water footprints per ton of product consumed[109].

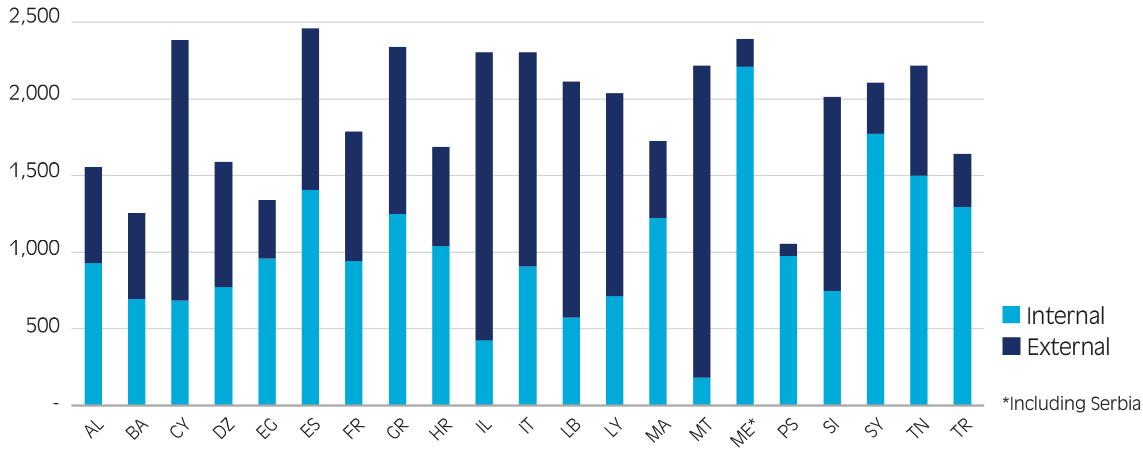


Figure 163 - Water footprint of Mediterranean countries (1996-2005)

In m³ per year per capita, internal share (volume of domestic freshwater used to produce the goods and services consumed by the country) and external share (volume of freshwater used to produce the goods and services consumed by the country originating outside of the country)
(Source: Mekonnen & Hoekstra, 2011)

[109] With the disclaimer that the extreme values can also partially relate to weak basic data on consumption and water productivity, the differences can be traced back to differences in consumption patterns, and differences in the water footprints of the products consumed.

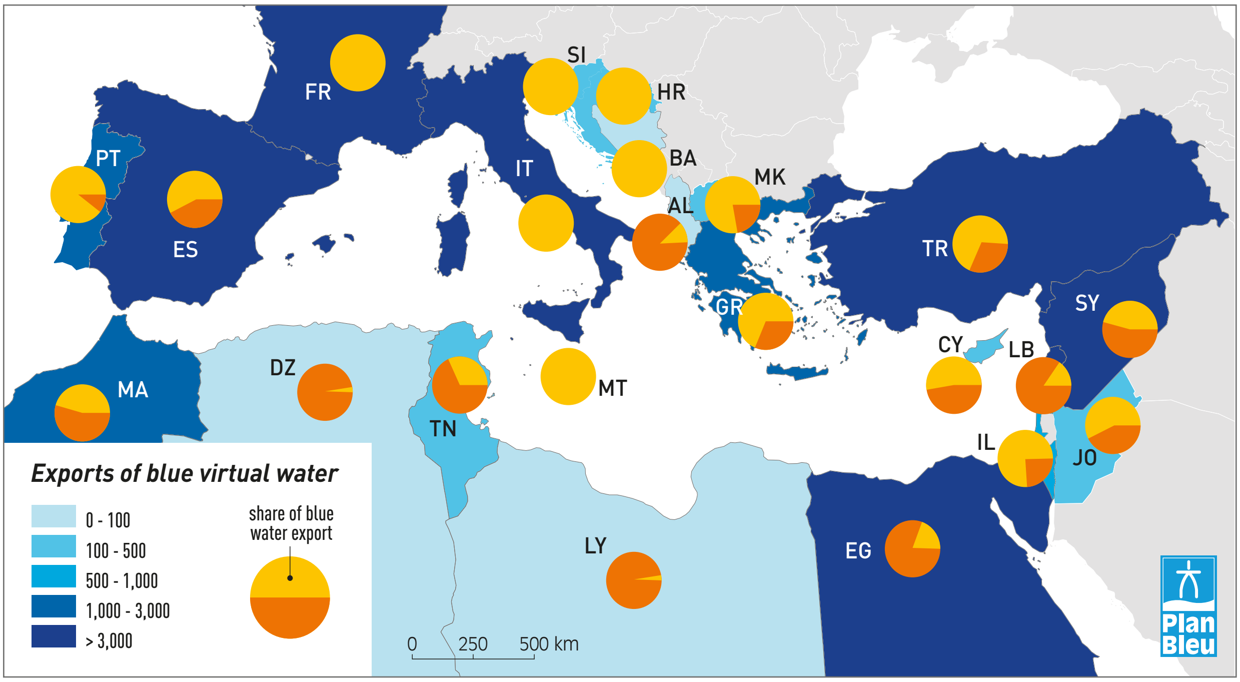


Figure 164 - Share of virtual blue water exported from the Mediterranean countries, 1996-2005 (in percentage of the total blue water consumed in the country)
(Source: Mekonnen & Hoekstra, 2011)

The 'water self-sufficiency' of a country or region is defined as the ratio of its internal water footprint to its total water footprint (Hoekstra et al. 2011). It denotes the capacity to supply the water needed for the production of the domestic demand for goods and services. The 'dependency rate' of a country or region is defined as the ratio of its external water footprint to its total water footprint[110].

Water-scarce countries with high external water dependency include Malta (92% dependency), Israel (82%), Lebanon (73%) and Cyprus (71%). Not all countries with a large external water footprint are water scarce. In this category are Northern European countries like Slovenia. They depend upon freshwater resources elsewhere, but their high dependency is not associated with their lack of water resources. These countries have ample room for expanding agricultural production and thus reducing their external water dependency (Mekonnen & Hoekstra, 2011).

A number of Mediterranean countries reduce the use of their national water resources (blue water) by importing agricultural and industrial products that are water-intensive in their production. Imports of virtual water associated with international trade of agricultural products or other water uses can help cope with water crises and shortages.

A first quantification of virtual water flows related to foreign trade in agricultural products of Mediterranean countries suggests that for some countries, virtual water imported exceeds national exploitable water resources (Fernandez, 2007). This analysis also revealed that some countries facing water stress situations also export a significant part of their irrigation water (blue water). Trade and food security policies thus impact virtual water flows and water uses.

In NMCs, Cyprus, Greece and Spain are net virtual blue water exporters[111]. Spain in particular exports large quantities of blue virtual water, due to crop products (Mekonnen & Hoekstra, 2011). When considering overall virtual water, including blue, green and grey waters, Cyprus, Greece and Spain are generally net importers.

[110] The virtual-water export of a country is the volume of virtual water associated with the export of goods or services from the country (i.e. the total volume of water required to produce for export). The virtual-water import of a country is the volume of virtual water associated with the import of goods or services into the country (i.e. the total volume of water used in the export countries to produce the products). Viewed from the perspective of the importing country, this water can be seen as an additional source of water that comes on top of the domestically available water resources. The virtual-water balance of a country over a certain time period is defined as the net import of virtual water over this period, which is equal to the gross import of virtual water minus the gross export. A positive virtual water balance implies net inflow of virtual water to the country from other countries. A negative balance means net outflow of virtual water (Source: Water Footprint Network definition).All external water footprints of Mediterranean countries together constitute 43% of the total overall water footprint (Plan Bleu, 2011). The share of external water footprint, however, varies from country to country. Some Northern Mediterranean countries, such as Malta, Cyprus, Slovenia and Italy have external water footprints that contribute 60% to 92% to the total water footprint. On the other hand, some countries such as Morocco, Egypt, Turkey and the Syrian Arab Republic have small external water footprints, i.e. 30% of the total footprint, which means a low dependency rate.

[111] With respectively 150 hm^3, 2,800 hm^3 and 9,050 hm^3 of blue water exported per year.

In the Eastern Mediterranean, Turkey is a net blue water exporter and the leading exporter of virtual blue water in the Mediterranean region. In the Southern Mediterranean, Egypt and Morocco are the countries that export the most virtual blue water[112], both also being net virtual blue water exporters (Mekonnen & Hoekstra, 2011).

The inter-Mediterranean trade of virtual water is low when compared to trade with the rest of the world. The Mediterranean region is the world's largest importer of cereals. The dependency on imports is a major hazard for food security.

6.2.4 Non-conventional water resources

To cope with situations of water stress, water demand management remains a priority and represents a cost-efficient set of tools with further potential to be leveraged in Mediterranean countries. The region also increasingly relies on non-conventional water resources such as desalination of seawater or brackish water and the reuse of treated wastewater. Wastewater reuse and seawater desalination have considerable potential in many Mediterranean countries to reduce water stress and can contribute to sustainable development.

The Mediterranean region produces 28.4 km^3 per year of municipal wastewater, divided between the three subregions, as 44% of wastewater is produced in the North, 33% in the South and 23% in the East *(Figure 165)*. While positive experiences in the region demonstrate that wastewater can be safely recycled for irrigation or aquifer recharge, about 80% of wastewater in the MENA region is released into the environment without being reused (World Bank, 2017).

The total wastewater treated in the Mediterranean region amounts to 21.4 km^3 per year (57% in the North, 22% in the South and 21% in the East, from the total treated wastewater). The South and the East of the Mediterranean have great potential to improve wastewater treatment, especially for agricultural use that consumes most of the fresh water resources. The reuse of drainage water in agriculture can also reduce the pressure on water resources. For instance, Egypt and the Syrian Arab Republic directly use 2.7 and 2.3 million m^3 of agricultural drainage water, respectively. Particular attention to degradation of drainage water quality should be paid. Israel is the reuse leader among the SEMCs, with a reuse rate of over 85% of collected wastewater. In Europe, Cyprus and Malta are the most advanced countries in terms of reuse, with 90% and 60% of their treated wastewater reused, far ahead of other countries (around 2.4% on average in Europe) and ahead of the rest of the world. France only reuses 0.2% of its wastewater (IPEMED, 2019).

First developed in situations of island isolation (Balearic Islands, Cyclades, Cyprus, Dalmatia, Malta, etc.) and in

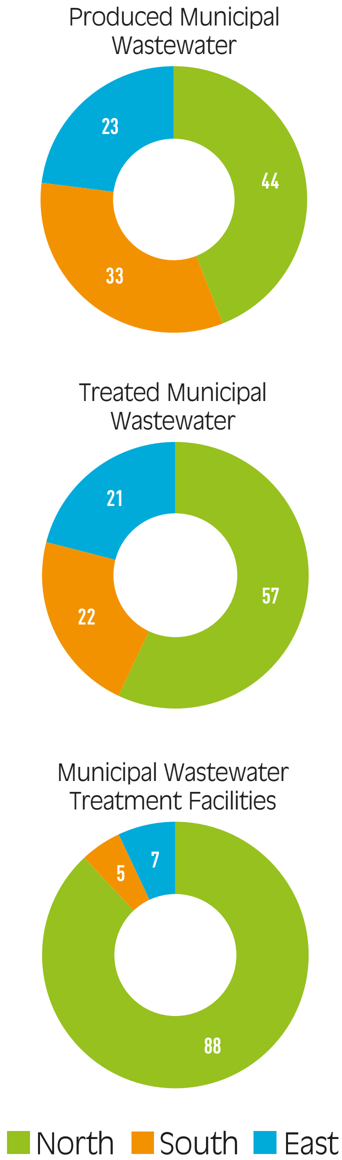


Figure 165 - Distribution of municipal wastewater produced and treated, in reference to total wastewater in the Mediterranean
(Source: FAO, 2016a)

coastal areas in Libya or in the desert of Algeria, particularly to meet the needs of tourism, freshwater production from desalination of seawater or brackish water now extends all around the Mediterranean, mainly for domestic use. It constitutes up to 60% of the drinking water supply in Malta. Spain, the fourth largest producer in the Mediterranean, has the particularity of allocating a significant portion of desalinated water to the agricultural sector *(Figure 166)*. Many coastal cities have been equipped with desalination plants for their municipal water supply. Algeria is the higher producer of desalinated water with 615 million m^3 (2012), representing 45% of the total desalinated water in the Mediterranean. As of 2018, the country has built 11 desalination plants since 2003, and plans to build two new

[112] Turkey, Egypt and Morocco export 11,370; 6,800 and 2,400 hm^3 of blue water per year respectively.

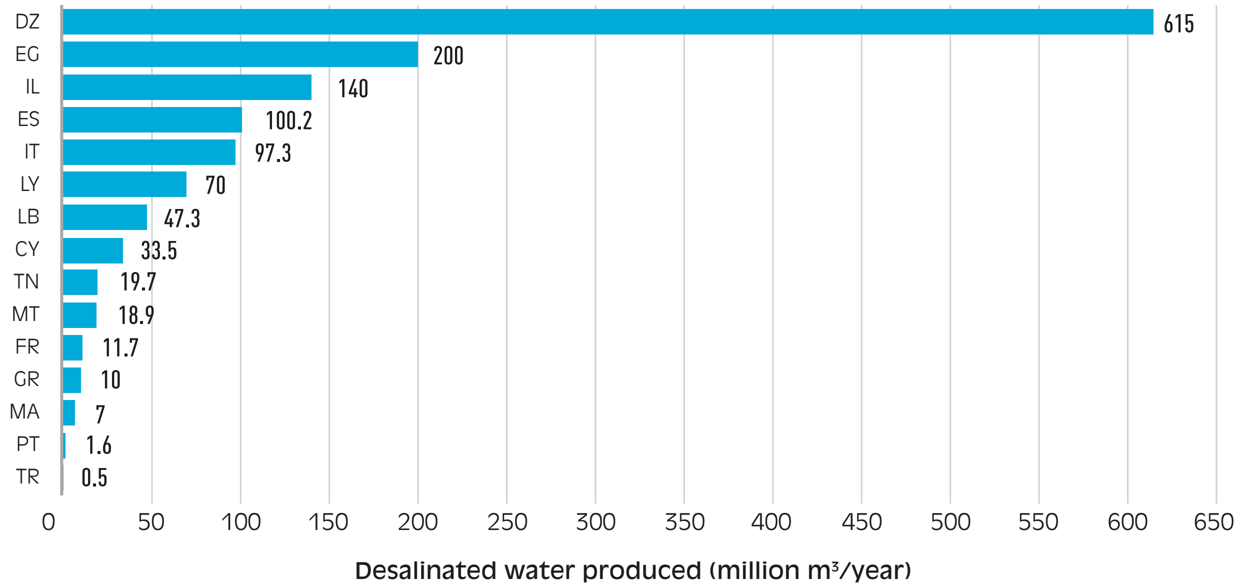


Figure 166 - Production of desalinated water in the Mediterranean
(Source: FAO, 2016a)

desalination plants, each with capacity of 300,000 m^3 per day. This is part of a plan to have 13 facilities and a total capacity of 2.31 million m^3 per day. The two new plants will increase desalinated water to 25% of the national drinking water supply, up from 17% currently. Other countries such as Egypt, Israel and Spain are also working towards increasing their capacity for seawater desalination to reduce the impact of water scarcity on development and food security[113].

Large-scale desalination remains a costly option that consumes large amounts of energy and emits greenhouse

BOX 73 Trade-offs between desalination and recycled water: The Israeli experience

In Israel, desalination produces half of the water supply, and more than 85% of wastewater is recycled. The high percentage of recycled water used in agriculture has led to a demand for salinity rates in desalinated water ranging from 20 to 80 mg/l Cl-. This rate is lower than the salinity rate accepted in most places in the world and lower than the mandatory rate defined by the Israeli drinking water quality law (400 mg/l Cl-). This allows recycled water to be used for any crop without limitations and protects the soil and the aquifers. The price of this low salinity desalinated water is relatively high. However, the low salinity improves the recycled water's quality and reduces the amount of water needed to irrigate each crop (improves utility water consumption), increases agricultural production (raises profits) and reduces the costs of treating salted soil and aquifers. Overall, there are more benefits than costs.

The increase in water desalination reduces water withdrawals from the country's overdrawn natural drinking water storage bodies, the Sea of Galilee and the two main aquifers. It also helps avoid their further degradation by saline water intrusion and can raise their levels to hydrologically safe values and renew natural water levels in rivers and springs. The rehabilitation of the natural drinking water storage bodies is implemented in spite of the loss of fresh water into the sea through rivers and underground flows from the shore aquifer.

The wide use of recycled water in agriculture raises questions about the presence of medical waste in the irrigation water and its impacts on underground water quality (and on crops and soil). These questions are still being studied (Chapter 7).

A potential trade-off between desalination and recycled water can arise from the use of recycled water as an alternative to water from rivers while transferring the original freshwater to other uses. The aim of this type of policy is to achieve two objectives at the same time: conserving aquatic ecosystems and using freshwater more efficiently. However, this may potentially pollute the desalination water source in a disruptive way. Such disruption may also occur in unintended cases of spills into the sea or rivers. According to Israeli experience, it has been found that there were very few occasions when treated wastewater streams caused the shutdown of desalination plants. It more commonly forced authorities to increase the number and frequency of laboratory testing to assess water quality. It should be noted that the Israeli experience is not sufficient to generalize the existence of this trade-off; (because there is almost no wastewater or recycled water in Israeli rivers and coastal areas due to the high percentage of wastewater directed to recycling and then to agriculture). Precautionary measures to avoid potential trade-offs between desalination and recycled water can include building new desalination plants as far away as possible from wastewater flows.

[113] In the Mediterranean, desalination production in 2008 was at 10 Mm^3 per year and could multiply several times over the next decade.

gases. The cost of water produced by desalination of seawater is around 0.4 to 0.6 Euro per m^3 for large units, which is about 2 times higher than that of conventional water and does not take into account the initial investment. In addition, desalination has negative impacts on the environment, related to the development of coastal infrastructure but also to the discharge of brines. Energy-efficient desalination systems with relatively low CO_2 emissions are possible and need to be implemented. This includes reverse osmosis, in combination with thermal power plants, energy recovery from residual pressure within desalination plants and improvement of existing facilities. Renewable energies (wind, solar) applied to desalination, are promising for the future, even if their development remains linked to financing and competitiveness issues.

A limiting factor for desalination plants can be the quality of the sea water or brackish water used. In fact, cases of intermittent closures of desalination plants have been reported in the Mediterranean due to contamination of seawater by land-based sewage, including discharges into streams that flow into the sea. The proximity of seawater inlets to infrastructure, such as oil terminals and ports, can also potentially lead to closures, when oil is released into the Mediterranean (Tal, 2018).

6.2.5 Water supply and sanitation

In the Mediterranean, access to water and sanitation remains a major challenge for the coming years, despite significant progress. This progress must be pursued because the stakes are high when it comes to achieving the Sustainable Development Goals by 2030 in order to guarantee access for all to safely managed water and sanitation services.

It should be noted that there has been a change in the definition of indicators for access to water and sanitation. Until 2015, the Millennium Development Goals (MDGs) focused on access to water and sanitation using two indicators, related to target 7.c, "By 2015, halve the proportion of people without sustainable access to safe drinking water and basic sanitation":

- the proportion of the population using an improved drinking water source (7.8)
- the proportion of the population using improved sanitation facilities (7.9).

At the Sustainable Development Summit in September 2015, the Sustainable Development Goals (SDGs) were adopted to consider the different dimensions of sustainable development: economic growth, social integration and environmental protection. SDG 6 is to "ensure availability and sustainable management of water and sanitation for all". At present, access to water takes into account the notions of availability, accessibility of service and potability of the water supplied, which represents a significant step forward in comparison to MDG 7.c, which was limited to the existence of a water point, without taking into account the quality of the water distributed, nor the functionality and accessibility of the water point. Target 6.2 on sanitation and hygiene and Target 6.3 on pollution reduction broaden the MDG framework beyond the consideration of toilets and now cover the entire sector, highlighting the importance of sludge management and treatment.

The novelty of the SDG indicators in relation to the MDG indicators is the introduction of the notion of "safely managed" drinking water and sanitation services, which corresponds to the top of the scale in terms of access to water and sanitation, above the "improved" level, which was used in the MDG indicators. The previously used "improved" level corresponds to what is now called "at least basic" level, including the "basic" and "safely managed" water levels.

In 2015, around 18 million Mediterranean people did not yet have access to an improved drinking water supply (WHO & UNICEF, 2017), i.e. 3.6% of the total population of the Mediterranean region, 89% of which come from Southern and Eastern Mediterranean Countries (SEMC). Countries in the region recorded an average rate of access to improved water of 96%, which is higher than the global average of 91% (World Bank, 2019). It should be noted that if we consider the number of people without access to a safe water service (as defined in SDG 6, i.e. having access to drinking water from an improved source, located/accessible on premises, available when needed, and free from contamination), this figure increases to 26 million Mediterranean people. Having sustainable access to water directly impacts the living conditions of women, who can spend hours fetching water, and improves school attendance for girls.

In 2015, around 23 million people, with disparities between countries, did not yet have sustainable access to adequate sanitation (WHO & UNICEF, 2017), i.e. 5% of the total population of the Mediterranean region, 80% of which are from SEMCs.

As for access to water, SEMCs have also made very encouraging progress, with an average sanitation access rate of 91%, which is higher than the global average of 68% (World Bank, 2019). When it comes to access to safely managed sanitation services (as defined in SDG 6, i.e. improved sanitation facilities that are not shared with other households and where excreta are safely disposed of in situ or offsite), 182 million Mediterranean people still lack these services. Enormous efforts still remain to be made, specifically in the sanitation sector.

Good hygiene habits, such as washing hands with soap and water after using the toilet and before food preparation and consumption, are equally important in limiting the spread of communicable diseases.

SDG indicator 6.a.1 is the "Amount of water- and sanitation-related official development assistance that is part of a government-coordinated spending plan". It is defined as the proportion of total disbursements of public support for development related to water and sanitation included in the government budget. Between 2000 and 2015, the amount of public aid for development related to water and sanitation

Figure 167 - The Sustainable Development Goals for Water and Sanitation Services; Interpreting the Targets and Indicators
(Source: Ps-EAU, 2018)

allocated to North Africa (Algeria, Egypt, Libya, Morocco and Tunisia) rose from USD 455 million to USD 777 million (UNSD, 2015), representing a growth rate of 71% unequally distributed among the 5 countries. Disparities are significant between countries, with a minimum of USD 430,000 recorded for Libya and a maximum of USD 404 million for Morocco.

This increase in official development assistance (ODA) devoted to water and sanitation can explain the considerable progress recorded over the same period, in particular in terms of access to drinking water and sanitation in the Southern Mediterranean region (rise from 88% to 96% and from 65% to 91% respectively; WHO & UNICEF, 2017).

6.2.6 Status and trends of water quality

SDG Target 6.3 calls for "*[improving]* water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally".

There is a lack of integrated historical data for the Mediterranean region on the status and trends of water quality parameters. The number of existing contaminants, as well as their spatial and temporal variations, amplify the difficulty of monitoring.

The main water quality environmental impacts in the Mediterranean, which have been recently reported in relation to the water framework directive (WFD), are seawater intrusion, eutrophication, heavy metal, pesticides from agricultural runoff, pharmaceuticals and persistent chlorinated hydrocarbon pollution (Nikolaidis et al. 2014). Considering the 16 River Basin Districts monitored for surface water pollution and habitat degradation along the Mediterranean coastline, 49% of water bodies on average are failing to achieve Good Environmental Status, the highest proportion of which are in Sicily, Italy, and lowest in Corsica, France (EEA, 2018).

Nitrate concentrations and loads increased steadily from the 1970s in the Rhone, Po and Ebro rivers, and have remained relatively constant since the 90s (Ludwig & Montreuil, 2013). Over the past decade, progress has been made to treat urban wastewater and reduce total nitrogen and total phosphorus loads, yet there is a need for further efforts to accommodate the increasing volumes of wastewater resulting from population growth and fluctuations from tourism. Nitrogen and Phosphorus are essential for maintaining biological productivity at sea and are strongly associated with water fluxes. They are therefore strongly affected by dams and river discharge alterations.

The Water-Food connection is clear when looking at nutrient loads as agriculture and wastewater treatment plants are the most significant sources of TN and TP (Malagò & Bouraoui, 2017).

Increasing water temperatures and decreasing dissolved oxygen levels are caused by air temperature increases in the Ebro (Spain) and Adige (Italy) river basins (Diamantini et al. 2018). Agricultural practices and population density have had some influence on chloride, Biochemical oxygen demand (BOD) and phosphate contents in the Sava (Slovenia) and Ebro river basins.

6.2.7 Stability and fragility

The Vicious Cycle of Water Security and Fragility

The World Bank considers that four of the top five global risks (water crises, failure of climate change adaptation and mitigation, extreme weather events, and food crises) are directly related to water management and water-related risks, while the fifth global risk, profound social instability, is a common characteristic of fragile states (Sadoff, Borgomeo & De Waal, 2017). As the most water scarce region in the world, the Mediterranean region is a stark illustration of the links between water security and regional stability.

The concept of water security is located at the nexus between environmental, socioeconomic and political factors. In its absence, short- to long-term processes leading to political instability, loss of livelihood, ecosystem degradation and population displacement may arise. Water insecurity and fragility feed into a vicious cycle, as fragility makes it more difficult to achieve water security, the failure to achieve the latter in turn leads to greater social, political, economic and environmental costs and consequences, thereby further exacerbating fragility (Sadoff, Borgomeo & De Waal, 2017).

Water, Instability and Population Displacement

One of the manifestations of this vicious cycle can potentially be population displacement. Recent phenomena in the Mediterranean region, such as the Syrian refugee crisis and the ongoing flow of migrants crossing the Mediterranean to reach its northern shores bring about questions concerning possible links between water security and voluntary migration and forced displacement in the Mediterranean region.

When and where long-term efforts to adapt to climatic variability fail, the ability of populations to ensure their livelihoods (notably through agriculture) is strongly impacted, which can lead to conflicts and potentially migration due to competition for resources, as well as increased pressure on resource governance in host communities. Nonetheless, it is widely agreed that it is not possible to simply "blame the drought", namely environmental factors such as climate change: Water scarcity or water-related factors rarely figure in migrants' and refugees' decisions to flee their homes (Jobbins, Langdown & Bernard, 2018). Rather, the water insecurity and fragility dynamics play out in the mid- to long-term, feeding into processes of rising instability that may lead up to forced displacement or voluntary migration. Initially, it is more often than not instigated by water governance failures, such as failure to provide water services, failure to protect against water-related disasters, or failure to preserve surface and ground water resources (Sadoff, Borgomeo & De Waal, 2017).

These policy failures can threaten social cohesion while increasing tensions between governments/policymakers and citizens, and can either be partly caused or exacerbated by long-term environmental factors, such as the numerous effects of climate change. Linking the wave of rural to urban migration and the ensuing broader crisis and conflict to the severe drought which struck the Syrian Arab Republic starting in 2005 is controversial. They are also associated with broad governance failures (De Châtel, 2014). The drought did not lead to widespread migratory phenomena from rural to urban areas in other neighbouring countries that were also affected, such as Iraq, Turkey, Lebanon and Jordan (Weinthal, Zawahri & Sowers, 2015). Rather than focusing on the potential for extreme weather events and climatic factors to cause long-term displacements (as opposed to short-term emergency displacements due to sudden floods), the literature argues that the true challenge for achieving water security in relation to migration depends on the extent to which governments and utilities can strengthen governance and water services to better respond to migration (Jobbins, Langdown & Bernard, 2018). Nonetheless, while water resources and water, sanitation and hygiene (WASH) services are most often not the main drivers of large-scale migration, they can fuel underdevelopment and marginalization in migrants' communities of origin and economic opportunities in host communities (Jägerskog & Swain, 2016).

Emerging from the "vicious cycle" of water security and instability

When studied in situations of fragility (such as migration and conflict), caution is needed since there are no "easy answers" to achieving water security (Jägerskog & Swain, 2016). Profound social instability is one of the main factors that prevent integrated water strategies from taking root in fragile areas. Without stability in water service provision, water policy and management and water infrastructure, large swathes of populations can be cut off from this essential resource and deprived of their capacity to access clean drinking water, proper sanitation, and to produce food to ensure their subsistence and income. Food crises can be directly related to water shortages or water supply inefficiencies. Food is essentially water that humans "eat". When water is lacking due to environmental or human factors, food production is directly impacted further down the chain. Unable to feed themselves or to obtain sufficient income from their agricultural production, populations are forced to migrate to survive. Finally, the vicious cycle also has numerous negative effects on the health of ecosystems in affected areas, which bear the brunt of water scarcity and populations' efforts to maintain their subsistence in increasingly barren areas. Thus, the vicious cycle can also instigate protracted processes of environmental degradation caused by resource depletion.

Devising new strategies to emerge from the vicious cycle of water scarcity and fragility is a fundamental regional challenge for the Mediterranean. It involves thinking beyond immediate water supplies to ensure sustainable resource management and affordable water provision services (FAO & World Bank, 2018). This long-term, regional and collaborative approach is instrumental in building regional resilience to human or environmental disasters such as conflict, forced displacement and extreme weather events and ongoing environmental degradation.

6.3 Agroecosystems, soils and food security

6.3.1 Agroecosystems

Agroecosystems are generally defined by a dominant agricultural activity influencing the living and non-living components interacting in an ecosystem. Research increasingly considers socio-agroecosystems to take into account the human component, most relevant in the Mediterranean region, where ancient traditions and consumption habits have shaped many agricultural activities and landscapes.

The Mediterranean region hosts a variety of contrasting agroecosystems, including traditional and technologically intensive irrigated agriculture, rainfed agriculture, in particular permanent crops, pastoral and agro-sylvo-pastoral systems, coastal fisheries and aquaculture.

Permanent crops most typical of Mediterranean agroecosystems include olives, grapes, citrus and nuts. Due to their historical relevance, these agricultural products have acquired a significant share of the global food market, including organic markets. They are increasingly labelled and sold under a mark of origin label, adding value to local productions. While such profitable development is expanding in the North of the Mediterranean Basin, opportunities can be further taken advantage of in SEMCs. This would involve support to farmers' organization around local value chains, branding traditional knowledge and "terroirs", connections with local markets (in particular in touristic areas), and international export on markets for recognized quality products.
In addition to these typical crops, there is a strong presence of legumes, fresh vegetables, wheat, often complemented by a more extensive presence of livestock, mostly sheep and goats.

The Mediterranean agroecosystem can schematically be divided into two categories:

- In "fertile" areas, large irrigation systems and rainfall agroecosystems occur. These areas are said to be favourable because they receive more than 400 mm in annual rainfall. They are limited spatially by resource availability (water and land).
- "Disadvantaged/marginal" areas are characterized by mountains and semi-arid, non-irrigated fields, where agriculture is often marginal and interferes with the pastoral economy, the latter becoming dominant in the steppes. The agricultural economy in these areas can be considered "agro-sylvo-pastoral". In the Southern Mediterranean in particular, it is dependent on access to common lands and forested pastures.

Other fertile areas, typical of the Mediterranean region, include oasis and lagoon systems.
Finally, specific peri-urban agricultural models have developed in the Mediterranean region.
Agroecosystems provide a variety of ecosystem services in the Mediterranean region, including services to other sectors (tourism, industry, etc.).

In the fertile areas, the most significant type of ecosystem services rendered are the supply of food, fuel (timber) and fibre (e.g. from Egyptian cotton) contributing to food and energy security and export earnings. Other services provided by these systems, to a lesser extent, include:

- cultural services, including aesthetic and existence value and recreational activities, which contribute to the quality and attractiveness of the "Mediterranean landscapes", and impact possibilities of tourism development;
- regulating services, including:
  - the capacity of irrigated systems to create microclimates favourable for the life of plants, animals and humans, which are particularly important in arid zones, both in the oases of North Africa and the Middle East, and throughout the Nile Valley;
  - carbon sequestration, while urban sprawl in rural areas prevents water infiltration and increases greenhouse gas emissions (increase in transport consumption, etc.);
  - fire prevention by grazing activities, which decrease woody vegetation density;
  - water regulation through specific agrarian and forestry practices; and

- pollination by maintaining larger floral diversity communities; urban effluents recycling; habitat creation and protecting agricultural biodiversity.

In "disadvantaged/marginal" zones, the main services provided by agroecosystems include:

- supplying water for downstream users (essential "water tower" role and provision of hydroelectricity potential), and to a lesser extent, food (agricultural and pastoral) and wood production with limited productivity, complemented by honey, mushrooms and aromatic and medicinal plants;
- regulating services, mainly water infiltration, which can contribute to a positive hydrology and the storage and reorganization of carbon, but also protecting biodiversity; and
- cultural services rendered by mountainous areas, including aesthetic, recreational and spiritual functions.

Mediterranean agroecosystems are characterized by trade-offs between interdependent ecosystem services. While regulating and cultural services are necessary for certain provisioning services, the maximization of provisioning services can alter certain regulating and cultural ecosystem services.

In the last several decades, most of the agricultural areas with a Mediterranean climate have been affected by various pressures, including climate change, depleting water resources, water and soil salinization, soil degradation, and rapid urban sprawl.

In NMCs, agriculture in marginal mountainous areas is being progressively abandoned, leaving ground for forest expansion. This trend raises risks associated with forest fires and threatens unique biodiversity components associated with Mediterranean grasslands.

In SEMCs, agricultural systems in marginal mountainous areas continue to sustain small family farms. While these agro-pastoral systems have strong potential for ecological integration and sustainability, they have low labor productivity and incomes due to poor access to land and water (Alary et al. 2017). Families in these systems progressively diversify their resources towards more diverse income sources. Over-grazing continues to degrade forested areas, triggering erosion issues, and threatening downstream irrigation systems. Marginal and mountainous environments will continue to be critical to the future

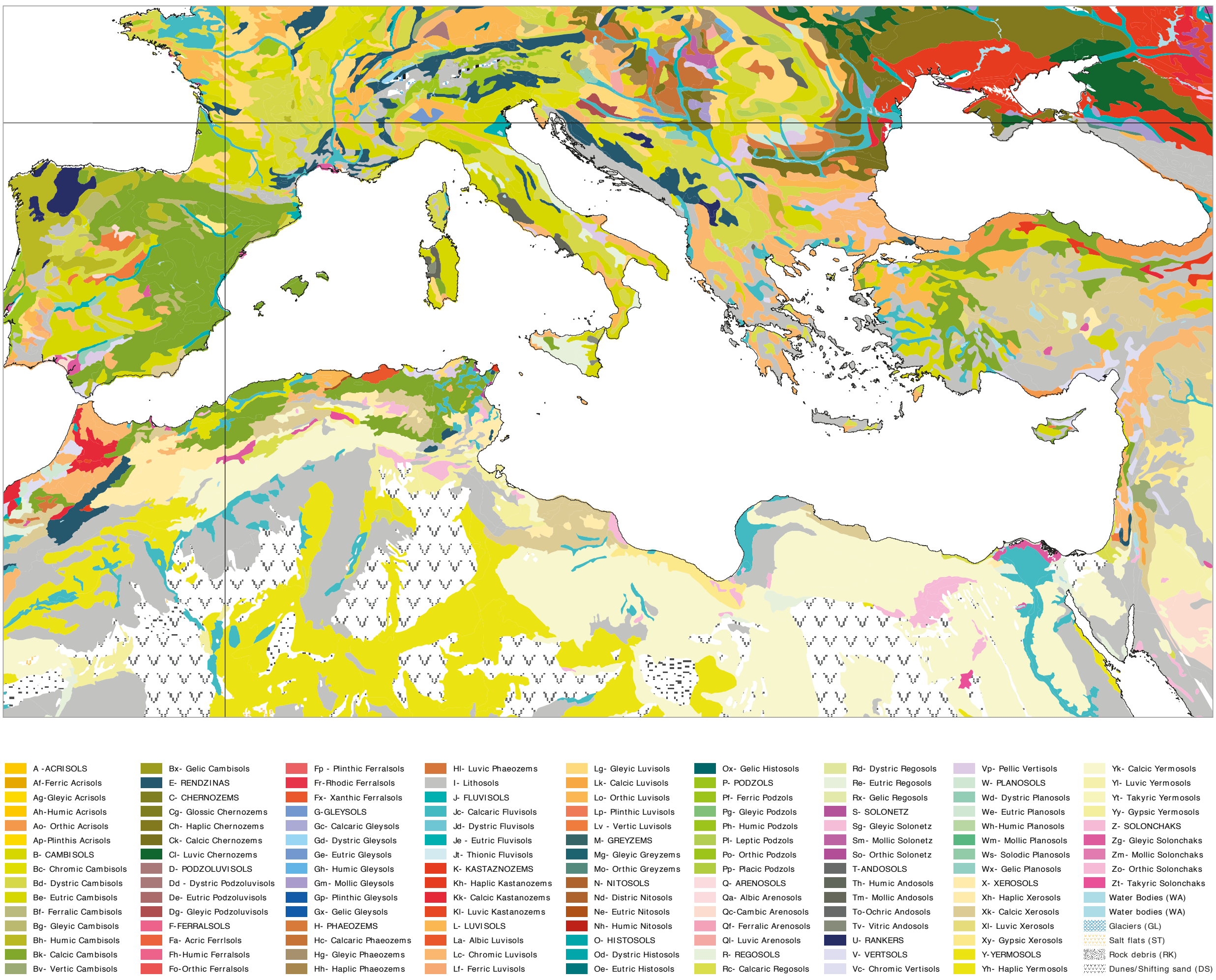


Figure 168 - Main soil types in the Mediterranean region
(Source: FAO-UNESCO, 2020))

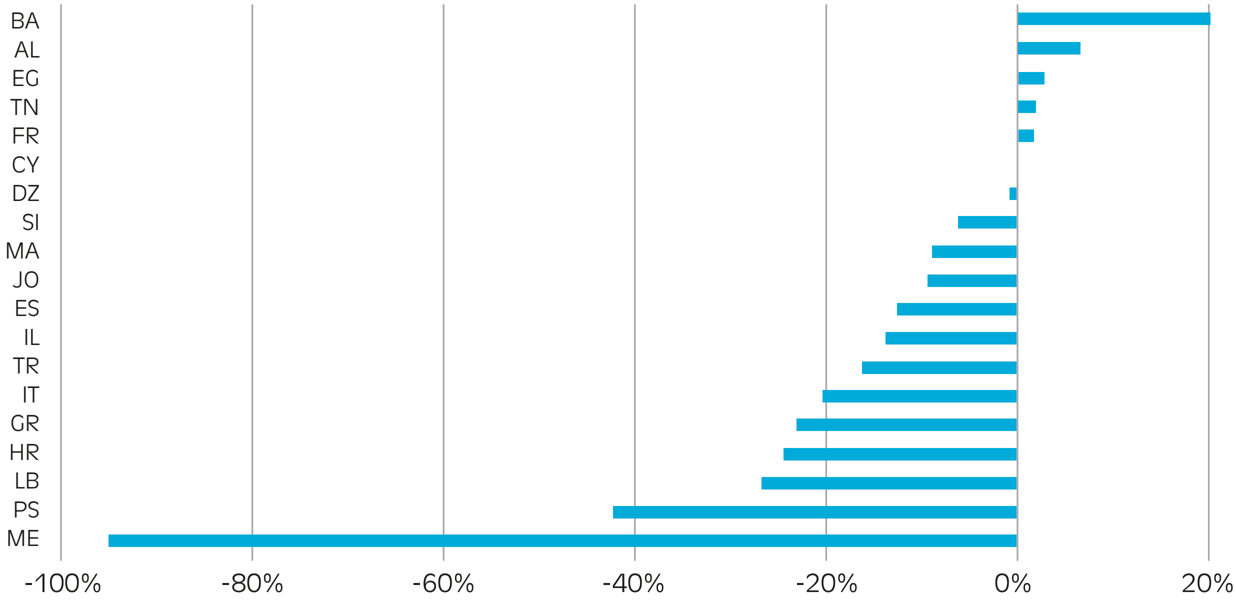


Figure 169 - Arable land area changes between 1995 and 2015, difference in %
(Source: World Bank, 2019) Note: In Montenegro, data collection for agricultural land statistics have followed a new method since 2013, which explains the unrepresentative change in arable land surface

of the Mediterranean basin as a source of livelihood for rural families and water "towers" for downstream activities. Recent research recommends *"taking advantage of the spatial mobility abilities of livestock farming in the Mediterranean to reinforce crop-livestock integration at a regional level, promoting collective actions allowing a wider range of livestock farmers in hinterlands to participate, thereby limiting loss of efficiency and reinforcing sustainability for the most vulnerable livestock farmers"* (Alary et al. 2017).

Other more localized farming systems in the Mediterranean are undergoing profound transformations.

Oasis agriculture, a fragile, complex, and highly productive ancestral system, is threatened by climate change and groundwater over-extraction.

Vast areas in the Nile Delta previously based on rice production are progressively converting to aquaculture as waters become increasingly brackish (Kara et al. 2016). This attests to the capacity of systems to adapt to profound changes if relevant solutions/innovations and policy support are in place.

6.3.2 Soil

Soil is one of the main contributors to agroecosystem functions and food security, and it is as precious as water throughout the Mediterranean. In Mediterranean history, the disappearance of some civilizations can be linked to a decline in food production due to a significant increase in soil salinity stemming from weakly drained, mismanaged alluvial soils.

The Mediterranean basin is located between two very different pedogenetic zones. In the North, where the climate is wetter, soils are generally richer in organic matter and have higher humidity. In the South, because of extreme temperatures, soil mineralization is accelerated and soils are very sensitive to desertification (Plan Bleu, 2003). The dominant soils in the Mediterranean basin are cambisols *(Figure 168)*, which are mostly fertile and appropriate for agricultural production. Fluvisols, young alluvial soils, are especially productive and are found along major river basins such as the Ebro and Rhône.

Soils are shaped by several soil forming factors including geology, topography, biota, climate, vegetation, time and human influence. They provide essential ecosystem services for food security and beyond, including organic matter decomposition, primary production, nutrient cycling, water quality regulation, water supply regulation, climate regulation and carbon storage, erosion regulation, food supply, fibre and fuel supply, raw earth material supply, and surface stability. They also host biodiversity, have an aesthetic and spiritual value, and provide an archive of geological and archaeological heritage (FAO & ITPS, 2015). These services are supported by a myriad of organisms, many of which are invisible to the naked eye but are extremely diverse, abundant and active. For example, bacteria and fungi play a role in biogeochemical cycles and are responsible for nutrient supply by mineralizing organic matter (Orgiazzi et al. 2012). Small hexapods and earthworms play an important role in litter decomposition and microstructure formation (Renaud et al. 2004).

Around half of the world's soils are degraded and in the Mediterranean basin, about 8.3 million hectares of arable land have been lost since 1960 (Zdruli, 2014), affecting mainly poor populations. Scientific literature for the Mediterranean basin currently lacks a comprehensive synthesis of the state and trends of Mediterranean soil.

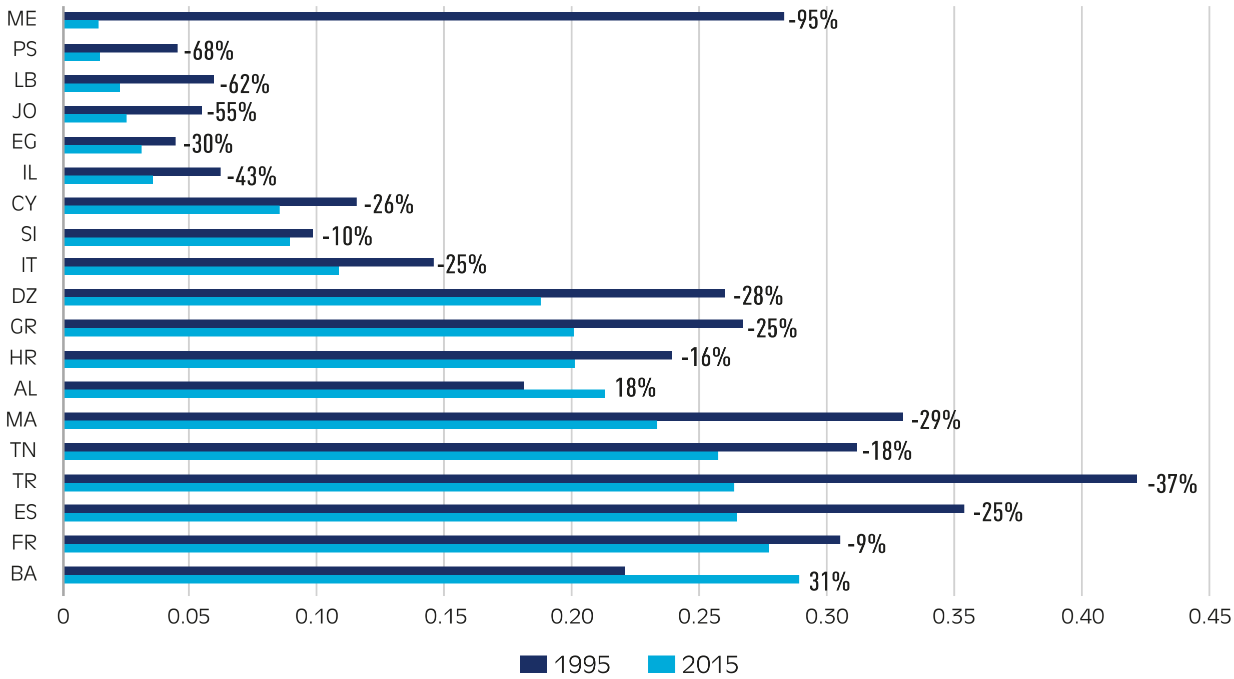


Figure 170 - Number of hectares of arable land per capita in 1995 and 2015 and changes between these dates
(Source: World Bank, 2019) Note: In Montenegro, data collection for agricultural land statistics have followed a new method since 2013, which explains the unrepresentative change in arable land surface.

The area of arable land decreased by an average of 13% from 1995 to 2015. In SEMCs, this decline is particularly notable in the State of Palestine (-42%), Lebanon (-27%), Turkey (-16%) and Israel (- 14%). In NMCs, the number of hectares of arable land increased in Bosnia and Herzegovina (+21%) and in Albania (+ 8%), and decreased in other countries, particularly in Greece (-24%) and Croatia (-22%). The total number of hectares of arable land decreased by an average of 10% in the Balkan countries between 1995 and 2016.

The area of arable land per capita *(Figure 170)* fell by an average of 41% over the same period, more than double the loss experienced by middle-income countries globally. The Mediterranean countries most affected by the decline in the number of hectares per inhabitant are the State of Palestine (-68%), and Lebanon (-62%).

Arable land is also unequally distributed across the Mediterranean, with over 46% of arable land in the North and only 31% in the South (FAOSTAT, 2019). Turkey has almost 23% of arable land. Taking into account population, the ratio of arable land per person is lower in Southern Mediterranean countries with only 0.16 hectares per person compared to just over 0.20 hectares in NMCs.

Factors influencing soil health and functions

The Mediterranean region combines factors that are conducive to soil degradation: often sparse vegetation cover, high annual climatic variability alternating wet and (very) dry years and frequent high intensity rainfall and wind, easily erodible rocks, a rugged relief where 45% of the area has slopes greater than 8%, and relatively shallow soils (Garcia-Ruiz et al. 2013). In addition, the region has a long history of human occupation with continuous agricultural and livestock raising activities dating back to the Neolithic period (Lahmar & Ruellan, 2007).

Soil degradation is mainly caused by agricultural and non-agricultural land intensification, resulting from the expansion of cultivation, industrial and urban areas in response to a combination of drivers. These include population growth (particularly in the Southern Mediterranean), and access to subsidies (in countries under the EU Common Agricultural Policy), changes in agricultural practices (e.g. mechanization of tillage operations, land levelling to facilitate irrigation, cultivation of steep slopes, deforestation, overgrazing), intensive coastal development and urban sprawl, and construction of transport infrastructure. The soil degradation processes include water and wind erosion, salinization and sodification, sealing and compaction, loss of organic matter and permanent loss of vegetation cover. Soil degradation is included in SDG indicator 15.3.1 "Proportion of land that is degraded over total land area", with the aim of monitoring progress towards the goal to "by 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world".

In addition to intensification, many inland areas of European Mediterranean countries are experiencing increasing rural land abandonment and associated depopulation and economic marginalization. Land abandonment brings about aging and depopulation of rural areas, and migration to urban areas. When rainfall conditions are favourable, a woody encroachment of former agricultural

BOX 74

State of soil erosion

Quantifying the extent and intensity of soil erosion has proved a difficult task subject to high uncertainty. Erosion is scale-dependent with highly temporal variability that requires creating standardized, long-term monitoring systems with nested scales to gather representative, reliable and comparable data.

Reported erosion rates show high variability depending of the approach used (whether measured in plot or modelled), the monitored processes (sheet, erosion, gully) and the scale (plot, hillslope or catchment). Based on an extensive review of published erosion plot data, a rill and interrill erosion rate of 1.3 t/ha/year for the Mediterranean area of Europe was estimated (Cerdan et al. 2010). This accounts for 21.5% of total Pan-European soil losses. Measured erosion is strongly influenced by land use *(Table 27)*. A similar study confirms the key role of land use as a determinant factor in erosion rates in the Mediterranean (Maetens, 2013). The mean annual rate for bare plots and plots where crops have been cultivated ranges from 1 to 20 t/ha/year while plots with permanent cover have erosion rates lower than 1 t/ha/year.

The erosion rates are lower for bare and cultivated areas than in wetter parts of Europe. However, areas covered by (semi-)natural vegetation showed higher rates than in the rest of Europe (yet lower than 1 t/ha/year). These counterintuitive low soil erosion values obtained for the Mediterranean region are explained by the large fraction of rock fragments on the topsoil and other significant erosion mechanisms such as gully erosion, landslides and riverbank erosion that are not well-represented at a plot scale.

Land use	Erosion rate (t/ha/year) measured at plot scale	
	Cerdan et al. 2010	Maetens, 2013
Bare	9.05	9.1
Arable	0.84	2.9[1]
Forest	0.18	0.4
Grassland	0.32	0.6-0.8
Shrubs	0.54	0.6
Vineyards	8.62	1.8
Orchards	1.67	11.6[2]

[1] The data is shown as the erosion rate for croplands (cereal, maize, sugar beet, sunflower) in the original paper.
[2] This is referred to as tree crops (olive, almond, citrus) in the original paper.

Table 27 - Estimated average erosion rates by land use in the Mediterranean region

Modelling soil erosion rates provides a slightly different picture in which Mediterranean Europe is identified as a global hot spot (i.e. areas where soil loss rates are above 20 t/ha/year) at a global level (Borreli et al. 2017). At a European level, a study estimated the soil erosion rate by using a revised version of the Universal Soil Loss Equation (RUSLE2015) (Panagos et al. 2015). The results showed that the Mediterranean climate area has a high erosion rate (4.6 t/ha/year). In this study, the estimated soil loss of eight Mediterranean EU Member States (CY, ES, FR, GR, HR, IT, MT and PT) accounted for 67% of total soil loss in the European Union (28 countries) *(Table 28)*. These higher values are mainly explained by the fact that these countries have the highest rain erosivity and permanent crops, which include most of the vineyards, almond and olive trees growing in the Mediterranean region, and sparsely vegetated land areas, with both land uses suffering from high erosion rates of 9.5 and 40.2 t/ha/year, respectively.

Countries	Estimated soil loss rate (t/ha/yr)		% of the total soil loss in EU
	Overall mean	Mean in arable land	
Cyprus	2.89	1.85	0.25
Spain	3.94	4.27	19.61
France	2.25	1.99	11.85
Greece	4.13	2.77	5.31
Croatia	3.16	1.67	1.74
Italy	8.46	8.38	24.13
Malta	6.02	15.93	0.01
Portugal	2.31	2.94	2.01

Table 28 - Average soil loss rate per EU-Mediterranean country (all land, arable lands) and share of EU soil loss
(Source: Panagos et al. 2015)

lands follows land abandonment. This secondary process results in higher biomass, which can provide habitats for various species (though it is unfavourable for grassland specific species, which are often rich components of local biodiversity), but also create an increased fire risk.

Soil erosion is a natural process, but it becomes an issue when erosion rate is higher than the soil formation rate. Natural erosion in a balanced ecosystem has a tolerable level of annual surface horizon loss (5 tonnes/ha). This loss can be accelerated by human activities to rates higher than 50 tonnes/ha. The most evident on-site impact of erosion is the truncation of the soil profile that can result in the emergence of bedrock outcrops and loss of cultivable area, the depletion of soil nutrients, the reduction of the water holding capacity of soil, and changes of other soil properties (e.g. coarsening soil texture). Erosion also affects the capacity of soil to store and regulate carbon, eventually making it a net contributor to greenhouse gas emissions. Studies in semiarid parts of Spain have shown that the total organic carbon lost by erosion in the sediments was around three times higher in cultivated (5.12 g C m^{-2}) than forest land (1.77 g C m^{-2}) (Martinez-Mena et al. 2008). Off-site impacts of erosion include diffuse pollution and eutrophication of downstream water bodies caused by eroded sediments being transported along with and the nutrients and pesticide attached to them, higher risks of flash floods transporting high loads of sediments, and reservoir siltation. The reduction of reservoir capacity is a serious issue in North African and Eastern Mediterranean countries where water availability for irrigation and drinking relies mainly on surface water storage (Ayadi et al. 2010).

Soil salinization is one of the most widespread soil degradation phenomena that not only affects soil fertility, productivity and resilience against stressful environmental factors, but also reduces land use options (crop selection, land suitability) to accommodate market conditions and demand. Salinization results from excessive fertilizer input, over-irrigation or irrigation with low-quality water, inappropriate irrigation schedule, ineffective drainage and monoculture. Soil salinity and sodicity caused by the accumulation of salts and sodium (Na) negatively affect soil fertility and productivity. High soil osmosis and head potentially restrict water availability to plants, which negatively affect plant growth and reduce crop production. Conditions causing low biological activity such as low surface organic matter content after fires, weak microbial activity caused by salinity or pollution, leading to insufficient oxidation-reduction and ammonification/ nitrification potential, may reduce the efficiency of urea and other nitrogen fertilizers' application and transformation in the soil-soil solution-root continuum.

Global warming and climate change in the Mediterranean have a specific impact on soil functions and are associated with an increasing risk of desertification, i.e. the process of land degradation in arid, semi-arid and dry sub-humid areas. It is considered that approximately 10% of the European territory is affected by varying degrees of desertification (Rubio & Recatala, 2006). Soil is the main actor in desertification processes. It is a living environment with enormous biological activity that is highly sensitive to the availability of water and climate variation. In Mediterranean terrestrial ecosystems, the short-term effects of a drier climate on decomposition lead to a reduction in soil microbial biomass (Curiel-Yuste et al. 2011), reduced soil respiration (Asensio et al. 2007; De Dato et al. 2010; Emmett et al. 2004) and reduced soil enzyme activities (Hueso, Hernández & García, 2011; Sardans & Peñuelas, 2005). The medium-term (i.e. a few decades) effects impact litter quality by reducing nutrient content (Sardans et al. 2008; Wessel et al. 2004) or by increasing recalcitrant compounds (molecules resisting microbial decomposition) (Hernandez, Alegre & Munné-Bosch, 2004; Munné-Bosch & Alegre, 2000), and altering the composition of decomposer communities via feedback processes.

Soil degradation, in turn, affects important climate regulation factors and atmospheric chemical composition, including changes in albedo, radiative forcing, soil moisture, surface roughness, evapotranspiration, emission and retention of greenhouse gases (carbon dioxide, methane, nitrous oxide), changes in the condensation surfaces and the emission of aerosols and dust particles. Hence, the feedback from desertification processes increases the tendency of climate change (Rubio, 2007). In the Mediterranean, this feedback mechanism not only affects the stability and functioning of the natural environment, but also involves environmental security problems and major socioeconomic consequences (water scarcity, food insecurity, forest fires, forced displacement).

6.3.3 Food security

The four pillars of food security are availability, access, utilization and stability (Committee on World Food Security, 2009). In 2015, the United Nations General Assembly adopted the 2030 Agenda for Sustainable Development, whose second goal (SDG 2) is to "End hunger, achieve food security and improved nutrition and promote sustainable agriculture".

Although the Mediterranean is not the region most impacted by food insecurity in the world, it is facing an increasing number of complex and interlinked challenges. Limited natural resources and population growth are preventing the region, particularly the South and East, from being self-sufficient. Conflicts are also a highly worrisome source of food insecurity. Food security for populations therefore depends on stability, partially from internal production, but especially from trade and reliable international markets. The price volatility of agricultural commodities can harm countries with a vulnerable economy and limited public finances.

One of the visible manifestations of the world food crisis of 2007-2008 was the instability of agricultural commodity markets and price volatility. This volatility came at a time of prevailing difficulties for international agricultural commodity markets, as evidenced in numerous studies. This instability resulted in price increases in 2008-2012, especially affecting food expenditure, which in some countries, represents up to 25% of total import expenditure. To manage the inflation of food prices, governments in SEMCs generally provide subsidies for bread and basic food products from compensation funds, which place a heavy burden on public finances. Aiming to achieve complete national food self-sufficiency in countries in the region without the use of imports may be a utopian ideal due to the agro-climatic characteristics and available water and soil resources, but reducing external food dependency is an important goal. Although a relative decline of agriculture in national wealth creation has been observed in recent decades, governments in the Southern Mediterranean region have placed food security and agriculture at the heart of their national priorities.

This section will discuss each of the four pillars of food security in the Mediterranean, while reiterating its importance for political and social stability in these countries.

6.3.3.1 Food availability: production imbalance between the Northern and Southern Mediterranean regions and increased dependence of Southern countries on basic food commodities

Trends in food production

The demand for livestock products is expected to grow in the coming decades, but there are significant challenges for livestock systems under changing climate and social conditions (Herrero et al. 2013). In 2014, animal food and feed imports represented around 32% of total food imports (Weindl et al. 2015). The impacts of climate change on local production potential, combined with the growing demand for animal products due to demographic growth and changing consumption habits will increase the food dependence of the Southern Mediterranean countries in the coming decades (estimated at around 50% of all food products in the Maghreb (FAO, 2016). Human population growth and increased affluence in some regions, along with changing diets, will lead to higher demand for food products, while crop and livestock yields are projected to decline in many areas due to climatic and other stress factors.

Extreme events such as drought, heat waves and heavy rainfall occurring in critical phenological stages could bring unexpected losses and increase crop yield variability (Barbagallo et al. 2013; Fernando et al. 2016; Fitzgerald et al. 2016). Pests and diseases, as well as mycotoxins could also present a serious threat under unfavourable climate conditions (Bernués et al. 2011). Sea level rise, combined with land subsidence, may significantly reduce the area available for agriculture. The effects of sea level rise in North Africa, especially on the coast of the Delta region of Egypt, could impose additional constraints on agricultural land (Herrero & Thornton, 2013).

Yields for many winter and spring crops are expected to decrease due to climate change, especially in the South. It is estimated that by 2050, Egypt will see a 40% reduction in legume production, with a 12% reduction for sunflowers and 14% reduction for tuber crops in Southern Europe. Warming will also affect olive production by increasing irrigation needs (Tanasijevic et al. 2014), the risk of heat stress around flowering and the lack of chilling accumulation (Gabaldón-Leal et al. 2017), and by altering fly infestation risks (Ponti et al. 2014). Although the impact is not projected to be significant for aggregated productions, local and regional disparities will emerge (Ponti et al. 2014). Changes in the phenological cycle towards shorter durations and early flowering are projected for grapevines, with associated increased exposure to extreme events and water stress (Fraga et al. 2016). These conditions could also affect quality. Early blooming and insufficient cold weather (chilling accumulation) are expected to impact yields from fruit trees as well (Funes et al. 2016). For vegetables such as tomatoes, reduced water availability will be the main factor limiting yields (Arbex de Castro Vilas Boas et al. 2017), although water-saving strategies to enhance quality and nutritional aspects while maintaining satisfactory yield levels could be developed (Barbagallo et al. 2013). For some crops, yields may increase due to CO_2-fertilization effects which could improve water use efficiency and biomass productivity (Deryng et al. 2016; Fraga et al. 2016), although significant uncertainties exist due to complex interactions among the various factors and current knowledge gaps (Fitzgerald et al. 2016; Link, Kominek & Scheffran, 2012). Furthermore, these yield increases are expected to be combined with decreased quality (e.g. lower protein content in cereals) (Fernando et al. 2015).

Fisheries and aquaculture are currently impacted mostly by overfishing and coastal development, but climate change and acidification may play an important role in the future. Mediterranean countries import more fish products than they export as a result of increasing demand for seafood. Despite being major exporters, France, Spain and Italy are the countries with the highest trade deficits for seafood. There are no quantitative estimates on the impact of climate change on future seafood production in the Mediterranean region, but ocean acidification and warming will very likely impact an already-stressed fishing sector. By 2040-2059, compared to 1991-2010, more than 20% of fish and invertebrates currently fished in the Eastern Mediterranean are projected to become locally extinct under the most pessimistic scenario (RCP 8.5) (Cheung et al. 2016; Jones & Cheung, 2015). By 2070-2099, forty-five species are expected to qualify for the IUCN Red List and fourteen are expected to become extinct (Ben Rais Lasram et al. 2010). The maximum catch potential on the Southern coast of the Mediterranean Sea is projected to decline by more than 20% by the 2050s with respect to the 1990s under RCP 8.5 (Cheung et al. 2016). In the face of climate change, the expected migration of species to cooler areas as the ocean warms (Poloczanska et al. 2016) may be limited to enclosed seas and the Mediterranean Sea has been described as a 'sans issue' (no exit) for endemic fish, including commercial species (Ben Rais Lasram et al. 2010).

BOX 75 Impacts of climate change on agricultural production

Food production in the Mediterranean region is changing rapidly due to multiple local and global social and environmental changes. Food demand in areas unsuitable for agricultural production and with significant water restrictions is increasing. The capacity to cope with these challenges is limited. For example, water reserves were not able to cope with extensive droughts in the last two decades in Spain, Morocco and Tunisia, causing losses in irrigation-dependent agricultural systems (Ponti et al. 2014). Climate change has significant impacts on the sustainability of food production, soil and water use. In terms of crop yield, major uncertainties and significant local-to-regional differences exist (Fraga et al. 2016; Funes et al. 2016). Warmer and drier conditions reduce the duration of the growing period and increase irrigation demand (Arbex de Castro Vilas Boas et al. 2017).

Livestock production systems play a central role in climate change and agriculture due to their productive, environmental and social functions (Bernués et al. 2012; Herrero & Thornton, 2013). Currently, the Mediterranean region is characterized by a mixed production system in the North and some Southern regions, while grazing systems dominate the Southern regions (Herrero et al. 2013b). The number of agricultural holdings with grazing livestock is on the decline but the number of animals per farm is increasing (Bernues et al. 2011). The abandonment of marginal land threatens the future of these pasture-based systems. Transition to mixed crop-livestock systems could help in reducing climate adaptation costs and increase resilience to climate extremes in the Middle East and North Africa (Weindl et al. 2015). In these regions, livestock units increased by 25% from 1993 to 2013.

Overall, expected climate and socioeconomic changes pose threats for food security in the Mediterranean region. These pressures will not be consistent across the region and different production sectors, creating further regional imbalances. Sustainable food production is an issue under unfavourable climate and socioeconomic conditions.

Trade: Imports are crucial to cover food needs

The Mediterranean is home to just over 6% of the world's available arable land. Mediterranean food production has a surplus of fruit and vegetables, wine and olive oil, but increasing cereal deficits.

The region's agro-climatic characteristics explain its 15% contribution to global fresh fruit and vegetable production in recent years (2015-2017) (30% for fresh tomatoes and over 40% for industrial tomatoes), making it the leading vegetable supplier in Europe.

The Mediterranean basin accounts for 20% of global citrus fruit production and more than half (53%) of global citrus fruit trade. It also provides 98% of global olive oil production and 50% of wine production, and accounts for 60% of global wine trade and a significant share of olive oil trade. For wine, three European countries (Italy, France, Spain) dominate the wine trade, while for olive oil, four major exporting countries (Spain, Italy, Greece and Tunisia) account for three quarters of global olive oil exports. Although Egypt, Algeria and Tunisia are the world's main date producers[114], Tunisia, and to a lesser extent Algeria, currently dominate the global market, while Turkey is one of the main global producers and exporters of dried fruit (raisins, dried apricots and dried figs[115].

The main Mediterranean players in the world agricultural trade are Northern countries (Spain, France, Italy and Greece), three North African Countries (Morocco, Egypt and Tunisia) and Turkey in the East. Finally, Croatia and Slovenia in Eastern Europe, Israel and, to a lesser extent, Lebanon in the Middle East, export fruit and vegetables across Europe and the world.

Although France is one of the main exporters of cereals and dairy products, all Mediterranean countries, except Croatia and Turkey, register a net cereal deficit and a high cereal dependency ratio (see *Figure 170* and *Figure 171*).

The climate regime and natural resources limit cereal production[116]

Cereals are vital and strategic products for food security. Bread and semolina-based products are food staples in the region. Cereal crops in the Mediterranean region represent less than 10% of the land used for global cereal crop production (65.5 million ha compared to 718.1 million ha in 2014), and the Mediterranean's contribution to global production is relatively modest with less than 7% of global cereal supply in recent years (FAOSTAT, 2017). In light of growing demand for cereals, food security in Southern Mediterranean countries is now increasingly threatened, particularly in countries with high population growth and demand.

The Mediterranean Agricultural Market Information Network (MED-Amin) coordinated by the International Center for Advanced Mediterranean Agronomic Studies (CIHEAM) was launched in 2014 in 13 countries to process information on cereal markets in the Mediterranean. The first Policy Brief (MED-Amin, 2016) summarized the cereal situation in the region as highly imbalanced as the region is facing strong constraints and is exposed to cereal market reversals.

Figure 171 shows wheat import volumes between 2011 and 2013, which are some of the highest in the world (particularly for Egypt, which is the largest global importer), the self-sufficiency ratio for soft wheat, and the origin of wheat imports. The proportion of imports from the Mediterranean region was higher in the West than in the East for 2011-2013.

[114] 5th most traded fruit in the world after citrus fruits, bananas, mangos and pineapples.
[115] Turkey is the largest global exporter of dried apricots. It is also the world's second producer and leading exporter of raisins (FAOSTAT, 2017).
[116] This paragraph specifically mentions cereals given the importance of these crops in Southern and Eastern Mediterranean countries (SEMCs).

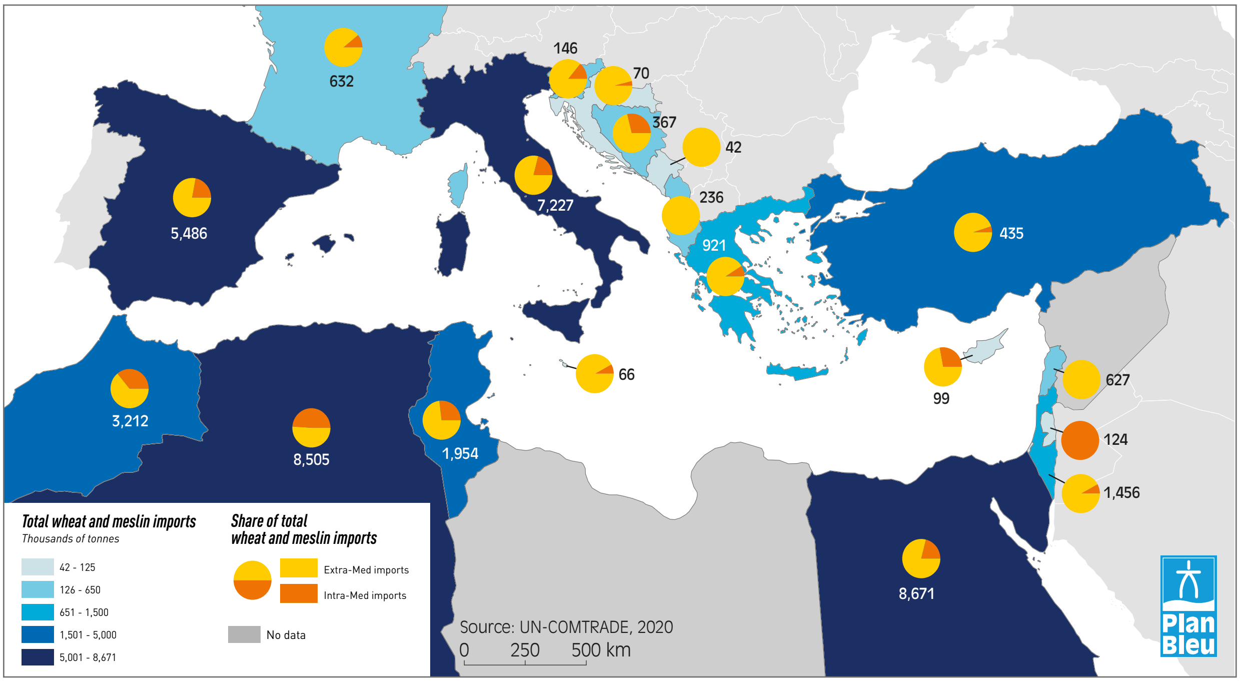


Figure 171 - Wheat and meslin[117] imports in Mediterranean countries, 2015
(Source: UN-COMTRADE, 2020)

The agricultural production deficit is primarily due to agro-climatic conditions and the scarcity of arable land (see above) and water resources[118]. Average rainfall is another agricultural difficulty facing Mediterranean agriculture, particularly in Southern countries *(Table 29)*.

Southern countries are affected by natural conditions that are generally more difficult for agriculture. Water resources are scarce and the extension of irrigated land is limited everywhere by non-sustainable agricultural practices and intensive water usage, resulting in groundwater depletion and soil salinization due to lack of drainage.

In addition to these characteristics, Southern Mediterranean countries have major land ownership constraints, with small family farms with under 5 ha of arable land dominating the agricultural landscape.

Imports are crucial to cover food needs

Increased food demand and water and soil scarcity have resulted in increased dependency on imports of basic food commodities, on which many countries spend a large proportion of their export income.

Food imports represent over 20% of total trade for countries such as Montenegro (23.8%), Egypt (22.6%) and Algeria (20.6%) (WTO, 2017), with Egypt and Algeria experiencing rapid population growth, ongoing demographic transition and insufficient natural resources.

The Mediterranean is a region with some of the highest net importers of food in the world, taking into account all food products. Although France, Italy, Spain and Turkey are in the top 30 exporter countries in the world, they also feature alongside Egypt and Algeria in the list of the top 50 importer countries of agricultural and food products.

Recent changes between 1995 and 2016 have shown an increase in agricultural trade across all Mediterranean countries. Both agricultural exports and imports have increased (FAO, 2018), as shown in *Table 30*.

There is a large food trade deficit in the commercial balance of food products in the Mediterranean of USD 36.6 billion (WTO, 2017).

The only Mediterranean countries with a positive agricultural trade balance are France (+ USD 3.4 billion) and Spain (+ USD 13.1 billion). Turkey registered a positive trade balance of over USD 5.7 billion in 2016 (FAOSTAT, 2019), but a negative balance (- USD 99 million) in 2017 (WTO, 2017).
In 2017, food import expenditure per capita varied by country. It was especially high in countries like Malta (USD 1,198 per capita), Montenegro (USD 820 per capita), Cyprus (USD 738 per capita), Israel (USD 547 per capita) and Lebanon (USD 461 per capita). It is low in Tunisia (USD 92 per capita), Croatia (USD 78 per capita), Turkey (USD 12 per capita) and Morocco (USD 5 per capita).

[117] The FAO defines meslin as a mixture of wheat and rye.
[118] The Mediterranean is one of the world's regions that suffers most from water stress. Most southern countries currently abstract groundwater at a rate that is incompatible with internal freshwater renewal capacities (World Bank, 2019).

Countries	Arable land (ha) 2016	Hectares/ person	Average precipitation mm/year 2014	Cereals (ha) 2016	Permanent crops	Irrigated land as a % of usable agricultural area
Albania	615,100	0.21	1,485	148,084	22.4	19.2
Algeria	7,762,100	0.19	89	2,207,307	3.1	
Bosnia and Herzegovina	1,029,000	0.29	1,028	319,265	20.1	
Croatia	844,100	0.20	1,113	527,374		1.0
Cyprus	98,900	0.09	498	24,238	10.7	22.3
Egypt	2,895,860	0.03	51	3,403,715	2.9	
France	18,478,700	0.28	867	9,620,740	33.7	16.6
Greece	2,224,000	0.21	652	1,052,271	17.3	19.7
Israel	297,200	0.04	435	61,451	13.7	35.8
Italy	6,601,000	0.11	832	3,253,985	22.4	20.5
Lebanon	132,000	0.02	661	61,234	12.9	
Libya	1,720,000	0.28	56	321,232	1.0	
Malta	8,970	0.02	560	3,819	28.0	36.2
Montenegro	8,700	0.01		2,152	0.6	
Morocco	8,130,000	0.23	346	3,804,161	18.2	
State of Palestine	64,000	0.01	402	24,497	10.6	
Slovenia	184,050	0.09	1,162	99,435	9.1	0.5
Spain	12,338,000	0.27	636	6,265,086	24.7	17.6
Syrian Arab Republic (2007)	4,662,000	0.25	252	2,244,751	25.4	9.4
Tunisia (2016)	2,900,000	0.26	207	859,013	18.7	3.9
Turkey	20,645,000	0.26	593	11,359,619	26.8	13.6
Total	**91,637,680**	-	-		-	-
Global	**1,500,000,000**	**0.19**	-	**718,123,234**	**11.0**	

Table 29 - Land availability, rainfall and cereal crops in the Mediterranean in 2017
(Source: World Bank, 2019)

The Mediterranean basin is therefore unable to produce sufficient basic commodities for its own consumption, and the cereal deficit can be observed in all countries, except for France and Croatia.

Mediterranean countries received one third of global cereal imports (Abis, 2015). Algeria and Egypt are some of the largest wheat importers in the world and their deficit is likely to increase due to a failure to diversify food intake and population growth.

Wheat is the traditional basic food staple in the Mediterranean region and its consumption per capita currently stands at approximately 200 kg per person per year, around 60 kg more than the global average (OECD/FAO, 2018). Wheat is one of the most internationally traded food commodities, with demand concentrated in North Africa and the Middle East. In 2014, SEMCs spent almost USD 10 billion on wheat (3.5 times the expenditure in 2000), and half of this import expenditure was for durum wheat (IPEMED, 2017).

The cereal import dependency ratio is especially high in this region, with the exception of France and Croatia (export countries) and Turkey (which only imports 4%), as shown in *Table 31*.

UN forecasts to 2050 predict that North Africa and the Middle East will remain the world's most cereal import-dependent region, with a deficit of up to 140 million tonnes (FAO, 2018b). The contribution of national agriculture, and especially family farms, must not be overlooked. Crop and livestock systems on small family farms make a significant contribution to ensuring the food intake of rural households, including the farmers themselves, and help provide a diet suited to local tastes and the varying purchasing powers of urban households for some products (Marzin et al. 2016). There is a clear link between food security in rural regions and the presence of small family farms to offset necessary imports. In Lebanon, in 2010, around 85% of agricultural products consumed were imported and over one third (37%) of farmers used their production primarily for their

Countries	Exports			Imports			Balance of agricultural trade
	1995	2005	2016	1995	2005	2016	2016
Albania	1	5	84	140	346	481	-397
Algeria	92	86	373	2,778	3,455	7,388	-7,015
Bosnia and Herzegovina	2	114	423	245	890	1,190	-767
Croatia	333	576	1,484	683	1,005	2,113	-629
Cyprus	212	160	296	272	456	702	-406
Egypt	320	898	2,919	2,795	3,417	8,480	-5,561
France	29,078	30,782	38,184	19,545	24,308	36,807	1,377
Greece	2,260	2,590	4,638	2,978	4,300	4,890	-252
Israel	988	964	1,588	1,435	1,829	3,931	-2,343
Italy	10,529	17,523	28,227	15,026	22,547	29,411	-1,184
Lebanon	80	205	565	886	1,095	2,469	-1,904
Libya	37	1	6	1,175	1,113	2,452	-2,446
Malta	18	63	101	198	319	414	-313
Monaco	-	-	-	-	-	-	-
Montenegro	-	-	30	-	-	404	-
Morocco	6¬1	1,167	2,479	1,323,	1,774	3,861	-1,382
State of Palestine							
Slovenia	231	421	1,201	559	931	1,883	-682
Spain	10,984	20,468	37,399	8,620	14,180	21,337	16,062
Syrian Arab Republic	469	817	348	580	1,253	1,452	-1,104
Tunisia	396	782	1,130	816	861	1,731	-601
Turkey	3,530	6,612	13,571	2,031	2,361	7,819	5,752

Table 30 - Exports and imports, balance of agricultural trade (106 USD)
(Source: FAO, 2018a; FAOSTAT, 2019)

own consumption and food security. In North Africa, family farms supply fruit and vegetables to local rural souks, unpasteurised milk to dairy collectors and cooperatives, and contribute to the food security of agricultural households and local populations by eating their produce themselves (wheat, potatoes, eggs, milk, meat, etc.) or supplying domestic markets.

Food security in the Mediterranean is closely dependent on the international trade of agricultural products. In the future, the region will need to manage uncertainty in terms of both supply and demand. For example, wheat supply is uncertain due to limitations associated with the sustainability of land areas suitable for production and highly exposed to climate change (FAO et al. 2018).

6.3.3.2 Access to food: rural populations are more exposed to poverty and food insecurity

One of the main factors contributing to food insecurity is limited access to food for physical (lack of infrastructure, markets, etc.) or economic reasons (limited purchasing power, rising domestic prices, etc.). Ensuring food security requires first and foremost adequate means of subsistence and standards of living. In the Mediterranean region, the situation is different between the North (EU) and the SEMCs. The global economic, financial and food crisis of 2008 increased the impoverishment of entire sections of society, including in the European Union, especially in Mediterranean countries, accentuating economic difficulties in local economies and societies, especially among the most vulnerable populations (poverty, food insecurity, lack of social infrastructure and public services, etc.).

Food insecurity returned to certain population segments, especially in rural areas, even in Europe.

Despite increasing urbanization in the region, there is still a large rural population. Major territorial divides are forming between rural and marginalized zones (mountains, desert areas, etc.), and big cities and coastal areas. Alongside poor urban populations, statistically, rural populations are more affected by poverty and food insecurity. It is paradoxical

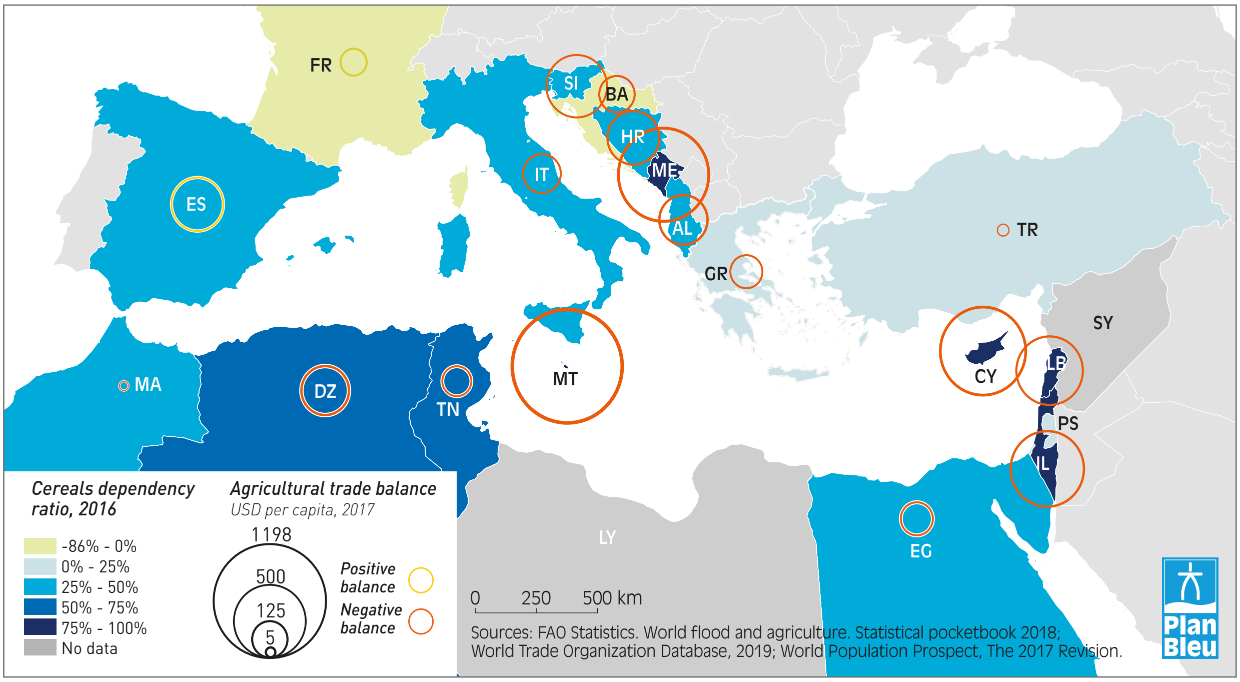


Figure 172 - Agriculture balance and cereal dependency ratio for Mediterranean countries
(Source: FAOSTAT, 2019; WTO, 2017)

Countries	Cereal import dependency ratio (%) in 2016
Albania	40.2
Algeria	72.2
Bosnia and Herzegovina	37.0
Croatia	-11.6
Cyprus	100
Egypt	42.1
France	-86.3
Greece	18.2
Israel	93.2
Italy	25.3
Lebanon	86.5
Libya	N/A
Malta	92.8
Montenegro	91.4
Morocco	42.1
Slovenia	36.9
Spain	31.8
Syrian Arab Republic	N/A
Tunisia	59.7
Turkey	4.0

Note: Negative values mean that the country is a net exporter of cereals.
N/A: data unavailable

Table 31 - Cereal Import Dependency Ratio in the Mediterranean
(Source: FAO 2018a; FAOSTAT, 2019)

that smallholder farmers, who produce their own food, are highly vulnerable to food insecurity. Nevertheless, this is the case, especially when they are not connected to markets, live in isolated rural areas and hold multiple jobs (with numerous professional activities forcing them to migrate to find work, often within the same country). An estimated 50% of agricultural households hold multiple jobs (Marzin et al. 2016).

Statistics show that poverty rates are generally much higher in rural areas, where the agricultural sector is dominant, than in big cities. Comparing socio-professional categories shows that agricultural workers and farmers are some of the poorest populations, and that the poverty rate varies significantly from one region to another within each country (Marzin et al. 2016). The relationship between poverty, the unemployment rate and wages needs further assessment. In Egypt, the unemployment rate is lower in rural areas than in urban areas (7% compared to 11.7%), but poverty remains, on average, higher in rural than in urban areas (28.9% compared to 11.6%).

Young people are losing interest in agricultural jobs and rural activities for many reasons, including precarious and seasonal work, informal employment contracts, limited access to social security and other benefits, difficult working conditions, low wages and a poor social status (AFD & CIHEAM, 2019). Cities are attractive due to real or supposed attractions (opportunities for work and independence, infrastructure, services, etc.). With little or no skills, capital, access to credit and land, rural young people have very limited opportunities. Migration from the countryside to cities is a strategy intended to improve the life of households through material and immaterial

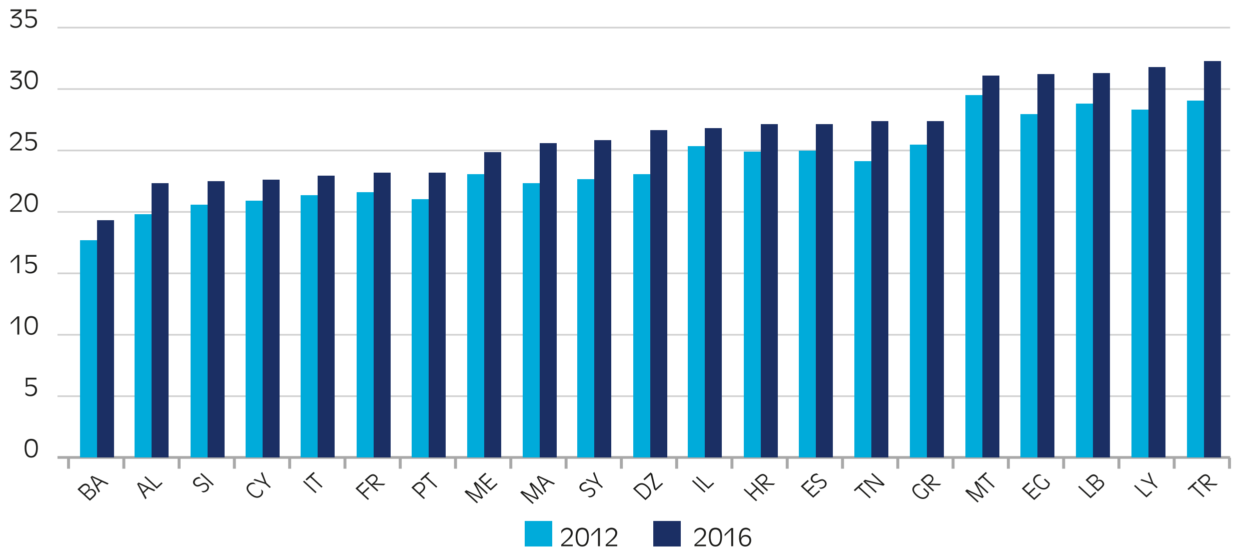


Figure 173 - Prevalence of obesity in adults (18 and over) in %
(Source: FAO et al. 2018)

transfers from migrants, and constitutes a lever of local development, but also compromises the attractiveness of rural regions, particularly for young people. It also deprives the agricultural and agrifood sectors of necessary human capital.

In Mediterranean countries, intra-family and inter-generational solidarity within households (gifts, shared meals) still effectively contributes to preventing food vulnerability and collective social insecurity, particularly for rural populations.

At a political level, social protection (in the EU) and public subsidies for commodities (in SEMCs) or social safety nets help to mitigate food price increases and improve purchasing power to a certain extent. These policies are also limited, as demonstrated by the food riots of 2007-2008 (Egypt, Morocco) and more recent social unrest associated with purchasing power (France, Greece, Italy, Tunisia, etc.). Public action associated with rural development policies (construction of community infrastructure, improved public services, job-creation and income-generating programmes, etc.) often fail to meet expectations. The issue of social protection, social insurance and pensions for smallholder farmers, and social assistance is currently emerging in some Southern Mediterranean countries (Egypt, Lebanon, Morocco, and Tunisia).

6.3.3.3 Nutrition, quality and food use: the end of the Mediterranean diet?

Despite the Mediterranean Diet's inclusion on the UNESCO Intangible Cultural Heritage of Humanity list in 2010 and its worldwide reputation, one may wonder if the Mediterranean diet still exists in practice. The Mediterranean diet is more than just the high consumption of fruit, vegetables and legumes, moderate consumption of dairy products (cheese and yoghurt), low to moderate consumption of seafood and poultry, and low consumption of red meat, with olive oil as the main fat (Hachem et al. 2016). More broadly, this notion covers a way of living and eating associated with social norms, traditions for preparing and eating meals, a degree of frugality, social dining, the practice of moderate physical activity and adequate rest.

Food products from smallholder farming are more suited to these dietary traditions (cereals, olive oil, dairy products, etc.) and the Mediterranean diet persists better in rural areas. The transition towards high-energy diets with large amounts of animal protein, fats and refined cereals has accelerated in recent decades. The Mediterranean diet has been gradually abandoned due to urbanization, changes to food distribution, the globalization of markets and cultural models, and the relative prosperity of Mediterranean countries. Family and social structures have been transformed, moving from an extended family model where passing down culinary knowledge was encouraged, to a family model where this know-how has been lost. The role of women, traditionally centred on preparing meals in patriarchal Mediterranean societies, is changing with their entry onto the employment market, and lifestyles are being transformed. In cities, major retailers are taking over from local shops, and fast food chains are thriving. Even the reputation of the Mediterranean diet's healthy model has worked against it, by promoting olive oil exports to rich countries that did not traditionally consume it (North America and Northern Europe, Japan, Australia, etc.) and replacing it with cheap vegetable oils in diets in the producing countries (SEMCs).

The abandonment of the Mediterranean diet has resulted in a loss of sustainability with both environmental and nutritional impacts, including increased pressure on the environment for food production, a larger environmental footprint, loss of biodiversity and increased food waste. In many Mediterranean countries, a double or triple

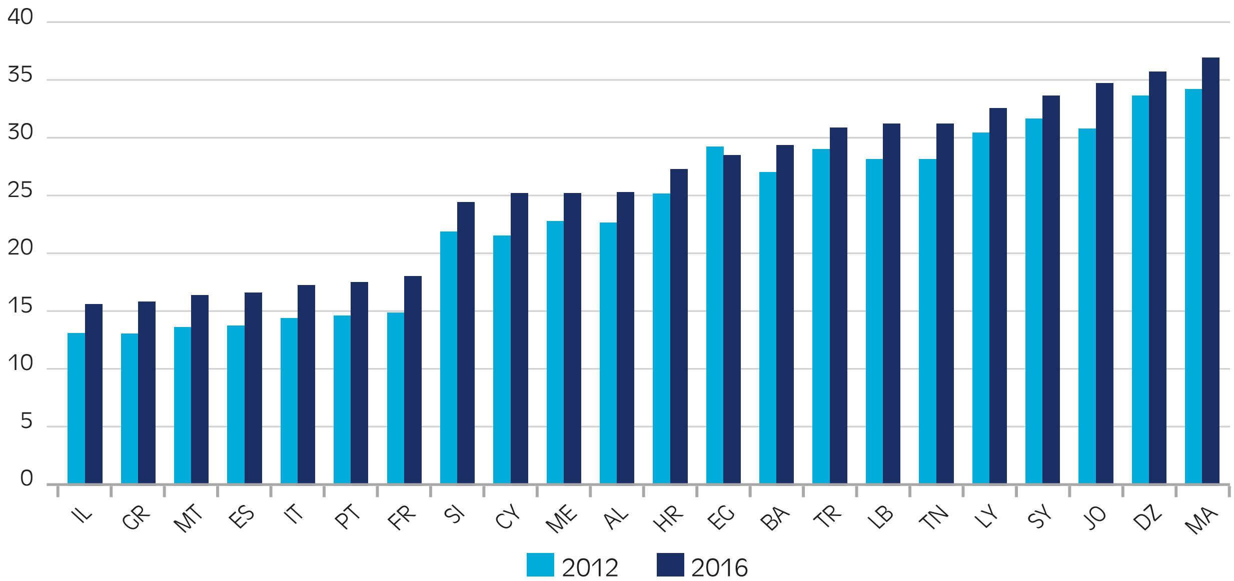


Figure 174 - Prevalence of anaemia in women of childbearing age (15-49 years)
(Source: FAO et al. 2018)

nutritional burden can be observed, with the combination of undernutrition, overeating (obesity and non-transmissible diseases) and nutritional deficiencies.

The most recent United Nations data (FAO et al. 2018) shows a worrying increase in the number of people who are overweight or obese between 2012 and 2016 in all Mediterranean countries *(Figure 173)*. In 2016, the rate of obesity among adults exceeded 30% in Eastern Mediterranean countries (Egypt, Lebanon, Libya, Malta, and Turkey). It is lower in the Balkans, but still in excess of 20% (except in Bosnia and Herzegovina), leading to increased public health risks (cardiovascular diseases, type-2 diabetes, metabolic syndrome).

Although undernourishment, emaciation and stunted growth in children under 5 have almost disappeared in the region (excluding countries in conflict and, to a lesser extent, Egypt and Lebanon), nutrition security is not fully guaranteed in the Mediterranean.

In 2017, about 21 million Mediterranean people lived below the level of food requirements, representing 4% of the total population (Blinda, 2018). This undernourished population is unevenly distributed with 74% living in SEMCs and 26% in NMCs (Blinda, 2018).

In addition to problems associated with overweight, nutritional deficiencies can be observed, including iron deficiency in women of childbearing age. Anaemia increased in all Mediterranean countries between 2012 and 2016, except in Egypt *(Figure 174)*, and exceeds 30% in Algeria, Lebanon, Libya, Morocco, Syrian Arab Republic, Tunisia and Turkey.

Although food safety has generally improved in recent decades with the rise of globalization and major retailers, nutritional quality is somewhat lacking, with less food diversity, reduced consumption of local and seasonal products, and the loss of traditional recipes and know-how for conservation. However, since the 1990s, citizens' movements have promoted short supply chains and food that is local, organic or produced through responsible farming. Initiatives have been taken to teach young people about food (and not just nutrition).

6.3.3.4 Stability: conflicts and climate change are hampering food security in the Mediterranean region

Finally, the "stability" pillar in food security presumes that populations have more or less guaranteed stable access to adequate food, based on relatively consistent supply. This dimension could be among the greatest challenges for food security in the Mediterranean region now and in the future. Three major factors are at play to weaken the stability of food supply.

Firstly, due to population growth, particularly in the South, and the natural limitation of agricultural production, the region is highly dependent on international markets and therefore exposed to their volatility. This volatility has been under relative control since 2012, with several world record years in cereal production, but this situation may not continue in the future. FAO-OECD estimates show that the price volatility of global agricultural products is likely to increase or remain high in the future (OECD/FAO, 2018). It is also highly dependent on the political decisions of the major producing countries (export restrictions or bans, closure of markets, etc.). The current uncertain geopolitical context challenges the sustainability of supply from world markets, as demonstrated by recent incidents (export taxes in Argentina, rumours of restrictions on Russian wheat exports that impacted the global wheat market, etc.). On the demand side, instability of the global markets for oil and other commodities, and exchange rate fluctuation (particularly with the US Dollar) are an economic risk factor for dependent countries, their external revenues and purchasing power.

The second factor to take into account in the stability pillar is political instability, crises and conflicts. Food security in the Mediterranean has deteriorated rapidly in recent years due to conflicts in several countries. The FAO considers that in countries in the Middle East and North Africa directly affected by conflicts, 27.2% of people suffered from chronic hunger or undernourishment in 2014-2016 (FAO, 2017). That is six times higher than the number of undernourished people in countries not affected by conflicts (4.6% on average). For example, the prevalence of undernourishment in Libya or the Syrian Arab Republic is similar to the Least Developed Countries (LDCs). "Acute food insecurity" is currently twice as high in countries in conflict than in countries not affected by unrest. The Syrian Arab Republic and Libya are no longer able to cover their needs and are affected by severe food insecurity. A recent FAO warning note (December 2017) identified severe localized food insecurity in Libya, with 6% of people requiring external assistance for food. "The number of people in need of food assistance is estimated at 0.4 million, with refugees, asylum seekers and internally-displaced among the most vulnerable. Food shortages are reported mostly in the South and East where basic food items are in short supply. Access to subsidized food among the affected population is limited." In the Syrian Arab Republic, violence led to a 67% drop in the Gross Domestic Product (GDP) and has seriously compromised food security. According to FAO estimates, 70% to 80% of Syrians are currently in need of humanitarian aid, with 50% requiring food assistance. The report mentions an exceptional deficit in production and food availability. The ongoing conflict has already placed approximately 6.5 million people in a situation of food insecurity, with an additional 4 million people at risk of food insecurity. Despite international food assistance, Syrian refugees are putting a strain on host communities in neighbouring countries (Lebanon and Turkey).

Food security and instability are interlinked in a vicious circle. Food insecurity, the increased price of basic food commodities, and especially bread, is often the source of food riots and unrest, which sometimes leads to political instability. Drought also reduces agricultural production, resulting in higher food prices, which can also be one of the causes of popular rebellions. Conversely, conflicts drastically increase food insecurity, in a region where chronic hunger ordinarily affects less than 5% of the population.

Finally, climate change is the third factor to take into account in the medium- to long-term. It has already had an impact on food production in the Mediterranean (see Chapter 2). Agricultural production could drop dramatically due to a global increase in temperatures, prolonged periods of drought and extreme climate events. According to the World Bank report (World Bank Group, 2014) entitled "Turn down the heat: confronting the new climate normal", by 2050, cereal yields in Egypt and the region could fall by 30% due to a 1.5°C temperature increase. The stability of food supply is already fragile, and if disturbed, could have very troubling social and political consequences.

In conclusion, it is important to fight on all fronts and all pillars of food security, particularly to strengthen the resilience of the populations most at risk of food insecurity (poor urban households, young unemployed, smallholder farmers and rural residents). Better, more inclusive governance and global, consistent and specific policies need to be implemented to achieve SDG 2 and the Zero Hunger objective by 2030.

6.4 Responses and priorities for action

The status and trends of water and food security in the Mediterranean region described above show that among Mediterranean people and countries, there is an increasing risk of resource depletion (water, soil), diminished resource quality, uneven access to resources, and instability. Specific management responses to ensure food and water security include:

- Integrated Water Resources Management, Water Demand Management and Good Water Governance;
- Increased monitoring;
- Wastewater treatment, recycling and reuse;
- Clean production techniques;
- Ecohydrological conservation and restoration techniques such as aquifer recharge, soil and water conservation practices;
- Rainwater and stormwater capture and use;
- Desalination;
- Agro-ecology and sustainable land management;
- Rural development and support to smallholder farming.

6.4.1 Integrated Water Resources Management

As presented throughout this chapter, water security entails ecosystem and human health issues, tackles water quantity and quality issues, and questions water governance arrangements. Water security is not yet a ready-made operational concept. A first step in fully introducing this concept is the promotion and assessment of integrated water resources management (IWRM). IWRM is defined as "a process which promotes the coordinated development and management of water, land and related resources in order to maximize economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems and the environment" (GWP, 2000). Integrated frameworks have been developed in line with this definition to address water resources and demand relationships and their evolution under climatic and anthropogenic changes, and promote dynamic water resources and demand management. These modelling tools first evaluate the hydro-climatic conditions of catchment areas and then water demands to finally assess water stress or water allocation rates under climate and anthropogenic changes.

Therefore, regional integrated frameworks are useful to identify the areas that are most likely to be under pressure and to explore the capacity of regional sustainable development strategies to reduce water tensions. However, water management decisions are more often made at the river basin scale. Subregional decision support systems were then developed. These include the WEAP model (Yates et al. 2005), REALM model (Perera et al. 2005), Aquatool model (Andreu, Capilla & Sanchis, 1996) or the generic method for Mediterranean catchments developed by Plan Bleu in partnership with HydroSciences Montpellier laboratory (Milano et al. 2013b). Developed for catchment-scale studies, these tools provide a detailed spatial and temporal description of water and land use, water supply and demand site relationships, dam operating systems or even local institutional instruments. They therefore provide better insights on local water issues and on the effectiveness of adaptation policies and techniques. They are also useful to identify the regions that are most vulnerable to climate and/or anthropogenic pressures as well as sectors and seasons during which water shortage might occur.

The development of integrated approaches for water resources reflects the spatial diversity of pressures and availability. It also provides local support for deciding which sustainable development strategy to adopt based on the specific geographical and anthropogenic issues of the area.

6.4.1.1 Water demand management

Water Demand Management (WDM) aims to encourage better use of existing water supply - through efficient and cost-effective management - before considering an increase in supply. It includes all the actions and organizational systems intended to increase the technical, social, economic, environmental and institutional efficiency in the different sectors of water use (intra-sectoral efficiency), and to better allocate water between different uses (inter-sectoral efficiency). This concept of WDM was developed in the 1990s in response to water supply development policies, particularly in the agricultural sector.

ιt is based on the implementation of a combination of legislative, institutional, technical, economic and other actions and tools, such as reducing leaks, using water-saving equipment, establishing progressive water pricing, environmental taxes, quotas, water rights or payments for environmental services.

Economic valuation also suggests that WDM measures are often cost-effective and enable better allocation of scarce financial resources, when compared to, for example, dam construction, water transfers or desalination in areas facing water scarcity problems. This underlines the importance of developing the use of cost-benefit or cost-effectiveness analyses comparing several water management options, by internalizing, as much as possible, the cost of the social and environmental impacts of the different options. These analyses represent real decision-making tools.

6.4.2 Integration of the WEF nexus

Delivering water, energy and food for all in a sustainable and equitable way, while preserving the health of the natural systems that form the basis of any economic activity, is one of the major challenges that the Mediterranean countries face. Traditionally, these sectors have been dealt with separately in their management and investment planning, with separate strategies, priorities, infrastructure, and regulatory and institutional frameworks to address sector-specific challenges and demands. During the past decade, it is being increasingly realized that in a traditional fragmented approach, attempting to achieve security in one of these sectors without addressing trade-offs with the other two sectors will endanger their sustainability and security. Overall results can be achieved by creating intelligent synergies and fair trade-offs among them, while providing opportunities for innovation and learning to minimize security risks and enhance resource efficiency and equity.

This rationale led to the "Water-Energy-Food-Ecosystems Nexus approach", moving beyond the traditional sectoral thinking and adopting an integrated approach for the water-energy-food sectors, to assess interlinkages as well as existing or potential synergies and trade-offs among them. The goal is to reconcile their interests and resolve conflicts as they compete for the same scarce resources, while respecting environmental constraints as well as human rights, and exploring emerging opportunities. Such an approach requires enhanced technical assessment, policy

BOX 76

Examples of progress made in water efficiency and sensible management of demand in Mediterranean countries

In a coastal area such as the Nile Delta, the productivity and efficiency of water in agriculture is being significantly improved using technologies like the construction of raised growing beds facilitating irrigation. This system reduces water inputs by 30%, while improving yield by 25% and efficiency by 72%.

In Tunisia, conservation agriculture trials were conducted with French research services and the French Development Agency (AFD) and showed that changes in farming practices can stop erosion and improve resilience to drought. Water does not destroy, but builds because it infiltrates the soil and recharges the water table.

There are no large scale examples in the Mediterranean, but they exist elsewhere. In Ethiopia, for example, the water table had previously fallen to a 30 m depth and has been recovered to less than 3 meters in just 20 years. Poverty has been halved simply by better managing all vegetation, soil and water.

dialogue, governance improvements, mobilization of financing, replicable applications, collaboration and coordination.

In order to fully capitalize on the benefits and synergies under a Nexus approach, the development and management choices in the water-energy-food sectors require enhanced integration in terms of knowledge, policy, legislation and institutional frameworks.

The current, commonly uncoordinated governance settings and policies, constitute an impediment in addressing issues related to the management and security of the Nexus resources at the national and regional levels. Most governments have separate agencies to oversee water, energy, and agricultural food production, and they set policies and plan for each sector separately. The same is also true, to some extent, of research on these issues. Expertise on energy, water and land use is clustered into separate groups, with limited interaction.

There are increasingly evident on-going efforts at the governmental level in the Mediterranean Region for the coordination of actions across the water, food, energy and environment sectors. Integration is also being achieved when it comes to action planning and implementation, even though some ministries or sectoral institutions often have stronger leverage and decision-making power.
At the institutional level, *Table 32* presents a mapping of the nexus-related competencies of the relevant Ministries in all Mediterranean countries.

<table>
<tr><th>Countries</th><th>Environment</th><th>Energy</th><th>Water</th><th>Agriculture</th><th>Nexus Integration of Ministerial competencies</th></tr>
<tr><td>Spain</td><td colspan="3">Ministry for the Ecological Transition</td><td>Ministry of Agriculture, Fisheries and Food</td><td>Environment, Energy, Water</td></tr>
<tr><td>France</td><td colspan="2">Ministry for the Ecological and Inclusive Transition</td><td>Cross-ministerial</td><td>Ministry of Agriculture and Food</td><td>Environment & Energy (and partially water)</td></tr>
<tr><td>Italy</td><td>Ministry for Environment, Land and Sea Protection</td><td>Ministry of Economic Development</td><td>Ministry for Environment, Land and Sea Protection</td><td>Ministry of Agriculture, Food and Forestry Policies</td><td>Environment & Water</td></tr>
<tr><td>Slovenia</td><td>Ministry of Environment and Spatial Planning</td><td>Ministry of Infrastructure</td><td>Ministry of Environment and Spatial Planning</td><td>Ministry of Agriculture, Forestry and Food</td><td>Environment & Water</td></tr>
<tr><td>Croatia</td><td colspan="2">Ministry of Environmental Protection and Energy</td><td colspan="2">Ministry of Agriculture</td><td>Environment & Energy; Water & Agriculture</td></tr>
<tr><td>Bosnia and Herzegovina</td><td>Ministry of Environment and Tourism (FBiH) / Ministry of Spatial Planning, Construction and Ecology (RS)</td><td>Ministry of Energy, Mining and Industry</td><td colspan="2">Ministry of Agriculture, Water Management and Forestry</td><td>Agriculture & Water</td></tr>
<tr><td>Montenegro</td><td colspan="2">Ministry of Sustainable Development and Tourism</td><td colspan="2">Ministry of Agriculture and Rural Development</td><td>Environment & Energy; Water & Agriculture</td></tr>
<tr><td>Albania</td><td>Ministry of Tourism and Environment</td><td>Ministry of Infrastructure & Energy</td><td>Water Resources Management Agency</td><td>Ministry of Agriculture and Rural Development</td><td>-</td></tr>
<tr><td>Greece</td><td colspan="3">Ministry of Environment and Energy</td><td>Ministry of Agriculture</td><td>Environment, Energy, Water</td></tr>
<tr><td>Malta</td><td>Ministry of Environment, Sustainable Development, and Climate Change</td><td colspan="2">Ministry for Energy and Water Management</td><td>Ministry for Agriculture, Fisheries and Animal Rights</td><td>Energy & Water</td></tr>
<tr><td>Cyprus</td><td>Ministry of Agriculture, Rural Development and Environment</td><td>Ministry of Energy, Commerce, Industry and Tourism</td><td colspan="2">Ministry of Agriculture, Rural Development and Environment</td><td>Environment, Water, Agriculture</td></tr>
<tr><td>Turkey</td><td>Ministry of Environment and Urbanism</td><td>Ministry of Energy and Natural Resources</td><td colspan="2">Ministry of Agriculture and Forestry</td><td>Agriculture & Water</td></tr>
<tr><td>Lebanon</td><td>Ministry of Environment</td><td colspan="2">Ministry of Energy and Water</td><td>Ministry of Agriculture</td><td>Energy & Water</td></tr>
<tr><td>Israel</td><td>Ministry of Environmental Protection</td><td colspan="2">Ministry of National Infrastructure, Energy and Water Resources</td><td>Ministry of Agriculture and Rural Development</td><td>Energy & Water</td></tr>
<tr><td>State of Palestine</td><td>Environmental Quality Authority</td><td>Palestinian Energy and Natural Resources Authority</td><td>Palestinian Water Authority</td><td>Ministry of Agriculture</td><td>-</td></tr>
<tr><td>Egypt</td><td>Ministry of Environment</td><td>Ministry of Electricity and Renewable Energy</td><td>Ministry of Water Resources and Irrigation</td><td>Ministry of Agriculture and Land Reclamation</td><td>-</td></tr>
<tr><td>Libya</td><td>Ministry of Health & Environment</td><td>Ministry of Electricity & Renewable Energy</td><td>Ministry of Water Resources</td><td>Ministry of Agriculture, Animal and Marine Wealth</td><td>-</td></tr>
<tr><td>Tunisia</td><td>Ministry of Local Affairs and Environment</td><td>Ministry of Energy, Mines and renewable Energies</td><td colspan="2">Ministry of Agriculture, Hydraulic Resources and Fisheries</td><td>Agriculture & Water</td></tr>
<tr><td>Algeria</td><td>Ministry of Environment and Renewable Energies</td><td>Ministry of Energy</td><td>Ministry of Water Resources</td><td>Ministry of Agriculture, Rural Development and Fishing</td><td>Environment & Energy (only regarding renewables)</td></tr>
<tr><td>Morocco</td><td colspan="2">Ministry of Energy, Mines and Sustainable Development</td><td>Ministry of Public Works, Transportation, Logistics and Water</td><td>Ministry of Agriculture, Maritime fisheries, Rural Development, Water and Forests</td><td>Environment & Energy</td></tr>
</table>

Table 32 - Mapping of Nexus-related Ministerial Competencies in the Mediterranean
(Source: GWP-Med, 2018)

BOX 77

Water-Energy-Food Nexus: policy recommendations for the Euro-Mediterranean research agenda from the MedSpring project

The MedSpring Project (Mediterranean Science, Policy, Research & Innovation Gateway, 2013-2017) aimed to contribute to the quality of the Euro-Mediterranean research area, with a special focus on bi-regional Euro-Mediterranean scientific and technological cooperation, research and innovation, policy dialogue and cooperation monitoring. MedSpring has gained insight into the Nexus, based on the involvement of the scientific community and of the civil society, by investigating the relationship between research and innovation and the real needs of the civil society in the framework of the three societal challenges, i.e. water, food, and energy.

Experts have agreed on the following policy recommendations to support the identification of priorities and guide national and EU decision/policy makers in designing ad-hoc initiatives addressing the Nexus:

1. Integrating the Nexus concept in all relevant policies, laws and regulations by:
   - Promoting participatory policymaking through multilevel and participatory networks/fora;
   - Mapping and assessing existing national sectoral policies to develop an integrated Nexus strategy including effective implementation and monitoring plans;
   - Promoting the definition and implementation of a Euro-Mediterranean strategy on Nexus.
2. Increasing Nexus awareness and dissemination among relevant stakeholders through:
   - Multidisciplinary training and capacity-building activities;
   - Dissemination of success stories, initiatives, good practices and innovative technologies;
   - Including Nexus-related principles and concepts in educational systems;
   - Creating a Euro-Mediterranean platform (gathering MedSpring EMEG experts and additional players) for trans-boundary exchange and transfer of best practices.
3. Increasing funding for multidisciplinary and integrated research projects and initiatives, and promoting cooperation between public and private sectors through targeted funds and incentives.

In conclusion, adopting the Nexus approach on a large-scale, in a system-wide manner is challenging because of continued limited knowledge on how food, water and energy systems operate and interact. National and international policies should go beyond the isolated resource management approach and support deep understanding on how the Water-Energy-Food systems and processes overlap. These steps should be combined with forward-looking policies and regulations encouraging cooperation among citizens, research bodies, governments and industry so that all decisions taken are sustainable and legitimate.

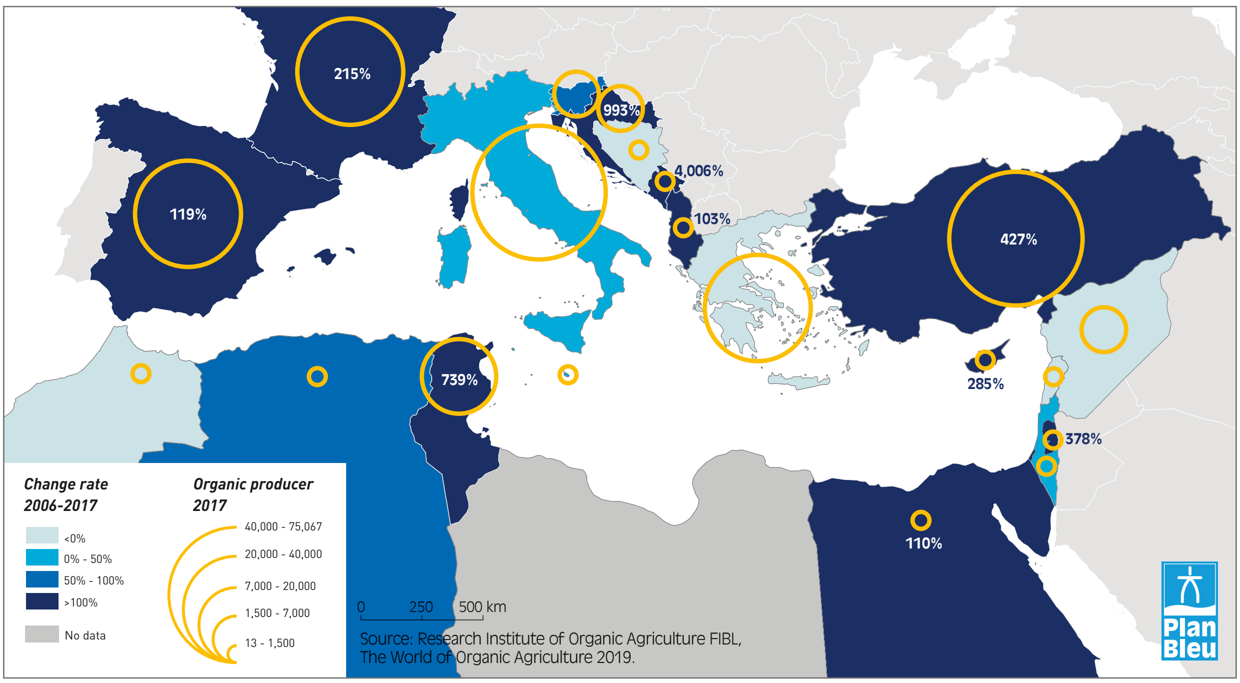


Figure 175 - Change in the number of organic farms in Mediterranean countries

6.4.3 Agro-ecological transition and sustainable agriculture

Considering agriculture as a producer of various services - besides food production only - would facilitate the transition towards sustainable agriculture.

SDG Target 2.4 calls for the development of sustainable food production systems and implementation of resilient agricultural practices that increase productivity and production, help maintain ecosystems, strengthen the capacity for climate change adaptation and progressively improve land and soil quality. This should be measured based

BOX 78 Chrichira case study - The principle of energy economy and recovery of energy lost in water pumping

CHRICHIRA in the Kairouan area, an example of the Water Energy Nexus in Tunisia, with the National Water Distribution Utility (SONEDE) and the United Nations Economic and Social Commission for Western Asia (ESCWA)

In all drinking water systems, considerable energy is spent on pumping, to fill water towers and reservoirs at height. When the water goes down, the potential energy is not used, and is lost. The aim of this Pilot Initiative of Chrichira was to reduce the electrical energy purchased for pumping and conveying water throughout the municipal water distribution system. For that purpose, SONEDE devised a preliminary plan for optimizing the piping layout to improve system efficiency and installing a hydroelectric micro turbine to generate electricity from hydraulic energy harnessed due to elevation differences.

ESCWA provided the technical and advisory support needed to assess the proposed SONEDE project from both the technical and financial perspectives and assist in the preparation of technical specifications to initiate the call for tenders. The main Stakeholders in Tunisia, are the Ministry of Agriculture, Water Resources and Fisheries; National Water Distribution Utility (SONEDE), and National Agency for Energy Efficiency (ANME). This initiative followed regional priorities related to the Water Energy Nexus of informing technology choices, ensuring availability and sustainable management of water, promoting renewable energy and increasing efficiency.

The Kairouan region is located at the centre of Tunisia, 150 km southwest of Tunis. The study area includes an elaborate water extraction and conveyance system supplied by water from two main aquifers, the Chrichira and the Bouhafna. The collection network consists of 27 boreholes along with a distribution network of around 226 km of pipes of different diameters, allowing the production and distribution of nearly 1000 l/s (2015) for drinking water supply in the governorates of Kairouan, Sousse, Monastir and Mahdia. Water pumped from boreholes is collected in reservoirs and redirected to load breakers to dissipate excess energy in the pipe network.

The financial assessment proved the proposed micro-hydro system feasible with a reduction in electrical energy purchased, and a return on investment for the envisaged project achieved in less than three years. Based on assessment outcomes, installing hydroelectric micro turbines in water distribution systems with favourable technical conditions may present a very promising energy resource within the water-energy nexus. Based on the Chrichira case study, conclusions and general recommendations are to be drawn for other drinking water network projects:

Figure 176 - Water pressure dissipation using a load breaker

- There is no standard solution, they need to be adapted to each context and each situation.
- First look for energy savings on pumping, by identifying the least useful expenses. Do not pump unnecessarily to excessive and unnecessary heights, avoid over-sizing pumps.
- Research the technical variants best adapted to each situation, a first choice technical solution, followed by thorough optimization in dialogue with the equipment suppliers, (e.g. fixed flow, variable flow, or combination of two turbines or Pump-as-Turbine (PaT)).
- After having chosen a turbine or pump according to the data of the studied site (height and flow), do not hesitate to **conduct a second optimization phase** according to the available equipment (adaptation of the flow of water to a specific pump, achieve optimum operation if possible).
- **In the choice of equipment, take into account the human dimension and corporate culture** (for operation and maintenance know-how, capacity-building and training needs). For example, PaTs are well adapted to the case of SONEDE, which already manages a large number of pumps.

on the proportion of agricultural area under productive and sustainable agriculture, considering the environmental, economic and social dimensions of sustainability. Between 2006 and 2017, the number of organic farms has highly increased in Croatia, Egypt, France, Slovenia, Spain, Tunisia and Turkey *(Figure 176)*. Better soil management would result in their enrichment in organic matter, through agro-ecology, irrigation and land protection.

6.4.4 Rural development and smallholder farming

The development of decent living conditions for residents in rural areas remains a necessary condition to ensure food security and even security itself. It is no longer enough to increase agricultural productivity to improve food availability, or to bring in foreign currency through exports to solve the problem of food security. Instead, opportunities for decent jobs and incomes need to be provided to millions of people to avoid internal and external migration, despair, radicalization and conflicts. Collective organizations (rural markets, farmer organizations, local value chains, infrastructure, distribution, new services) need to be developed with new citizen-based initiatives.

The link between food quality and the geographical location of farmland has been studied closely for the past thirty years. For example, the development of geographical indicators for farmland and local know-how has shown how local development can support food security. Capitalizing on local food experience can be a development strategy via tourism, local value chains and the promotion of distinctive high-quality products on niche markets. This would generate income in rural areas, and help preserve biodiversity and conserve traditional processes, agricultural practices and know-how in order to preserve recipes and products in accordance with the dietary preferences of populations and their identity.

Although the role of women in eating habits in Mediterranean households is recognized, and improving agricultural practices and production can help improve the nutrition of family members, including children, the causal link is

BOX 79

Climate change adaptation framework example in France

Since 2014, the 7 major French river basins have progressively committed themselves to climate change adaptation plans. They identify the phenomena for which there is a need to be prepared and define the strategic framework and the concrete actions which need to be taken in the face of climate change.

For the water sector, the challenges are relatively prevalent and affect the whole country. They include increased temperatures and soil desiccation, increased extreme events and frequency of heavy rains, lower groundwater levels and surface water flows. The intensity of these phenomena is nevertheless variable depending on the region and remains subject to uncertainties which need to be addressed.

Recommended solutions concern the efficiency in the use of available resources, the equitable share of water between users, greater solidarity, waste reduction and the development of more sustainable uses of water that are less vulnerable to hazards. The plans also call for preserving or restoring the proper functioning of aquatic, wetland and coastal environments in order to promote biodiversity and restore the services provided by the aquatic environment in terms of flood regulation.

Numerous actions of this type are already being carried out within the framework of *Schémas Directeurs de la Gestion des Eaux (SDAGE)*, i.e. water management guidelines, to recover the good status of water bodies and habitats. Climate change adds urgency and increasing efforts in their implementation. Given the widespread vulnerability of territories to water availability, the question is no longer whether or not to act, but rather to identify where and on what priority issues to invest efforts. To scale up this effort, the Rhône-Méditerranée (2014) and Corsica (2018) basin adaptation plans produced vulnerability maps that identify priority sectors.

In addition, adaptation strategies prioritize actions that are beneficial regardless of the magnitude of climate change. They allow actors to invest in adaptation without regret and avoid poor adaptation.

Initiatives are being multiplied to act locally on what makes a territory or economic sector vulnerable. Water managers provide a diagnosis in order to identify the different sectors, structures and natural environments that would be highly vulnerable to climate change phenomena. This work may include, for example, drinking water supply schemes, irrigated agricultural sectors or remarkable natural environments. This way, investment priorities are identified to act faster and more effectively in the face of climate change.

not currently systematic (Dury, Alpha & Bichard, 2015). **The involvement of women is important as "they are the nucleus of the Mediterranean family unit,** making them the best educators in terms of food and health" (Agropolis Fondation, 2011; CIHEAM, 2018). Food policies to achieve food and nutrition security for children that link schools and women's organizations, in their dual function as producers and mothers, should be tested as they may bring about progress. Many women now work in the production, processing and sale of local products, working within women's cooperatives, such as in Algeria or Lebanon. The number of businesses led by women who produce and sell traditional food has increased significantly in the past twenty years in Algeria, Egypt, Lebanon, Morocco, and Syrian Arab Republic (Hachem et al. 2016). **Supporting the emancipation of women therefore benefits both the local economy and food and nutrition security, especially for children.**

6.4.5 Climate change adaptation

MENA countries have acceded to international conventions and created institutions dedicated to climate change management. Various water saving measures have been planned and demonstrated, such as dam construction, adaptation of itineraries, introduction of new techniques and non-conventional water resources such as reuse of treated wastewater, systems of production conversion, combating desertification and drought, river basin management, activity diversification in rural areas, forest area management and development of insurance against climate risks. Another proposed measure is to mobilize civil society to contribute to environmental management. In priority 4 of its strategic guidelines, the Mediterranean Commission on Sustainable Development (MCSD) has included climate change. As such, important actions will be taken to address common adaptation and mitigation challenges.

At the national level, warning and surveillance tools, even if they exist, are not sufficiently mobilized, notably the tools developed by regional institutions. There are also no systems for monitoring or evaluating these measures.
At the regional level, research programmes are in place, but there is insufficient exchange and cooperation between countries around the issues of knowledge and means of action against climate change. Regional cooperation and coordination efforts should be developed through knowledge sharing platforms.

Finally, funding should be used to serve climate change adaptation strategies. Financial instruments and international cooperation would improve the negotiating capacity of States in international institutions. Thus, countries could mobilize climate-friendly investments.
Several recommendations can already be made:

- Structural reforms are needed to support family/smallholder farming.
- The gradual withdrawal of certain crops and practices should be organized due to their growing unsuitability to the bioclimatic environment.
- Equity financing measures, pricing policies, targeted subsidies, concessional interest rates, tax measures (eco-taxes), special "green" funds, etc. would be useful.
- It would be useful to develop economic and social incentives to establish non-agricultural activities in rural areas and / or to organize progress.
- Investment in human capital will provide a dignified living environment for rural populations.
- Agriculture and food production are highly globalized and interlinked sectors, and main sources of income for a vast

part of the Mediterranean population. Resources must be dedicated to secure and stabilize food systems by means of climate-change adaptation.

6.4.6 Knowledge and data gaps

The lack of data is a recurring problem in Mediterranean states. Countries lack homogeneous data and common indicators. Scientific research is carried out, but national reports contain official data that is not always consistent. Data is lacking on coastal areas or coastal watersheds despite the fact that they could be the most relevant scales of analysis in the context of the Barcelona Convention.

Monitoring the impact of tourism on water resources is one of the key areas where data is lacking. Only cities are covered by systems which monitor the impact of tourism on water resources and their seasonal variations. There is no general data on this topic in the Mediterranean.

An eco-systemic vision could help develop an expanded agroecosystem vision of the watershed, including water, agricultural ecosystems, and hydro and marine ecosystems. Through a broader understanding of ecosystem services, agriculture could be managed as a producer of a wide range of goods and services, including carbon storage, water infiltration, flooding and flood prevention, and coastal protection.

The major knowledge gaps highlighted throughout this chapter include:

- no recent data available at the catchment scale for the entire Mediterranean region, e.g. water availability and demand;
- low proportion of water bodies with functioning monitoring systems, e.g. gauging stations, water quality measurements;
- lack of integrated data on water quality, regional platform for gathering water quality data, selected list of parameters to focus on;
- no comprehensive synthesis of the status and trends of Mediterranean soils;
- limited quantification of soil erosion;
- high uncertainties concerning the potential influence of climate change on crop yield, including seafood production;
- statistics and typologies on small-scale family farming, are not broken down by gender to determine women's place in agriculture and their contribution.

6.4.7 Priorities for actions

This review of water and food security components, including aspects of availability, demand, quality and resource stability, points to the following priorities for action:

- plan for and manage sustainability transitions using preventive, integrative and inclusive approaches and coordinated responses across the Water-Energy-Food sectors, taking into account the increasing scarcity of available water resources;
- sustainably use water resources including rational water abstractions from rivers and aquifers, and consideration and implementation of environmental flows for the protection of freshwater ecosystems and the services they provide to humans;
- plan and implement water allocation to find a balance between different water users; find the "potential of compatibility" described above, thinking long-term, beyond immediate water supplies to ensure sustainable provision of services for all;
- upgrade non-conventional water source systems e.g. reuse of treated wastewater and desalination, partly to increase access to water supply and sanitation services;
- promote the emancipation of rural youth (and particularly women) through suitable training, job creation and innovation. To improve the attractiveness of agricultural work among young people, the following should be considered, (i) improving legislation relating to the protection of rights and social security (social protection against occupational accidents, sick leave, settlement of disputes and retirement pensions to ensure equality with labour laws used in other sectors), and ii) the institutional recognition of women's work in agriculture, which is sometimes not even paid. On the other hand, local collective actions for the creation of decent jobs, training adapted to the labour market, innovations and micro-businesses for rural youth would make it possible to diversify the rural economy and enable them to become independent without resorting to exodus.
- support the local collective organization of agricultural production and the use of natural resources involving all stakeholders, with particular emphasis on i) building and/or strengthening collective management tools for production and marketing (cooperatives, producer groups, etc.) with the aim of enabling better control by producers of value chains, and ii) improved public policies for monitoring and controlling the use of resources, particularly in regions with fragile ecosystems (oases, steppes, dry plains, irrigated perimeters, etc.) because of the risks associated with climate change that farmers are currently facing in Northern and Southern Mediterranean countries.

7.0 Health and Environment

Human-induced environmental degradation impacts not only ecosystems but also human health. Over 20 million life years are lost annually in Mediterranean countries due to ill-health, disability or death and more than 500,000 deaths occur each year as a result of living or working in unhealthy environments. The health burden is mainly due to air pollution but also to chemicals, lack of worker protection, inadequate water and sanitation and emerging pollutants, including from the health sector itself. Climate change is also a threat to human health, with increased risks of morbidity and mortality linked to heatwaves, extreme events such as drought, storms and floods, as well as increased transmission potential of vector-, water- and food-borne diseases. Integrated policies fostering the link between health and the environment, including emergency preparedness, response and recovery plans, need to be further developed, along with awareness-raising on environment-related risks within health care systems and the impact of the health sector on the environment.

7.1 Introduction: environmental issues are a critical public health concern

It is generally recognized that the environment in which people live significantly affects their health. Most environmental policies and regulations are both motivated by public health concerns, and human health impacts often represent a major part in the economic valuation of environmental damages. Health risks stemming from environmental conditions cannot be addressed by the health sector alone. They require integrated approaches that address root causes and environmental determinants of health, by involving sectors such as energy, transport, agriculture, fisheries, tourism and industry, in collaboration with the health sector and policymakers. Coordinated action will give priority to the prevention of risks rather than to health-sector activities that cure the resulting illnesses. The interactions between the environment and health also play an important role for development. Links between poor environmental health and poverty reinforce each other in multiple and complex ways (Arthur, 2006). Poor people typically face greater environmental health risks in their surroundings because they live in unhealthy locations and lack basic infrastructure and services. They are also the most vulnerable to the main environmental hazards and to deficiencies in access to health services and healthy food, including seafood. This is also recognized by the 2030 Agenda for Sustainable Development, which calls for a new approach to health, the environment and equality. In May 2019, the World Health Assembly endorsed the World Health Organization global strategy on health, environment and climate change, which states *"By interlinking socioeconomic development with environmental protection, health and well-being, it provides overall support for tackling determinants of health as relevant policies are being defined or key choices are being made, in a preventive and sustainable way, rather than repeatedly dealing with adverse impacts and inequalities. The commitment to sustainable patterns of consumption and production and tackling misuse of natural resources and large-scale generation of waste should allow more sustainable economic activities to be carried out and progress to be made on global, cross-border goods for health, such as clean air and a stable climate"* (WHO, 2019a).

Realizing the extent to which disease and early death can be prevented by acting on modifiable environmental conditions

INCLUDED

Included factors are the modifiable parts of:

- Pollution of air (including from second-hand tobacco smoke), water or soil with chemical or biological agents
- Ultraviolet (in particular, protection from) and ionizing radiation
- Noise, electromagnetic fields
- Occupational risks, including physical, chemical, biological and psychosocial risks, and working conditions
- Built environments, including housing, workplaces, land-use patterns, roads
- Agricultural methods
- Man-made climate and ecosystem change
- Behaviour related to environmental factors, e.g. the availability of safe water for washing hands, physical activity fostered through improved urban design

EXCLUDED

Excluded factors are:

- Alcohol and tobacco consumption
- Diet (unless linked to environmental degradation)
- The natural environments of vectors that cannot reasonably be modified (e.g. wetlands, lakes)
- Insecticide impregnated mosquito nets (for this study they are considered to be non-environmental interventions)
- Unemployment (provided it is not related to environmental degradation, occupational disease, etc.)
- Natural biological agents, such as pollen
- Person-to-person transmission that cannot reasonably be prevented through environmental interventions, such as improving housing, introducing sanitary hygiene or making improvements in the occupational environment

Figure 177 - Summary of included and excluded factors in WHO calculation of burden of disease attributable to the environment
(Source: Prüss-Üstün et al. 2016)

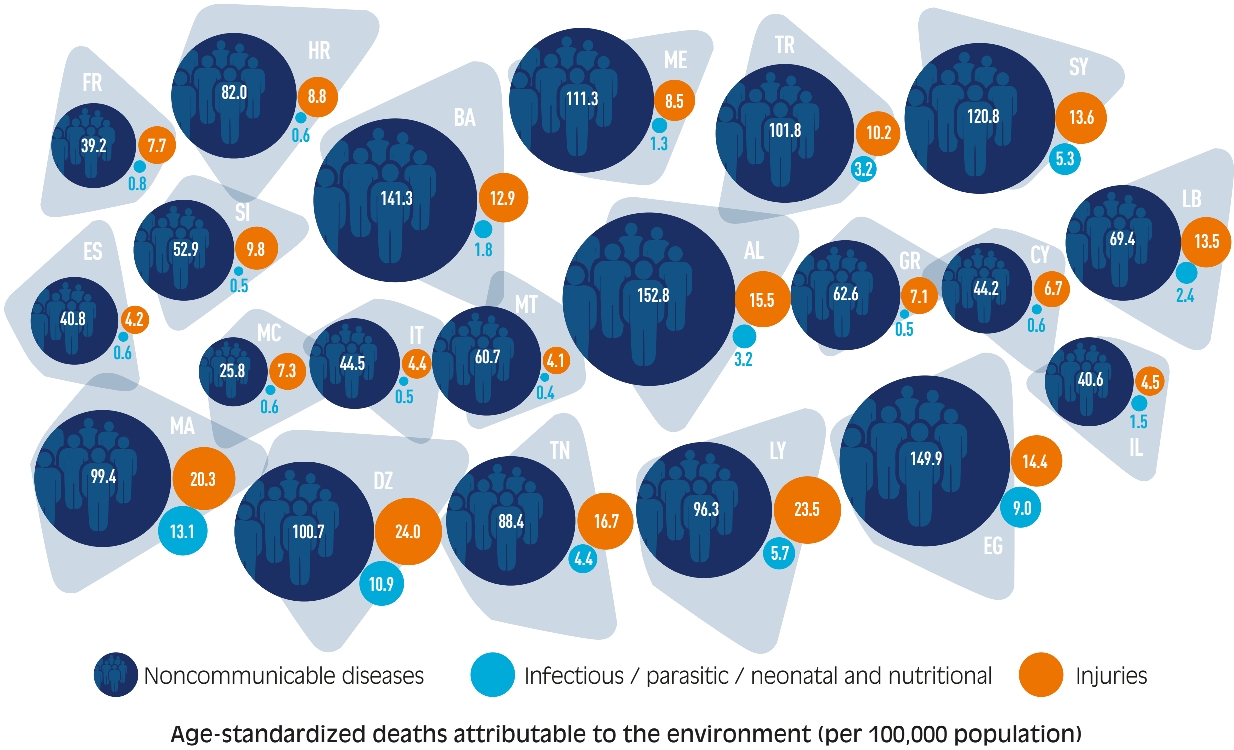


Figure 178 - Age-standardized deaths attributable to the environment, per 100,000 population, in Mediterranean countries, 2012
(Source: WHO, 2019b)

is a key lever for promoting healthy environments and encouraging the design and implementation of both public health and environmental strategies and actions.

As a way to measure the disease burden stemming from modifiable environmental conditions, disability-adjusted life years (DALYs) are a commonly used indicator, expressing the number of life years lost due to ill-health, disability or early death. In Mediterranean countries, the year 2012 registered 20.7 million DALYs attributable to the environment, representing 15% of total DALYs (WHO, 2019b). This means that 15% of life years lost due to disease, injury or early death could be prevented by mitigating environmental health risks.

A significant share of deaths can also be linked to environmental conditions (WHO, 2019b). In 2012, more than 500,000 people died as a result of living or working in an unhealthy environment, representing 15% of all deaths in Mediterranean countries. This share of deaths linked to modifiable environmental conditions is lower than the world average of 23% but shows high variability between Mediterranean countries, with Bosnia and Herzegovina reaching 27% and Monaco 8%.

Figure 177 presents the different factors included and excluded in the WHO (World Health Organization) calculation of DALYs and deaths attributable to the environment.

Age-standardized[119] deaths linked to preventable environmental conditions are twice as high in Southern and Eastern Mediterranean Countries (SEMC) compared to European Mediterranean countries and three times as high in some non-EU Balkan countries and Egypt (see *Figure 178*).

With 84% of all deaths attributable to modifiable environmental conditions, the large majority of these deaths is due to non-communicable diseases[120], in all Mediterranean countries where updated data is available, followed by injuries and infectious/parasitic/neonatal and nutritional diseases. *Figure 179* presents the non-communicable diseases with the highest preventable disease burden from environmental risks, indicating the share of environmental causes in the prevalence of diseases at the global level and the main areas of intervention to act on reducing these risks. As an example, 20% of global cancers are due to preventable environmental risks which are mainly caused by air pollution, management of chemicals, radiation and workers' protection.

Based on WHO-monitored data, analysis suggests that priority prevention opportunities for current health risks

[119] Age-standardization adjusts for differences in population age distribution.
[120] Non-communicable diseases (NCDs), also known as chronic diseases, tend to be of long duration. The main types of NCDs are cardiovascular diseases (like heart attacks and stroke), cancers, chronic respiratory diseases (such as chronic obstructive pulmonary disease and asthma) and diabetes.

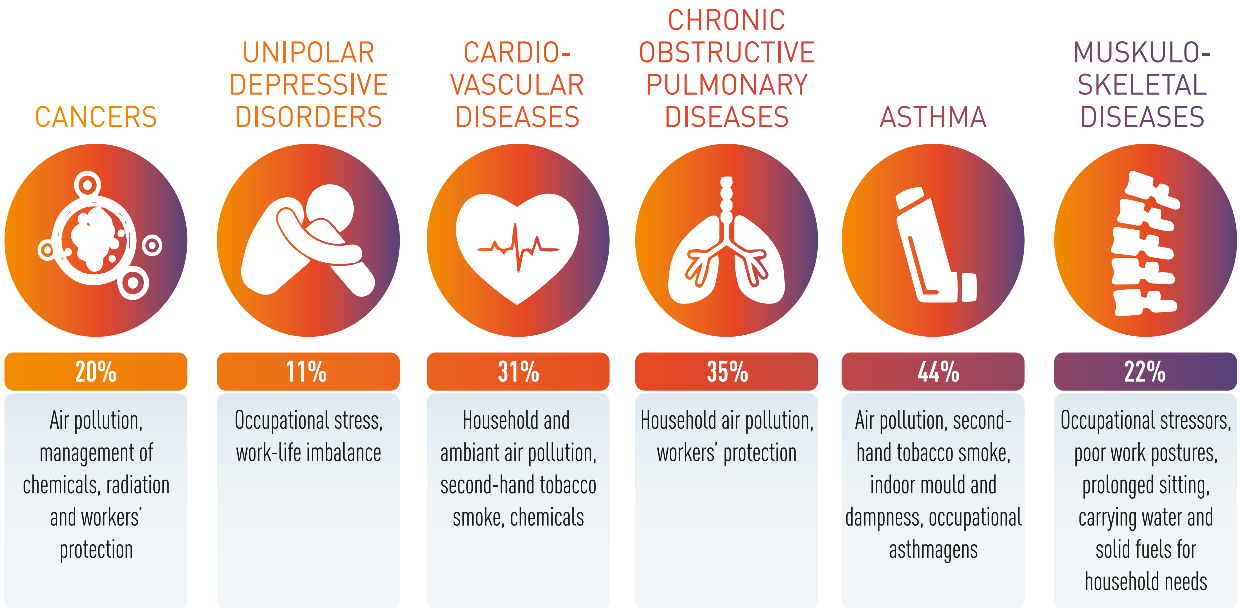


Figure 179 - Non-communicable diseases with the highest preventable disease burden from environmental risks
(Source: Prüss-Üstün et al. 2016)

linked to the environment in the Mediterranean are mainly linked to air pollution, chemicals, and workers' protection, but also to water and sanitation. The main economic sectors with mitigation potential are transport (air pollution), industry (exposure of workers, consumers and neighbouring inhabitants to air, water and soil pollution, chemical and drug residues in food, chemicals in consumer products including plastics and microplastics), agriculture (exposure of workers and consumers to chemicals), but also the water and sanitation sector (access to safely managed water and sanitation services and safely treated wastewater for reuse purposes) and waste management. The loss of biodiversity on land and at sea is also a cause of concern for human health, with healthy food lost due to overfishing and habitat loss, and soil degradation and land use change diminishing opportunities to grow healthy food on land. Consumers are also exposed to toxins, parasites and pollutants contained in food products, including in seafood.

Climate change is likely to bring about new challenges in terms of environmental risks for human health. It will also aggravate the impacts of existing environmental risks such as water and food scarcity, air pollution, and heat stress, along with natural and human-made disaster risks, as presented in the following sections.

7.2 Water and sanitation have improved remarkably well but remain critical in a context of demographic growth

Inadequate sanitation and access to water or hygiene increase the incidence of diarrheal diseases. Most diarrheal deaths in the world (60%) are caused by unsafe water, sanitation or hygiene (Prüss-Üstün et al. 2016). Mortality due to unsafe water, sanitation and hygiene is relatively low in Mediterranean countries, with the highest rate recorded in the Syrian Arab Republic (3.7 deaths for 100,000 population[121], compared to the worldwide average of 11.7 deaths per 100,000 population). The figure below presents the health impact of inadequate water and sanitation services in Mediterranean countries. Mortality attributed to unsafe water or sanitation and lack of hygiene is highest in countries in which access to sanitation is lowest.

In addition to providing generalized access to sanitation, other human health issues linked to sanitation are the management of sewage sludge and storm water as well as chemicals of emerging concern:

- Sewage sludge is a by-product of wastewater treatment. Different disposal solutions exist, depending mostly on sludge quality and regulatory frameworks. Approximately half the sewage sludge produced by EU Member States is spread on land as fertilizer and a quarter is incinerated (Eureau, 2017). High concentrations of metals, pathogens and persistent trace organic contaminants can be found in sludge and therefore its use on land must be restricted to protect the environment and human health.
- In the Mediterranean, extreme rainfall occurs regularly in many areas, which may even be accentuated in the future through climate change. In areas where rainwater drains into the sewers carrying urban domestic sewage and industrial wastewater, overloading of the sewer network can occur, leading to overflow at urban wastewater treatment plants. In these cases, untreated sewage can flow into rivers, lakes and coastal areas. Urban drainage systems need to adapt to these events to manage runoff in a sustainable way.

[121] This number may be significantly higher due to the fact that most WWTPs are today out of service due to the ongoing conflict in the country.

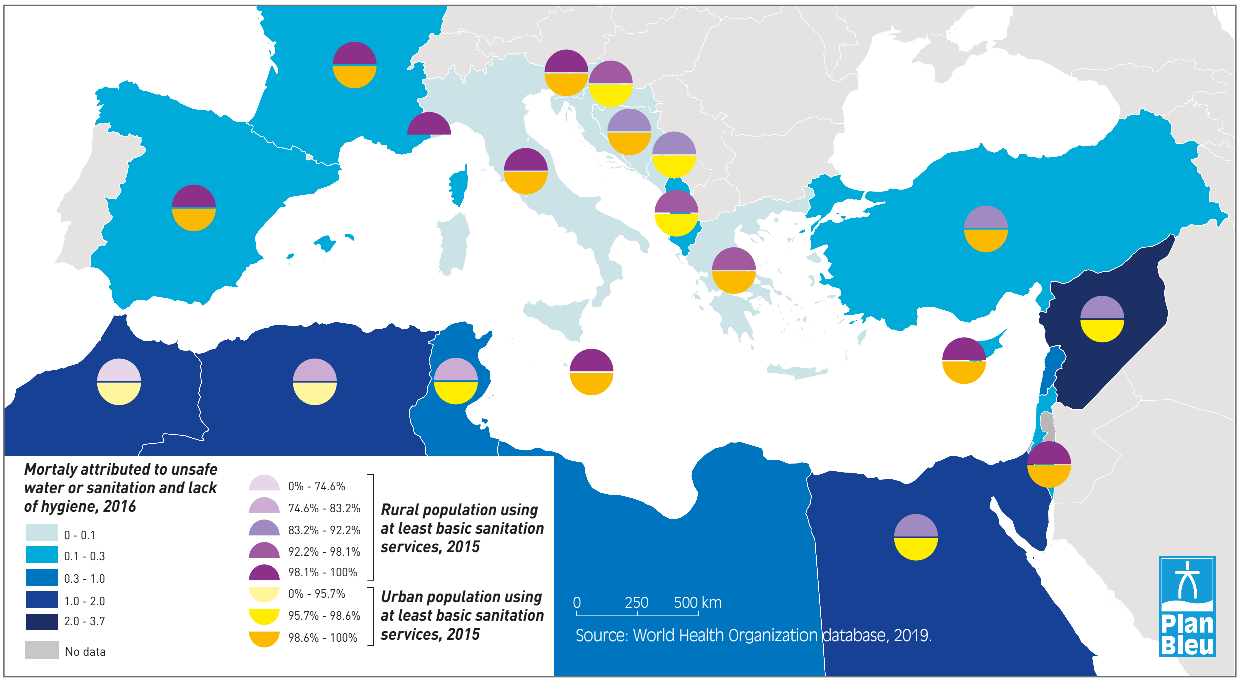


Figure 180 - Impact of inadequate water and sanitation on health in Mediterranean countries, 2015-2016
(Source: WHO, 2019b)

- An issue of increasing concern, including for human health, is the presence of a variety of chemicals at low concentrations within the aquatic environment. Substances reach surface waters via urban wastewater treatment plants applying traditional treatment methods unable to eliminate many chemicals, such as cleaning products and excreted pharmaceuticals (Gardner, 2018). More information on contaminants of emerging concern can be found in Chapter 4, and *Box 86* of this chapter provides information about antibiotic residues in wastewater.

More information about the Mediterranean situation with regard to water and sanitation can be found in Chapter 6 "Food and water security".

7.3 Air quality is the main health concern associated with environmental degradation

Fighting ambient air pollution is a priority health and environmental issue in the Mediterranean basin. In fact, air pollution is the number one cause for environment-related morbidity and mortality in the region.

BOX 80

Cholera outbreak in Algeria in 2018

(Source: WHO, 2018)

From the WHO Disease Outbreak News, 14 September 2018:

"On 23 August 2018, the Algerian Ministry of Health (MoH) announced an outbreak of cholera in northern parts of the country, in and around the capital province Algiers. From 7 August to 6 September, 217 cases with cholera-like symptoms have been hospitalized, two of the patients died (Case Fatality Rate: 0.9%). Cases have been reported from seven provinces (Wilayas). Of these, 83 have been confirmed as Vibrio cholerae serogroup 01 Ogawa at the Institut Pasteur Algiers. More than half of the confirmed cases have been registered in Blida Province, followed by Algiers, Tipaza, Bouira, Médéa and Ain Defla.

A total of 21, including three private, water sources in the affected areas were tested for bacterial contamination, and 10 of these were deemed inappropriate for human consumption. One of the water sources tested positive for V. cholerae and was condemned for human consumption. [...] The source of the outbreak and transmission vehicle is currently not known but the MoH and Institut Pasteur Algeria reported that most of the cases were clustered within a family group.

Cases have been reported in an urban setting where there is an increased risk of transmission [...]."
The Algerian public health response was able to stop the cholera outbreak within one month. While uncertainties remain about its source, it is likely that water-related issues played a role in the genesis of these recent cholera cases. This illustrates the importance of using safely managed water and sanitation, as well as proper waste management and the implementation of adequate food safety and hygienic practices.

Contaminants with the strongest evidence for public health concern include particulate matter (PM), ozone (O_3), nitrogen dioxide (NO_2) and sulphur dioxide (SO_2). Anthropogenic PM and NO_2 are directly related to fossil fuel combustion, causing respiratory and cardiovascular diseases (among others) that can be related to premature deaths. In addition, high levels of noise can cause heart conditions and reduce cognitive functions in children. Air pollution has a high cost for countries, the World Bank estimated the welfare losses due to $PM_{2.5}$ (particulate matter with a diameter less than 2.5 micrometres), derived from transport, at 2.3% of GDP in the Middle East and North Africa (MENA) region and 7.4% in Europe and Central Asia. Egypt, Libya, the Syrian Arab Republic and Tunisia are the countries with the highest exposure to ambient air pollution. Especially dangerous is the case of Egypt where more than 85% of the population is exposed to ambient pollution beyond the WHO threshold. Northern Mediterranean Countries (NMCs) generally show lower exposure levels, with between 25% and 42% of the population exposed. The general trend in NMCs is relatively constant, with exposure to particulate matter decreasing only slightly after a peak in 2011, whereas in SEMCs, particulate matter exposure has increased, except in Israel where the situation has improved slightly.

WHO estimated that more than 228,000 people died prematurely in 2016 because of exposure to ambient air pollution. Estimates per country are summarized in *Figure 181*. As clearly reflected, the impact of air pollution on health is generally much higher in SEMCs than in NMCs. Egypt is the country in the world with the highest death rate attributed to ambient air pollution (IHME, 2019).

The levels of fine particulate matter to which people living in Mediterranean cities are exposed have increased in recent years, and exceed the recommended threshold values everywhere (WHO, 2016). Exposure to ozone is also a matter of concern, especially since the region has all the climatic characteristics favourable to its formation and persistence.

The two figures below represent the number of days for which the WHO recommended thresholds were exceeded for $PM_{2.5}$ and for ozone in 2016. These thresholds are 25 µg/m³ on average daily and 100 µg/m³ on average over 8 hours respectively. These figures, drawn up for a year considered to be "low pollution" in Europe, highlight the important exposure levels of the Mediterranean basin. A higher number of exceedances of threshold values for particulate matter is observed in North Africa, the western Middle East and in the Adriatic. For ozone, a North-West / South-East gradient clearly distinguishes them, mainly due to weather conditions, making the Mediterranean basin a more sensitive area.

Atmospheric pollution has multiple origins. Anthropogenic sources, created by our daily activities (road and non-road traffic, industries, agriculture, domestic activities), but also natural sources (land-based and desert dust mainly in Southern and Eastern Mediterranean countries, marine salts, volatile organic compounds emitted by vegetation) are the main determining factors. The Mediterranean basin presents a number of specificities. The share of natural emissions is significant, because of the influence of the Sea, but also the proximity to the Sahara Desert, whose dust can be carried by the wind over very long distances, and the specific climate of arid or semi-arid zones. The high temperatures, high levels of solar radiation and the presence of diverse vegetation in several countries, explain why the Mediterranean region is one of the highest emitting areas of volatile organic compounds in Europe, which participate in the formation of ozone and secondary organic aerosols. The main anthropogenic sources of air pollution are road traffic in all major cities of the basin, industries (including oil refining and storage), and international maritime traffic. Unfortunately, comprehensive source apportionment studies to distinguish the level of natural pollution from the level of human-induced pollution are not available.

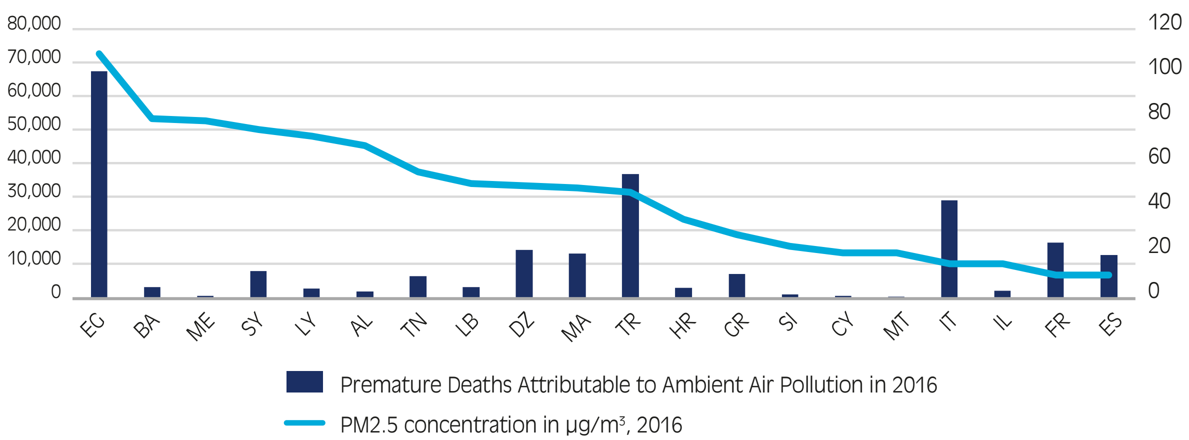


Figure 181 - Premature deaths attributable to ambient air pollution in 2016 and ambient air pollution by $PM_{2.5}$ microgram per cubic meter in Mediterranean countries, 2016
(Source: WHO, 2019b)

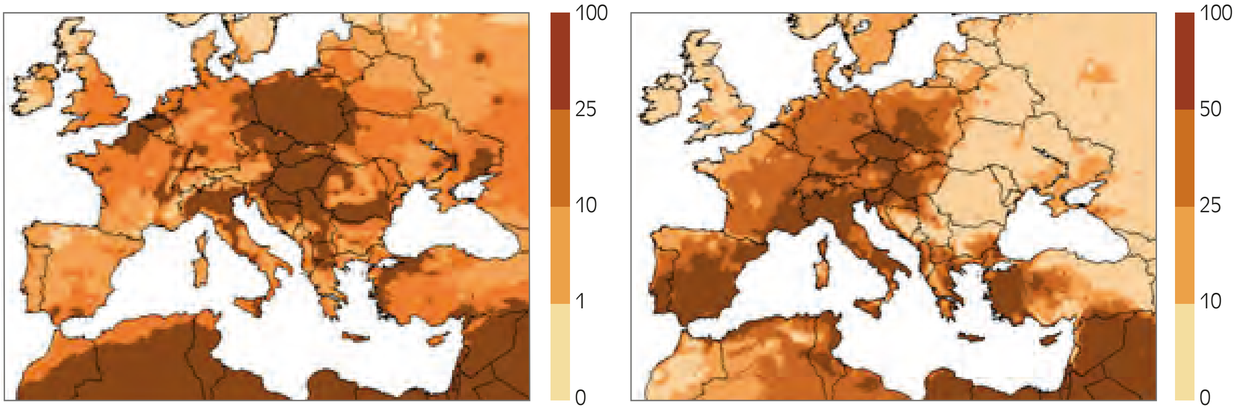


Figure 182 - Left: Number of days when WHO recommended threshold of exposure to 25 µg/m³ of particulate matter ($PM_{2.5}$) was exceeded in 2016. Right: Number of days when WHO recommended threshold of exposure to ozone of 100 µg/m³ was exceeded in 2016
(Source: European Commission, 2019)

BOX 81

Fuel emissions from cars - fuel quality

(Source: UNECE, 2019)

Fuel quality is a key lever for improving air quality and human health. A 2019 United Nations Economic Commission for Europe (UNECE) recommendation consists of worldwide vehicle emission standards that cap sulphur levels in both gasoline and diesel at 10 ppm (equivalent to Euro 5 and Euro 6 and in line with the EU Fuel Quality Directive), applicable to cars and trucks. Reducing sulphur to minimum levels will not only ensure optimal and reliable operation of emission controls systems in vehicles, it will also improve air quality, benefiting the environment and human health. Sulphur dioxide (SO_2) adversely impacts human health, causing skin irritation and inflammation as well as irritation of the respiratory system.

In the Mediterranean, almost all NMCs as well as Morocco and Turkey have already set sulphur level standards below 15 ppm. Many other SEMCs still have sulphur limits well above the recommended level for diesel *(Figure 183)* and gasoline.

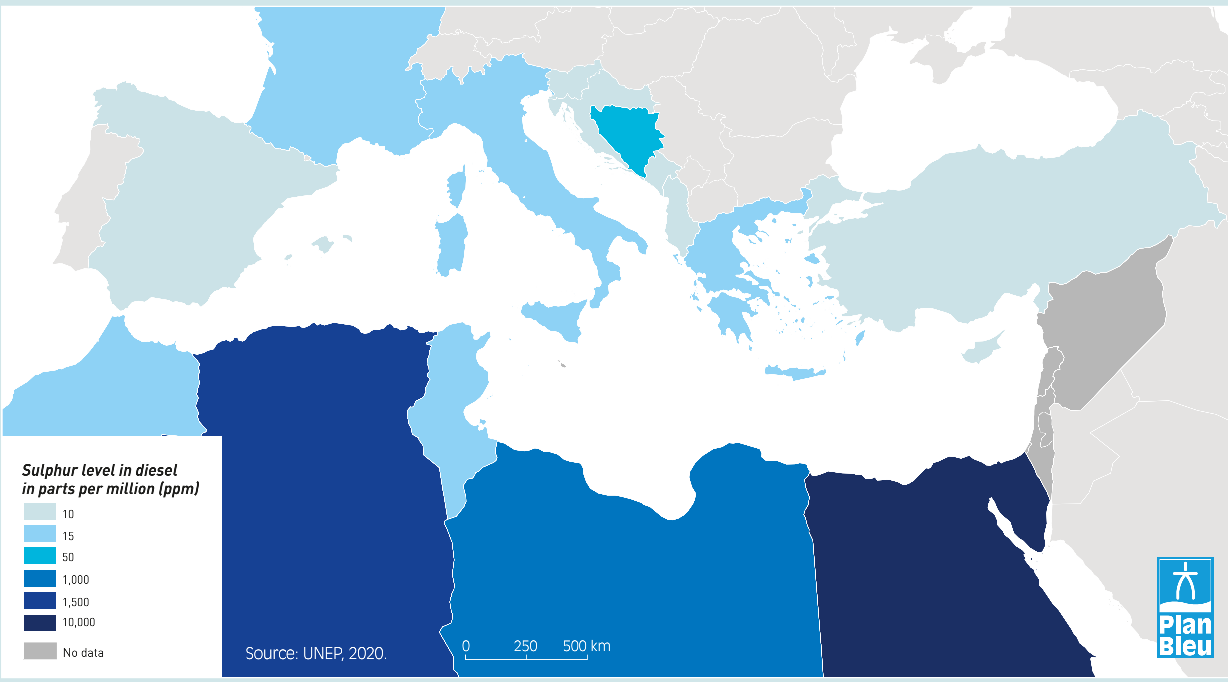


Figure 183 - Diesel Fuel Sulphur levels in the Mediterranean, March 2020
(Source: UNEP, 2020)

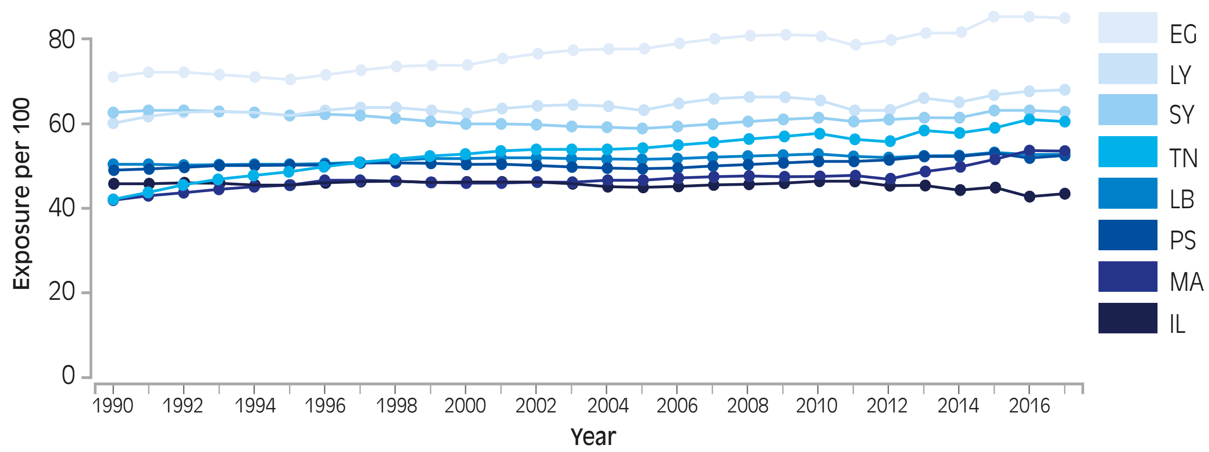


Figure 184 - Exposure to ambient particulate matter $PM_{2.5}$ pollution in SEMCs, in % of national population
(Source: IHME, 2018)

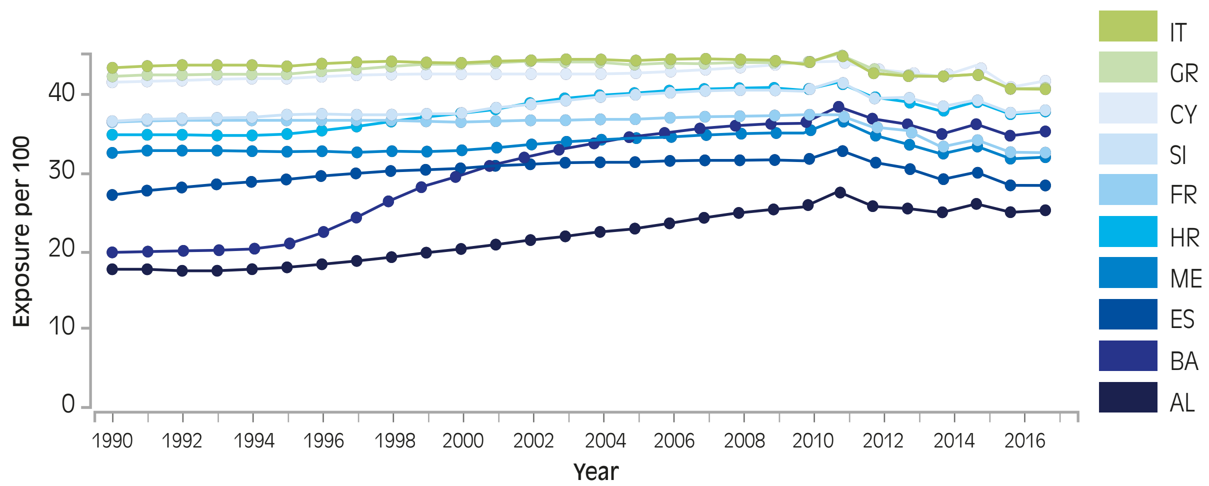


Figure 185 - Ambient particulate matter $PM_{2.5}$ pollution in NMCs
(Source: IHME, 2018)

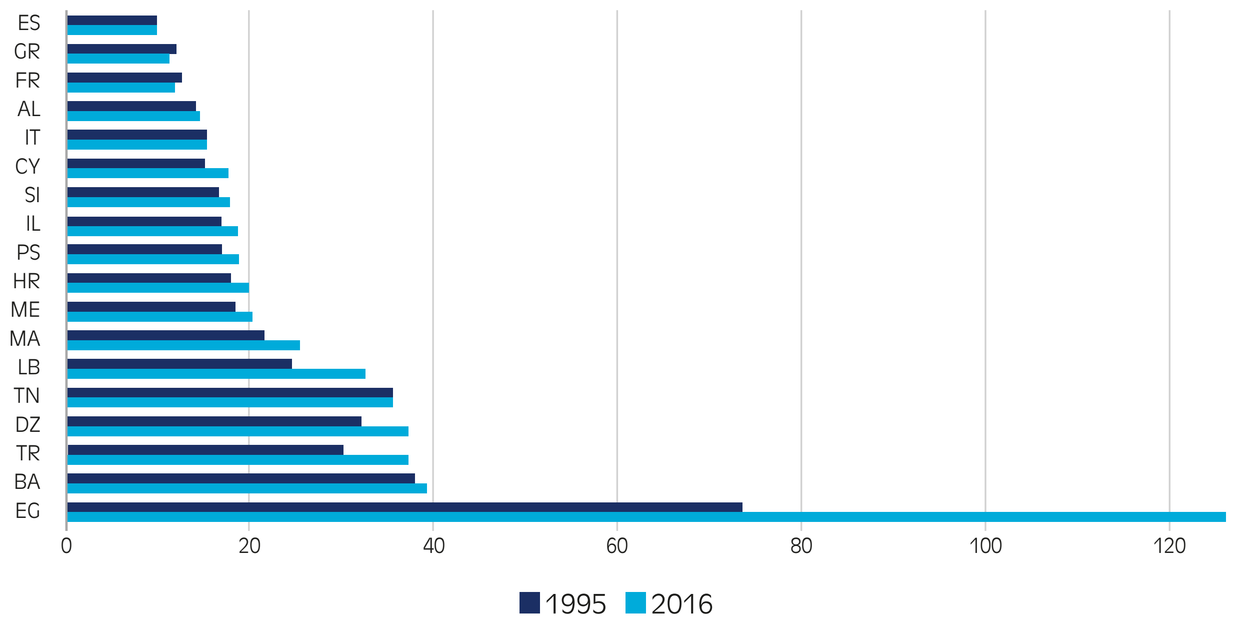


Figure 186 - Annual average exposure to particulate matter ($PM_{2.5}$), µg/m³
(Source: World Bank, 2019)

Air quality monitoring in the Southern and Eastern Mediterranean Countries is lacking in comparison to other Mediterranean countries. *Table 33* summarizes the number of urban areas that report air quality data to the WHO databases. Accordingly, assessment accuracy is linked to the number of monitoring stations.

In parallel to the share of population exposed to air pollution, average concentrations of particulate matter have also increased. Egypt shows the highest concentration with an average annual exposure of more than 120 micrograms per cubic meter (μg/m³), representing three times the regional average, with an even more extreme situation in the Cairo area, as indicated in *Figure 187*. In 2016, the Balkans (22 μg/m³) are on average more exposed to particulate matter than EU countries (14.4 μg/m³), with Bosnia and Herzegovina being particularly affected (39 μg/m³). Conversely, exposure to this type of pollution is below 15 μg/m³ in Albania, France, Greece and Spain.

Countries	Cereal import dependency ratio (%) in 2016	Number of Urban Areas Reporting PM_{10}
Albania	4	5
Algeria	0	0
Bosnia and Herzegovina	3	5
Croatia	10	10
Cyprus	9	7
Egypt	0	2
France	139	331
Greece	8	22
Israel	24	24
Italy	209	374
Lebanon	4	4
Libya	0	0
Malta*	4	3
Monaco	-	-
Montenegro	1	10
Morocco	1	49
Slovenia	3	16
Spain	142	638
Syrian Arab Republic	0	0
Tunisia	-	4
Turkey	15	103

Table 33 - Number of urban areas reporting $PM_{2.5}$ and PM_{10} per Mediterranean country
(Source: WHO, 2019b; * Malta Environment and Resources Authority, 2020)

Improving air quality in the Mediterranean basin is therefore both a health and environmental emergency and a real scientific and political challenge. The most recent studies show the complexity of the situation, the impact of local sources being intensified by the influence of long-range atmospheric transport of atmospheric pollution (desert dust, ozone), and by the climatic conditions of the region that promote the photochemical formation processes of pollutants. Ambitious policies to reduce emissions of pollutants and their precursors need to be implemented quickly and this is all the more necessary, as projections show that the region will be impacted by global climate change: more heat, less rainfall, more emissions and therefore ultimately potentially further degraded air quality.

7.4 Municipal waste management practices impact human health

Waste can generate negative impacts on both the environment and human health, even in cases where waste management is well regulated. Reducing adverse impacts of waste is most efficient when the waste hierarchy is optimized (see *Figure 189*). Preventing the generation of waste in the first place will also prevent related health risks from occurring and must be a priority.

Going down the waste hierarchy from prevention to reuse, recycling, (energy) recovery and disposal, health risks are likely to increase. While complete datasets for all waste streams are not available in all Mediterranean countries, a recent study (WWF, 2019) shows that more than 80% of plastic waste in Mediterranean countries is either incinerated (16%) or disposed of in controlled (50%) and uncontrolled (1%) landfills, or open dumpsites (13%). These waste streams involve potential risks for human health.

Negative impacts can be due to different handling and disposal activities resulting in soil, water and air pollution, e.g. heavy metals and persistent organic pollutants (POPs), that may cause serious human health hazards. Exposure to pollution from waste management facilities mainly affects the population living in the vicinity of the plants, often more deprived than the average population and thus creating environmental health inequalities. Exposure also affects people working in waste management. At the European level, studies estimate that the exposed population represents about 2 to 6% of the resident population (WHO Regional Office for Europe, 2015).

In cases of regulated management of urban waste, studies have identified adverse health impacts from incineration and landfills (WHO Regional Office for Europe, 2015), which are the dominant treatment types for municipal solid waste in the Mediterranean.

Landfills can expose populations living in its surrounding area to pollution via inhalation of substances emitted by the site and contact/consumption if water, soil or products are contaminated. Uncontrolled and illegal landfills that receive waste without sorting at source are of the highest

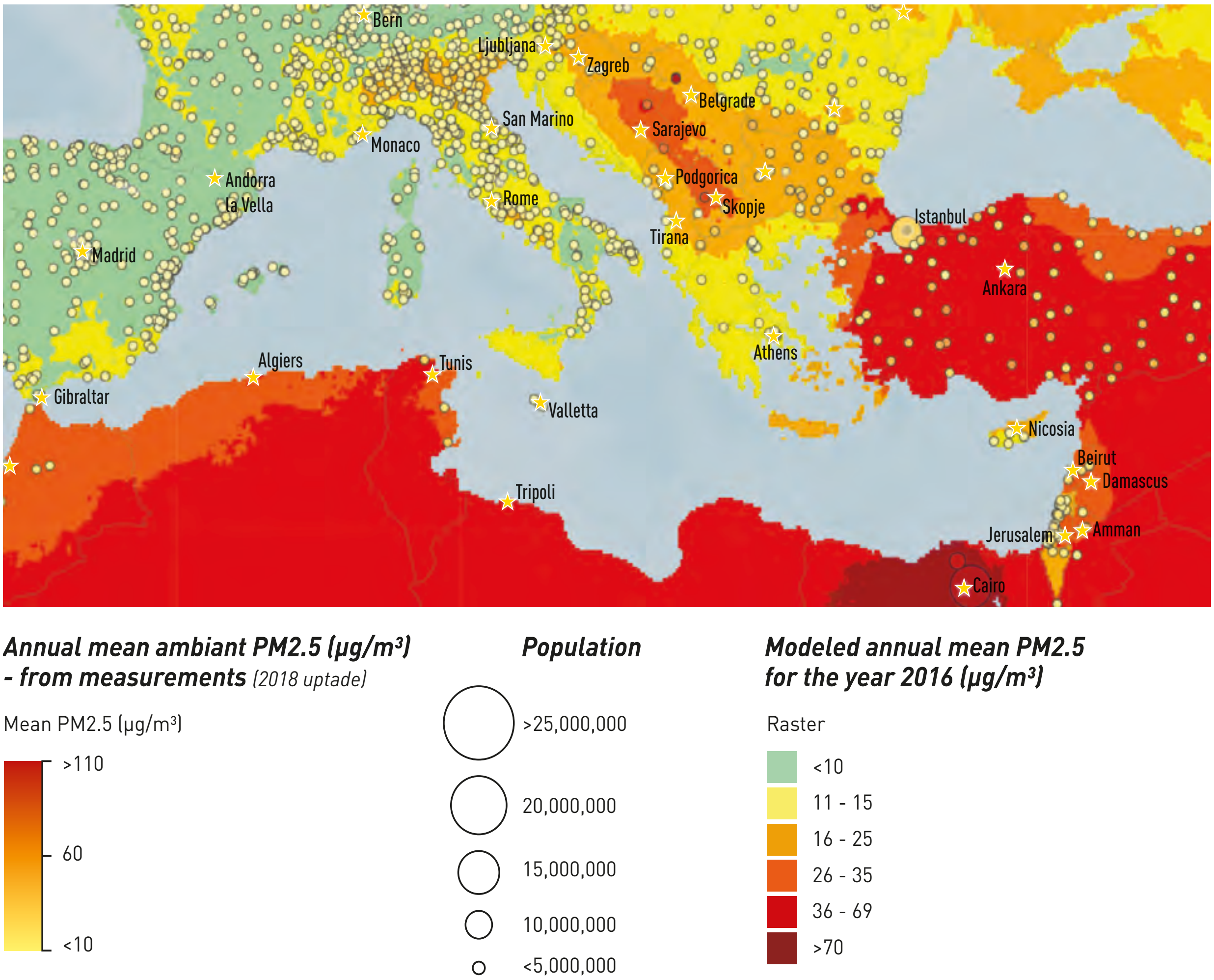


Figure 187 - Air pollution in the Mediterranean region, 2018 (cities) and 2016 (country level)
(Source: WHO Global Ambient Air Quality Database, 2019)

concern. Even controlled landfills have been reported to potentially generate health effects such as cancer and reproductive outcomes including an increased risk of congenital anomalies (WHO Regional Office for Europe, 2015).

Emissions from incinerators have been changing over time, with technology progressively reducing emissions via abatement measures. The co-existence of older and more recent incinerators makes it difficult to formulate general statements about their health effects. Studies on relatively old technologies (dominant incinerators until the mid-1990s) show solid evidence for detectable risks of stomach, colon, liver and lung cancer. Some evidence has also been found for an increased risk of congenital anomalies and associations between birth outcomes (preterm birth and spontaneous abortion) in relation to increased levels of exposure to incinerators (WHO Regional Office for Europe, 2015).

While many of the Northern Mediterranean countries have started to phase out landfilling recyclable waste and improved pollution abatement in incinerators, poor, outdated and illegal urban and hazardous waste disposal practices continue to affect some local communities in Northern Mediterranean countries and represent a problem in middle-low income countries (Landrigan et al. 2015), such as Southern and Eastern Mediterranean countries. In some cases, informal waste collection, treatment and disposal activities, despite only anecdotal evidence, have been identified that entail extremely high exposure to hazardous substances, for example through open-air waste burning, with a spectrum of health risks for populations living in the relevant areas (WHO Regional Office for Europe, 2015).

Electrical and electronic waste (E-waste) has become a major fast-growing issue of concern. While data at the Mediterranean level is not available, it is estimated that worldwide more than 40 million tonnes of e-waste are generated each year. E-waste contains a panel of more than 1,000 different chemicals (heavy metals, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs) and brominated flame retardants) that are hazardous to

BOX 82 Impact of maritime transport on human health and establishment of an Emission Control Area (ECA) in the Mediterranean

Harmful air emissions from ships are a major threat to the Mediterranean Sea environment and climate and also have significant impacts on human health. Sulphur oxides (SOx) are directly harmful to human health and can be fatal at a certain atmospheric concentration. Exposure to high concentrations of SOx may cause chest pain, breathing problems, eye irritation and a lowered resistance to heart and lung diseases. A secondary effect of SOx is the formation of sulphates in the form of fine airborne particles (particulate matter) that have been linked to increased asthma attacks, heart and lung disease and respiratory problems in susceptible population groups. Particulate matter (PM) has been specifically associated with cardiopulmonary disease and lung cancer in exposed populations. Nitrogen oxides (NOx) are also associated with adverse effects on human health as high concentrations cause respiratory illnesses (EGSA, 2016; OECD, 2013). Shipping-related PM emissions from marine shipping contribute to approximately 60,000 deaths annually at a global scale, with impacts concentrated in coastal regions on major trade routes (Corbett et al. 2008).

In response to this issue, the International Maritime Organization (IMO) has established worldwide limitations for the maximum sulphur content of fuel oils (SOx and PM emissions being proportional to sulphur content in the fuel). These limits vary. Inside the so-called Emission Control Areas (ECA), limits are more stringent than those applicable globally outside these areas. Mediterranean countries of the EU have been subject, since January 2010, to a sulphur limit of 0.1% in fuels used by ships when at berth in EU ports.

On 1st January 2020, the maximum sulphur limit in marine fuels used across the world (except for ships using exhaust gas cleaning equipment or alternative fuels) will decrease from 3.5% to 0.5%. This will result in significant reductions in sulphur oxides, particulate matter, and black carbon emitted by maritime transport operating across the globe.

Outside an Emission Control Area	Inside an Emission Control Are
0.5% m/m* per mass starting 1st January 2020	0.1% m/m

Table 34 - Global Sulphur Limits applicable to marine fuel

So far, four ECAs have been established around the world: Baltic Sea area (SOx); North Sea area (SOx); North American area (SOx, NOx and PM); and United States Caribbean Sea area (SOx, NOx and PM).

On 1st January 2019, amendments to MARPOL Annex VI to designate the North Sea and the Baltic Sea as ECAs for NOx entered into force. Both ECAs will take effect on 1st January 2021 and will result in considerably lower emissions of NOx from international shipping in those sea areas. In NOx emission control areas, ships are subject to so-called "Tier III" controls to limit NOx emissions.

In the Mediterranean region, work has been initiated regarding the possibility of establishing an ECA. This initiative is taking place under the Protocol concerning Cooperation in Preventing Pollution from Ships and, in Cases of Emergency, Combating Pollution of the Mediterranean Sea ("the 2002 Prevention and Emergency Protocol") to the Barcelona Convention, and the Regional Strategy for Prevention of and Response to Marine Pollution from Ships (2016-2021) (UNEP(DEPI)/MED IG.22/28).

The Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea (REMPEC) recently coordinated the development of a technical and feasibility study on the possible designation of the Mediterranean Sea, or parts thereof, as a SOx ECA. The ECA would set tougher limits of 0.1% sulphur content for marine fuel in the Mediterranean compared to the planned global sulphur cap of 0.5% from 2020 and the current level in the region of a maximum of 3.5% sulphur, except for EU ports in the Mediterranean, as explained above. Findings highlight substantial gains that could be made by improving the air quality of the Mediterranean Sea and port cities in particular. The contribution of maritime traffic to atmospheric concentrations of SOx and - if the ECA is extended to it - NOx, known for their adverse effects on health and ecosystems (acidification, eutrophication), could be reduced by factors 12 and 4 respectively. *Figure 188* below illustrates the effect of an "ECA" zone on the levels of nitrogen dioxide in the ambient air. These are reduced significantly all along the Mediterranean coast, by up to 60% in some places. Preliminary results based on the use of models also show that designating an ECA for the Mediterranean region would result in reducing lung cancer and cardiovascular disease mortality, as well as childhood asthma morbidity.

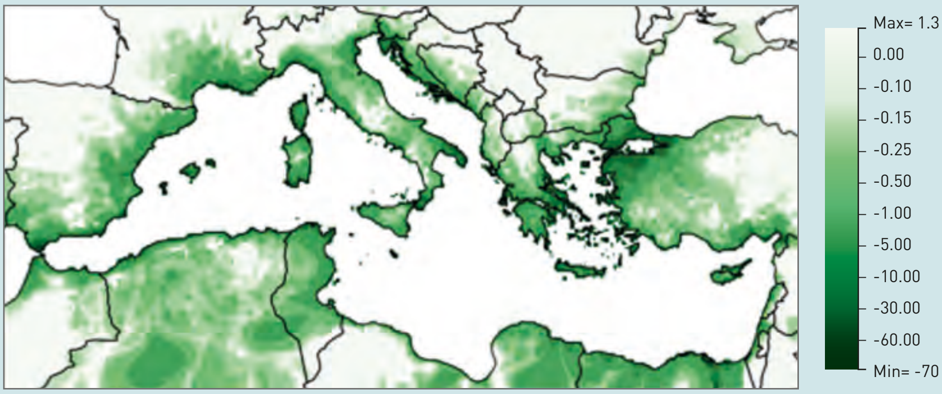


Figure 188 - Relative difference (%) in concentrations of nitrogen dioxide in coastal areas between a scenario with ECA and the current situation

Figure 189 - The waste hierarchy
(Source: European Commission)

human health in exposed populations living in the vicinity of disposal of this type of waste or involved in its treatment. Although detailed studies are still lacking, possible health effects include alterations in thyroid function, associations of exposure to chromium, manganese and nickel with lung function, adverse birth outcomes (preterm birth, low birth weight, stillbirth, and congenital malformations), behavioural alterations, as well as DNA damage and chromosomal aberrations in lymphocytes (WHO Regional Office for Europe, 2015).

In addition to the abovementioned health hazards, waste management practices also interfere with "soft" health issues linked to well-being, such as annoyance due to odour, which can be an issue of leverage in local policy debates. Finally, combined effects linked to the presence of an ever-increasing number of different substances and chemicals in the municipal waste stream needs further investigation and adequate management responses. Human biomonitoring, especially of persistent substances, is considered a mature and powerful tool in this respect.
Further studies are also required to increase knowledge on agricultural, industrial and medical waste streams and their interactions with human and environmental health.

7.5 Climate change already affects human health, with concerning trends

Climate, along with other environmental changes, has both direct and indirect effects on human health *(Figure 190)*. Direct effects include those caused by higher temperatures, increased UV radiation, droughts and other extreme events such as storms and floods. Climate change in the Mediterranean region is associated with a significant increase in the frequency, intensity and duration of heatwaves (Kuglitsch et al. 2010), amplified in Mediterranean cities by the urban heat island effect (Baccini et al. 2011). Heat-related illnesses and fatalities can occur when high ambient temperatures (in particular combined with high relative humidity) exceed the body's natural ability to dissipate heat. For example, a recent analysis for Barcelona (Spain) found an increased risk in mortality due to natural, respiratory, and cardiovascular causes during hot nights with temperatures higher than 23°C (Royé, 2017). In general, elderly people, children, people with pre-existing chronic conditions (i.e. respiratory diseases, cardiovascular disease, diabetes) are most affected (Michelozzi et al. 2009; Oudin Åström et al. 2015). Although most Mediterranean populations are relatively acclimatized to high temperatures, an increase in the intensity and frequency of heatwaves, or a shift in seasonality, are significant health risks for vulnerable population groups, including those who live in poverty with substandard housing and restricted access to air-conditioned areas (Paz et al. 2016). The degree to which heat-related morbidity and mortality rates will increase in the coming decades will depend on the adaptive capacity of Mediterranean population groups through acclimatization, adaptation of the urban environment to reduce heat-island effects, implementation of public education programmes and health system preparedness (Smith et al. 2014). Increased population life expectancy implies that protecting the health of elderly people will become a major challenge for all Mediterranean countries under heatwave conditions. Increased mortality was found among people over the age of 65 in Athens, Greece at high and very high temperatures (Paravantis et al. 2017). During the severe heatwave in France in the summer of 2003, most of the extra deaths occurred in the elderly population (Fouillet et al. 2008). Recent studies suggest that extremely high temperatures are associated with an increase in gender violence against women (Sanz-Barbero et al. 2018).

Climate change contributes to the transmission potential of vector-borne diseases since the life-cycle dynamics of the vector species, pathogenic organisms and reservoir organisms are all sensitive to weather conditions. The rates of replication, development, and transmission of pathogens depend more strongly on temperature than other host-pathogen interactions. In recent years, several outbreaks of different vector-borne diseases have been documented in the Mediterranean region. There is strong certainty that recently observed climate trends will contribute to the future transmission potential of vector-, food- and water-borne diseases in the region. Predicting the impacts of climate change on infectious disease severity and distributions remains a challenge, particularly for vector-borne infections of humans, which compounded by the complex interactions between hosts, pathogens and vectors or intermediate hosts, make the cumulative influence of climate change on disease outcomes elusive. For 2025 and 2050, areas with elevated probability for West Nile infections linked to climate change will likely expand and eventually include most of the Mediterranean countries. During recent years, dengue fever cases were reported in several Mediterranean countries, such as Croatia, France, Greece, Italy, Malta, Portugal and Spain. Although most cases were probably imported, in 2010, local transmission of dengue was reported in Croatia and France. During the hot summer of 2017, outbreaks of chikungunya were reported in France and Italy. Today, there is an apparent threat of outbreaks, transmitted by Aedes mosquitos, in the Mediterranean European countries (Cramer et al. 2018).

Extreme events, like floods, may lead to the spread of water-borne and vector-borne (e.g. mosquitoes) infectious diseases (Roiz et al. 2015; Vezzulli et al. 2012). Floods also cause personal injuries, enteric infections, allergies and asthma, increases in mental health problems and potential contamination by toxic chemicals (D'Amato et al. 2015; Messeri et al. 2015).

Indirect health effects are related to the deterioration of air, soil and water quality, changes in food supply and quality or other aspects of the social and cultural environments (Cecchi et al. 2010). The concentration of gases and particles in the air increases because of desertification and wildfires resulting from climate change (D'Amato et al. 2015), and due to direct human activity, especially in large cities. Air quality also impacts climate change, because many air pollutants are greenhouse gases (Ayres et al. 2009). Climate change leads to modification of the geographic distribution range of some plant species, an extended pollen season, and increased production of pollen and pollen allergens (D'Amato et al. 2007). Saltwater intrusion into groundwater caused by sea level rise (Leduc, Pulido-Bosch & Remini, 2017), may deprive some populations of drinking water, which may have serious health consequences.

In the marine environment, climate change can also favour the spread of invasive species, such as the poisonous pufferfish *Lagocephalus sceleratus*. This invasive fish, now largely present in the Eastern Mediterranean, contains tetrodotoxin, a neurotoxin that can prove deadly to humans and for which there is no known antidote (Nader, Indary & Boustany, 2012). Algal blooms with harmful effects on plants, animals and humans are likely to occur more frequently or more severely with climate change. Marine algal toxins develop under these algal blooms and are responsible for a variety of human illnesses associated with consumption of seafood. Generally, acute intoxications are observed, whereas the environmental health effects of chronic exposure to low levels of algal toxins are an emerging issue. In the Mediterranean, harmful algal blooms are commonly related to areas of constrained dynamism, such as bays, lagoons, beaches and estuaries (Ferrantel et al. 2013). In these areas, aquaculture and fishing activities are frequent and there is a risk of algal toxins reaching humans via consumption. Alterations in the types and occurrence of parasites in seafood linked to climate change can pose an additional concern for human health.

Human health in the Mediterranean is highly conditioned by societal trends and political situation. In some countries and regions, poor sanitary conditions increase the risk of consuming contaminated food or drinking water (for example countries impacted by conflicts in the Middle East and North Africa). Also, increased water scarcity, coupled with a lack in regulation, can induce practices of reuse of inadequately treated or untreated wastewater for irrigation, causing sanitary problems through consumption of contaminated food. Urbanization and growing human population density in coastal areas exacerbate air pollution and increase transmission of many contagious illnesses. Political conflicts lead to human migration, which influences the risk of disease proliferation (Vittecoq et al. 2013). Furthermore, human activities, like transportation of goods, animals and people, disappearance of natural wetlands, coastal planning, and dam construction on large Mediterranean rivers, may enhance natural cycle transmission of infectious agents (Roche et al. 2015; Rodriguez-Arias et al. 2008).

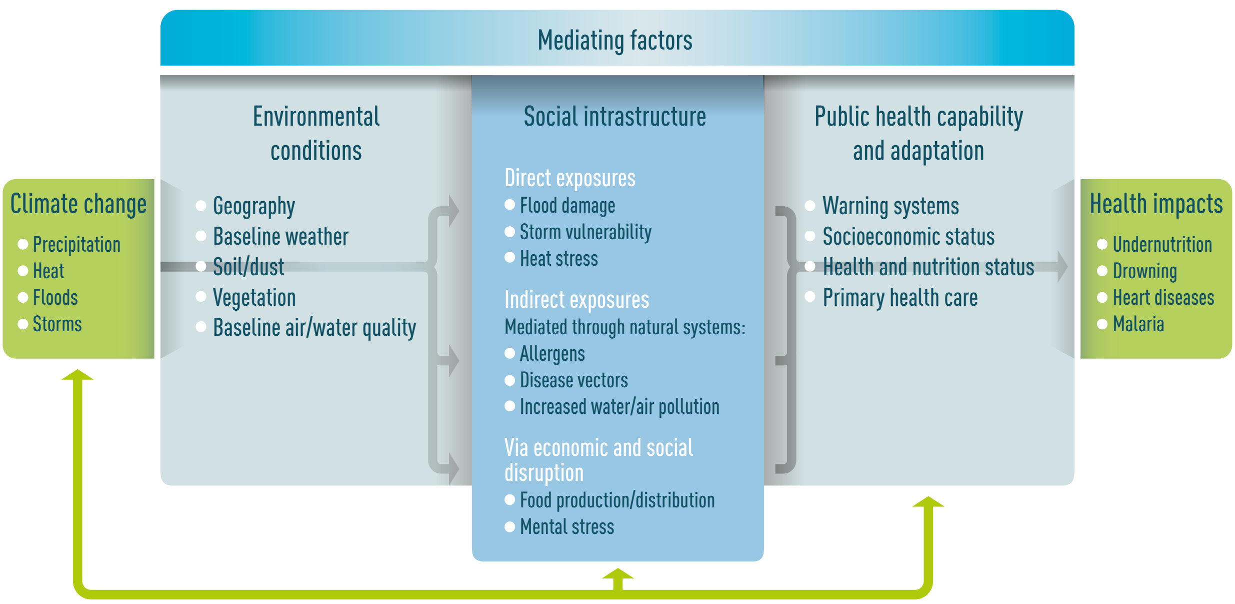


Figure 190 - Conceptual diagram showing primary exposure pathways by which climate change affects health
(Source: Smith et al. 2014)

7.6 Environmental health management in emergencies

7.6.1 Natural hazards

The Mediterranean basin is a zone of tectonic and volcanic activity resulting from the collision of the African plate into the western part of the Eurasian plate. This leads to volcanic and seismic risks, the latter potentially leading to tsunamis. A number of significant recent, historic and pre-historic volcanic eruptions, earthquake and tsunami events have been recorded in the Mediterranean basin. A relatively recent destructive event took place in August 1999 when a 7.4 magnitude earthquake struck the Kocaeli area in northwest Turkey, generating a tsunami within the Sea of Marmara, killing over 13,000 people, injuring more than 27,000 people and damaging over 54,000 buildings (Ansal et al. 1999). The 28th December 1908 7.1 magnitude earthquake in Messina, Italy, is the most destructive earthquake in Europe in the 20th and 21st century, with a death toll of more than 80,000 people (Meschis et al. 2019). *Figure 191* provides an overview of seismic hazards in the Mediterranean basin. Seismic risks are concentrated in the central northern and north eastern Mediterranean. In Turkey alone, close to 64 million people are exposed to seismic risk. In Italy, around 84% of built-up areas are located in hazard zones (Pesaresi et al. 2017).

Italy is among the ten countries with the highest number of inhabitants potentially exposed to volcano hazards, with around 10 million people exposed in 2015. It is the fourth country in the world with regard to the amount of built-up area potentially exposed to volcano hazards (2,700 square kilometres in 2015, with a significant increase over the 1975-2015 period) (Pesaresi et al. 2017).

The two principal mechanisms that generate tsunamis in the Mediterranean are earthquakes and submarine slides, although volcanic eruption and collapse cannot be ignored as potential mechanisms as well. A recent study (Samaras, Karambas & Archetti, 2015) suggests that even a moderate earthquake in the eastern Mediterranean could set off a tsunami with the potential to affect a large proportion of the population living on the coastline of the sub-basin. The high density of coastal settlements and infrastructure make the Mediterranean an area that is vulnerable to tsunami events. In tsunami scenarios based on historic and modelled data, an earthquake in the eastern Hellenic Arc, which has high seismic activity, is projected to leave around 10 to 80 minutes to warn Heraklion (Crete, Greece), a 60 to 160-minute warning time for Athens (Greece), and between 65 and 130 minutes for Alexandria (Egypt), (Sørensen et al. 2012).

7.6.2 Human-made emergencies

In addition to natural disasters, human-made emergencies, conflicts, and disasters occur in the Mediterranean, including chemical or radiological incidents, and complex emergencies such as wars or civil disturbance including events leading to forced displacement of people. According to the WHO, a substantial fraction of the disease burden derived from these events is attributable to environmental risk factors. For example, complex emergencies can be linked to (Zwijnenburg & te Pas, 2015):

- Targeting of industrial facilities and critical infrastructure. Damage to industrial facilities, critical infrastructure and military bases can lead to hazards associated with contamination, or loss of access to essential services such as clean drinking water and sanitation, energy and waste disposal. Additional risks can occur via artisanal oil production or looting of industrial sites.

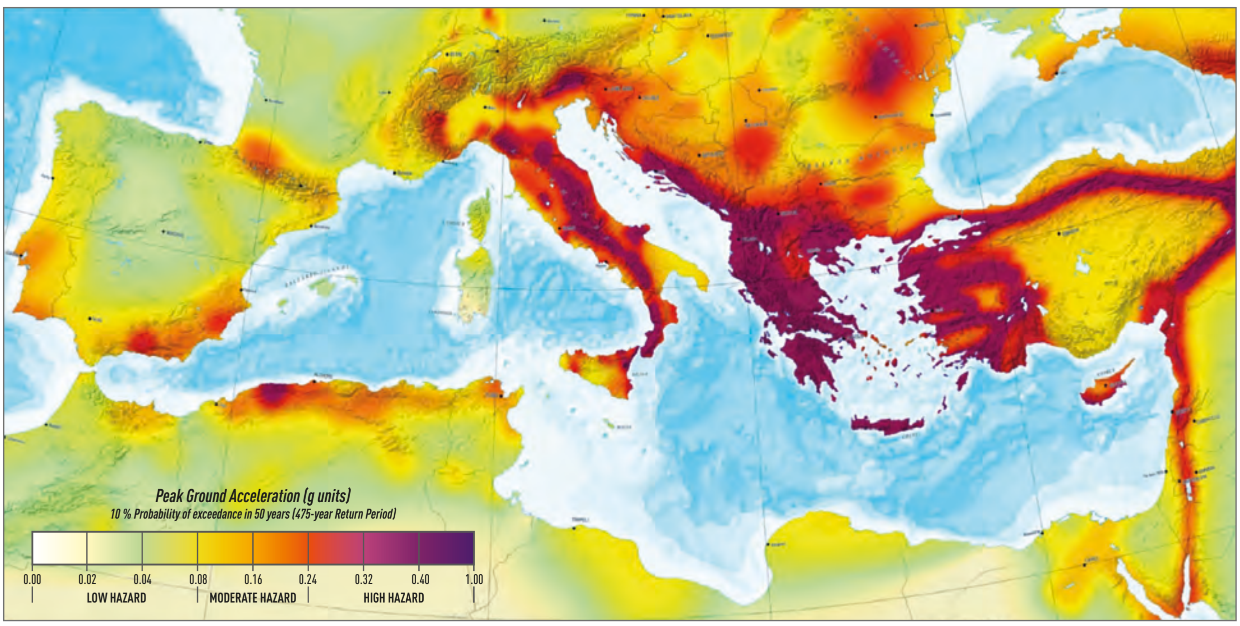


Figure 191 - Seismic hazards in the Mediterranean basin
(Source: European Seismological Commission, 2003)

- Heavy damage to residential areas and exposure to hazardous building rubble. The pulverization of building materials containing cement dust, household waste, medical waste, asbestos and other hazardous substances can cause acute and long-term exposure of civilians (mainly respiratory illness) and ecosystems.
- Contamination from the intense use of weapons. While data from conflict-affected areas on the environmental contamination of weapons is largely lacking, risks of heavy metal and military toxin contamination exist.
- The breakdown of waste management. An immediate threat of communicable disease through the breakdown of waste(water) management services and risks related to uncontrolled burning of waste are combined with long-term concerns about soil and groundwater pollution from poorly managed landfill sites and non-isolation of industrial or medical waste.

7.6.3 Environmental health management in natural and human-made emergencies

BOX 83

Early tsunami warning system

Natural hazards - volcano events, earthquakes and tsunamis - cannot be prevented nor accurately predicted. Measures can be taken to reduce the potential devastating impact of such events on the Mediterranean population. Following the 2004 Indonesian tsunami, UNESCO brought about the *Intergovernmental Coordination Group for the Tsunami Early Warning and Mitigation System in the North-eastern Atlantic, the Mediterranean and Connected Seas,* responsible for monitoring seismic activity, sea levels and other relevant data, and raising awareness and disseminating warnings when necessary. Such warnings saved many lives when a destructive tsunami hit Japan in 2011. While the development of early warning systems shows progress, they are not yet sufficiently user-friendly and widely disseminated. Education and awareness-raising are key, especially for particularly exposed communities, so that they can act quickly and adequately when needed.

For all emergencies, including those related to natural hazards and human-made disasters, disaster risk management frameworks can be applied at international, national and local levels. Such frameworks typically include three main steps: (i) disaster risk reduction: risk assessment, prevention, mitigation, preparedness, early warning; (ii) immediate disaster response: evacuation, saving people and livelihoods, immediate assistance, assessing damage and loss; and (iii) recovery and rehabilitation: ongoing assistance, restoration and reconstruction of infrastructure and services, resettlement/relocation, economic and social recovery, renewed risk assessment (FAO, 2008).
Effective mainstreaming of environmental and ecosystem considerations into all phases of disaster risk reduction and management frameworks, including into humanitarian programmes, remains challenging. However, it has strong potential to largely strengthen resilience and lead to improved outcomes for people and ecosystems.

BOX 84

The United Nations Office for Disaster Risk Reduction and the Sendai Framework

The United Nations Office for Disaster Risk Reduction (UNDRR) aims to reduce the damage caused by natural hazards like earthquakes, floods, droughts and cyclones, through an ethic of prevention. Following the 2015 Third UN World Conference on Disaster Risk Reduction (WCDRR), the Sendai Framework for Disaster Risk Reduction 2015-2030 (Sendai Framework) was endorsed by the UN General Assembly as the first major agreement of the post-2015 development agenda, with seven targets and four priorities for action.

7.7 Marine and coastal environments present specific human health benefits and risks

During the last few decades, there have been numerous studies investigating the impact that humans and climate change are having on marine ecosystems and their resources, but few have linked the marine environment directly with human health (Bowen et al. 2014; Depledge et al. 2013; Fleming et al. 2014). In this sense, a new line of research has recently emerged called "Oceans and Human Health" (OHH), which aims to study the relationships between the health and well-being of people and the goods and services provided by our seas and oceans (Depledge et al. 2013; Fleming et al. 2014). This type of research sheds light on the way marine ecosystems provide a wide range of goods and services that are essential for human health and well-being, as well as generating a variety of potential health hazards which need to be kept under control through effective management. Issues presenting risks and benefits to human and ocean health are diverse and range from climate change, extreme weather and natural events, harmful algal blooms, marine litter and sustainable fisheries to recreation, health and well-being (Fleming et al. 2014).

Several initiatives in the Mediterranean and Europe are targeting research, transfer of knowledge and management in the field of OHH, some of them with a large European scope such as the SOPHIE project[122] and some at a local or regional level such as the Oceans and Human Health Chair in Roses[123]. These initiatives aim to foster research and raise awareness on the complex links that exist between marine environments and human health. On the one hand, there are healthy seafood products, species from which new medicines can be produced, areas for relaxation and leisure, etc. On the other hand, in addition to the calamitous effects of extreme weather events, such as violent storms,

[122] https://sophie2020.eu/
[123] www.oceanshealth.udg.edu

or tsunamis, people are exposed to pollutants, toxins and pathogens - many of which are linked to human activity. The Mediterranean provides a sound example where all these benefits and risks interact. The overall benefits provided by Mediterranean marine biodiversity to human health are diverse but fragile, as anthropogenic and environmental factors are threatening these benefits (Lloret, 2010).

7.7.1 Provision of food

First, the Mediterranean Sea is a valuable source of seafood, which is an important component of the Mediterranean diet. This type of diet has several health benefits, including cardio and cancer protective effects, which are attributed to the high intake of seafood-derived n-3 (omega-3) fatty acids (Lloret et al. 2016). In the developed world, seafood does not play such an important role in food security, since people usually rely on animal protein from other sources (e.g. livestock). Most people in Mediterranean developed countries get sufficient protein in their diet and therefore much attention has been given to the contribution of seafood to a healthy diet because of the health benefits provided by the long-chain omega-3 (or n-3) fatty acids contained in seafood (Lloret et al. 2016). Despite the importance of seafood for a healthy diet, overfishing (mainly) and sea warming (secondly) in the Mediterranean is threatening some fish stocks (Lloret, 2010). The depletion of these fish stocks, particularly the pelagic oily fish populations, is reducing the potential supply of long chain omega-3 fats. Furthermore, microbial and chemical contamination is threatening the seafood quantities and quality in the Mediterranean. Pathogens such as parasites, pollutants such as heavy metals, dioxins and polychlorinated biphenyls (PCBs) and toxins from harmful microalgae blooms are affecting the safety of the seafood supply (Lloret, 2010).

7.7.2 Provision of bioactive metabolites

Mediterranean marine organisms, particularly benthic marine organisms, furnish a large variety of bioactive metabolites, some of which are being developed into new drugs to treat major human diseases such as cancer. In the Mediterranean Sea, the majority of bioactive (antibacterial, antifungal, antiviral, cytotoxic or antifouling) molecules have been isolated from benthic species: algae, marine phanerogams and, particularly, animals such as sponges, bryozoans, echinoderms, polychaetes, ascidians, molluscs and cnidarians (Uriz et al. 1991). Despite the human health benefits provided by benthic species, they are impaired by a wide variety of human activities, including bottom trawling, impacts related to recreational activities (e.g. anchoring) and other factors such as microbial and chemical contamination and sea warming.

7.7.3 Provision of leisure opportunities

The Mediterranean coastal areas provide environments for enjoying maritime leisure activities that provide physical and psychological benefits to users. The Mediterranean has become the world's leading tourist area, and different leisure activities such as recreational fisheries, scuba diving, whale watching and snorkelling have been built upon the exploitation of or encounters with different marine species. Leisure in natural settings offers humans a range of valuable services, including physical and psychological benefits (Gascon et al. 2017). New research about how recreational activities conducted in nature can improve mental attention and other psychological aspects of health such as mood and stress levels are gaining significance (Lloret, 2010). However, pollutants such as heavy metals, dioxins and polychlorinated biphenyls (PCBs), and toxins from harmful algal blooms (HABs), are affecting the recreational use of coastal marine waters in the Mediterranean (Lloret, 2010).

Governance aspects related to the Oceans and Human Health (OHH) field are particularly important in the Mediterranean because there is a need to safeguard the goods and services provided by the marine ecosystem in order to enhance health benefits and minimize health risks. There is a need to further address the interactions and the value of marine ecosystems for human health and well-being among researchers, policymakers, healthcare providers and public health practitioners, and the general public.

7.8 The medical and pharmaceutical sectors impact the environment

The previous sections have shown how environmental conditions impact human health. The environment-health nexus also includes interactions between the health sector itself and the environment. Healthcare activities produce a magnitude of different kinds of waste, including infectious waste contaminated with blood or other body fluids, pathological waste such as human tissues or contaminated animal carcasses, sharps waste such as syringes, needles etc., chemical waste such as solvents, disinfectants and heavy metals contained in medical devices, pharmaceutical waste, cytotoxic waste such as drugs used in cancer treatment, radioactive waste and non-hazardous general waste.

Data on the treatment of wastewater generated in medical settings has not been identified. It is possible that wastewater from healthcare facilities is discharged directly into municipal wastewater networks which are incapable of treating all specific elements of these effluents. This can include radioactive elements, heavy metals and other hazardous substances that can lead to environmental contamination.

An issue of emerging concern is linked to pharmaceutical residues that end up in the environment and lead to diffusion of substances through the water cycle into the coastal and marine environment:

- Sewage is one of the main sources of pharmaceutical contamination. Contaminated wastewater originates from households, tourist resorts and healthcare facilities where pharmaceutical products have been administered but only partially metabolized and excreted unaltered or as active metabolites via urine and faeces. Contaminated

85 Bathing water quality in Mediterranean coastal waters

Coastal bathing water assessment in some Northern Mediterranean countries shows that in almost all surveyed countries, bathing water quality is excellent or good in over 90% of bathing waters, with the exception of Albania where over 80% of bathing waters had excellent or good quality in 2018. Over a three years period, compared to 2015, the situation has generally remained relatively stable with some bathing sites improving and some deteriorating in quality. Albania is an exception, where 40% of bathing sites had poor quality in 2015 compared to only 20% in 2018. Data from other Mediterranean countries is currently lacking.

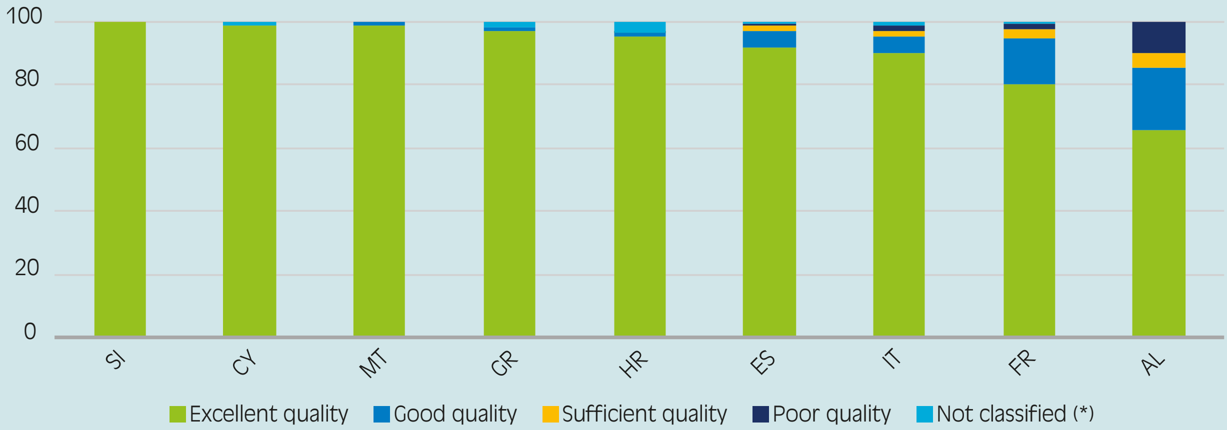


Figure 192 - Coastal bathing water quality in 2018, including all maritime façades for multi-façade countries
(Source: EEA, 2019)

Concrete measures, mainly the installation of sewage treatment plants to reduce, among other things, faecal pollution in coastal waters, has been a success in the Mediterranean Sea, with support from the United Nations Environment Programme/Mediterranean Action Plan (UNEP/MAP). The last decade has seen an increase in domestic wastewater depuration in a number of countries, demonstrating the benefits of implementing the Land-Based Sources protocol and other environmental measures to reduce pollution. Despite these positive developments, improvements are still to be made.

Figure 193 - Locations with poor bathing water quality in NMC as registered in EMODNET database
(Source: EMODNET database extraction, consulted in October 2019, based on 2017 data)

wastewater also originates from pharmaceutical manufacturing and from ships (cruise lines, pleasure boating, maritime transport). Depending on the physico-chemical characteristics of the pharmaceutical and the type of treatment technology (when wastewater treatment is in place), removal rates for pharmaceuticals in wastewater treatment plants are generally low because most Wastewater treatment plants (WWTPs) are not specifically designed to remove pharmaceutical residues (Kümmerer, 2009). Reuse of treated domestic wastewater for irrigation contributed to pharmaceutical contamination in groundwater on Mallorca (Rodríguez-Navas et al. 2013).

- Aquaculture is another way for pharmaceuticals to enter the marine environment, as a variety of veterinary medicines are used to control disease outbreaks or prophylactically in marine aquaculture. Rates as high as 75% of administered medicines can be lost to the surrounding environment (Grigorakis & Rigos, 2011). Freshwater farms located in the coastal area can also contaminate the marine environment through leaks and discharge of wastewater with elevated concentrations of pharmaceuticals.

- Veterinary use of pharmaceuticals added to animal feeds and in some cases drinking water to treat disease are another source of contamination through farm effluents and contamination of groundwater and water flows. The use of low doses of antibiotics in feed as growth promoters still occurs in some areas although being banned in Europe.
- Pharmaceutical residues also enter the environment through improper disposal of clinical and household waste. Landfill leachate on the island of Mallorca contained up to 27,000 ng/l total concentration of pharmaceuticals (Rodríguez-Navas et al. 2013).

Data on the toxicity of pharmaceuticals with respect to marine organisms is generally lacking. Reported adverse effects for marine organisms include reduced feeding rates, impacts on survival, reduced mussel byssus strength and changes in immune response and biochemical markers (Gaw, Thomas & Hutchinson, 2014). Pharmaceuticals are present in marine ecosystems as mixtures and combined with other contaminants which complicates the study of their effects their role in marine food webs. More generally, pharmaceutical residues potentially act as additional stressors on marine ecosystems already under high pressures from climate change, pollution and over-fishing and come with human health risks linked to bioaccumulation of pharmaceuticals in seafood and antibiotic resistance.

BOX 86

Antibiotics, ecosystems and human health

Antibiotics represent one of the many different pharmaceuticals present in soil and water, including in marine ecosystems. In the environment, antibiotics can impact natural microbial communities, which play key roles in ecological processes, such as the maintenance of soil and water quality (biogeochemical cycling, organic contaminant degradation, biomass production). Antibiotics can inhibit or kill such microbial communities with the consequent altering or disappearance of their ecological functions (direct impact) and associated ecosystem services.

Antibiotic concentrations in natural environments are generally highest in areas with strong anthropogenic pressures. Given the dense population of the Mediterranean coastal zone, it is thus potentially subject to high concentrations that can have - largely unknown -synergistic effects with high concentrations of other contaminants.

In addition, the chronic presence of sub-therapeutic quantities in natural environments raises serious concerns about the development of antibiotic resistance in bacteria and of bacteria being able to degrade antibiotics (Grenni, Ancona & Caracciolo, 2017). The emergence of antibiotic-resistant bacteria poses a very high risk on human and veterinary health, with medical research on new antibiotics currently not keeping up with the pace at which bacteria develop antibiotic resistance. The WHO lists five main points about antibiotic resistance:

- "Antibiotic resistance is one of the biggest threats to global health, food security, and development today.
- Antibiotic resistance can affect anyone, of any age, in any country.
- Antibiotic resistance occurs naturally, but misuse of antibiotics in humans and animals is accelerating the process.
- A growing number of infections - such as pneumonia, tuberculosis, gonorrhoea, and salmonellosis - are becoming harder to treat as the antibiotics used to treat them become less effective.
- Antibiotic resistance leads to longer hospital stays, higher medical costs and increased mortality."

7.9 Responses and priorities for action

7.9.1 Preventing human illness and disease by mainstreaming environmental health

Human activities impact the environment in various ways, often leading to different kinds of degradation and pollution, as well as climate change, which, in turn, impact human health. Medical treatment of the resulting illnesses is not only costly, it also comes with negative impacts on the environment linked to a number of different types of solid and liquid waste which pose further threats to the environment and human health.

Further environmental degradation caused by human activities can be prevented, thus providing opportunities to break this vicious circle. Preventive measures are cost-effective responses and come with win-win effects for environmental and human health outcomes. The *Figure 194* lists nine priority areas of action for improving human health by improving the state of the environment.

Realizing that the state of the environment and the state of human health are closely linked calls for a much more active integration of environmental health concerns in all policies and decisions and more inter-sectoral collaboration involving health and environment experts. In this sense, a common statement by the Food and Agriculture Organization of the United Nations (FAO) Regional Office for Europe and Central Asia, the World Organisation for Animal Health (OIE) Subregional Representation for Central Asia, and the World Health Organization (WHO) Regional Office for Europe, whereby the "One Health" approach is promoted, calls for cross-sector collaboration in fighting antibiotic resistance and bringing together human health, animal health and environment health as one, worldwide (WHO Regional Office for Europe, 2018). Along similar lines, the WHO global strategy on health, environment and climate change was endorsed by the World Health Assembly in May 2019.

7.9.2 Prioritizing knowledge for better action

Knowledge about human health risks and benefits resulting from the state of Mediterranean ecosystems is rather patchy. Data about concentrations of pollutants ("traditional" contaminants and those of emerging concern) exists in some places, but the Mediterranean is far from having complete comparable datasets about all relevant substances in all places, at regular coherent intervals.

Figure 194 - Nine priorities for action to improve human health by improving the environment
(Source: Prüss-Üstün et al. 2016)

Knowledge about the lifecycle of these substances in the different ecosystems, about cumulative and synergistic effects between them and about their impacts on human health is increasing but remains partial. Results of studies and data campaigns can even be contradictory because of different methodologies and (even slight) differences in time of year and geographical location. Bridging these knowledge gaps is a costly and time-consuming endeavour and can involve many cases of disproportionate costs in order to make relatively small knowledge gains.

Given these difficulties, resources must be used in a way to prioritize knowledge and understanding of phenomena that can enlighten decision-making and lead to evidence-based action in the most efficient way. Transitioning from a logic of pollution concentration to a logic of flows and impacts that takes the long term into consideration can help to yield more targeted decision-making.

8. Governance

Worldwide, a multitude of cooperation mechanisms exist in the field of sustainable development. The most prominent and overarching agreement is the 2015 consensus by the UN General Assembly on "Transforming Our World: The 2030 Agenda for Sustainable Development" (2030 Agenda) and its 17 Sustainable Development Goals.

In the Mediterranean region, countries have joined efforts for more than 40 years for the protection of the Mediterranean marine and coastal environment, under the Barcelona Convention and its 7 Protocols. They have jointly developed a Mediterranean "translation" of the 2030 Agenda through the Mediterranean Strategy for Sustainable Development, and have adopted over the years a series of frameworks, tools, action plans and strategies in an effort to improve cooperation and decision-making towards sustainable development. The implementation of these common frameworks relies on regulations, planning tools, economic and financial instruments, as well as information, education and awareness-raising activities.

Long-term cooperation among national governments and with the European Union is progressively paralleled with cooperation within stakeholder networks (of NGOs, local governments, private sector, parliamentarians, etc.). Inclusive governance, public participation and access to environmental information are also increasingly mainstreamed into the tools adopted at national and regional levels. Science policy Interfaces (SPIs) provide significant potential for better-informed decision-making and increasing SPI effectiveness has now been identified as a major lever for enhanced governance.

Only little is known about the actual effects of these mechanisms on the ground. The continuing degradation of the Mediterranean environment suggests that the enforcement of measures is likely to be a major challenge also in absence of effective environmental police and sanctioning mechanisms that could support implementation at the local level. In addition to ex ante environmental impact assessment, which is a requirement of the Barcelona Convention, ex post environmental and social assessment of policies, programmes and projects could further fill significant knowledge gaps on the obstacles for implementation and lead to better policies and decision-making.

8.1 Most global environmental agreements have been largely adopted in Mediterranean countries, with notable exceptions

8.1.1 Global environmental agreements

With regard to cooperation mechanisms for supporting decision-making and action related to the environment, environmental governance became a global issue at the UN Conference on the Human Environment in 1972 (Stockholm Conference), which decided to create the United Nations Environment Programme (UNEP). To date, hundreds of Multilateral Environmental Agreements (MEAs) have been negotiated with the support of UNEP.

Many global MEAs are of major importance for the protection of the marine and coastal environment, including in the field of Climate Change (UN Framework Convention on Climate Change (UNFCCC) and Paris Agreement), Biological Diversity (Convention on Biological Diversity (CBD) and its protocols), Wetlands (Ramsar Convention), Migratory species (Bonn Convention on the Conservation of Migratory Species of Wild Animals (CMS)), Waste (Basel Convention), and harmful substances, such as mercury (Minamata Convention), and other hazardous chemicals and pesticides (Rotterdam Convention), persistent organic pollutants (Stockholm Convention) or pollution from ships (MARPOL Convention). MEAs are instrumental in addressing important environment issues and the thematic network they form continues to grow. Eighteen regional sea programmes (14 of which are based on legally binding conventions) also support environmental governance in all oceans.

In addition, UNEP coordinated many actions in the field of marine environment, including actions to address land-based pollution (e.g. the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA)[124]), protect coral reefs (e.g. The International Coral Reef Initiative (ICRI)[125]), develop marine protected areas (MPAs) and reduce marine litter.

Ratification rates of Multilateral Environmental Agreements (MEAs) are generally high throughout in Mediterranean countries. The Convention on the protection of World Cultural and Natural Heritage (adopted by the General Conference of UNESCO in 1972), Basel Convention, Convention on Biological Diversity, United Nations Framework Convention on Climate Change (UNFCCC) and United Nations Convention to Combat Desertification (UNCCD) have been ratified by all 21 Mediterranean riparian countries and the European Union. Other conventions and agreements on biodiversity conservation and pollution reduction are strongly supported in the region, such as the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), Bonn Convention on the Conservation of Migratory Species (CMS), African-Eurasian Migratory

[124] The Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA) was adopted by 108 Governments and the European Commission at an intergovernmental conference convened for this purpose in Washington, D.C., United States of America, in 1995. https://www.unenvironment.org/explore-topics/oceans-seas/what-we-do/addressing-land-based-pollution/governing-global-programme.

[125] The International Coral Reef Initiative (ICRI) is an informal partnership among States, international organizations and NGOs to help protect coral reefs globally. It aims to implement Chapter 17 of Agenda 21, Aichi Target 10 of the Convention on Biological Diversity's 10-year Strategic Plan, and other relevant internationally agreed objectives and targets.

BOX 87 The Convention on Biological Diversity (CBD)

The Convention on Biological Diversity (CBD) was inspired by the world community's growing commitment to sustainable development, opened for signature at the UN Conference on Environment and Development (the Rio Earth Summit) in June 1992 and entered into force in December 1993. It has three main objectives: (i) the conservation of biological diversity; (ii) the sustainable use of the components of biological diversity; and (iii) the fair and equitable sharing of the benefits arising out of the utilization of genetic resources.

The CBD covers all ecosystems, species and genetic resources, and addresses the field of biotechnology, including technology transfer and development, benefit-sharing and biosafety. It sets policies and general obligations, and organizes technical and financial cooperation. Implementation is required at the national level and responsibility rests with national governments.

In 2010, the CBD Conference of Parties adopted a revised and updated Strategic Plan for Biodiversity for the 2011-2020 period. This Plan provides an overarching framework on biodiversity, not only for the biodiversity-related conventions, but for the entire United Nations system and all other partners engaged in biodiversity management and policy development. The Parties agreed to translate this overarching international framework into revised and updated national biodiversity strategies and action plans, covering 20 targets developed under the following 5 strategic goals: (i) address the underlying causes of biodiversity loss by mainstreaming biodiversity across government and society; (ii) reduce the direct pressures on biodiversity and promote sustainable use; (iii) improve the status of biodiversity by safeguarding ecosystems, species and genetic diversity; (iv) enhance the benefits to all from biodiversity and ecosystem services; (v) enhance implementation through participatory planning, knowledge management and capacity building.

In 2020, the CBD will adopt a post-2020 global biodiversity framework as a stepping stone towards the 2050 Vision of "Living in harmony with nature" whereby "by 2050, biodiversity is valued, conserved, restored and wisely used, maintaining ecosystem services, sustaining a healthy planet and delivering benefits essential for all people". The preparation of the post-2020 global biodiversity framework is supported by a comprehensive and participatory process.

The theme of the 2019 International Day for Biological Diversity, hosted by the CBD, is "Our Biodiversity, Our Food, Our Health", which clearly shows the systemic approach that underlies the CBD, while contributing to Sustainable Development Goals, including climate change mitigation and adaptation, ecosystems restoration, cleaner water and zero hunger, among others.

Waterbird Agreement (AEWA), the Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic Area (ACCOBAMS) and the Stockholm Convention (persistent organic pollutants).

Some conventions or their protocols remain under-ratified, with less than 50% of the Mediterranean countries having adopted them *(Table 35)*. This is the case in particular of the Nagoya Protocol[126], Minamata Convention[127], Aarhus Convention[128] and Espoo Convention[129].

In addition, MEAs often reach their limits when it comes to addressing causes, beyond effects and impacts, as most pressures on the environment are related to economic development (consumption and production patterns) and cannot be fully addressed by responses negotiated only through environmental governance.

8.1.2 Environmental and social assessments

Environmental and social assessments are broadly accepted planning tools for preventing adverse environmental and social impacts of human activities. Environmental impact studies stand as a requirement in Article 4.3.c of the Barcelona Convention. Generally less costly and leading to better outcomes than curative measures, ex ante environmental assessments aim at (i) identifying the negative and positive relationships between development Projects, Plans, Programmes and Policies (PPPP), environmental protection and human rights, and (ii) designing and implementing prevention, mitigation and assessment follow-up activities that ensure that PPPPs have net positive social and environmental impacts, or at least only minor negative social and environmental impacts. Environmental Impact Assessments (EIAs) constitute such a tool and take place at the project/local level. They are distinguished from Strategic Environmental Assessments (SEAs), which apply to development plans, programmes and policies and are used to control systemic effects when implemented timely and at the strategic decision-making level (e.g. ex ante SEA prior to adoption of a law).

While all Mediterranean countries have adopted legislation requiring EIAs, around three quarters of Mediterra-

[126] Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization (linked to the Convention on Biological Diversity) (2014).
[127] Minamata Convention on Mercury (2017).
[128] UNECE Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters (2001), and Protocol on Pollutant Release and Transfer Registers (PRTRs) (2009). The Aarhus Convention and its Protocol on PRTRs are the only legally binding global instruments on environmental democracy, empowering people with the rights to access information, participate in decision-making in environmental matters and to seek justice.
[129] Convention on Environmental Impact Assessment in a Transboundary Context (1997). The Espoo Convention sets out the obligations of Parties to assess the environmental impact of certain activities at an early stage of planning. It also lays down the general obligation of States to notify and consult each other on all major projects under consideration that are likely to have a significant adverse environmental impact across boundaries.

nean countries also require SEAs by law. In the absence of adopted legislation or while it is being developed, some Mediterranean countries have implemented pilot applications of SEA (Egypt, Morocco, Tunisia), as shown in *Figure 195*.

MEA Acronym	Entry into force	AL	BA	CY	DZ	EG	ES	FR	GR	HR	IL	IT	LB	LY	MA	MC	ME	MT	PS	SI	SY	TN	TR
CBD	1993	*	*														d		*				
Cartagena Protocol	2003	*	*	*				AA					*	*			d	*	*		*		
Nagoya Protocol	2014	*								*								*			*		
Nagoya - Supplementary Protocol	2018	*																			*		
ITPGRFA	2004	*			*			AA		*				*			*			*			
Ramsar Convention	1975	*	d	*	*		*		*	d			*	*		*	d	*		d	*	*	*
WHC	1975		d	A			A	A		d	A						d	A		d	A		
CITES	1975	*	*		*	*	*	AA	*	*			*	*		*	d	*		*	*		*
CMS	1983																						
AEWA	1999																						
ACCOBAMS	2001																						
UNCLOS	1994	*	d							d							d		*	d			
UNCCD	1996	*	*	*						A						*	*		*	*			
UNFCCC	1994	*	*							A							d		*		*		*
Kyoto Protocol	2005	*	*	*	*			AA					*	*	*		*				*	*	*
Paris Agreement	2016																				*		
Vienna Convention	1988	*	d	*	*		*	AA		d	*		*	*		*	d	*		d	*	*	*
Montreal Protocol	1989	*	d	*	*			AA		d			*	*		*	d			d	*	*	*
Basel Convention	1992	*	*		*	*		AA		*				*	*	*	d	*	*	*		*	
Stockholm Convention	2004			*				AA						*					*				
Rotterdam Convention	2004	*	*					AA		*			*	*	*		*	*	*				
Minamata Convention	2017												*										
Aarhus Convention	2001		*					AA									*						
PRTR Protocol	2009	*						AA			*							*					
Espoo Convention	1997		*	*				AA		*							*	*		*			
Protocol on SEA	2010																	*					
MARPOL	1983	*		*	*	*		AA	*		*	*	*	*	*	*	d	*		d	*	*	
Barcelona Convention	1978	*	d		*	AA		AA		d			*				*			*	*		

***** Accession: the state accepts the offer or the opportunity to become a party to a treaty already negotiated and signed by other states.
A Acceptance
AA Approval
d Succession

Ratification | Signature | No Signature

Table 35 - Ratification of Multilateral Environmental Agreements (MEAs) in Mediterranean countries
(Source: United Nations, accessed 13 February 2019)

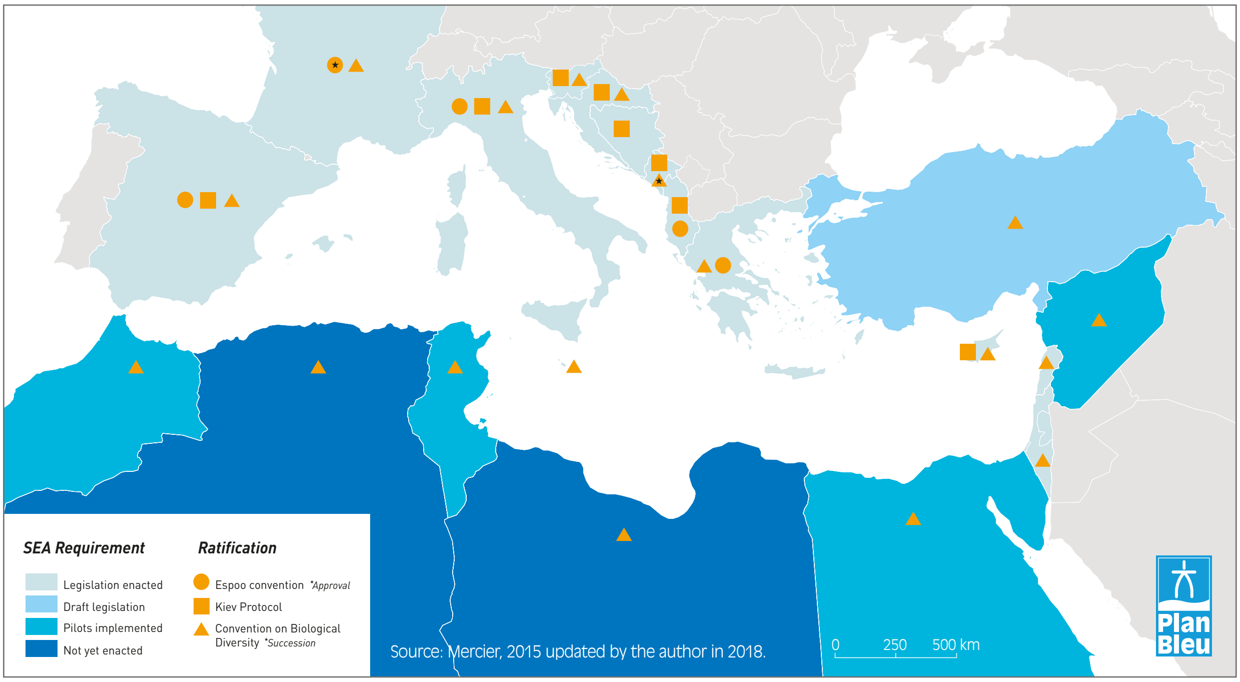


Figure 195 - Implementation status of SEA in the Mediterranean, and ratification of the Espoo Convention, Kiev Protocol and CBD, 2018
(Source: Mercier, 2015 and updates by the author in 2018)

In addition to national and EU legislation on EIA and SEA, several international Conventions and Protocols include obligations concerning the assessment of environmental impacts of certain activities[130]. This is the case for the Espoo Convention, the Kiev Protocol and the CBD for which the ratification status of Mediterranean countries is reflected in *Table 35*.

The Convention on Environmental Impact Assessment in a Transboundary Context (informally called the Espoo Convention) lays down the obligations of Parties to carry out an environmental impact assessment (EIA) of certain activities at an early stage of planning. It also sets out the general obligation of States to notify and consult each other on all major projects under consideration that are likely to have a significant adverse environmental impact across boundaries.

The Protocol on Strategic Environmental Assessment to the Convention on Environmental Impact Assessment in a Transboundary Context (Kiev Protocol to the Espoo Convention), requires its Parties to evaluate the environmental consequences of their official draft plans and programmes, and thus to conduct SEAs.

The Convention on Biological Diversity's Article 14 focuses on impact assessment and minimizing adverse impacts. It sets out that Parties shall introduce appropriate procedures requiring environmental impact assessment of their proposed projects and appropriate arrangements to ensure that the environmental consequences of their programmes and policies are duly taken into account.

In recent years, assessment and planning tools have been evolving to adopt increasingly integrated assessment approaches, drawing together biophysical and socioeconomic aspects. In this sense, EIA and SEA more and more include social and health impacts and changes to Environmental and Social Impact Assessment (ESIA) and Strategic Environmental and Social Assessment (SESA).

There is currently no comprehensive assessment to evaluate the level of effective application of these assessment tools in the Mediterranean region. However, their development towards ESIA and SESA, the level of public participation in the assessments, as well as implementation of the recommendations resulting from these assessments remain challenging but key to achieving transformative change.

[130] Overarching for EU members: http://ec.europa.eu/environment/eia/index_en.htm; and http://www.unece.org/info/ece-homepage.html; https://www.unece.org/env/eia/resources/legislation.html; https://www.unece.org/env/eia/eia.html
Kiev Protocol Status of ratification: https://treaties.un.org/Pages/ViewDetails.aspx?src=TREATY&mtdsg_no=XXVII-4-b&chapter=27&clang=_en
Morocco, Tunisia, Egypt, Palestine, Lebanon: http://planbleu.org/sites/default/files/publications/manuel_eval_sociales_environnementales_en.pdf
More specifically: Morocco http://www.environnement.gov.ma/index.php/fr/service/etude-impact (in French)

Countries	EIA requirement	SEA requirement
Albania	Law No. 10 440, dated 7 July 2011, is approximated to the Council Directive 85/337/EEC of 27 June 1985.	Law on "strategic environmental assessments" (No. 91/2013).
Algeria	Original decree 1990 (90-78), revised 2007 (07/145).	Not yet enacted.
Bosnia and Herzegovina	Laws on Environmental Protection (2002 in Serb Republic in Bosnia and Herzegovina with revised version from 2012 and 2003 in Federation of Bosnia and Herzegovina, with subsequent amendments).	Law on Environmental Protection includes the main provisions from the Espoo Convention and Protocol on SEA.
Croatia	Environmental Protection Act (OG, No. 80/13, 153/13, 78/15, 12/18, 118/18) and Regulation on the EIA (OG, No. 61/14, 3/17).	Basic requirements for SEA are set in the Environmental Protection Act (OG, No. 80/13, 153/13, 78/15, 12/18, 118/18) and further elaborated in the Regulation on Strategic Environmental Assessment of Strategies, Plans and Programmes on the Environment (OG, No. 3/17).
Cyprus	Evaluation of the Consequences on the Environment of Certain Projects Law 140(I) of 2005, which was subsequently amended by Laws 42(I) of 2007, 47(I) of 2008, 80(I) of 2009, 137(I) of 2012 and 51(I) of 2014 (the EIA Law).	No. 102 (I)/2005 "Assessment of impacts on the environment from certain plans and/or programmes".
Egypt	Act 4 for the Protection of the Environment (1994) requires EIA to be carried out. The provisions for application are given in Decree No. 338 of 1995, and the law was revised in 2009.	Not yet enacted. A couple of pilot SE(S)A have been conducted.
France	Nature protection law of 1976, EIA decree of 1977, periodic transpositions of the 1985/337 European Directive as it evolves (latest version Directive 2014/52/EU).	Periodic transpositions of the 2001/42 European Directive on the environmental assessment of certain plans and programmes ("SEA Directive"), as the Directive itself evolves.
Greece	Originated with Law 1650/1986, updated to Law 3010/2002 and more recently to Law 4014/2011.	Joint Ministerial Decision 107017/2006 "on the assessment of the effects of certain plans and programmes on the environment" (Gov. Gazette B 1225).
Israel	1982 initial law, updated in 2003 (Environmental Impact Statements) Law 5763-2003.	Israel does not differentiate between SEAs and EIAs. The latter are mandatory for major infrastructure projects with potential environmental effects.
Italy	Started the implementation process of the EIA by Law 349/1986.	Decree No. 152/2006 (so-called Environmental Code) that transposed the SEA Directive, as further amended and supplemented by Legislative Decree No. 4/2008 and by Legislative Decree No. 128/2010.
Lebanon	Decree of 2012.	Decree of 2012.
Libya	Law No. 15 of 2003 awaiting implementation decrees.	Not yet enacted.
Malta	Subsidiary Legislation 549.46: The Environmental Impact Assessment Regulations.	Subsidiary Legislation 549.61: Strategic Environmental Assessment Regulations.
Monaco	Same requirements as France.	Same requirements as France.
Montenegro	Official Gazette of the Republic of Montenegro, No. 12/1996.	Official Gazette of Montenegro, No. 80/05 as of 28.12.2005.
Morocco	Act 12-03 of 2003 requires EIA to be conducted on a list of project types.	No requirements for SE(S)A. Some Strategic Environment Assessments (SEA) have been carried out with international funding.
State of Palestine	Environmental assessment policy in place since April 2000.	EA Policy includes provisions for the application of this approach for some plans and programmes. Annex 4 of the Policy includes a list of sectors/subsectors where initial scoping is required.
Slovenia	Environmental Protection Act *(Zakon o varstvu okolja - ZVO)* (Official Gazette of the Republic of Slovenia, No. 32/93 and 1/96).	Environmental Protection Act (Uradni list RS, št.39/06-uradno prečiščeno besedilo, 49/06-ZMetD, 66/06).
Spain	Initiated with RD 1131/1988 updated to RDL 1/2008.	Initiated with Law 9/2006 updated to Law 21/2013, December 9th, on environmental assessment.
Syrian Arab Republic	Draft decree from 1995 and Syria environmental law No. 50 of 2002, with executive EIA procedures adopted in 2008.	Not yet enacted.
Tunisia	Decree No. 2005-1991, updated from Decree No. 91-362 in application of Act No. 88-91.	Pilot studies conducted and capacity building activities implemented. No enactment yet.
Turkey	By-law on EIA (Official Gazette: 7 February 1993, no. 21489), followed by five revisions (latest Official Gazette no. 29186 dated 25 November 2014).	Draft by-law preparation and capacity building activities conducted with the objective of adapting EU Directive 2001/42.

Table 36 - Legal requirements for EIA and SEA in Mediterranean countries
(Source: Mercier, 2015 and updates by the author[131])

[131] Members of the European Union apply the rules of the 1985 and 2002 Environmental Assessment Directives or more stringent regulation.

8.1.3 Environmental measures in non-environmental agreements

Besides multilateral environmental agreements, important global agreements are linked to sustainable development of oceans and seas, such as the **UN Convention of the Law of the Sea** (UNCLOS) adopted in 1982, entered into force in 1994 and ratified by most of the Mediterranean States. Part XII of this Convention is devoted to the protection and preservation of the marine environment.

Protection of marine living resources belonging to straddling and highly migratory species is achieved through the **United Nations Fish Stocks Agreement** (UNFSA) (1995) also negotiated within the framework of the UN.

While UNCLOS is implemented mostly through national action, recent initiatives by the UN General Assembly are considering more coordinated approaches to the governance and management of oceans, for instance in areas beyond national jurisdiction (ABNJ). Regarding the governance of marine biodiversity in high seas, the UN at large has placed biodiversity conservation high on the global agenda towards an international legally binding instrument on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction.

In specialized areas, the work of the **International Maritime Organization** (IMO) and **Food and Agriculture Organization** (FAO) is notable. IMO has adopted widely ratified treaties on pollution of the marine environment by vessels (MARPOL, Ballast Water Convention), civil liability and compensation (CLC Convention) of damage (FUND Convention), ship recycling (Hong Kong Convention), and dumping (London Convention and Protocol). The FAO, apart from following the implementation of the UNFSA, has adopted treaties and soft law instruments to combat Illegal, Unreported, and Unregulated (IUU) fishing, which include the Compliance Agreement, the Agreement on Port State Measures to combat IUU fishing, the International Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing (FAO, 2001), and the Code of Conduct for Responsible Fisheries, as well as sets of guidelines.

8.2 The Barcelona Convention is a leading Regional Sea Convention, but gaps in implementation and enforcement remain

The UNEP Regional Seas Programme (1974) inspired the 1976 Barcelona Convention for the Protection of the Mediterranean Sea against Pollution (Barcelona Convention), which, in 1995, became the Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean with a wider scope.

BOX 88

The UNEP/MAP - Barcelona Convention regional framework

In 1974, UNEP established its Regional Seas Programme with the scope of coordinating activities aimed at the protection of the marine environment through a regional approach. The United Nations Environment Programme/Mediterranean Action Plan (UNEP/MAP) was the first UNEP initiative to be developed under the Programme and became the model for other seas across the globe. In 1975, Mediterranean States and the European Communities approved the MAP as the institutional framework for cooperation in addressing common challenges related to marine environmental degradation. The MAP also endorsed the preparation of a framework convention for the protection of the marine environment against pollution (the Barcelona Convention), and related Protocols that provide a legal basis for action in protecting the Mediterranean marine environment against pollution.

In 1995, following the outcomes of the Rio Summit (1992), the Contracting Parties revised the MAP and its legal framework. The Conference of Plenipotentiaries on the Convention for the Protection of the Mediterranean Sea against Pollution and its Protocols (Barcelona, 9-10 June 1995) adopted the Action Plan for the Protection of the Marine Environment and the Sustainable Development of the Coastal Areas of the Mediterranean Basin (MAP Phase II)[132]. Furthermore, the Convention for the Protection of the Mediterranean against Pollution (Barcelona Convention), adopted in 1976, was amended in 1995 as the Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean, which entered into force in 2004. The 22 Contracting Parties to the Barcelona Convention are Albania, Algeria, Bosnia and Herzegovina, Croatia, Cyprus, Egypt, France, Greece, Israel, Italy, Lebanon, Libya, Malta, Monaco, Montenegro, Morocco, Slovenia, Spain, Syrian Arab Republic, Tunisia, Turkey and the European Union.

The 22 Contracting Parties to the Barcelona Convention *(Box 88)* decide on the UNEP/MAP policies, strategies, programme of work and budget at their Ministerial level meetings (Conferences of the Parties), held every two years. They appoint Focal Points to review the progress of work and ensure the implementation of recommendations at the national level. A rotating Bureau of six representatives of the Contracting Parties provides guidance on the implementation of the programme of work in the interim period between the biennial meetings.

UNEP provides secretariat services to the Contracting Parties through the MAP Coordinating Unit, established in Athens, Greece, in 1982. The overall mandate of the Coordinating Unit, as provided for in Decision IG.17/5 of COP15 (Almeria, Spain, January 2008), is to promote and facilitate the implementation of the Barcelona Convention, its protocols and strategies, and the decisions and recommendations of the Contracting Parties. It ensures that the MAP system functions properly, develops and implements the programme of work, and supports the Contracting Parties in meeting their commitments under the Convention. MAP operates through the Secretariat of the Barcelona Convention, including the Coordinating Unit

[132] UNEP(OCA)/MED IG. 6/7. Barcelona Resolution on the Environment and Sustainable Development in the Mediterranean Basin.

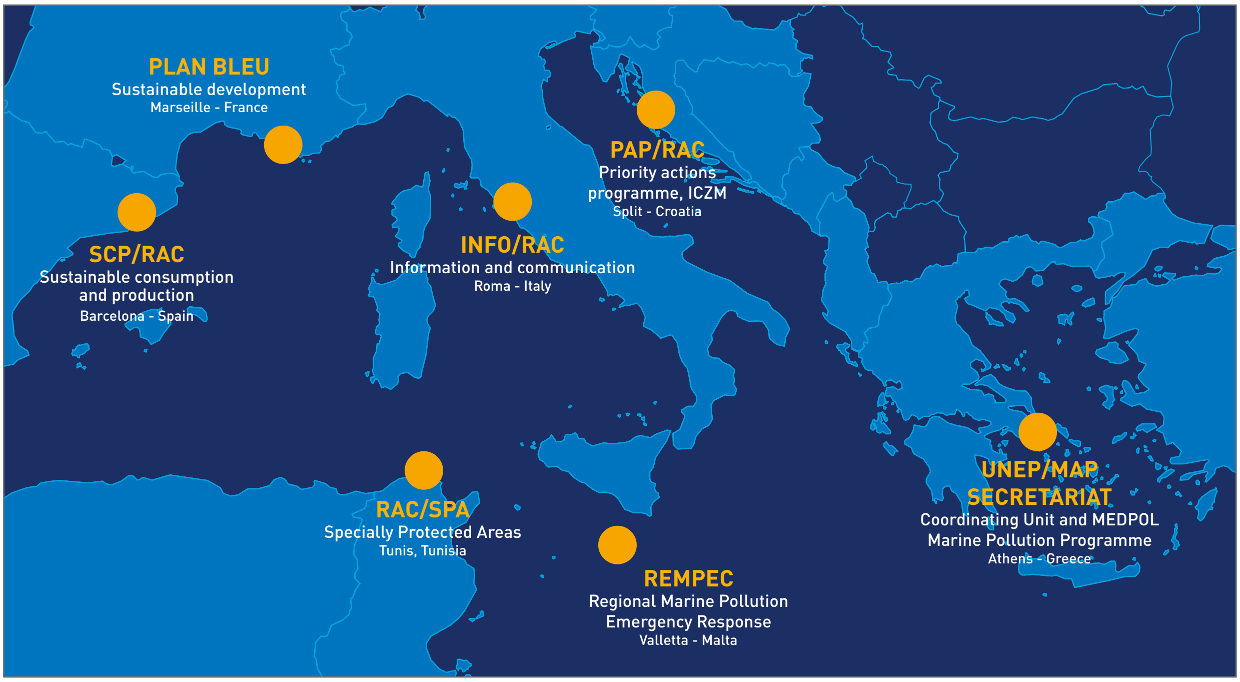


Figure 196 - UNEP/MAP and the Regional Activity Centres

and seven implementing components: the Programme for the Assessment and Control of Marine Pollution in the Mediterranean (MED POL), under the Coordinating Unit, Athens; the Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea (REMPEC), Malta; Plan Bleu Regional Activity Centre (PB/RAC), France; Priority Actions Programme Regional Activity Centre (PAP/RAC), Croatia; Specially Protected Areas Regional Activity Centre (SPA/RAC), Tunisia; Regional Activity Centre for Sustainable Consumption and Production (SCP/RAC), Spain; Regional Activity Centre for Information and Communication (INFO/RAC), Italy.

To facilitate and promote compliance with the obligations under the Barcelona Convention and its Protocols, the Barcelona Convention Compliance Mechanism: (1) Establishes a Compliance Committee dedicated to helping Parties implement the Barcelona Convention and its Protocols; (2) Establishes a procedure that is non-adversarial, transparent, preventive and non-binding in nature; (3) Takes into account the specific situation of each Party, paying particular attention to developing countries; (4) Considers specific situations of actual or potential non-compliance by individual Parties with a view to determining the facts and causes of the situation; (5) Promotes compliance and addresses cases of non-compliance by providing Parties with advice and non-binding recommendations; and (6) Considers, at the request of the Meeting of the Contracting Parties, general issues of compliance under the Barcelona Convention and its Protocols.

The Compliance Committee consists of seven Members and seven Alternate Members. Members and Alternate Members are both nominated by the Parties and elected by the Meeting of the Contracting Parties while taking into consideration equal geographical representation and ensuring rotation. The Members and Alternate Members of the Compliance Committee serve in their individual capacity, objectively and in the best interest of the Barcelona Convention and its protocols[133].

The Barcelona Convention urges Contracting Parties to individually or jointly adopt all appropriate measures to prevent, abate, combat and, to the fullest extent possible, eliminate pollution of the Mediterranean Sea Area, and to protect and enhance the marine environment in that area so as to contribute to its sustainable development (Article 4.1). This general obligation is reiterated, on the one hand, as regards the UNCLOS sources of pollution of the marine environment, i.e. pollution caused by dumping from ships and aircraft or incineration at sea (Article 5), pollution from ships (Article 6), pollution resulting from the exploration and exploitation of the continental shelf and the seabed and its subsoil (Article 7), pollution from land-based sources (Article 8), pollution resulting from emergency situations

[133] Parties, the Secretariat or the Compliance Committee can trigger the compliance mechanism as follows: (a) Self-trigger procedure: a Party may make a submission as to its own actual or potential situation of non-compliance; (b) Party-to-Party trigger procedure: a Party may make a submission as to another Party's situation of non-compliance; (c) Secretariat trigger procedure: the Secretariat may make a referral as to the difficulties faced by a Party in complying with its obligations under the Barcelona Convention and its Protocols; and (d) Committee trigger procedure: the Compliance Committee may make a referral as to any difficulties encountered by a Party in the implementation of the Barcelona Convention and its protocols. Under this procedure, communications are addressed to the Compliance Committee by the public and observers.

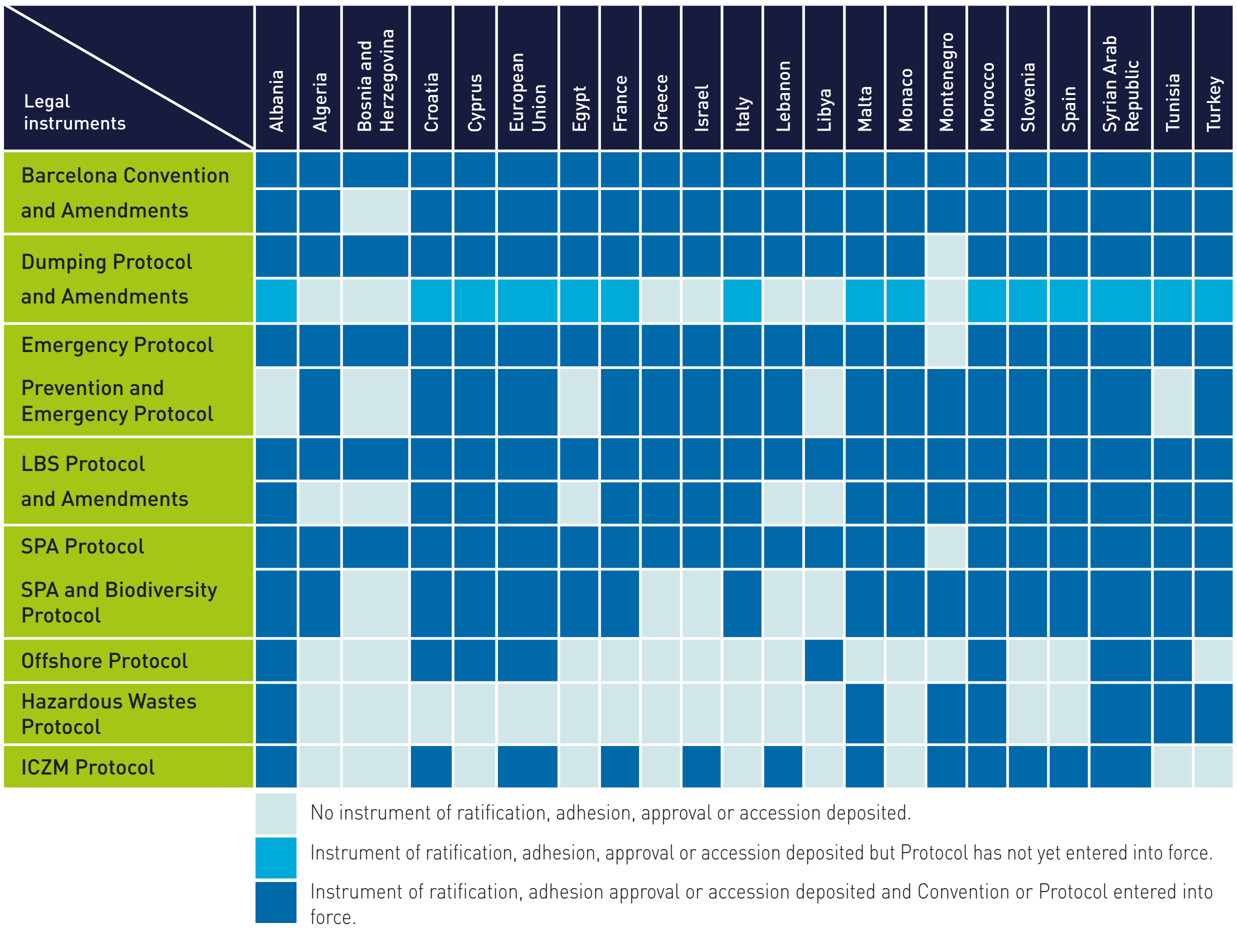


Table 37 - Ratification of Barcelona Convention and Protocols by the individual Contracting Parties, December 2019

(Article 9) and pollution resulting from the transboundary movement of hazardous wastes and their disposal (Article 11); and on the other hand, in relation to the conservation of biological diversity (Article 10). This has been translated into the adoption of the Protocols to the Barcelona Convention. Furthermore, in implementing the Barcelona Convention and the related Protocols, the Contracting Parties adopt strategies, action plans, programmes and measures.

Table 37 shows the status of ratification of the Barcelona Convention and its Protocols by the individual Contracting Parties as of December 2019. The 1995 Dumping Protocol is the only Protocol not yet in force out of seven Protocols. Three of the six Protocols in force have only been ratified by half or less than half of the Contracting Parties and still require particular attention to ensure full regional coverage. These include the Integrated Coastal Zone Management Protocol (11 ratifications), the Offshore Protocol (8 ratifications) and the Hazardous Wastes Protocol (7 ratifications).

Under Article 26 of the Barcelona Convention, the Contracting Parties shall submit reports on: (a) the legal, administrative and other measures they have taken for the implementation of the Barcelona Convention, its Protocols and the recommendations adopted by their meetings, and (b) the effectiveness of the measures taken, and problems encountered in the implementation of the Barcelona Convention and its Protocols. Reports are submitted on a biennial basis through the UN Mediterranean knowledge platform (INFO/MAP).

By submitting their national implementation reports, Contracting Parties not only meet their reporting obligations pursuant to Article 26 of the Barcelona Convention and relevant articles of its Protocols. They also provide to the meetings of the Contracting Parties an essential tool for keeping the implementation of the Barcelona Convention and its Protocols under review.

Overall reporting rates have steadily increased since the launch of the Barcelona Convention Reporting System (BCRS) in 2008. For the 2008-2009 biennium, 15 reporting Contracting Parties submitted their national implementation reports. This figure was raised to 19 reporting Contracting Parties for the 2014-2015 biennium. The submission of national implementation reports for the 2016-2017 biennium is still ongoing in preparation for the 21st Meeting of the Contracting Parties to the Barcelona Convention (COP 21) (Naples, Italy, 2-5 December 2019).

Dumping Protocol. The Protocol for the Prevention of Pollution of the Mediterranean Sea by Dumping from Ships

BOX 89

Main findings from national Barcelona Convention implementation reports, reported for 2016-2017

(Source: UNEP/MAP, 2019)

Based on the national implementation reports received for the 2016-2017 biennium, a report has been prepared by the Secretariat and relevant MAP components on the "General Status of Progress in the Implementation of the Barcelona Convention and its Protocols: Synthesis of the Information Contained in the National Implementation Reports for the 2016-2017 Biennium".

The report's main findings highlight that all reporting Contracting Parties have incorporated the following tools and principles into their domestic law, through a variety of instruments: the precautionary principle and the polluter pays principle, Environmental Impact Assessment (EIA) and/or Strategic Environmental Assessment (SEA) laws and associated regulations, Environmental monitoring programmes, public access to environmental information, public participation and consultation in environmental legislation decision-making processes, as well as Integrated Coastal Zone Management (ICZM) principles. Many reporting Contracting Parties indicated having put in place the legal and regulatory framework for the use of Best Available Technology (BAT) and Best Environmental Practices (BEP) and most reporting Contracting Parties have cooperation mechanisms for notifying, exchanging information and consulting the relevant states in cases of transboundary EIA.

The report also underlines that **cooperation in the fields of science and technology** needs to be further reinforced, as only some reporting Contracting Parties have indicated action in this field. The same holds true for the promotion of research on, access to and transfer of environmentally sound technology, including clean production technologies. Also, less than half of reporting Contracting Parties have answered affirmatively to the question on the implementation of the **Guidelines for the Determination of Liability and Compensation for Damage** resulting from Pollution of the Marine Environment in the Mediterranean Sea Area.

A general finding is that data collection through the existing INFO/MAP system and its further development should be enhanced, which suggests that Contracting Parties require additional support in terms of capacity-building for facilitating the collection and submission of data for reporting purposes.

Main findings also show that **reporting on enforcement measures** is extremely scarce and represents a major lead for improvement.

and Aircraft was adopted in 1976 and has been in force since 1978. Its objective is to take all appropriate measures to prevent, abate and eliminate to the fullest extent possible pollution of the Mediterranean Sea by dumping of waste or other matter. To that end, a "black- and grey-list approach" is applied, under which the dumping of waste or other matter listed in Annex I to the Protocol ("black list") is prohibited (Article 4), the dumping of waste or other matter listed in Annex II to the Protocol ("grey list") requires a prior special permit from a designated national authority, provided that certain conditions are met (Article 5, Annex III), and for all other waste or other matter, dumping is subject to a prior general permit from a designated national authority, provided that certain conditions are met (Article 7, Annex III).

In 1995, the Dumping Protocol was amended, resulting in the Protocol for the Prevention and Elimination of Pollution of the Mediterranean Sea by Dumping from Ships and Aircraft or Incineration at the Sea. The 1995 Protocol has not yet entered into force. Under the 1995 Dumping Protocol, a "reverse list" approach is adopted, so all dumping is prohibited, except for the following waste or other matter listed in Article 4.2 of the Protocol: dredged material, fish waste, vessels (until 31 December 2000), platforms and other human-made structures at sea, and inert, uncontaminated geological materials. Applications to the designated national authority to dump the listed waste or other matter have to give appropriate consideration to the factors set forth in Annex III to the Protocol (i.e. Characteristics and Composition of the Matter, Characteristics of Dumping Site and Method of Deposit and General Considerations and Conditions) and the Guidelines adopted by the Contracting Parties (Article 6). Specific guidelines have been developed for all waste and other matter listed in the 1995 Protocol[134].

These Guidelines contain step-by-step procedures to evaluate waste and other matter considered for sea disposal. The Programme for the Assessment and Control of Marine Pollution in the Mediterranean (MED POL) assists Contracting Parties in meeting their obligations under the Dumping Protocol.

Prevention and Emergency Protocol. The Protocol Concerning Cooperation in Combating Pollution of the Mediterranean Sea by Oil and other Harmful Substances in Cases of Emergency was adopted in 1976 and entered into force in 1978. In 2002, the 1976 Protocol was replaced by the Protocol Concerning Cooperation in Preventing Pollution from Ships and, in Cases of Emergency, Combating Pollution of the Mediterranean Sea, which has been in force since 2004.

The Prevention and Emergency Protocol provides a regional framework for international cooperation and mutual assistance in preparing for and responding to oil and hazardous and noxious substances pollution incidents. Contracting Parties to the Prevention and Emergency

[134] (1) COP Decision IG. 23/13: Updated Guidelines for the Management of Dredged Material, 2017; (2) UNEP(DEC)/MED IG.13/5: Guidelines for the Management of Fish Waste or Organic Materials Resulting from the Processing of Fish and other Marine Organisms, 2001; (3) UNEP (DEC)/MED IG.15: Guidelines for the Dumping of Platforms and other Man-Made Structures at Sea, 2003, and (4) UNEP(DEPI)/MED IG.16: Guidelines for the dumping of inert uncontaminated geological materials, 2005. UNEP/MAP website: http://web.unep.org/unepmap/meetings/search-meeting-documents

BOX 90

Main findings from the 2016-2017 national reports on the implementation of the Dumping Protocol

(Source: UNEP/MAP, 2019)

The report's main findings underline that with most reporting Contracting Parties, the prohibition of dumping waste or other matter, as well as the establishment of the required permitting system are in place and for nearly all reporting Contracting Parties, incineration is prohibited as per the Dumping Protocol. Findings call for action to strengthen the institutional structure to implement the Protocol, as only a limited number of reporting Contracting Parties have designated a competent national authority responsible for keeping records of the nature, quantities of the waste or other matter, dumping locations and methods. Further action is also needed for addressing critical and force majeure dumping at sea as per the conditions set out in the Protocol, and for enhancing data collection and capacity-building. Finally, findings reveal that strengthening cooperation between the Dumping Protocol and the London Convention and its Protocol would lead to synergies and positive outcomes.

BOX 91

Main findings from the 2016-2017 national reports on the implementation of the Prevention and Emergency Protocol

(Source: UNEP/MAP, 2019)

The report's main findings show that monitoring and surveillance programmes to detect accidental or operational pollution, as well as contingency plans and other means of preventing and combating oil and hazardous and noxious substances (HNS) have been adopted by nearly all reporting Contracting Parties. Reporting procedures to ensure that those required (e.g. ships, aircraft, offshore installations, and Port Facility Authorities) report on oil and HNS pollution incidents to the designated authorities and have contingency plans on board are in place for many reporting Contracting Parties. Communication to REMPEC and relevant Contracting Parties of information on oil and HNS pollution incidents is carried out by many reporting Contracting Parties. Conducting oil and HNS pollution incident assessments and taking every practical measure to prevent, reduce and, to the fullest possible extent, eliminate the effects of the pollution incident is part of the national contingency plans' requirements for many reporting Contracting Parties. Nearly all reporting Contracting Parties have available port reception facilities and are able to meet the needs of ships, including pleasure crafts. Many reporting Contracting Parties have assessed and taken measures to reduce the environmental risks, including via Vessel Traffic Services (VTS), and the designation and management of Particularly Sensitive Sea Areas (PSSAs). Most reporting Contracting Parties have adopted measures dealing with places of refuge for ships in distress. Many reporting Contracting Parties have response strategies for marine pollution incidents in place. National contingency plans cover both oil and HNS for half of the reporting Contracting Parties. The Prevention and Emergency Protocol's requirements in terms of disseminating and exchanging information have been generally achieved and should be further promoted.

Protocol are required to have contingency plans, either nationally or in cooperation with other countries, backed up by a minimum level of response equipment (Article 4), communications plans (Article 8) and reporting procedures in place (Article 9). This applies to ships, platforms and ports (Article 11). Contracting Parties to the Protocol are also called to provide assistance to others in the event of a pollution emergency (Article 12) and provision is made for the reimbursement of any assistance provided (Article 13). This adds to the requirement to ensure adequate port reception facilities (Article 14) and the obligation to define national, regional or subregional strategies for places of refuge for ships in need of assistance (Article 16). In 2016, within the framework of the Protocol, Contracting Parties adopted the Regional Strategy for the Prevention of and Response to Marine Pollution from Ships (2016-2021)[135]. This comprehensive Strategy is complemented by other measures addressing specific issues under the Protocol[136]. The Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea (REMPEC) assists Contracting Parties in meeting their obligations under the Prevention and Emergency Protocol[137].

Land-Based Sources and Activities (LBS) Protocol. The Protocol for the Protection of the Mediterranean Sea Against Pollution from Land-Based Sources was adopted in 1980 and entered into force in 1983. In 1996, the Land-Based Sources Protocol was amended by the Protocol for the Protection of the Mediterranean Sea Against Pollution from Land-Based Sources and Activities, which has been in force since 2006.

The objective of the LBS Protocol is to take all appropriate measures to prevent, abate and eliminate to the fullest extent possible pollution of the Mediterranean Sea from land-based sources and activities, by reducing and phasing out substances that are toxic, persistent and liable to bioaccumulate listed in Annex I to the Protocol (Article 5). Under the LBS Protocol, point source discharges and pollutant releases are subject to an authorization or regulation system by countries (Article 6), taking into account factors ranging from the characteristics and composition of the discharges to the potential impairment of marine ecosystems and seawater uses (Annex II). Regional Action Plans and National Action Plans containing specific measures and timetables have been developed to implement the LBS

[135] COP Decision IG.22/04: Regional Strategy for the Prevention of and Response to Marine Pollution from Ships (2016-2021). This Strategy updated and further developed the previous Strategy adopted in 2005. http://www.rempec.org/

[136] COP Decision IG.20/11: Regional Strategy addressing Ship Ballast Water Management and Invasive Species, 2012 , and COP Decision IG. 17/10: Guidelines on the Decision-Making Process for Granting Access to a Place of Refuge for Ships in Need of Assistance, 2008. http://www.rempec.org/

[137] REMPEC website http://www.rempec.org/

BOX 92 Main findings from the 2016-2017 national reports on the implementation of the LBS Protocol

(Source: UNEP/MAP, 2019)

The report's main findings underlined that the legal and regulatory measures to eliminate pollution from Land-based Sources (LBS) and phase out Persistent Organic Pollutants (POPs), as well as environmental monitoring programmes that assess the effectiveness of measures under the Protocol are reported to be in place for most of the reporting Contracting Parties. However, findings highlight ongoing difficulties in data collection and the need for capacity-building.

For all reporting Contracting Parties, discharges and pollutant releases are subject to authorization or regulation and measures to reduce to a minimum the risk of accidental pollution are reported to be in place. All reporting Contracting Parties also indicated having an inspection system to assess compliance with authorizations and regulations and to impose sanctions in the event of non-compliance.

Very few reporting Contracting Parties provided data on **enforcement** measures taken to implement the Protocol, suggesting the need to take action in this area.

BOX 93 Main findings from the 2016-2017 national reports on the implementation of the SPA/BD Protocol

(Source: UNEP/MAP, 2019)

The report's main findings highlight that most reporting Contracting Parties have designated Marine Protected Areas (MPAs), as well as the measures for their protection, preservation and sustainable management (including regulatory measures for endangered or threatened species; national strategies and action plans for the conservation of biological diversity components; inventories of the components of biological diversity; regulatory measures concerning dumping, passage and anchoring of ships, offshore activities, sampling of species and scientific research in SPAs; planning, management, supervision and monitoring measures for SPAs, measures dealing with the deliberate or accidental introduction into the wild of non-indigenous or genetically modified species; diverse funding mechanisms for the management and promotion of protected areas including income-generating activities compatible with the protection measures), and established new SPAs in their territories during 2016-2017. Reporting Contracting parties have taken action with regard to 8 Regional Action Plans (Cartilaginous Fishes, Invasive Species, Bird Species, Marine Vegetation, Conservation of the Monk Seal, Turtles, Dark Habitats, Coralligenous and other Calcareous Bio-concretions) and additional efforts are required for full implementation of these plans.

Identified leads for improvement include strengthening SPA **management effectiveness**, enhancing **monitoring** of the Biodiversity related Ecological Objectives within the framework of the Integrated Monitoring Assessment Programme (IMAP), and **capacity-building** to improve the submission of information and data.

Protocol[138]. Among them, the Regional Plan on Marine Litter Management in the Mediterranean stands out. It is a legally binding pioneering instrument in its category, setting specific measures and operational targets to achieve Good Environmental Status in the Mediterranean Sea, including a basin-wide marine litter reduction target of 20% for beach litter by 2024[139]. The Programme for the Assessment and Control of Marine Pollution in the Mediterranean (MED POL) assists Contracting Parties in meeting their obligations under the LBS Protocol.

SPA/BD Protocol. The Protocol Concerning Mediterranean Specially Protected Areas was adopted in 1982 and replaced by the Protocol Concerning Specially Protected Areas and Biological Diversity in the Mediterranean, the SPA/BD Protocol for short, adopted in 1995 and in force since 1999. The SPA/BD Protocol provides the regional framework for the conservation and sustainable use of biological diversity in the Mediterranean. Under the Protocol, Parties are called: (1) to protect areas of particular natural or cultural value, by the establishment of Specially Protected Areas (SPAs) or Specially Protected Areas of Mediterranean Importance (SPAMIs), and (2) to protect the threatened or endangered species of flora and fauna listed in the Protocol. Annex I to the Protocol sets the common criteria for the establishment of SPAMIs, Annexe II provides the list of endangered and threatened species and Annex III the list of species whose exploitation is regulated. Annexes II and III are amended to keep them up to date with the evolving status of species. Regional Action Plans with specific actions to protect, preserve and manage the species listed in the SPA/BD Protocol have been developed, such as the Plan for the Conservation of Mediterranean Marine Turtles and the Plan for the Management of the Mediterranean Monk Seal[140]. The Specially Protected Areas Regional Activity Centre (SPA/RAC) assists Contracting Parties in meeting their obligations under the SPA/BD Protocol.

Offshore Protocol. The Protocol for the Protection of the Mediterranean Sea against Pollution Resulting from the

[138] (1) COP Decisions IG. 19/8, 19/9, adopted in 2009 and COP Decision IG. 20/8.3, adopted in 2012: Regional Action Plans on Persistent Organic Pollutants (POPs); (2) COP Decision IG. 19/7, adopted in 2009 and COP Decision IG. 20/8.2, adopted in 2012: Regional Action Plans on the Reduction of Biochemical Oxygen Demand (BOD) from urban wastewater and in the food sector; (3) COP Decision IG. 20/8.1, adopted in 2012: Regional Plan on the Reduction of Inputs of Mercury; and (4) COP Decision IG. 22/5, adopted in 2016: Regional Action Plan on Sustainable Consumption and Production in the Mediterranean. UNEP/MAP website http://web.unep.org/unepmap/meetings/search-meeting-documents

[139] COP Decision IG. 21/7: Regional Plan on Marine Litter Management in the Mediterranean, 2016. http://web.unep.org/unepmap/meetings/search-meeting-documents

[140] 1) COP Decision IG. 21/4: Action Plan for the conservation of Cartilaginous Fishes (Chondrichthyans) in the Mediterranean Sea, 2013; (2) COP Decision IG. 22/12: Updated Action Plan concerning Species Introductions and Invasive Species in the Mediterranean Sea, 2016 http://web.unep.org/unepmap/meetings/search-meeting-documents (3) COP Decision IG. 22/12: Updated Action Plan for the Conservation of Cetaceans in the Mediterranean Sea, 2016; (4) COP Decision IG. 20/6: Action Plan for the conservation of Marine Vegetation in the Mediterranean Sea, 2012; (5) COP Decision IG. 21/4: Action Plan for the Conservation of Bird Species listed in Annex II of the SPA/BD Protocol in the Mediterranean, 2013; (6) COP Decision 21/4: Action Plan for the Management of the Mediterranean Monk Seal, 2013; (7) COP Decision IG. 21/4: Action Plan for the Conservation of Mediterranean Marine Turtles, 2013; (8) COP Decision IG. 22/12: Updated Action Plan for the Conservation of the Coralligenous and Other Calcareous Bio-concretions in the Mediterranean Sea, 2016, and (9) COP Decision IG. 21/4: Dark Habitats Action Plan, 2013. http://www.rac-spa.org/

BOX 94

Main findings from the 2016-2017 national reports on the implementation of the Offshore Protocol

(Source: UNEP/MAP, 2019)

The report's main findings point out that for all reporting Contracting Parties, offshore activities are subject to prior authorization as required by the Offshore Protocol. For some reporting Contracting Parties, the use and storage of offshore chemicals is approved by the competent national authority on the basis of the Chemical Use Plan as required by Article 9 of the Offshore Protocol. Legal and regulatory measures are reported to be in place for some reporting Contracting Parties, calling upon operators to remove disused offshore installations and pipelines. Some reporting Contracting Parties reported having adopted special measures to prevent offshore pollution in specially protected areas.

Further improvement is found to be necessary to streamline submission of data through capacity-building.

BOX 95

Main findings from the 2016-2017 national reports on the implementation of the Hazardous Wastes Protocol

(Source: UNEP/MAP, 2019)

The report's main findings show that all reporting Contracting Parties indicated having adopted measures to reduce to a minimum and possibly eliminate the amount of hazardous waste subject to transboundary movement, at the heart of their national legislation on waste management. The notification procedure sets out in Article 6 of the Hazardous Wastes Protocol in cases of transboundary movement of hazardous waste is reported to be in place for all reporting Contracting Parties. Restrictions on the export and import of hazardous waste are indicated to be in place for more than half of the reporting Contracting Parties.

Data collection and transmission, as well as capacity building in this area, are identified as leads for improvement.

Exploration and Exploitation of the Continental Shelf and the Seabed and its Subsoil, the Offshore Protocol for short, was adopted in 1994 and has been in force since 2011.
The Offshore Protocol addresses all aspects of offshore oil and gas activities in the Mediterranean. This includes measures to reduce pollution from all phases of offshore activities (e.g. reduction of oil in produced water, substantial restrictions on the use and discharge of drilling fluids and chemicals and removal of disused offshore installations) (Articles 4 to 14 and Article 20), to respond to offshore pollution incidents (Articles 15 to 18) and concerning liability and compensation (Article 27). The Offshore Protocol is complemented by the Mediterranean Offshore Action Plan[141]. The Protocol provides for the Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea (REMPEC) to play an important coordinating role.

Hazardous Wastes Protocol. The Protocol on the Prevention of Pollution of the Mediterranean Sea by Transboundary Movements of Hazardous Wastes and their Disposal, the Hazardous Wastes Protocol for short, was adopted in 1996 and has been in force since 2008.

The overall objective of the Hazardous Wastes Protocol is to protect human health and the marine environment against the adverse effect of hazardous waste. The provisions of the Protocol address the following principal aims: (1) the reduction and, where possible, the elimination of hazardous waste generation (Article 5), (2) the reduction of the amount of hazardous waste subject to transboundary movement (Article 5), and (3) a regulatory system applying to cases where transboundary movements are permissible (Articles 6 and 9). The Programme for the Assessment and Control of Marine Pollution in the Mediterranean (MED POL) assists Contracting Parties in meeting their obligations under the Hazardous Wastes Protocol.

ICZM Protocol. The Protocol on Integrated Coastal Zone Management in the Mediterranean, the ICZM Protocol for short, was adopted in 2008 and entered into force in 2011.
The ICZM Protocol provides the legal framework for the integrated management of the Mediterranean coastal zone. Under the Protocol, Parties are called to take the necessary measures to strengthen regional cooperation to meet the objectives of integrated coastal zone management (Article 5). Measures range from those aimed at protecting the characteristics of certain specific coastal ecosystems (e.g. wetlands and estuaries, marine habitats, coastal forests and woods and dunes) (Articles 10 to 12) to those devised to ensure the sustainable use of the coastal zone (Article 8), and those aimed at ensuring that the coastal and maritime economy is adapted to the fragile nature of coastal zones (Article 9). In 2012, within the framework of the Protocol, Contracting Parties adopted the Action Plan for the Implementation of the ICZM Protocol (2012-2019)[142]. The Priority Actions Programme Regional Activity Centre (PAP/RAC) assists Contracting Parties in meeting their obligations under the ICZM Protocol.

8.3 Other regional cooperation mechanisms, including stakeholder networks, call for strong synergies and collaboration

8.3.1 Institutional cooperation

Various UN entities and other intergovernmental organ-izations (IGOs) are active in the field of Mediterranean environmental protection. The UNEP/MAP - Barcelona Convention system cooperates with several of them. To

[141] COP Decision IG. 22/3: Mediterranean Offshore Action Plan, 2016. http://www.rempec.org/

[142] COP Decision IG. 20/2: Action Plan for the Implementation of the ICZM Protocol (2012-2019) http://web.unep.org/unepmap/meetings/search-meeting-documents For additional information, consult the PAP/RAC website https://www.pap-thecoastcentre.org/

BOX 96

Main findings from the 2016-2017 national reports on the implementation of the ICZM Protocol

(Source: UNEP/MAP, 2019)

ICZM is mainly implemented through a large number of individual projects. Half of the reporting Contracting Parties have adopted a national ICZM or coastal strategy, and none of them has established a specific ICZM centre, which would guarantee the sustainability of the ICZM effort. All reporting Contracting Parties have legal measures for controlling urban development along the coastline, but the **enforcement and control** of the application of these measures, in particular the 100-meter setback zone, remain a challenge.

In addition to a lack of **coastal observatories,** the use of **indicators** for coastal management is limited, in particular regarding the evaluation of economic impacts on the coastal zone. When there is a national ICZM or coastal strategy, some indicators are used for monitoring the implementation of the ICZM Protocol. Protection measures appear to be the prevalent type of action and only a few countries have taken measures to **restore** coastal wetlands and islands, as well as underwater sites. Mechanisms for management of coastal land in the public domain exist and are operational for the majority of the reporting Contracting Parties while the use of **economic and/or financial instruments** to support ICZM is very limited.

Risks and emergency situations seem to be of a major concern for most reporting Contracting Parties that have established national contingency/emergency plans and undertaken comprehensive coastal risk assessments. While progress is noticed in terms of integration of climate change into coastal and marine strategies and planning schemes, there is still considerable room for increasing resilience and adaptive capacity, first of all to sea level rise. The establishment of the 100-meter setback zone is considered extremely useful.

Awareness-raising, education, training and international cooperation are considered crucial for making progress. The cooperation established via the preparation of the Common Regional Framework for ICZM is recognized as important and further support is deemed crucial, especially with regard to **Marine Spatial Planning** (MSP) and **adaptation to climate change.**

this end, UNEP/MAP has signed individual Memoranda of Understanding with organizations such as the International Union for Conservation of Nature (IUCN), the Union for the Mediterranean (UfM), the Agreement on the Conservation of Cetaceans of the Black Sea and contiguous Atlantic Area (ACCOBAMS), the Permanent Secretariat of the Commission on the Protection of the Black Sea Against Pollution (BSC PS), and the General Fisheries Commission for the Mediterranean (GFCM).

The Union for the Mediterranean (UfM) is an intergovernmental Euro-Mediterranean organization which brings together all 28 countries of the EU and 15 countries of the Southern and Eastern Mediterranean. The creation of the UfM in 2008 built on the principles of the Euro-Mediterranean Partnership, also known as the Barcelona Process launched in 1995: "turning the Mediterranean basin into an area of dialogue, exchange and cooperation guaranteeing peace, stability and prosperity" (Barcelona Declaration, 1995). "Union for the Mediterranean aims to build on that consensus to pursue cooperation, political and socioeconomic reform and modernization on the basis of equality and mutual respect for each other's sovereignty" (Paris Declaration, 2008). In a globalized world, the objective is to reduce the gap between developed and developing countries, while strengthening commitment, solidarity, and integration between Northern, Southern, and Eastern Mediterranean countries. The scope of this governance framework includes contribution to achieving SDGs in the region.

The Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic area (ACCOBAMS) entered into force in 2001. It resulted from consultations between the Secretariats of four Conventions, namely the Barcelona Convention, the Bonn Convention on the Conservation of Migratory Species of Wild Animals, the Bern Convention on the Conservation of European Wildlife and Natural Habitats, and the Bucharest Convention on the Protection of the Black Sea Against Pollution.

Global agreements concluded in the field of fisheries are applied in the Mediterranean through the **General Fisheries Commission for the Mediterranean** (GFCM), which is a Regional Fisheries Management Organization (RFMO) under the FAO.[143] The adoption of an ecosystem-based approach for fisheries by FAO has prompted cooperation between Regional Seas Programmes (RSPs) and RFMOs in various parts of the world, including the Mediterranean. A Memorandum of Understanding (MoU) was signed in 2012 between the MAP and the GFCM, which cooperate on area-based management measures, including ongoing work on harmonization of existing respective criteria to identify Specially Protected Areas of Mediterranean Importance (SPAMIs) and Fisheries Restricted Areas (FRAs), in particular those located partially or entirely in areas beyond national jurisdiction (ABNJ).

European Union. As most of the Northern Mediterranean States are European Union Member States (EU MSs), EU policies influence regional policies, including the Marine Strategy Framework Directive (MSFD), which aims to achieve or maintain Good Environmental Status (GES) in all areas under the sovereignty and jurisdiction of EU MSs, the Maritime Spatial Planning Directive, and many other directives that directly or indirectly tackle environmental issues, e.g. Directive on Environmental Impact Assessment (EIA), Directive on Strategic Environmental Assessment (SEA), Water Framework Directive, NATURA 2000 Directive, EU Common Fisheries Policy (CFP) etc. These policies

[143] The International Commission for the Conservation of Atlantic Tunas (ICCAT) is also responsible for managing tuna in the Mediterranean.

should be considered in the broader framework of the EU Integrated Maritime Policy, which supports and underlies many thematic or cross-cutting policies, instruments and initiatives such as Marine Spatial Planning, H2020 on research and innovation, etc. Regional cooperation mechanisms support the adoption and implementation of coherent measures beyond EU boundaries, within the framework of the European Neighbourhood Policy[144] between the EU and Southern Mediterranean countries. European States are also bound by the Aarhus Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters, which links protection of the environment and human rights, and by the Espoo Convention, which provides for the obligation to conduct EIAs in certain circumstances involving transboundary activities.

Bilateral or multilateral cooperation, for instance the **Arab Maghreb Union** (AMU) or **League of Arab States** (LAS), support growing cooperation in the broader region on issues linked to sustainable development and environment. At a sub-basin level, the **Dialogue 5+5** offers a framework for intergovernmental cooperation between Western Mediterranean countries, along with initiatives supported by the EU to develop common strategies in the Adriatic-Ionian (EUSAIR) and in the Western Mediterranean (WESTMED).

A legally binding instrument has been adopted by France, Italy and Monaco, establishing the **Pelagos Sanctuary for Mediterranean Marine Mammals** in the north-western Mediterranean.

Other environmental agreements such as the CBD or the **Ramsar Convention on Wetlands of International Importance** are applied in the Mediterranean region through various regional instruments, including in the framework of the Barcelona Convention (e.g. management of Ecologically or Biologically Significant Marine Areas) or the **Mediterranean Wetlands Initiative** (MedWet), which is one of the 15 regional initiatives recognized under the Ramsar Convention.

Three of the five **UN Regional Economic Commissions** cover Mediterranean countries, i.e. UN Economic Commission for Africa (ECA), UN Economic Commission for Europe (UNECE), and UN Economic and Social Commission for Western Asia (ESCWA). They convene regional forums for Sustainable Development, supporting peer learning processes and the implementation of the 2030 Agenda/SDGs. They also undertake numerous activities on SDG implementation, including data management and assessments, knowledge-sharing and capacity-building. Further collaborations between the UN Regional Commissions and the Mediterranean Commission on Sustainable Development (MCSD, see below) represent potential levers for the follow-up and implementation of 2030 Agenda/SDGs in the Mediterranean basin.

BOX 97

Addressing pollution from ships through regulations and collaboration

Given that the Mediterranean hosts one of the world's most important sea traffic lanes, global arrangements addressing pollution from ships are particularly relevant for the region. The International Maritime Organization (IMO) is the UN specialized agency in charge of setting standards for the safety, security and environmental performance of international shipping. Under IMO's coordination, there are more than 20 international conventions addressing the prevention of and response to pollution from ships. The most important of these is the International Convention on the Prevention of Pollution from Ships, commonly known as the MARPOL Convention, and its six annexes, which provide regulations on the prevention of pollution by oil (Annex I), the control of pollution by noxious liquid substances in bulk (Annex II), the prevention of pollution by harmful substances carried by sea in packaged form (Annex III); the prevention of pollution by sewage from ships (Annex IV), the prevention of pollution by garbage from ships (Annex V), and the prevention of air pollution from ships (Annex VI).

Alongside International Conventions, more than 20 pieces of relevant European legislation as well as relevant Protocols of the Barcelona Convention address prevention and response to pollution from ships in Mediterranean waters.

A number of gaps remain in Mediterranean coastal States' ratification of the relevant international conventions. In order to establish and maintain the comprehensive legal basis that would enable coastal States to take the necessary action to prevent and respond to cases of pollution by ships in the Mediterranean Sea, it is therefore essential that all Mediterranean coastal States take action, where necessary, to ratify and simultaneously ensure the effective implementation and enforcement of these conventions.

To ensure coherence between the international and regional levels, the Barcelona Convention Regional Activity Centre dealing with the prevention of pollution from ships REMPEC is hosted by IMO.

In addition to regional and subregional cooperation mechanisms, **national initiatives** are multiplying, with several coastal States working on the preparation of a national maritime policy integrating the blue economy. A growing number or States now claim **Exclusive Economic Zones** (EEZs) in the Mediterranean, which could result in the gradual disappearance of ABNJs in the Mediterranean and strengthen the importance of cooperation and progress towards stronger integration of national policies and regulations. This integration could be supported by coordinated strategic planning mechanisms such as MSP that can be instrumental for the consistent transboundary management of shared areas with common concerns related to the marine environment and management of marine resources.

8.3.2 Stakeholder mobilization

Informed participation of non-state and sub-state actors in the decision-making process can lead to (i) better decisions, as the government or implementing agencies take into account valuable information from the public

[144] In 2003, the EU launched a policy instrument, the European Neighbourhood Policy (ENP), which addressed through its financial instrument, the European Neighbourhood and Partnership Instrument (ENPI), cooperation with the neighbouring countries of the EU including those of the Mediterranean area.

concerned and (ii) enhanced public confidence and acceptance of governmental decisions. Dialogue with and active involvement of civil society and the private sector, as well as local governments at all stages of policymaking and implementation are particularly crucial, because the current situation requires systemic changes in the behaviour of all actors if sustainability is to be achieved in the Mediterranean region. The 2030 Agenda advocates for both multi-stakeholder and multi-level governance in the pursuit of the SDGs.

Inclusive development must pay attention to inequalities and involve civil society in decision-making and action. Women can play a major role: (i) in promoting sustainable household consumption and investment (e.g. in food/agriculture, in energy), and (ii) in entrepreneurship and economic development. Mediterranean policies increasingly integrate participatory and multi-stakeholder tools. Younger generations and their demands and potential for action are key to short-term and longer-term progress, including in countries with strong demographic trends today and tomorrow.

Since Rio 1992 and the 2015 Paris Agreement, stakeholder mobilization on sustainable development goals has begun to thrive, with the emergence of numerous stakeholder networks and governance forums. In the Mediterranean, networks often bring together stakeholders of similar profile, and governance forums often focus on a specialized theme. Interrelations between different types of stakeholders and across governance forums are generally limited in time and dependent on externally funded projects. The few exceptions include the Egyptian Sustainable Development Forum at the national level, the *Parlement de la Mer* in the French Region of *Occitanie* at the local level, and, at the regional level, the Mediterranean Commission on Sustainable Development, which recommended the creation of a Mediterranean Forum on Sustainable Development. Efforts are required to develop long-term or permanent interlinkages.

Since its inception, UNEP/MAP has recognized the value of public awareness and support from civil society in fulfilling its mission. To this end, Contracting Parties have developed fruitful working relationships with civil society organizations by granting them Observer and Partner status, thus encouraging their participation in meetings and activities, while UNEP/MAP provides assistance to partners from developing Mediterranean countries with a view to further strengthening their capacities. With Decision IG.19/6 of COP 16, the Contracting Parties adopted the criteria and procedures for admission of international, national, and local civil society organizations/NGOs as MAP Partners.

The Contracting Parties to the Barcelona Convention have a series of commitments to engage stakeholders and the public in consultations and participatory governance. These commitments concern all countries of the region, and should lead to the implementation of participatory processes for Environmental Impact Assessment (EIA), Strategic Environmental Assessment (SEA), Integrated Water Resources Management (IWRM), management of specially protected areas, adaptation to climate change, etc. Participatory and information/communication processes are also related to and supported by the Mediterranean Strategy on Education for Sustainable Development (MSESD)[145] and its Action Plan[146], both of which are endorsed and constitute integral parts of the MSSD.

Accession to the UNECE Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters (Aarhus Convention) also provides a solid and comprehensive framework for governance to engage the public effectively. The Aarhus Convention is widely accepted to be the leading example of implementation of Principle 10 of the Rio Declaration. Apart from engaging the public, accession to the Convention can facilitate the design and implementation of National Strategies for Sustainable Development, green economy strategies and 2030 Agenda and SDGs at the national level[147]. Being a Party to the Aarhus Convention significantly contributes to countries' efforts to promote citizen-centred and environmentally sound policies. Twelve of the 22 Contracting Parties to the Barcelona Convention are Parties to the Aarhus Convention *(Table 35).* The Aarhus Convention is open for accession to any UN Member State[148]. The familiarization with and possible accession to the Aarhus Convention requires first and foremost a strong political will from governments to fulfil commitments concerning access to information, public participation and access to justice in environmental matters.

8.3.3 Multi-level governance, local governments

Multi-level governance involves planning and management in line with the principle of subsidiarity, by virtue of which issues should be dealt with at the closest or most local level consistent with their resolution, for example in a local area rather than a whole country if the issue can be adequately managed at this level. With observed and projected

[145] http://ufmsecretariat.org/wp-content/uploads/2014/05/Mediterranean-Strategy-on-Education-for-sustainable-development-.pdf

[146] http://www.esdmedcyprus.pi.ac.cy/files/ENG_Action_Plan.pdf

[147] Owing to their cross-cutting nature, the Aarhus Convention and its Protocol on Pollutant Release and Transfer Registers (PRTRs) have multiple benefits to the successful implementation of the 2030 Agenda/SDGs and are directly linked to a very wide array of issues and policies such as ending poverty (SDG 1), health protection (SDG 3), water and sanitation management (SDG 6), clean energy (SDG 7), green economy (SDGs 8, 9 and 12), reduction of inequalities (SDG 10), sustainable consumption and production (SDG 12), climate action (SDG 13), tourism (SDGs 8, 12, 14 and 15), urban planning (SDGs 11 and 13), and the promotion of effective, accountable and transparent institutions, effective access to information, effective and inclusive public participation and transparency in national and international decision-making and effective and equal access to justice for all (SDG 16).

[148] For States which are not Members of UNECE, accession requires an approval by the Aarhus Convention's Meeting of the Parties. In recent years, the Parties to the Aarhus Convention have made clear their strong encouragement for countries outside the UNECE region to join

environmental and climate changes, local resilience and local risk management have become more challenging than ever. Exposure to environmental and climate risks, resilience and the adaptive capacity of local communities vary significantly around the Mediterranean basin. Local planning approaches are often best tailored to reflect these specificities by integrating locally held knowledge about specific local contexts.

Local planning and management can either be ensured by developing local offices of the national government or empowering local authorities to engage local citizens in decision-making, and strong consideration of local specificities and concerns. In practice, several Mediterranean countries have already transferred key responsibilities over sustainable development planning and implementation to local governments, or are in the process of doing so. Waste, wastewater and drinking water management are often decentralized responsibilities. Others depend on specific country policies and evolve over time. Albania, for example, has transferred the 80% of forest area ownership and management responsibility from the central government to local governments (Kacani & Peri, 2019), with the exception of protected areas. In Tunisia, the new 2014 Constitution sets ambitious decentralization targets.

Decentralization can only function if local governments have the financial and human capacities to sustainably manage often complex environmental and development challenges. Decentralization thus requires support via both capacity-building and funding programmes. Mobilizing specific local tax revenues, suitable to equitably manage environment and natural resources, is often a constraint, especially in Southern and Eastern Mediterranean Countries (SEMCs), and requires transfers from the central government.

Institutionalization of local planning at the national level is important because it is often a condition for long-term national funding. As long as local planning is not institutionalized at the State level, its implementation is not factored into the national budget system. As a result, its funding needs to come from a sector or international and bilateral donors.

Another important factor is the way the environmental dimension is taken into account in local planning processes. While most sustainable development strategies and commitments are designed and adopted at the national or international level, it is actually at the local level that concrete action for conservation and management of natural resources for human well-being can be taken. This is particularly true for adaptation to environmental and climate change to which the Mediterranean region is very vulnerable. Clear mechanisms to mainstream international commitments into local planning often lack effective tools that need to be catered to the differing stages of decentralization in Mediterranean countries. A gap often remains between the ambition of international agreements and their implementation at the local level. Coordination between local administrations and central and decentralized sectoral technical services, as appropriate, requires further capacity-building and implementation support to become more effective. In addition, environmental enforcement is critical in many Mediterranean countries where illegal activities raise strong environmental concerns (illegal logging, waste disposal, sand mining, protected species collection, discharge in the environment, building in coastal setback zones, etc.). Enforcing national laws and international agreements can rarely be a decentralized responsibility only.

Increasing resilience can also be strengthened by promoting innovative local-level systems and governance models, around emerging (or re-emerging) value chains. Collective organization and citizen-led innovations in sustainable agriculture, aquaculture, fisheries and ecotourism sectors, creating jobs and diversifying the economy, can be further strengthened and supported. The value chain approach encourages the participation of local producers, who are "vulnerable" individually, by grouping together to act collectively to overcome market barriers and increase revenue. A local value chain approach can also help identify opportunities for achieving a circular economy.

8.3.4 Towards strengthened cooperation

From the analysis of changes in global and regional governance in recent years, some trends are emerging and call for changes to environmental governance in the Mediterranean region. There is a clear trend to multiply governance forums in the Mediterranean, at all scales, many of which aim to support sustainable development, including in maritime and coastal areas. Most of them focus more on development (economic and social drivers) than environmental protection. It is increasingly apparent that the environmental governance supported by the UNEP/MAP - Barcelona Convention system, despite its many positive outcomes, can succeed in achieving its environmental objectives only by simultaneously addressing economic and social objectives that are the drivers of most pressures on the environment. Furthermore, pressures from land-based activities on the marine and coastal environment are still predominant, and must be addressed in an integrated way, which calls for better regional integration between land and marine governance.

Building on the experience gained in the region and beyond, it seems that integration should be further developed to bring more consistency into regional/Mediterranean environmental governance and efficiently mobilize it in order to achieve SDGs in the region. It should be considered along several lines, including:

- *Integration of regional governance,* establishing stronger links between all relevant regional frameworks, particularly the UNEP/MAP - Barcelona Convention system, FAO-GFCM, ACCOBAMS and UfM by supporting common strategies and coordinated action plans including spatial plans;
- *Vertical integration of governance,* establishing top-down and bottom-up mechanisms to ensure coordination between high-level regional policies and objectives such

as SDGs, and strategies and action plans carried out at all other scales and levels, including the local/municipal level;
- *Land-sea integration,* through better consideration of land-sea interactions and related governance issues.

These kinds of changes should be in line with the trend observed at the overall level to shift from fragmented governance of maritime affairs towards more inclusive governance of sustainable development, fully considering protection of the marine environment and natural heritage as a primary policy objective.

8.4 2030 Agenda and SDGs renewed the recognition of the cross-cutting and integrated nature of environmental and development issues

The UN Conference on Sustainable Development in 2012 (Rio+20) decided to expand the Millennium Development Goals, which were reaching their deadline, with a set of universal Sustainable Development Goals (SDGs). This decision was followed by unprecedented public engagement and intense involvement of UN Member States across the globe. This process came to an end in September 2015, with an agreed consensus by the UN General Assembly on "Transforming Our World: The 2030 Agenda for Sustainable Development" (2030 Agenda), with 17 SDGs and 169 targets. The agreement on the SDGs is a recognition of the interconnectivity of socioeconomic development and environmental protection. Opportunities offered by a green and blue economy were explicitly recognized. For the first time, an international development goal was dedicated to the oceans. SDG 14 (Life Below Water) aims to "Conserve and sustainably use our oceans, seas and marine resources for sustainable development". Other SDGs are directly or indirectly linked to marine issues, e.g. climate action (SDG 13), responsible production and consumption (SDG 12), affordable and clean energy (SDG 7), clean water (SDG 6), conserve biodiversity (SDG 15), etc. Half of the SDGs directly focus on environmental issues or address the sustainability of natural resources. Over 86 of the SDG Targets pertain to environmental sustainability, including at least one in each of the 17 SDGs. The 2030 Agenda also takes on board the commitments of the Paris Agreement on Climate (2015).

Furthermore, the 2030 Agenda welcomes the cooperation of regional and subregional commissions and organizations for follow-up and review, and encourages States to identify the most suitable regional forum in which to engage. The Mediterranean Commission on Sustainable Development (MCSD) provides such a cooperation framework in the Mediterranean region.

The **Mediterranean Commission on Sustainable Development** (MCSD) was established in 1995 as a multi-stakeholder advisory body to assist the Contracting Parties to the Barcelona Convention in their efforts to integrate environmental issues in socioeconomic programmes and to promote sustainable development policies in the Mediterranean region. The MCSD is unique in its composition, which includes, on an equal footing, 40 representatives from governments, local authorities, socioeconomic actors, the scientific community, IGOs, NGOs, and parliamentarians. The MCSD coordinated the preparation of the Mediterranean Strategy for Sustainable Development (MSSD), which was adopted by the Contracting Parties in 2005 and 2016.

BOX 98

The Regional/Mediterranean Dimension as a Bridge Between Global Processes and National Policies for Sustainable Development

The UNEP/MAP - Barcelona Convention system has a leading role in facilitating the coordinated implementation of the 2030 Agenda and SDGs at the regional level, and in ensuring the transition towards a green and blue economy in the Mediterranean. It supports long-standing mechanisms and structures that adapt the global processes to the Mediterranean dimension:

- In line with SDG 12 on Sustainable Consumption and Production (SCP), the Mediterranean Strategy for Sustainable Development (MSSD) 2016-2025 supports investment in the environment as the optimum way to secure long-term sustainable jobs and socioeconomic development;
- As a regional forum for discussion and exchange of best available practices, the MCSD represents a unique mechanism in the panorama of Regional Seas worldwide that looks at sustainable development in its entirety and gives a strong voice to actors that work towards sustainability in the Mediterranean region;
- The Simplified Peer Review Mechanism (SIMPEER) is an innovative framework for promoting dialogue and experience sharing on National Strategies on Sustainable Development among Mediterranean countries. SIMPEER is an adaptive tool which supports the preparation and follow-up of the Voluntary National Reviews (VNRs) presented to the UN High-level Political Forum (HLPF). The SIMPEER pilot edition was carried out in 2016-2017 with the voluntary participation of France, Montenegro and Morocco. Albania, Egypt and Tunisia joined the second edition in 2018-2019.

The **Mediterranean Strategy for Sustainable Development** (MSSD) 2016-2025 (Decision IG.22/02) was adopted in 2016 by COP 19 as a strategic guiding document for all stakeholders and partners to translate the 2030 Agenda and SDGs at the regional, subregional, national and local levels.

Developed through a highly inclusive process in which all Contracting Parties and key stakeholders had the opportunity to participate, the MSSD aims to provide a strategic policy framework to secure a sustainable future for the Mediterranean region, adapt international commitments to regional conditions, guide national strategies and stimulate regional cooperation to achieve sustainable development goals, and link the need to protect the environment with socioeconomic development.

As highlighted by its subtitle "Investing in environment sustainability to achieve social and economic development",

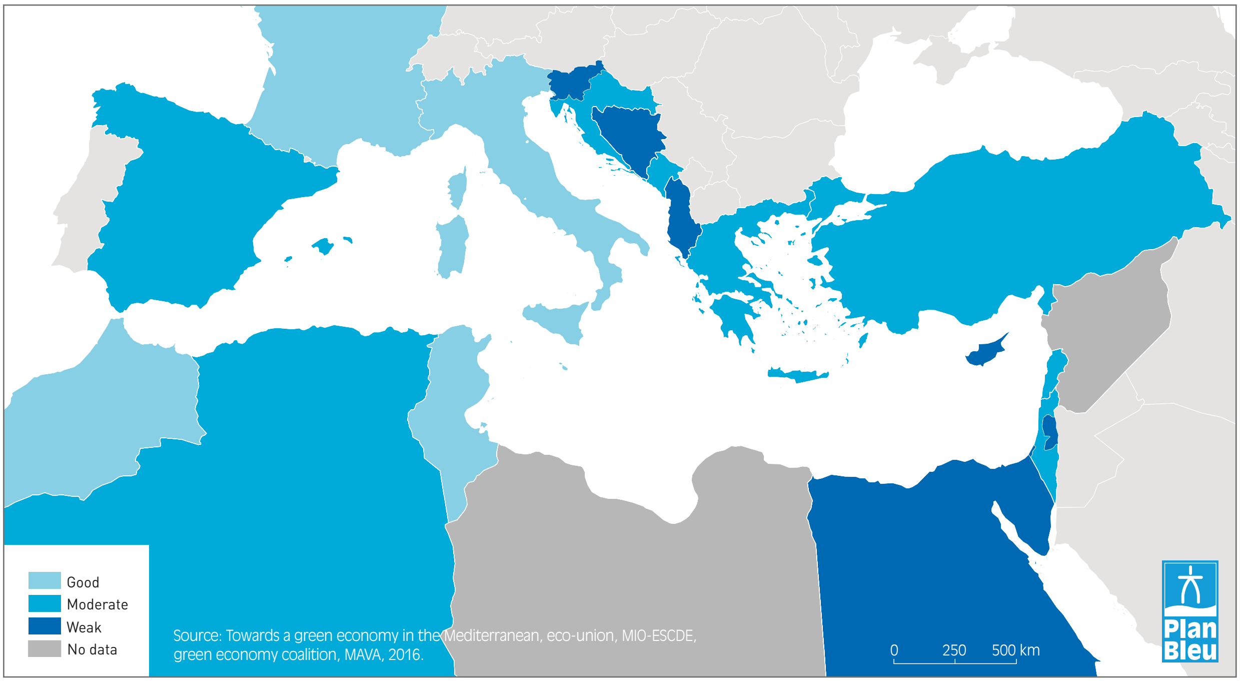


Figure 197 - Assessment of published national strategies
(Source: Fosse et al. 2016)

the vision of the MSSD[149] is based on the principle that socioeconomic development needs to be harmonized with the environment and protection of natural resources; *"Investing in environment is the best way to secure long-term sustainable job creation: an essential process for the achievement of sustainable socioeconomic development for the present and future generations"* (MSSD). The vision of the MAP Medium-Term Strategy 2016-2021 (MTS 2016-2021) (Decision IG.22/1) - *"a healthy Mediterranean with marine and coastal ecosystems that are productive and biologically diverse contributing to sustainable development for the benefit of present and future generations"* - is inspired by the vision of the MSSD.

The MSSD addresses key areas impacted by human activity, from the marine and coastal environments, using an ecosystem-based approach and planning tools such as Integrated Coastal Zone Management (ICZM) and Marine Spatial Planning (MSP), to urban settlements and the rural and agricultural systems. It also focuses on climate change, which is expected to severely impact the Mediterranean. The MSSD also introduces emerging approaches that help in turning political intentions into reality: e.g. green and blue economy approach combined with Sustainable Consumption and Production (SCP).

The MSSD follows a structure based on six objectives that lie at the interface between environment and development. The first three objectives of the Strategy reflect a territorial approach, while the three other objectives are cross-cutting approaches[150]. A set of strategic directions is formulated for each of the six overall objectives. The strategic directions are complemented by national and regional actions, as well as flagship initiatives and targets. The MSSD also looks into the means for financing implementation and measuring effects, as well as the governance prerequisites. A monitoring system is also provided through the establishment of a Mediterranean Sustainability Dashboard, including socioeconomic indicators aligned with SDG indicators.

The most recent comprehensive assessment of National Strategies on Sustainable Development (NSSDs) in the Mediterranean region was conducted in 2016 (Fosse et al. 2016). It covers NSSDs and national Green Economy strategies and concludes that the majority of Mediterranean States have outdated or incomplete strategies, which are often vague, and do not give clear definitions, objectives, budgets or indicators. Only four countries (France, Italy, Morocco and Tunisia) can claim to have detailed strategies with concrete roadmaps, or - in the case of Italy - supporting legislation in place. Seven countries (Albania, Bosnia and Herzegovina, Cyprus, Egypt, State of Palestine,

[149] "A prosperous and peaceful Mediterranean region in which people enjoy a high quality of life and where sustainable development takes place within the carrying capacity of healthy ecosystems. This must be achieved through common objectives, strong involvement of all stakeholders, cooperation, solidarity, equity and participatory governance".

[150] The six MSSD Objectives are the following: 1. Ensuring sustainable development in marine and coastal areas; 2. Promoting resource management, food production and food security through sustainable forms of rural development; 3. Planning and managing sustainable Mediterranean cities; 4. Addressing climate change as a priority issue for the Mediterranean; 5. Transition towards a green and blue economy; 6. Improving governance in support of sustainable development.

BOX 99

The Moroccan Pact for Exemplarity of the Administration for Sustainable Development

(Source: Kingdom of Morocco, 2019)

As part of the implementation of its National Strategy for Sustainable Development (NSSD), the Moroccan government aims to set an example by implementing the sustainability recommendations recommended for all economic and social actors within its own institutions. The government's exemplary approach is based on objectives for sustainable public procurement, eco-responsibility and social responsibility. In order to operationalize the first strategic direction of the SNDD, which aims to make the exemplary nature of the administration a lever for the implementation of sustainable development, Morocco has undertaken several actions, including:

- Development of a Pact for the Exemplarity of the Administration (PEA) based on 6 strategic objectives;
- Development of a methodological guide as a toolbox that has been made available to all ministerial departments;
- A memo sent from the Head of Government to all public administrations urging them to conduct environmental audits of their buildings and propose a ministerial plan for the Exemplarity of the Administration in terms of sustainable development;
- The establishment of three working groups to make proposals on specific topics (the first group on sustainable construction techniques, the second group on responsible public employment and the third group on sustainable mobility);
- All ministerial plans will be grouped together to develop the National Sustainable Development Plan, which will set the targets to be achieved by 2021 in terms of energy efficiency, sustainable mobility, waste recycling, sustainable procurement, etc.

Countries	Year of VNR
Albania	2018
Algeria	2019
Bosnia and Herzegovina	2019
Croatia	2019
Cyprus	2017
Egypt	2016, 2018
France	2016
Greece	2018
Israel	2019
Italy	2017
Lebanon	2018
Libya	2020
Malta	2018
Monaco	2017
Montenegro	2016
Morocco	2016, 2020
Slovenia	2017, 2020
Spain	2018
Tunisia	2019
Turkey	2016, 2019

Table 38 - Year of Voluntary National Review of 2030 Agenda implementation in Mediterranean countries
(Source: United Nations Sustainable Development Knowledge Platform, Voluntary National Reviews Database, accessed October 2019)

Slovenia and Spain) have outdated green economy/sustainable development strategies or none at all. NSSDs are not the only way to guide decision-making regarding sustainable development in national policies. Courses for achieving SDGs can be set in many different ways and do not necessarily materialize in an NSSD.

As part of the follow-up and review mechanisms of the 2030 Agenda for Sustainable Development, states are encouraged to "conduct regular and inclusive reviews of progress at the national and sub-national levels, which are country-led and country-driven", referred to as Voluntary National Reviews (VNRs). VNRs aim to both facilitate the sharing of experiences and to mobilize multi-stakeholder support and partnerships for the implementation of the Sustainable Development Goals. The Contracting Parties to the Barcelona Convention that have undergone and/or will go through the VNR process are listed in the table below.

8.5 Governance is increasingly supported by research, innovation and education for sustainable development; dissemination is a key challenge for a sustainability transition

Good decisions rely on sound knowledge, targeted research and innovation, and call for education and dissemination of knowledge to all stakeholders.

8.5.1 Supporting governance through research and innovation for sustainable development

Education, research, innovation and capacity-building are inherently interconnected and offer significant opportunities for Mediterranean countries and people to develop and exploit their natural and cultural assets for the benefit of their economies and their societies, acting as drivers of development. Increased knowledge, coupled with skills development through capacity-building, research and innovation could significantly strengthen and support the various components of sustainable development. These are also keys to the successful deployment of solutions which, in turn, may address the many environmental and socio-political challenges of the region and deliver economic benefits on a wider scale, while safeguarding environmental integrity and social cohesion and well-being.

Despite the fact that for thousands of years, the Mediterranean was cradle of knowledge generation, education, research and innovation, and without ignoring the excellent records of several Mediterranean countries, the region as a whole, in modern times, is lagging behind, in comparison with other areas, e.g. Northern Europe or the US.

In the second half of the 20th century, many strong national academic and research institutions are relatively well-connected with industry and other economic activities in countries and deploy efforts to collaborate at many levels with other nations. Some Mediterranean-wide organizations have been established, supporting science, technology or institution-building and international governance, such as the Mediterranean Science Commission (CIESM), initially with strong links with the Monaco Museum of Oceanography, the *"Pacem in Maribus"* established by Elisabeth Mann Borgese and operating from Malta in the 1970's, etc.

Gradually, the educational, research and development models applied have been challenged and changed, several times. Nearly all of them have been now deeply affected by the globalization of the world economy, the rapid expansion of information technologies and the role of international cooperation schemes, which are by far better supported financially for research and innovation than for education.
Within the UNEP/MAP - Barcelona Convention system, MED POL and RACs have played an important role for many decades in stimulating research and monitoring, particularly on pollution assessment and abatement issues. A series of capacity-building activities were, and still are, part of MAP activities. Several of them have also been connected to educational activities of Universities or other appropriate scientific institutions. Although science and research do not directly fall within the scope of the Barcelona Convention and its protocols, a series of programmes and projects coordinated by MAP lie within the borderline between applied research and policy formulation and implementation. One of these projects is the MedPartnership (2009-2015), the Global Environment Facility (GEF) and MAP Strategic Partnership for the Mediterranean Sea Large Marine Ecosystem that aimed at reversing the degradation trends which affect the Mediterranean's unique large marine ecosystem, including its coastal habitats and biodiversity. Within this project, some of the biggest organizations working in the field of sustainable development in the Mediterranean joined forces and, through a coordinated and strategic approach, including the use of scientific results from research, strived to catalyse policy, legal and institutional reforms along with investments.

The follow up of MedPartnership is being developed within the MedProgramme[151], a flagship initiative supported by the GEF and 9 Countries in the region, addressing land-based pollution in coastal hotspots, sustainability and climate resilience in the coastal zone, marine biodiversity, and knowledge management. The MedProgramme is putting words into actions by engaging one investment bank (European Investment Bank - EIB) and one development bank (European Bank for Reconstruction and Development - EBRD) in MAP activities. This is the culmination of a process that exemplifies how regional governance and private/financial institutions can work together for sustainability: (i) the governance and regulatory framework is provided by the Barcelona Convention and its protocols; (ii) the technical and scientific assessments identified the main pressures in the Mediterranean and defined Strategic Action Programmes to address them; and (iii) the countries developed National Action Plans to define the hotspots requiring intervention.

National and bilateral initiatives in the areas of science and innovation on "green issues" are also important with impacts on the Mediterranean environment and development, particularly when they are connected to major investments such as large renewable energy parks. A major impetus for Euro-Mediterranean cooperation in science, technology and innovation was provided by the launching of the Barcelona Process in 1995. A Group of Senior Officials (GSO) (Former Monitoring Committee - MoCo) for Euro-Mediterranean cooperation was created in 1995 within the framework of the Barcelona Process to monitor and promote cooperation in research, technology and development. The EU-Med GSO was tasked with making recommendations for the joint implementation of research policy priorities and is an important bi-regional policy dialogue platform which brings together EU Member States and all the non-EU Mediterranean (partner) countries. The last meeting of the EU-MED GSO took place in 2015 and emphasized the crucial role of innovation as a game-changer in the Mediterranean. It also highlighted the importance of stepping up efforts towards a common Mediterranean research and innovation agenda.

The European Neighbourhood and Partnership Instrument (ENPI)136, was followed by association agreements signed between the EU and individual Southern Mediterranean countries, thus creating the entry point for the establishment of Science and Technology Cooperation Agreements with the EU. To date, the EU has signed science and technology cooperation agreements with Algeria (2013), Egypt (2008), Morocco (2005), and Tunisia (2004).

A milestone in Euro-Mediterranean dialogue in research and innovation is the adoption of the Cairo Declaration (2007) Towards a Euro-Mediterranean Higher Education and Research Area, at the first Ministerial Conference on higher education and research. In May 2011, the High Representative of the Union for Foreign Affairs and Security Policy and the EC published a joint communication (COM (2011) 303) presenting a new approach to strengthen the partnership. For research and innovation, the communi-

[151] The MedProgramme is the final step of a clear, politically supported and technically consistent strategy, which will provide an example to establish similar and even bigger operative partnerships between countries, international organizations, financial institutions, the private sector and NGOs.

cation suggests working towards the establishment of a Common Knowledge and Innovation Space (CKIS), which pulls together policy dialogue, national and regional capacity-building, cooperation in research and innovation and increased mobility of researchers.

The Union for the Mediterranean (UfM) reinvigorated the partnership between the Euro-Mediterranean countries and identified higher education and research as one of its six priority areas. The strategic value of increasing integration among Euro-Mediterranean and national research programmes and the need for greater investments in research and innovation in the Mediterranean basin was further stressed at the Euro-Mediterranean Conference held in Barcelona in 2012. The Conference affirmed the political aim to better integrate research and innovation in the Euro-Mediterranean area through a co-designed, co-financed and co-owned joint programme on commonly agreed topics. At the Conference, the EC suggested the need for an initiative based on Article 185 of the Treaty on the Functioning of the EU, in order to define a long-term, strategic and integrated Research and Innovation Programme focused on the implementation of a common strategic agenda and the alignment of the relevant national research and innovation programmes.

Within this policy context, several mechanisms and tools have been set in motion with the aim to advance research and innovation for Sustainable Development in the Mediterranean:

- **The EU Framework Programmes for Research and Innovation** (i.e. FP7, Horizon 2020 Research) constitute the backbone for Euro-Mediterranean cooperation in research and innovation. **The European Neighbourhood Partnership Instrument (ENPI)** and its successor, **the European Neighbourhood Instrument (ENI)** are, from a resources point of view, the most important instruments for regional Mediterranean cooperation. Research and innovation for sustainable development are a high priority for these instruments[152].
- **The Cross-Border Cooperation for the Mediterranean (CBC-Med)** programme currently implemented under the ENI aims to strengthen cooperation in the Mediterranean area during the 2014-2020 period.
- **The Interreg MED Programme** (funded by the European Regional Development Fund, the Instrument of Pre-Accession and national co-funding) aims to promote sustainable growth in the Mediterranean area by fostering innovation and supporting social integration through an integrated and territorially based cooperation approach.

Some of the main challenges for strengthening and substantially advancing research and innovation in the Mediterranean include:

- The need for further streamlining the different instruments to address the sustainable development-related issues the Mediterranean is facing. This requires better information for the people and organizations involved and enhanced coordination between different types and scales of research and innovation programmes, including those that are EU-funded.
- The need to strengthen the science policy interface and develop research and innovation projects that produce ‘fit-for-purpose’ information to feed into the various stages of the policy cycle.
- The need for sharing data and outputs produced by research and innovation projects more effectively through suitable platforms.
- The need for enhancing efficient science to policy communication via capacity-building activities targeting policy and decision makers.
- The need to develop new mechanisms for dialogue to allow research projects and policy actors to interact more, be more aware of the strategic policy contexts of projects, and jointly identify ways in which evidence and research outcomes can be incorporated into the management processes vital for the sustainable development of the region.

8.5.2 Education for sustainable development

Education for Sustainable Development (ESD) was developed during the Rio-1992 process, justified and promoted through Chapter 36 of Agenda 21, with the key objective of supporting the introduction and implementation of the concept of sustainable development through formal (schooling systems) and informal (awareness-raising) channels, taking into account the relevant experience of pre-existing environmental education.

The First International Working Conference on “Reorienting Environmental Education for Sustainable Development” was organized jointly by UNESCO, UNEP/MAP, MIO-ECSDE and the University of Athens (1996), and marked the needed appropriate shift from Environmental Education towards Education for Sustainable Development (ESD). The landmark UNESCO International Conference on Environment and Society: Education and Public Awareness for Sustainability (Thessaloniki, Greece, 1997) promoted ESD as an “umbrella” type of education. In 1998, the Mediterranean Workshop on Education and Public Awareness for Environment and Sustainability further promoted ESD as an education approach that is essential for supporting the implementation of the sustainable development agenda.

From 1998 until the Johannesburg Summit (2002), the educational community of the Mediterranean gained valuable experience through participation in regional networks and projects, sharing knowledge and practices, co-creation and making the agenda on ESD policy and teaching more specific and concrete. The decision about the UN Decade of

[152] Under ENI, a project entitled SWIM-H2020 SM (Sustainable Water Integrated Management and Horizon 2020 Support Mechanism 2016-2019) was funded with the aim of contributing to reduced marine pollution and sustainable use of scarce water resources in the Mediterranean region with emphasis on the countries of North Africa and the Middle East (Algeria, Egypt, Israel, Jordan, Lebanon, Libya, Morocco, State of Palestine, Syrian Arab Republic and Tunisia) (Vlachogianni, Roniotes, & Alampei, 2018).

ESD, suggested at the Johannesburg Summit (2002), was prepared and promoted in collaboration with Mediterranean networks, while the Mediterranean Education Initiative for Environment and Sustainability (MEdIES), the main Mediterranean Network on ESD (which brings together more than 6,500 educators) was established as a UN Type II Partnership[153]. The UN Decade of ESD (2005-2014) provided a solid framework for mainstreaming, boosting and applying ESD. It was suggested that Regional ESD Strategies be adopted to help countries introduce and implement ESD[154]. The Mediterranean region was the first to respond to this call, drafting the Mediterranean Strategy on ESD (MSESD) from 2005 to 2014. In 2014, the strategy was endorsed by the UfM Ministerial Meeting on Environment and Climate Change.

Although the MSESD was developed through a long participatory process, it is still unevenly implemented in the various countries. An Action Plan for the implementation of the MSESD, serving as a flexible framework for the fulfilment of countries' national ESD, as well as regional/global agendas were developed and adopted at the Conference of Ministers of Education (Cyprus, 8-9 December, 2016). To ensure efficient regional governance and communication, the countries have appointed focal points to communicate with the Mediterranean Committee for ESD. UNEP/MAP, UfM, UNESCO, LAS and UNECE are members of the Committee.

ESD is widely recognized in the region as a key tool for promoting sustainable development. In many countries, inter-ministerial committees established for the promotion and implementation of the SDGs also include the promotion of ESD. The majority of Mediterranean countries have already developed National Strategies or Plans on ESD. The Action Plan of the MSESD provides an appropriate and useful framework to complement, improve and adapt national policies on ESD.

Despite all the aforementioned initiatives and progress in networking, cooperation involving ESD research needs further mainstreaming and enhancement, especially to include maritime education, and should be considered a main priority. It is equally important to enhance "citizen science", including a cooperative inquiry and participatory action research approach as a method for shifting from "research on/about people" to "research with people".

Despite the gradual progress achieved in implementing ESD, some common challenges are identified by most Mediterranean countries. Strengthening much-needed interdepartmental and cross-sectoral collaboration and effective coordination of the various ESD initiatives, including education on maritime issues, are among these challenges. Another major challenge is the lack of adequate human and financial resources for the promotion of ESD. What is stressed by the countries is the need for continued efforts at the regional level, connecting regional initiatives to the national and local level, including "trainings of trainers" as a major tool in a more systematic and intensive manner.

It is critical that MSESD and its Action Plan receive more political support and become better known among decision makers, as a prerequisite for the promotion of sustainable development and the SDGs in the region.

8.5.3 Knowledge and partnerships for environment and development

The capacity to generate knowledge has tremendously increased and new cost-effective sources of information have emerged throughout the last decades. Big and open data, widespread use of remote sensing and GIS, aerial and underwater drones, etc. have considerably increased the capacity to generate and process new data at relatively low cost. Whether or not an environmental component can be observed remotely has now become one of the most significant limiting or enabling factors for its regular and affordable surveillance. At the same time, the booming coverage of Internet access, social networks and open-source software including mobile applications have revolutionized knowledge generation, dissemination and management.

Citizen science projects have emerged in the context of booming Internet access as a virtual and physical place where citizens, researchers and decision makers can cooperate to monitor the state of the environment in the Mediterranean, especially in relation to conservation biology or ecology (e.g. COMBER[155], CIGESMED[156]). The information thereby collected can provide a strong basis for short- and long-term planning and decision-making in the region, while educating the public and enhancing public participation. Integrating citizen science as a source for evidence-based decision-making has become a major lever for action.

Overall, the information landscape in the region is characterized by an abundance of organized or dispersed, sometimes redundant and sometimes contradictory or inconsistent sets of information from multiple sources with varying levels of reliability. Critical knowledge is generated in knowledge hubs, universities, local assessments or research programmes, or is held by local communities and practitioners. This information is often insufficiently

[153] Type II partnerships, which were meant to complement Type I outcomes or agreements and commitments made by Governments, are characterized as 'collaborations between national or sub-national governments, private sector actors and civil society actors, who form voluntary transnational agreements in order to meet specific sustainable development goals. Source: https://www.un.org/en/ecosoc/newfunct/pdf15/2015partnerships_background_note.pdf

[154] This acknowledged the pioneering work of the UNECE region which managed to prepare a Strategy adopted in Vilnius in 2005 benefiting from the UNECE Strategy.

[155] Citizens' Network for the Observation of Marine Biodiversity.

[156] Coralligenous based indicators to evaluate and monitor the "Good Environmental Status" of Mediterranean coastal waters.

or ineffectively transmitted to public and private decision makers and citizens, leading to significant amounts of knowledge that is "wasted". Given the diffuse nature of information sources and data collection processes, the abundance of information needs to be organized effectively to feed into commonly agreed observatories, as well as monitoring and surveillance frameworks at the regional and national level. This may include the development of new indicators or the adaptation of existing or setting-up of new sustainable surveillance processes, platforms, institutions and partnerships. Transmitting project results to common existing platforms and generating data and knowledge in consistency with agreed methodologies as a condition for project and public research funding can be a major lever for action.

In the Mediterranean region, despite the development of various instruments for scientific cooperation (in research and innovation), with strong support from the European Union, significant disparities remain in the level of monitoring and innovation support between NMCs and SEMCs. When science policy-practice collaboration and information-sharing exist, they are often project dependant and thus short-lived with important initial costs and limited capitalization over time. Recent initiatives such as the MedECC scientific network on climate and environmental change pave the way towards further consolidated and "user-ready" knowledge resources.

Common monitoring and assessment frameworks that have been adopted to improve information-based decision-making in the framework of the UNEP/MAP system are also important ways to streamline and prioritize data collection and aggregation.

- **The INFOMAP system.** INFOMAP is being designed as the UN Mediterranean knowledge platform to provide and share data, information services and knowledge for the benefit of the UNEP/MAP components and Contracting Parties. Its purpose is to: (i) Provide access to the reporting system; (ii) Harmonize data structure and models; (iii) Create a common catalogue of resources; (iv) Integrate data with interoperability layer; (v) Create a common platform to view, query and analyse data; (vi) Produce tools to support data and information dissemination.
- **The Integrated Monitoring and Assessment Programme (IMAP).** IMAP is being developed with support from the MAP system, as part of the implementation of the Ecosystem Approach (EcAp) to assess progress towards achieving Good Environmental Status of the Mediterranean Sea and coast. IMAP is based on eleven Ecological Objectives (EO), corresponding to 28 operational objectives and their related 27 agreed common indicators covering three clusters (i) pollution and marine litter, (ii) biodiversity and non-indigenous species and (iii) coast and hydrography. The initial implementation phase of the IMAP (2016-2019) resulted in the development of the first 2017 Mediterranean Quality Status Report (MED QSR).
- A **shared environmental information system with EU countries.** Mediterranean countries collaborate to improve data availability and access to environmental information. The EU-supported Shared Environmental Information System (SEIS) for the reduction of marine pollution fosters the regular production and sharing of quality-assessed environmental data, indicators and information in Algeria, Egypt, Israel, Jordan, Lebanon, Libya, Morocco, Palestine, and Tunisia. This complements information available in EU countries.
- The **European Marine Observation and Data Network (EMODnet)** is a network of organizations supported by the EU's integrated maritime policy. These organizations work together to observe the sea, process data according to international standards and make that information freely available as interoperable data layers and data products. EMODnet covers issues linked to geology, bathymetry, seabed habitats, chemistry, biology, physics and human activities. Originally focused on European countries only, EMODnet also increasingly includes data related to neighbouring countries, including SEMCs.

8.5.4 Science Policy Interfaces

Science Policy Interfaces (SPIs) are tools that can be used to improve environmental governance, conservation and management in the Mediterranean region. UNEP defines an SPI as a structure or process that aims to improve the identification, formulation and evaluation of policies to improve the effectiveness of governance (UN Environment, 2009).

SPIs involve deliberate interactions between scientists and policymakers to build a common understanding of policy-relevant issues. Instead of just communicating information, scientists and policymakers interact and exchange ideas. In this arrangement, policymakers can inform scientists about their knowledge needs and expectations, their analysis of issues and current policymaking processes and bottlenecks, while scientists can clarify the scope of their scientific results and the way it can be translated into recommendations, concrete measures and future research *(Figure 197)*.

Cooperation does not occur within two fully distinct spheres of activity. The scientific and political spheres have a continuous mutual influence on each other. The concept of SPI also calls for a common "space and time" between these two spheres to promote regular interactions and collaboration.

In the Mediterranean, the SPI approach is incorporated into a number of environmental institutions, networks and projects. Science policy interactions have achieved many results at both the national level (e.g. drafting of National Action Plans to address pollution) and regional level (e.g. MSSD Review Process). To go beyond occasional exchanges, the Contracting Parties called for a stronger SPI and for efforts to structure relationships between the UNEP/MAP - Barcelona Convention system and scientific communities by creating scientific committees and expert groups with an advisory role to support policymaking processes at their COP19 (Athens, Greece, February 2016).
This dialogue can be hindered by communication barriers

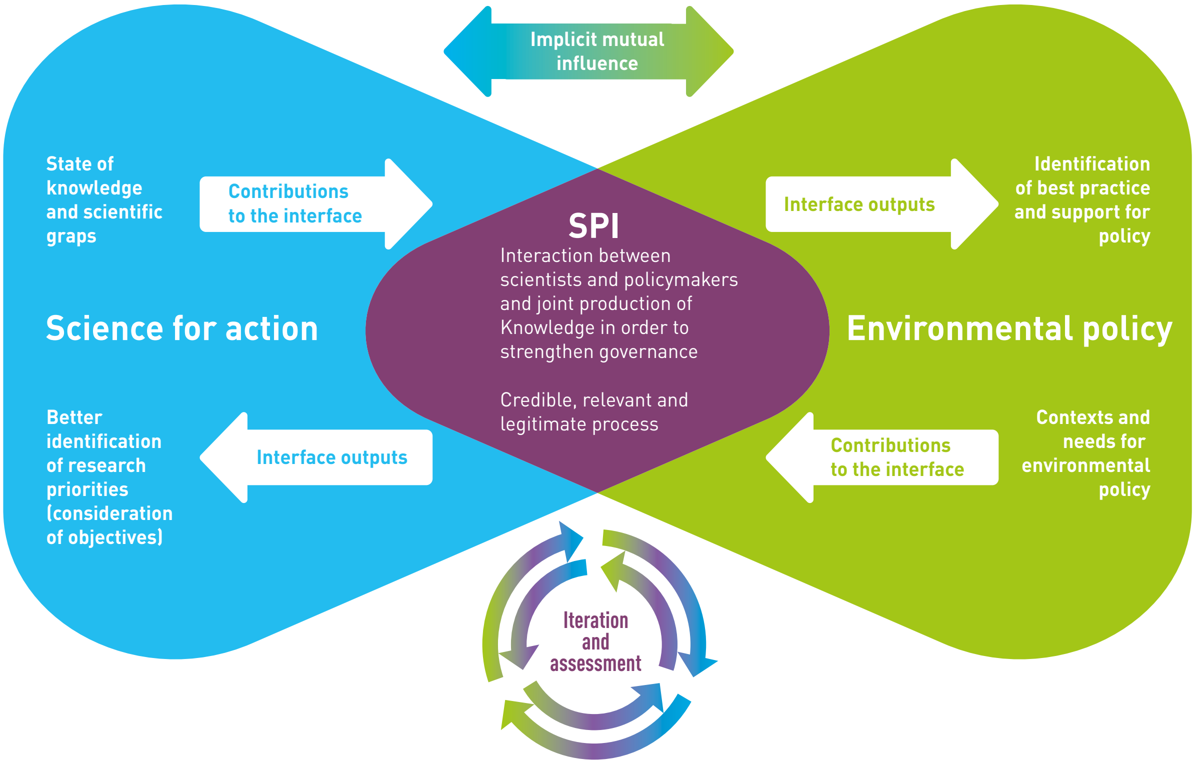


Figure 198 - Designing optimal Science policy Interfaces

between the scientific and political spheres. For instance, research timeframes are generally very different from policymaking timeframes. Policy decisions are made today based on present knowledge, whereas additional knowledge produced by research will be available only in the future. The production of knowledge is sometimes unbalanced since some fields receive more funding and are better documented than others due to a lack of initial discussion between scientists and policymakers to better identify where efforts should be placed.

8.6 Priority responses: balancing policy mixes, managing knowledge for action, enforcing existing commitments and regulation

Previous reports on the state and outlook of environment and development interactions in the Mediterranean published by Plan Bleu in 1989 and 2005 had identified three main policy challenges, falling under the overarching theme of governance: (i) strengthening regional cooperation; (ii) integrating environment into sectoral policies, and (iii) promoting sustainable local and territory-specific development. Despite the progress achieved, these three levers of action remain insufficiently addressed in 2019:

- Over the last decade, **regional cooperation** in the Mediterranean has experienced major difficulties due to geopolitical circumstances, but cooperation on environmental matters has remained active. Countries have adopted common objectives, commitments and monitoring frameworks. Stakeholder networks have also expanded and diversified. With increased relevant information sources and pilot experiences, cooperation will remain a key condition of environment and development progress in the upcoming decades, with permanent cooperation frameworks across different institutions and types of stakeholders being a key priority.
- With regards to **integrating the environment into sectoral policies,** progress has been achieved through the Barcelona Convention and the establishment of integrated tools, including the ICZM Protocol, the Ecosystem Approach and the Sustainable Consumption and Production (SCP) Action Plan. However, much remains to be done. As the importance of the environment in decision-making is not yet fully recognized, administrations in charge of the environment remain under-considered and underfunded compared to the magnitude of challenges and the comprehensiveness of plans and strategies they are to implement. They lack the necessary institutional clout that would allow firm and effective mainstreaming of environment and related long-term planning in sectoral management. With the rapid development of sectors impacting the environment, ensuring a transition towards environmentally sustainable and socially inclusive sectors remains a critical goal, as demonstrated by mobilization surrounding the blue, green and circular economy. Enhanced communication and awareness-raising about the issues associated with degradation or increasing inequalities on environmental, social and economic components via evaluations of key ecosystem services and socioeconomic impacts can contribute to better integration of environmental issues

in decision-making. Full involvement and support from economic sectors is crucially needed to succeed in integrating the environment into sectoral activities.
- **Territorial approaches** have been successfully strengthened with decentralization moving forward in some countries, and advocacy for local decision-making progressing through various forums. For example, local authorities play a crucial role in planning and implementing concrete climate change mitigation and adaptation measures. Much remains to be done in empowering local governments and mainstreaming environmental awareness into all levels of decision-making.

In addition to these challenges, major governance bottlenecks currently hindering sustainable development in the Mediterranean are linked to shortcomings in (i) policy design with coherent policy mixes and adequate funding mechanisms, (ii) action-oriented knowledge management, and (iii) enforcement of existing commitments and regulation.

8.6.1 Balancing policy mixes and ensuring adequate funding mechanisms

Efficient environmental policies require adjusted policy mixes, as systemic issues can rarely be solved by stand-alone regulatory measures. Environmental challenges associated with multiple pressures and activities, including strong economic interests, can be tackled only by a conjunction of coordinated instruments through policy mixes, associating regulatory measures with: (i) economic instruments, fiscal measures, extended producer responsibility in application of the polluter-pays principle, diverse funding mechanisms and partnerships (in line with the 2015 Addis Ababa agreement: national and international, public and private, conventional and non-conventional, microcredit, etc.); (ii) incentives for technological and social innovations development and dissemination / scaling-up, (iii) awareness-raising, education, certifications and voluntary agreements, as well as training programmes; and (iv) instruments supporting environmentally-friendly land tenure, land use and land use planning in areas under significant pressures and (v) surveillance measures to monitor factual progress.

Considering measures and policies not individually but as a coherent whole makes it possible to assess and share the expected co-benefits and trade-offs of decisions and to discuss them with relevant stakeholders. This will also identify ways in which the potential adverse effects of measures can be mitigated, ideally by applying a mitigation hierarchy aiming to first avoid, then reduce or eventually compensate remaining trade-offs.

Investing in policy platforms can help understand and share experience on suitable combinations of policy instruments. **Policy platforms** can also provide a context in which synergies and trade-offs between measures can be best dealt with and improve policy learning between countries. At the Mediterranean level, the upcoming seventh step of the EcAp roadmap aims to develop coherent

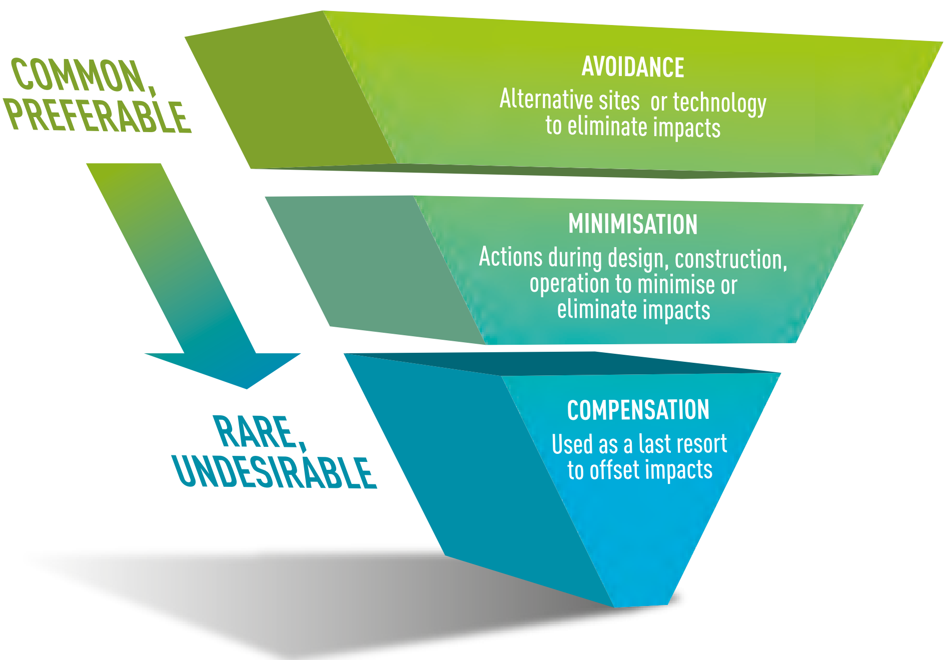


Figure 199 - The mitigation hierarchy at project level
(Source: Open online course on Environmental Impact Assessment of the United Nations University, RMIT University, and the United Nations Environment Programme (UNEP), University of the South Pacific, UNU-Global Virtual University, consulted in October 2019)

action plans and programmes of measures for achieving Good Environmental Status (GES) of the Mediterranean Sea and coast and can present an opportunity to re-think policy mixes in the region.

Appropriate funding mechanisms are a vital part of policy mixes. Many regional sustainability strategies, programmes and plans are designed without adequate funding plans and mechanisms. Investments in infrastructure development, including water drinking water supply, sanitation, wastewater treatment, waste management, and more recently renewable energy have been key to progress on sustainability indicators, in particular in SEMCs. Continuous need for investments is expected in these areas as populations continue to grow in SEMCs. Emerging challenges, including climate change, are also expected to require considerable public and private investment, with early action a condition to prevent major subsequent costs. As for other environmental policies, including biodiversity conservation, while investment costs may be limited, funding for recurring costs is a condition of effectiveness.

8.6.1.1 Economic and financial instruments

As defined by the United Nations Glossary of Environment Statistics (1997) *"Economic instruments are fiscal and other economic incentives and disincentives to incorporate environmental costs and benefits into the budgets of households and enterprises. The objective is to encourage environmentally sound and efficient production and consumption through full-cost pricing. Economic instruments include effluent taxes or charges on pollutants and waste, deposit—refund systems and tradable pollution permits."* The common element of all economic instruments is that they influence behaviour through their impact on market signals. They are a means of considering "external costs" (costs to the public incurred during the life cycle of various goods and services) in market prices. These "external costs" may include natural resource depletion, environmental degradation, health impacts or social impacts.

In the Mediterranean, the use of economic instruments has been studied in the framework of National Action Plans (NAPs) towards the achievement of Good Environmental Status (GES) of Mediterranean marine and coastal waters. Available information indicates that there is a range of experiences across the Mediterranean mainly linked to waste, wastewater, and marine litter. *Table 39* shows the number of economic instruments used in NAPs in some non-EU Mediterranean countries and *Table 40* indicates the economic instruments in use and planned in the same countries.

Relevant stakeholders can be encouraged to accept and take ownership of economic instruments for environmental management by demonstrating and communicating on the economic and social (including health) benefits of measures, and by providing comparison to scenarios of inaction. Natural capital, ecosystem and ecosystem services accounting could contribute in this case and should therefore be further developed as a component of national accounts.

Subsidies are another way of influencing market signals. It has been recognized since the 1980s and early 1990s that subsidies can stimulate economic activities that are environmentally harmful, such as subsidies for fossil fuel and electricity or marine capture fisheries and certain kinds of agriculture (OECD, 2017). It is estimated that the following amounts of subsidies with significant environmental footprints are granted, in the following sectors (OECD, 2017):

- Fossil fuel production and consumption: at least USD 400 billion per year, globally, leading to potential impacts such as land degradation (coal and petroleum production), spills (petroleum production), methane emissions (natural gas, deep-mined coal production), CO_2, sulphur and particulate emissions during consumption.
- Water use and treatment: around USD 450 billion globally in 2012, according to the IMF, leading to potential overuse (depleting aquifers, reducing flows in some rivers) and encouraging investment in unsustainable uses.

Countries	Legal	Institutional	Policy	Economic	Technical	Total
Albania	5	32	10	5	29	81
Algeria	6	21	7	15	14	63
Bosnia and Herzegovina	0	2	2	1	0	5
Egypt	2	2	3	-	33	40
Jordan	8	11	7	6	23	55
Lebanon	9	13	5	12	22	61
Montenegro	17	42	4	13	48	124
Morocco	8	11	2	9	19	49
State of Palestine	14	23	1	6	51	95
Tunisia	22	0	25	0	28	75
Total	91	157	63	70	267	648

Table 39 - Number and types of policy instruments in National Action Plans (NAPs) of some Mediterranean countries
(Source: UNEP/MAP, 2017)

Countries	In use	Planned
Albania	Water tariffs (issues: low tariffs, not based on consumption; metering, non-billed water; 34% of operational costs of utilities subsidized). Weak instruments in waste sector.	Implementation of water pollution charge. Fiscal and economic instruments to reduce use of plastic bags. Enforcement.
Algeria	Eleven taxes/charges for pollution, hazardous substances, petroleum products and fuels, plastic bags, tyres, lubricants + waste and water utilities.	Improve collection. Incentives for mercury waste management. Incentives for recycling.
Bosnia and Herzegovina	Charges for public services and natural resources; progress in waste sector. Issues: inadequate level, collection (legislative gaps, organizational weaknesses); Economic instruments not effective in changing behaviours.	Development of economic instruments to address marine litter, disposal of inert waste and separate collection of waste.
Egypt	Incentives provided to industries to adopt cleaner production technologies. Pollution taxes and fines (enforcement; low tariffs).	Application of economic instruments to irrigation.
Lebanon	Irrigation charges. Water tariff. Solid waste collection. Incentives for municipalities hosting landfills.	Tax breaks on recycled material and for recycling industries. Waste taxation, fines on plastic packaging. Water tariffs, wastewater discharge fees. Incentives for food sector; fines and incentives for cement industries.
Montenegro	Water/ waste tariffs + Charges for air pollutants, use of Ozone Depleting Substances, generation and disposal of hazardous waste, use of vehicles, aircrafts, vessels.	Fuel taxes. Instruments to stimulate recycling. Penalties/ noncompliance fees.
Morocco	Water abstraction. Wastewater discharges. Increasing block tariffs for water. Some waste instruments (e.g. waste disposal charge), but not applied. Eco-tax on plastic bags. Subsidies to reduce env. impact of irrigation and transport.	Enforcement of penalties (especially targeting illegal waste disposal). Incentives to chlor-alkali industry. Waste management instruments.
Tunisia	Environmental tax for plastics. Progressive tariffs for utilities. Tax exemptions/reduced rates for pollution abatement, recycling.	Achieve cost-recovery levels for water charges Introduction of water pollution tax.

Table 40 - Economic instruments in use and planned in some non-EU Mediterranean countries
(Source: UNEP/MAP, 2017)

- Agricultural production: around USD 100 billion in support considered potentially environmentally harmful provided by OECD countries in 2015, potentially leading to habitat destruction, land degradation, nutrient pollution (including via aquaculture).
- Fisheries: around USD 35 billion (including fuel subsidies) a year globally, potentially leading to over-fishing and associated externalities from fishing as well as damaging practices that are facilitated by low-cost fuel.
- Others: subsidies that favour the extraction of primary (non-energy) minerals and metals production, and for activities that indirectly lead to increased pressure on the environment (e.g., tax policies that encourage the provision of company cars and fuel credit cards in lieu of cash), leading to potential land degradation, water pollution and discouraging re-use and recycling.

While a comprehensive study of environmentally harmful subsidies has not yet been carried out for Mediterranean countries, they have committed to international agreements and targets addressing the issue of environmentally harmful subsidies, such as the Convention on Biological Diversity which adopted a Strategic Plan for 2011-20 that foresees that "by 2020, at the latest, incentives, including subsidies, harmful to biodiversity are eliminated, phased out, or reformed ... ", or the Sustainable Development Goals (SDGs), which include targets relating to agricultural export subsidies (SDG target 2.b), fossil fuel subsidies (SDG target 12.C), and certain forms of fisheries subsidies that contribute to overcapacity and overfishing (SDG target 14.6).

In the Mediterranean region, priorities for phasing-out such environmentally harmful subsidies include continuing to remove subsidies on **non-renewable energies** (showing an upward trend at a global level after a period of significant decrease), **unsustainable fisheries** and **groundwater extraction. Adequately targeting direct consumption support to the poorest and most vulnerable groups** would help improve the efficiency of environmental measures, in particular in the water and energy sectors of critical importance in the Mediterranean.

8.6.2 Action-oriented knowledge management

Knowledge about different sustainability issues of concern in the Mediterranean has greatly increased throughout recent decades. However, much of this knowledge is neither generated nor managed in a harmonized way, but generally in a disparate manner, making it difficult to collect and compare. Common agreed knowledge platforms to which both temporary projects and longer-term initiatives and institutions report are needed to reduce "knowledge waste" and allow decision makers to put existing knowledge to use.

Building on existing common frameworks is a condition for efficiently following-up on recent efforts. In the context of the Barcelona Convention, priorities for action-oriented knowledge management include implementing **national monitoring programmes in alignment with IMAPs** to fill priority knowledge gaps[157], establishing data exchange protocols, covering issues of emerging concern (mineral extraction and other emerging activities at sea, proliferation of pollutants of emerging concern), and expanding monitoring to also cover drivers, pressures, impacts and responses (including policy platforms) in order to provide integrated information for the effective design of measures to achieve GES.

The prevailing type of environmental information that is shared through common platforms relates to the state of the environment. Even though information concerning drivers, pressures, impacts and responses is also collected, it is less often shared and compared with environmental status and impact information via permanent knowledge sharing platforms that go beyond a project logic which is generally limited in scope and time. Therefore, extending existing initiatives to drivers, pressures, impacts and responses can lead to significant improvement.

In fact, addressing the necessary transitions also requires a precise understanding of non-environmental issues and challenges, including economic and employment benefits and impacts, as well as operational, social, cultural and behavioural aspects associated with the sectors or issues being addressed. This most likely requires working with the private sector and local communities of targeted subregions. It also requires strengthened knowledge in the field of **behavioural sciences**, as sustainability can only be achieved through profound changes in human behaviour at all levels.

Furthermore, information about responses and their effectiveness in tackling environmental issues can be collected to show examples of good practices, **capitalizing on lessons learned** from projects or from the implementation of innovative policies. This can take the form of policy platforms, ideally integrated into existing monitoring networks.

For any type of knowledge-sharing, developing sustainable platforms and networks can only be achieved through **permanent collaboration frameworks** at the sub-national, national and regional level. The sustainability of cooperation mechanisms should be a key concern from the design stage of any knowledge platform. As most cooperation mechanisms are currently dependant on project funding, innovation is required to design agile, mutually beneficial and long-term institutional initiatives. This would especially apply to necessary long-term science policy interfaces.

To influence decision-making and design efficient measures, and in addition to carrying out *ex ante* EIA and SEA (see above), it is key to conduct in *itinere* and *ex post* evaluation of measures and policies. This identifies successes, failures, and difficulties in the way environmental issues are addressed in decision-making. Evidence from appraisal conducted during and after policy implementation can largely contribute to better informed and more effective policies, more interdisciplinary approaches and accountability, and

BOX 100 The UN Sustainable Development Solutions Network (SDSN)

The UN Sustainable Development Solutions Network (SDSN) mobilizes global scientific and technological expertise to promote practical problem solving for sustainable development. The SDSN has operated under the auspices of the UN Secretary General since 2012. It is committed to supporting the implementation of the SDGs at local, national, and global scales. UN SDSN mobilizes the academic community to translate the latest expertise in sustainable development into action. To this end, UN SDSN includes a global network of universities, research centres, and other knowledge institutions. Spanning six continents, the SDSN Networks Programme draws upon the knowledge and educational capacity of over 800 member institutions.

SDSN Mediterranean is the regional sub-network of UN SDSN that aims to boost knowledge on the Agenda 2030 and the SDGs in the Mediterranean area, promoting research, innovative teaching, youth leadership, and engaging in a wide array of projects and partnerships with over 70 Universities and research institutions from the Mediterranean countries. In the field of research and innovation, **"PRIMA"** is an example of an initiative developed to implement the Agenda 2030 and the SDGs. PRIMA means Partnership for Research and Innovation in the Mediterranean Area. It involves 19 countries from the Med Region aiming to develop a 10-year programme to fund research and innovation projects in the field of sustainable water use, agriculture, and the food value chain as a driver of regional and local development. In the field of Education for Sustainable Development, SDSN Mediterranean understands that innovative and high quality teaching methods are essential to shape the common values required to improve social inclusion and to leave no one behind. To this end, the network has kick-started several education projects, including the **Massive Open Online Course (MOOC)** "Sustainable Food Systems: a Mediterranean Perspective" and the first **Siena Summer School on Sustainable Development.** The MOOC has been developed in collaboration with the Barilla Foundation and the SDG Academy, showcasing a successful model of public-private partnership. The flagship project of SDSN Mediterranean is the Plastic Busters Project. The nature and effects of plastic litter on the marine ecosystem, fisheries, and human health are largely unknown and are important issues to be investigated. The **Plastic Busters Project** aims to enhance stakeholder awareness and change perceptions and attitudes regarding waste. In the field of IT innovation tools, SDSN Mediterranean promotes the **Prima Observatory on Innovation (POI)** in agrifood. POI is a digital platform designed to monitor and report on the state of research, innovation, and education within the context of agrifood development in the Mediterranean area.

[157] Identified in the 2017 MED QSR.

potentially reduce the regulatory burden. Rather than general processes and statistics alone, evaluation at all stages of policy implementation should consider some practical applications on the ground, and discuss with practitioners to identify lessons learned, adaptations (to be) made during implementation, and bottlenecks. In the Mediterranean region, the Barcelona Convention provides for a comprehensive policy evaluation mechanism for measures taken by Contracting Parties in application of the Convention. However, it is only partially implemented and does not currently allow conclusions to be drawn on the effectiveness of the Contracting Parties' actions. By virtue of Article 26 of the Barcelona Convention, Contracting Parties commit to report *ex post* on the measures taken for the implementation of the Convention, its Protocols and of the recommendations from the Conference of Parties as well as on the effectiveness of these measures. Article 27 further stipulates that, on the basis of these elements, the Conference of Parties shall evaluate compliance with the Barcelona Convention and its Protocols and recommend potential corrective measures. This policy evaluation mechanism is crucial for the effective implementation of the Convention and its tools and requires further support for Contracting Parties for full application of the provisions of the Convention.

Data gaps are likely to remain a reality in the future and should not prevent decision makers from taking action. In accordance with the precautionary principle stipulated in the Barcelona Convention, stakeholders are invited to take evidence-based action embracing the different available data sources, without delaying the implementation of critical measures when data is incomplete.

8.6.3 Enforcement of existing commitments and regulation

Mediterranean countries have adopted ambitious objectives including some legally binding agreements (some of which are Protocols under the Barcelona Convention) on sustainability, but critical gaps remain in implementing and enforcing them. The Barcelona Convention provides a twofold mechanism to ensure enforcement of its provisions, yet to be fully enacted:

- **The Compliance Committee.** The Compliance Committee of the Barcelona Convention and its Protocols was created in 2008 to help identify implementation and compliance difficulties as early as possible. The Compliance Committee can be triggered by Contracting Parties, the Secretariat and the Committee itself. It has not been triggered to date.
- **Reports by Contracting Parties on measures implemented and their effectiveness** (Article 26) reviewed by the COP to recommend potential corrective measures (Article 27): national reporting of measures taken and evaluation of their effectiveness is insufficient to date, with a significant number of unsubmitted or incomplete national reports. The Barcelona Convention does not provide for a sanctioning mechanism in case of non-compliance. Strengthening the fulfilment of Articles 26 and 27 presents an opportunity to close the adaptive policy cycle from planning, to implementation, enforcement, monitoring and evaluation, based on commonly agreed measures.

BOX 101

The European Court of Justice ruling on the case of l'Etang de Berre for more effective enforcement of the Barcelona Convention and its Protocols

The Etang de Berre, close to Marseille, France, consists of salt-marshes and salt farms around the Berre lagoon and is an important wetland site. The site is threatened by tourism as well as by urban and industrial development (Daumalin, 2018), with significant water pollution from industry. A group of fishermen who saw the Berre ecosystem and their professional activity impacted, complained before a French domestic court against discharges by an electricity company that was polluting the Etang de Berre with fresh water and sediments from the river Durance. The fishermen stated that the discharges were in violation of Article 6(3) of the Land-Based Sources Protocol to the Barcelona Convention, to which France and the European Union are Parties.

The French *Cour de Cassation* requested a preliminary ruling from the European Court of Justice (ECJ) on the question of whether or not Article 6(3) of the Protocol has direct effect. The ECJ ruled that Article 6(3) of the Protocol lays down clear obligations as to discharges of certain substances and that a permit for the discharges is needed. The ECJ also ruled against France for failing to implement the same Convention and Protocol, with violations of Article 6(1) (obligation to rigorously reduce pollution) and Article 6(3). In its ruling, the ECJ has made the Barcelona Convention and the Protocol part of the EU Community legal order, even though they had not yet been implemented into European law. The ECJ also allowed individuals to rely on the provisions of the Barcelona Convention before the national courts of the EU Member States, thus allowing both the Commission and individuals to enforce compliance by the EU Member States in the implementation of the Barcelona Convention and its protocols (Hildering, Keessen & van Rijswick, 2009).

Mediterranean coastal States increasingly declare Exclusive Economic Zones (EEZ) at sea. This can facilitate enforcement in these areas, as States can apply national laws for environmental violations. For example, violations from ships sailing under foreign flags in an EEZ can be handled by the respective Mediterranean State, rather than having to wait for action from the State under whose flag the ship sails.

Still, enforcement of environmental legislation on land and at sea remains limited at the national level, where human resources, training and budgets in this area are often insufficient to provide effective solutions, and sanctioning mechanisms are often inexistent or ineffective. At the European level, the Barcelona Convention and its Protocols are part of the European legal order and the European Court of Justice can sanction EU countries for non-compliance with the Barcelona Convention and its Protocols *(Box 101)*. Cases of rulings by the European Court of Justice with regard to the Barcelona Convention are rare. The systematic inclusion of operational implementation and enforcement instruments into environmental policies remains a key gap and calls for increased efforts and capacity-building.

Other critical areas for increased enforcement include environmental crimes such as illegal waste disposal and trafficking (including criminal activities), illegal mining (including illegal sand extraction and smuggling (UNEP, 2019)), illegal fishing (including in Marine Protected Areas, with enforcement needed along the value chain), illegal construction in coastal zones and protected coastal areas, etc. Recent enforcement measures (e.g. on air pollution by ships) and subregional collaborations (e.g. on illegal discharge at sea) can serve as examples for upscaling surveillance and legal action on environmental regulations.

Leads for strengthening enforcement include:

- developing and testing of a set of criteria and associated indicators to assess compliance (including with the Barcelona Convention and its Protocols);
- adopting necessary provisions in national legislation to allow for legal action, including notions of precautionary principles, environmental prejudice, non-regression on environmental regulations, environmental prevention, and adopting effective legal and administrative mechanisms to implement these principles;
- building capacities for surveillance and intervention at land and sea, particularly offshore (ships and airplanes) and enlarge maritime surveillance to not only cover safety and security but also compliance with environmental regulations;
- strengthening cooperation between judiciary and administrative bodies;
- building capacities of judiciary and administrative resources along the enforcement chain, on environmental legal frameworks, jurisprudence, environmental and economic issues, with both a general awareness programme and specialized training;
- developing cooperation and synergies with other MEA Compliance Committees in areas of common concern including joint activities to promote and facilitate compliance;
- exploring the (potential) role of non-governmental actors, such as NGOs and broader civil society, in the enforcement of environmental regulation; and
- developing judicial cooperation at the Mediterranean level.

BOX 102

Judicial cooperation for environmental protection in the Mediterranean: The case of the Mediterranean Network of Law Enforcement Officials (MENELAS)

In the framework of the Barcelona Convention, promising leads for administrative and judicial cooperation have developed with regard to detecting and sanctioning intentional pollution from maritime transport at the Mediterranean level. The Mediterranean Network of Law Enforcement Officials relating to the International Convention for the Prevention of Pollution from Ships (MARPOL) within the framework of the Barcelona Convention (MENELAS) has been exploring the possible development of regional jurisdictional and judicial cooperation in the Mediterranean. It has also discussed a common report that would enable the courts of the Contracting Parties to the Barcelona Convention to prosecute all individuals, irrespective of the place of pollution. MENELAS has also been considering the possibility of accompanying this judicial cooperation with the establishment of a regional "Blue Fund", to which a part of the pecuniary sanctions would be transferred. Stakeholders have mentioned aligning the level of sanctions or nature of acceptable proofs as potential areas for future progress.

This type of judicial cooperation could be further extended to other policy areas of common interest.

BOX 103

Climate change litigation and the role of civil society

Several cases of judicial litigation have been recorded in EU Mediterranean countries, 40 of which were brought before the European Court of Justice, 13 in Spain and 4 in France (UNEP & Columbia University, 2017). One of the trends in climate change litigation is related to holding governments to their legislative and policy commitments, thereby enforcing climate engagements via legal action. The most famous of such cases took place in the Netherlands, where a Dutch environmental group, the Urgenda Foundation and 900 Dutch citizens sued the Dutch government to require it to do more to prevent global climate change. The court in the Hague agreed with the plaintiffs and ordered a limitation of greenhouse gas emissions to 25% below 1990 levels by 2020 finding the set goal of 17% to be insufficient with regard to the Paris Agreement. The court concluded that the state has a duty to take climate change mitigation measures due to the "severity of the consequences of climate change and the great risk of climate change occurring." In reaching this conclusion, the court cited (without directly applying) Article 21 of the Dutch Constitution, EU emissions reduction targets, principles under the European Convention on Human Rights, the "no harm" principle of international law, the doctrine of hazardous negligence, the principle of fairness, the precautionary principle, and the sustainability principle embodied in the UN Framework Convention on Climate Change, and the principle of a high protection level, the precautionary principle, and the prevention principle embodied in the European climate policy.

A similar case filed in France is pending judgment.

BOX 104 Environmental Compliance Assurance in the EU

As part of environmental governance, environmental compliance assurance describes ways in which public authorities promote, monitor and enforce compliance with such rules.

- *Promote* means helping stakeholders to comply: awareness-raising, guidance, advice;
- *Monitor* means using inspections and other checks to collect information about levels of compliance and provide evidence for enforcement: routine environmental inspections, police investigations and environmental audits by public audit bodies, examination of complaints from the public;
- *Enforce* means stopping those who violate the rules, sanctioning them and obliging them to rectify the damage: audit recommendations, official warnings, cease-and-desist orders, administrative fines, criminal prosecutions and demands to take remedial action.

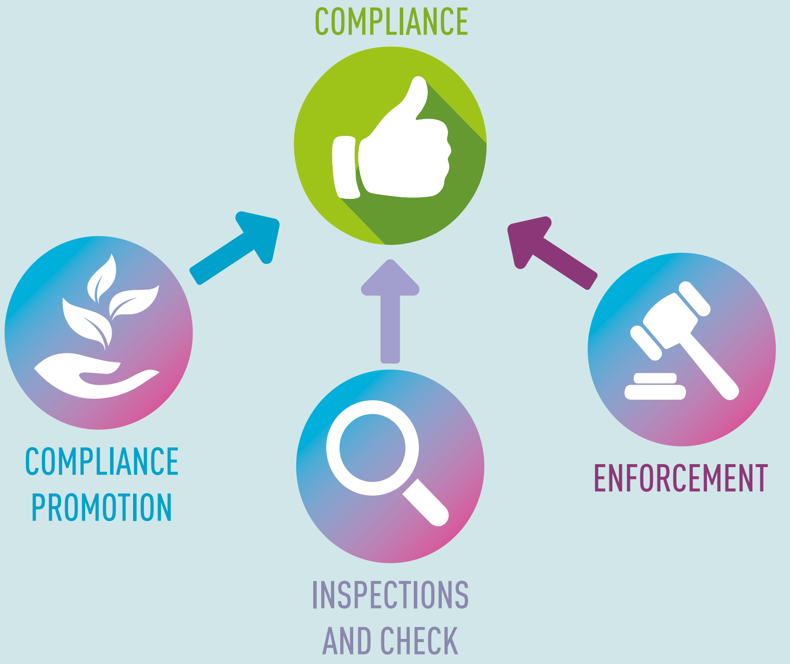


Figure 200 - Three steps of Environmental Compliance Assurance
(Source: European Commission, 2019)

Based on this environmental compliance assurance framework, in January 2018, the European Commission adopted a 9-point Action Plan to increase compliance with and improve governance on EU environmental rules on activities. The actions are implemented with the help of EU countries and European networks of environmental agencies, inspectors, auditors, police, prosecutors and judges. The actions aim to:

- help inspectors and law officers to combine forces, including through joint inspections and enforcement actions,
- improve professional training,
- provide guidance on combating environmental crime, complaint handling at the national level, inspecting extracting waste facilities, compliance assurance in rural areas, and using satellite images and other spatial data to detect crimes like illegal waste disposal,
- improve Commission information to Member States and practitioners.

Conclusions

Progress has been achieved throughout the last decade. Sustainable development policies, strategic frameworks and action plans have been developed and improved. Knowledge on ecosystems and their role for human well-being has increased. However, these areas of progress have not been sufficient to reduce pressures on and degradation of the Mediterranean coastal and marine environment. They have not allowed Mediterranean coastal populations to adapt to current and projected environmental and climate change and to increase their resilience. To reach commonly-set goals and objectives such as achievement of Good Environmental Status of the Mediterranean sea and coast, and more broadly the SDGs, and to avoid projected failures, current trajectories must urgently be corrected. The transition towards more sustainable pathways requires radical changes in behaviour at all levels and in all areas, the main driver for increasing pressures and degradations being our production and consumption patterns.

Transitions are required in all production and consumption systems, and cannot be brought about by policymakers alone. Changing development pathways is a responsibility shared by all stakeholders in civil society, the private sector, including banking and insurance, the scientific community, judicial systems, etc. Fostering participation and taking advantage of stakeholder mobilization to engage in dialogue and coordinated action will improve policy outcomes at all levels. The current mobilization of youth for sustainable development must be seized as an opportunity for policymakers to take into account long-term goals, and translate them into short- and medium-term investments and reforms. Scientists are increasingly mobilized to produce policy relevant assessments and collaborate in organized science policy interfaces such as the Intergovernmental Panel on Climate Change (IPCC), the Intergovernmental Science policy Platform on Biodiversity and Ecosystem Services (IPBES) or, at the Mediterranean level, MedECC. Judicial systems increasingly deal with environmental and climate litigation and support the enforcement of sustainability regulations. The private sector's powerful role in funding and inventing sustainable lifestyles is increasingly acknowledged.

The UNEP/MAP - Barcelona Convention system can play a major role in fostering sustainability transitions. This requires an urgent step up from planning, engagement and local innovation, to widespread implementation on the ground and effective enforcement, in collaboration with local authorities and relevant stakeholders, including relevant private sector and funding agencies. Implementation and enforcement are lagging behind the ambition of commonly agreed objectives and measures, and risk discrediting their comprehensiveness and the major achievements in environmental diplomacy in the region. The imminent threat of severe and irreversible damage to ecosystems and subsequent human well-being calls for the urgent implementation and enforcement of agreed actions, capitalization, scaling-up and dissemination of a multitude of relevant innovations within a coherent approach, as well as adequate monitoring and evaluation to ensure that measures are leading to the desired effects, and necessary adjustments when achievements fall behind.

References

References used in the Foreword, Preface and Introduction

- Benoit, G. & Comeau, A. (Ed(s)). (2005). *A sustainable future for the Mediterranean: the Blue Plan's environment and development outlook.* London, UK: Earthscan.
- Grenon, M. & Batisse, M. (1989). Futures for the Mediterranean basin: The Blue Plan. Oxford University Press, Oxford.
- MERICS. (2018). *Interactive map of the Belt and Road Initiative.* Retrieved from https://www.merics.org/en/bri-tracker/interactive-map
- UN Environment (2019). *Global Environment Outlook - GEO-6: Healthy Planet, Healthy People.* Nairobi, Kenya: UNEP. doi:10.1017/9781108627146.
- UNEP/MAP-Plan Bleu. (2009). *State of the environment and development in the Mediterranean.* UNEP/MAP-Plan Bleu.

References Chapter 1

- AGAM. (2013). *Atlas des villes portuaires du Sud et de l'Est de la Méditerranée.* Retrieved from http://www.agam.org/fr/newsletter-2/newsletter-n18-atlas-des-villes-portuaires-du-sud-et-de-lest-de-la-mediterranee.html
- American Enterprise Institute & the Heritage Foundation. (2019). *China Global Investment Tracker.* Retrieved from https://www.aei.org/china-global-investment-tracker/
- Arrault, J-B. (2006). À propos du concept de *Méditerranée*. Expérience géographique du monde et mondialisation. *Cybergeo: European Journal of Geography.*
- Ayadi, R. & Sessa, E. (2017). *Regional integration in the Euro-Mediterranean.* EMNES Working Paper N° 1.
- Belguidoum S. & Pliez O. (2019). La géographie discrète des réseaux transnationaux entre l'Algérie et la Chine. *Confluences Méditerranée,* 109(2), 63-76.
- Blanc, P. (2010). Pays du Golfe en Méditerranée : les registres de l'influence. *Confluences Méditerranée,* 74(3), 83-96.
- Choplin, A. & Pliez, O. (2018). La mondialisation des pauvres. Loin de Wall Street et de Davos, Paris, Seuil, Coll. La République des idées, 128 p. *Cybergeo: European Journal of Geography*.
- Cook, E.R., Seager, R., Kushnir, Y., Briffa, K.R., Büntgen, U., Frank, D., Krusic, P.J., Tegel, W., Van der Schrier, G., Andreu-Hayles, L., Baillie, M., Baittinger, C., Bleicher, N., Bonde, N., Brown, D., Carrer, M., Cooper, R., Čufar, K., Dittmar, C., Esper, J., Griggs, C., Gunnarson, B., Günther, B., Gutierrez, E., Haneca, C., Samuli, H., Herzig, F., Heussmer, K., Hofman, J., Janda, P., Kontic, R., Köse, N., Kyncl, T., Levanič, T., Linderholm, H., Manning, S., Melvin, T.M., Miles, D., Neuwirth, B., Nicolussi, K., Nola, P., Panayotov, M., Popa, I., Rothe, A., Seftigen, K., Seim, A., Svarva, H., Svoboda, M., Thun, T., Timonen, M., Touchan, R., Trotsiuk, V., Trouet, V., Walder, F., Ważny, T., Wilson, R. & Zang, C. (2015). Old World megadroughts and pluvials during the Common Era. *Science Advances*, 1(10), e1500561.
- Croitoru, L. & Sarraf, M. (2010). *The cost of environmental degradation: case studies from the Middle East and North Africa.* Washington, DC: World Bank.
- Croitoru, L. & Sarraf, M. (Ed(s)). (2017). *Le coût de la dégradation de l'environnement au Maroc.* Washington: World Bank Environment and Natural Resources Global Practice Discussion Paper #5.
- De Souza, L.E.V., Bosco, E.M.G.R.L., Cavalcante, A.G. & Da Costa Ferreira, L. (2018). Postcolonial theories meet energy studies: "Institutional orientalism" as a barrier for renewable electricity trade in the Mediterranean Region. *Energy Research & Social Science*, 40, 91-100.
- Delanoë, I. (2014). Le retour de la Russie en Méditerranée. *Cahiers de la Méditerranée,* 89.
- Deprest, F. (2002). L'invention géographique de la Méditerranée : éléments de reflexion. *L'espace géographique, 31*(1), 73-92.
- Doceul, M-C. & Tabarly, S. (2018). Le canal de Suez, les nouvelles dimensions d'une voie de passage stratégique. *Géoconfluences*.
- Eder, T.S. & Mardell, J. (2019). *Powering the Belt and Road.* Mercator Institute for China Studies. Retrieved from https://www.merics.org/en/bri-tracker/powering-the-belt-and-road
- Efoui-Hess, M. (2019). *Climate crisis: the unsustainable use of online video. The practical case for digital sobriety.* The Shift Project. Retrieved from https://theshiftproject.org/wp-content/uploads/2019/07/2019-02.pdf
- Ekman, A. (2018). China in the Mediterranean: An Emerging Presence. *Notes de l'IFRI, Ifri, February 2018.*
- Global Footprint Network. (2018). *Global Footprint Network.* Retrieved from https://www.footprintnetwork.org/
- Hache E. & Mérigot, K. (2017). Géoéconomie des infrastructures portuaires de la route de la soie maritime. *Revue internationale et stratégique, 107*(3), 85-94.

- IMF. (2018). *World Economic Outlook Database*.
- International Telecommunications Union. (2018). *Measuring the Information Society Report, Vol. 2,* 2018. Geneva, Switzerland: ITU Publications.
- International Telecommunications Union. (2019). *Fracture(s) numérique(s).* Retrieved from https://espace-mondial-atlas.sciencespo.fr/fr/rubrique-contrastes-et-inegalites/article-1A09-fracture(s)-numerique(s).html
- Internet World Stats. (2019). Retrieved from www.internetworldstats.com
- Intracen (2018). *International Trade Statistics Database*. International Trade Center
- Jabbour, J. (2014). Le retour de la Turquie en Méditerranée : la « profondeur stratégique » turque en Méditerranée pré- et post-printemps arabe. *Cahiers de la Méditerranée, 89*.
- Loichinger, E., Goujon A. & Weber D. (2016). *Demographic Profile of the Arab Region. Realizing the Demographic Dividend*. United Nations Economic and Social Commission for Western Asia (ESCWA).
- Morvan, Y. (2011, June 27). Kanal Istanbul, un « projet fou » au service d'ambitions politiques. *Métropolitiques.* Retrieved from https://www.metropolitiques.eu/Kanal-Istanbul-un-projet-fou-au.html
- OECD. (2019). *Turkey highlights 2019.* OECD Environmental Performance Reviews. Paris, France: OECD Publishing. doi:10.1787/9789264309753-en
- Piante, C. & Ody, D. (2015). *Blue Growth in the Mediterranean Sea: The Challenge of Good Environmental Status*. MedTrends. Project. WWF-France. 192 pages.
- Sachs, J., Schmidt-Traub, G., Kroll, C., Lafortune, G. & Fuller, G. (2019). *Sustainable development report 2019.* New York, NY: Bertelsmann Stiftung and Sustainable Development Solutions Network (SDSN).
- Sarraf, M., Larsen, B. & Owaygen, M. (2004). *Cost of Environmental. Degradation - The Case of Lebanon and Tunisia.* World Bank Environmental economics series (97). Washington, DC: World Bank. Retrieved from http://documents.worldbank.org/curated/en/445831468760782622/Cost-of-environmental-degradation-the-case-of-Lebanon-and-Tunisia
- Schmitt, T.M. (2018). (Why) did Desertec fail? An interim analysis of a large-scale renewable energy infrastructure project from a Social Studies of Technology perspective, *Local Environment,* 23(7), 747-776. doi:10.1080/13549839.2018.1469119
- Selby, J., Dahi, O.S., Fröhlich, C. & Hulme, M. (2017). Climate change and the Syrian civil war revisited. *Political Geography, 60,* 232-244. doi:10.1016/j.polgeo.2017.05.007
- Sidło, K., Frizis, I., Dragouni, O., Ruzik-Sierdzińska, A., Gigitashvili, G., Beaumont, K. & Hartwell, C.A. (2017). *Women's Empowerment in the Mediterranean Region*. European Committee of the Regions. doi:10.2863/878975
- Telegeography. (2019). *Submarine Cable Map.* Retrieved from URL: https://www.submarinecablemap.com/
- Tozy S., Trifaia A. & London M. (2018, April). *Les nouvelles routes du commerce méditerranéen.* Les publications économiques du Coface. Retrieved from https://www.coface.ch/fr/content/download/162212/2665334/file/FR+Coface+RoutesCommerce+Panorama+100418.PDF
- UN-COMTRADE (2018). *International Trade Statistics Database*.
- UNCTAD. (2019, April). *Merchandise: Total trade and share*. Retrieved from: https://unctadstat.unctad.org/EN/
- UNDP. (2018). *Human Development Indices and Indicators, 2018 Statistical Update.* New York, NY: United Nations Development Programme. Retrieved from: http://hdr.undp.org/sites/default/files/2018_human_development_statistical_update.pdf
- UNEP IRP. (2018). *Global Material Flows Database*. Retrieved from https://www.resourcepanel.org/global-material-flows-database
- UNEP. (2016). *Global Gender and Environment Outlook. The Critical Issues.* Nairobi, Kenya: United Nations Environment Programme.
- UNHCR. (2017). *Migration Data Portal.* Retrieved from https://data2.unhcr.org/en/situations/mediterranean/location/5179
- UNHCR. (2019). *Operational Portal Refugee Situations.* Retrieved from https://data2.unhcr.org/en/situations
- United Nations (2018). *World Urbanization Prospects: The 2018 Revision, Online Edition.* New York, NY: Department of Economic and Social Affairs, Population Division. Retrieved from https://population.un.org/wup/Download/
- United Nations Environment Assembly of the United Nations Environment Programme. (2019, March 15). *Promoting gender equality and the human rights and empowerment of women and girls in environmental governance.* Resolution UNEP/EA.4/L.21. Retrieved from https://papersmart.unon.org/resolution/uploads/k1900914.pdf
- United Nations. (2017). *World Population Prospects: The 2017 Revision*. New York, NY: Department of Economic and Social Affairs. Retrieved from https://esa.un.org/unpd/wpp
- United Nations. (2019). *World Population Prospects 2019, Online Edition.* New York, NY: Department of Economic and Social Affairs. Retrieved from https://population.un.org/wpp/
- UNWTO (2019). *Yearbook of Tourism Statistics, Data 2013-2017, 2019 Edition.* Madrid, Spain: World Tourism Organization. doi:10.18111/9789284420414
- Werz, H. & Hoffman, M. (2017). *Climate change and migration in the Mediterranean: Challenges for the future.* IEMed Mediterranean Yearbook. Retrieved from https://www.iemed.org/observatori/arees-danalisi/arxius-adjunts/anuari/med.2017/IEMed_MedYearbook2017_climate_change_Werz_hoffman.pdf
- World Bank. (2018). *International Comparison Programme Database.* Retrieved from: https://www.worldbank.org/en/programs/icp
- World Bank. (2019a). *World Development Indicators.* Retrieved from: http://datatopics.worldbank.org/world-development-indicators/

- World Bank. (2019b). *Private Participation in Infrastructure (PPI) Database.* Retrieved from: https://ppi.worldbank.org/en/ppi
- World Economic Forum (2020). *Global Gender Gap Report 2020.* Geneva, Switzerland: World Economic Forum. ISBN-13: 978-2-940631-03-2
- World Economic Forum. (2017). *The Global Human Capital Report 2017.* Geneva, Switzerland: World Economic Forum. ISBN 978-1-944835-10-1
- WWF. (2017, May). *The Belt and Road Initiative - WWF Recommendations and Spatial Analysis.* WWF Briefing Paper. Retrieved from http://awsassets.panda.org/downloads/the_belt_and_road_initiative___wwf_recommendations_and_spatial_analysis___may_2017.pdf

References Chapter 2

- ACSAD. (2000). Alternative Policy Study: Water Resource Management in West Asia. Part of the Preparation for UNEP's Global Environment Outlook-2000 Report. United Nations Environment Programme.
- Adloff F., Jordà, G., Somot, S., Sevault, F., Arsouze, T., Meyssignac, B., Li, L. & Planton, S. (2018). Improving sea level simulation in Mediterranean regional climate models. *Climate Dynamics, 51*(3), 1167-1178.
- Adloff, F., Somot, S., Sevault, F., Jordà, G., Aznar, R., Déqué, M., Herrmann, M., Marcos, M., Dubois, C., Padorno, E., Alvarez-Fanjul, E. & Gomis, D. (2015). Mediterranean Sea response to climate change in an ensemble of twenty first century scenarios. *Climate Dynamics, 45*(9-10), 2775-2802.
- Álvarez, M., Sanleón-Bartolomé, H., Tanhua, T., Mintrop, L., Luchetta, A., Cantoni, C., Schroeder, K. & Civitarese, G. (2014). The CO_2 system in the Mediterranean Sea: a basin wide perspective. *Ocean Science, 10,* 69-92.
- Antonioli, F., Anzidei, M., Amorosi, A., Lo Presti, V., Mastronuzzi, G., Deiana, G., De Falco, G., Fontana, A., Fontolan, G. & Lisco, S. (2017). Sea-level rise and potential drowning of the Italian coastal plains: Flooding risk scenarios for 2100. *Quaternary Science Reviews, 158*. doi.org/10.1016/j.quascirev.2016.12.021
- Aucelli P.P.C., Di Paola, G., Incontri, P., Rizzo, A., Vilardo, G., Benassai, G., Buonocore, B. & Pappone, G. (2017). Coastal inundation risk assessment due to subsidence and sea-level rise in a Mediterranean alluvial plain (Volturno coastal plain - southern Italy). Estuarine, *Coastal and Shelf Science, 198*(B), 597-609.
- Azzurro, E., Moschella, P. & Maynou, F. (2011). Tracking signals of change in Mediterranean fish diversity based on local ecological knowledge. *PLoS ONE 6*(9), e24885.
- Bally, M. & Garrabou, J. (2007). Thermodependent bacterial pathogens and mass mortalities in temperate benthic communities: a new case of emerging disease linked to climate change. *Global Change Biology, 13*(10), 2078-2088.
- Bamber, L., Oppenheimer, M., Kopp, R., Aspinall, W. & Cooke, R. (2019). Ice sheet contributions to future sea-level rise from structured expert judgment. *Proceedings of the National Academy of Sciences, 116*(23), 11195-11200. doi.org/10.1073/pnas.1817205116
- Becker, A., Inoue, S., Fischer, M. & Schwegler, B. (2012). Climate change impacts on international seaports: knowledge, perceptions, and planning efforts among port administrators. *Climatic Change, 110*(1), 5-29.
- Ben-Gharbia, H., Yahia, O. K-D., Amzil, Z., Chomérat, N., Abadie, E., Masseret, E., Sibat, M., Zmerli Triki, H., Nouri, H. & Laabir, M. (2016). Toxicity and growth assessments of three thermophilic benthic dinoflagellates *(Ostreopsis cf. ovata, Prorocentrum lima and Coolia monotis)* developing in the Southern Mediterranean Basin. Toxins, 8(10), 297.
- Bensoussan, N., Garreau, P., Pairaud, I., Somot, S. & Garrabou, J. (2013). Multidisciplinary approach to assess potential risk of mortality of benthic ecosystems facing climate change in the NW Mediterranean Sea. 2013 OCEANS - San Diego, San Diego, CA, 1-7. doi:10.23919/OCEANS.2013.6741328
- Bindoff, N.L., Stott, P.A., AchutaRao, K.M., Allen, M.R., Gillett, N., Gutzler, D., Hansingo, K., Hegerl, G., Hu, Y., Jain, S., Mokhov, I.I., Overland, J., Perlwitz, J., Sebbari, R. & Zhang, X. (2013). Detection and Attribution of Climate Change: from Global to Regional. In Stocker, T.F., Qin, D., Plattner, G.-K., Tignor, M., Allen, S.K., Boschung, J., Nauels, A., Xia, Y., Bex, V. & Midgley, P.M. (Eds.). *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.* Cambridge, United Kingdom and New York, NY: Cambridge University Press.
- Bird E. & Lewis, N. (2015). *Beach Renourishment.* SpringerBriefs in Earth Sciences. Springer, Cham. doi:10.1007/978-3-319-09728-2_2
- Bramanti, L., Movilla, J., Guron, M., Calvo, E., Gori, A., Dominguez-Carrió, C., Grinyó, J., Lopez-Sanz, A., Martinez-Quintana, A. & Pelejero, C. (2013). Detrimental effects of ocean acidification on the economically important Mediterranean red coral *(Corallium rubrum). Global Change Biology, 19*(6), 1897-1908.
- Brown, C.J., Fulton, E.A., Hobday, A.J., Matear, R.J., Possingham, H.P., Bulman, C., Christensen, V., Forrest, R.E., Gehrke, P.C. & Gribble, N.A. (2010). Effects of climate-driven primary production change on marine food webs: implications for fisheries and conservation. *Global Change Biology, 16*(4) 1194-1212.
- Calvo, E., Simó, R., Coma, R., Ribes, M., Pascual, J., Sabatés, A., Gili, J.M. & Pelejero, C. (2011). Effects of climate change on Mediterranean marine ecosystems: the case of the Catalan Sea. *Climate Research, 50*(1), 1-29.
- Chefaoui, R.M., Duarte, C.M. & Serrão E.A. (2018). Dramatic loss of seagrass habitat under projected climate change in the

Mediterranean Sea. *Global Change Biology, 24*(10), 4919-4928.
- Cheung, W.L., Sarmiento, J.L., Dunne, J., Frölicher, T.L., Lam, V.W.Y., Deng Palomares, M.L.Watson, R. & Pauly, D. (2013). Shrinking of fishes exacerbates impacts of global ocean changes on marine ecosystems. *Nature Climate Change, 3*(3), 254-258.
- Chevaldonné, P. & Lejeusne, C. (2003). Regional warming-induced species shift in north-west Mediterranean marine caves. *Ecology Letters, 6*(4), 371-379.
- CIESIN. (2013). *Center for International Earth Science Information Network at the Colombia University.* Retrieved from http://www.ciesin.org/
- CIESM. (2008). Impacts of acidification on biological, chemical and physical systems in the Mediterranean and Black Seas. In: F., Briand (Ed). *CIESM workshop monograph 36.* CIESM.
- Ciscar Cuñat, E., Mancomunitat Camp de Túria, SEAFI Camp de Túria & Generalitat Valenciana Consellería de Benestar Social. (2005). SEAFI *Camp de Túria: un modelo de funcionamiento.* Generalitat Valenciana.
- Coll, M., Piroddi, C., Steenbeek, J., Kaschner, K., Lasram, F.B.R., Aguzzi, J., Ballesteros, E., Bianchi, C.N., Corbera, J. & Dailianis, T. (2010). The Biodiversity of the Mediterranean Sea: Estimates, Patterns, and Threats. *PLoS ONE, 5*(8), e11842.
- Coma, R., Ribes, M., Serrano, E., Jiménez, E., Salat, J. & Pascual, J. (2009). Global warming-enhanced stratification and mass mortality events in the Mediterranean. *Proceedings of the National Academy of Sciences, 106*(15), 6176-6181.
- Cramer, W., Guiot, J., Fader, M., Garrabou, J., Gattuso, J-P., Iglesias, A., Lange, M.A., Lionello, P., Llasat, M.C., Paz, S., Peñuelas, J., Snoussi, M., Toreti, A., Tsimplis, M.N. & Xoplaki, E. (2018). Climate change and interconnected risks to sustainable development in the Mediterranean. *Nature Climate Change, 8*, 972-980.
- Danovaro, R., Canals, M., Gambi, C., Heussner, S., Lampadariou, N. & Vanreusel, A. (2009) Exploring benthic biodiversity patterns and hotspots on European margin slopes. *Oceanography, 22,* 16-25.
- Darmaraki, S., Somot, S., Sevault, F., Nabat, P., Narvaez, W.D.C., Cavicchia, L., Djurdjevic, V., Li, L., Sannino, G. & Sein, D.V. (2019). Future evolution of Marine Heat Waves in the Mediterranean Sea. *Climate Dynamics, 53*(3-4), 1371-1392. doi:10.1007/s00382-019-04661-z.
- Daw, T., Adger, W.N., Brown, K. & Badjeck M-C. (2009). *Climate change and capture fisheries: potential impacts, adaptation and mitigation.* FAO Fisheries Aquaculture Technical Papers 530, 107-150.
- Dias, B.B., Hart, M.B., Smart, C.W. & Hall-Spencer, J.M. (2010). Modern seawater acidification: the response of foraminifera to high-CO_2 conditions in the Mediterranean Sea. *Journal of the Geological Society, 167*(5), 843-846. doi: https://doi.org/10.1144/0016-76492010-050
- Díaz-Almela, E., Marbà, N. & Duarte, C.M. (2007). Consequences of Mediterranean warming events in seagrass *(Posidonia oceanica)* flowering records. *Global Change Biology, 13*, 224235.
- Doblas-Miranda, E., Alonso, R., Arnan, X., Bermejo, V., Brotons, L., De las Heras, J., Estiarte, M., Hódar, J.A., Llorens, P. & Lloret, F. (2017). A review of the combination among global change factors in forests, shrublands and pastures of the Mediterranean Region: Beyond drought effects. *Global and Planetary Change, 148*, 42-54.
- Duguy, B., Paula, S., Pausas, J.G., Alloza, J.A., Gimeno, T. & Vallejo, R.V. (2013). Effects of climate and extreme events on wildfire regime and their ecological impacts. In: A., Navarra & L., Tubiana (Ed(s)). *Regional Assessment of Climate Change in the Mediterranean. Volume 2: Agriculture, Forests and Ecosystem Services and People* (pp. 101-134). Dordrecht: Springer.
- ENERGIES 2050, Institut de la Méditerranée & FEMISE. (2018). *Les Défis du Changement Climatique en Méditerranée : Le bassin méditerranéen dans le nouvel Agenda climatique international.*
- ENERGIES 2050. (2018a). *Le bassin méditerranéen dans le nouvel Agenda climatique international.* ENERGIES 2050, Institut de la Méditerranée, FEMISE. Retrieved from http://energies2050.org/rapport-mediterranee-2018/
- ENERGIES 2050. (2018b). *Analyse sectorielle des Contributions déterminées au niveau national (CDN) dans le bassin méditerranéen à travers l'étude des Parties à la Convention de Barcelone.* Rettrieved from https://www.econostrum.info/attachment/1349446/
- ENERGIES 2050. (2018c). *Commitments of Mediterranean countries within the Paris Agreement. GUIDES TO ACT #6*. Retrieved from http://energies2050.org/ressources/rapports/
- Enriquez, A.R., Marcos, M., Alvarez-Ellacuria, A., Orfila, A. & Gomis, D. (2017). Changes in beach shoreline due to sea-level rise and waves under climate change scenarios: application to the Balearic Islands (western Mediterranean). *Natural Hazards Earth System Sciences, 17*, 1075-1089.
- European Commission (2018, November). *Financing Adaptation.* Retrieved from https://ec.europa.eu/clima/policies/adaptation/financing_fr.
- European Commission (2019, January). *EU budget spending: where the money goes.* Retrieved from http://ec.europa.eu/budget/mff/index_en.cfm
- European Commission. (2019, October). *EU-ETS revision for phase 4.* Retrieved from https://ec.europa.eu/clima/policies/ets/revision_en
- European Environment Agency. (2016). *Urban adaptation to climate change in Europe.* EEA Report No. 12/2016. doi:10.2800/021466
- European Environment Agency. (2018). *Environmental indicator report 2018 in support to the monitoring of the 7th Environment Action Programme.* EEA Report No. 19/2018. doi:10.2800/180334
- Flecha, S., Pérez, F.F., García-Lafuente, J., Sammartino, S., Ríos, A.F. & Huertas, I.E. (2015). Trends of pH decrease in the

Mediterranean Sea through high frequency observational data: indication of ocean acidification in the basin. *Scientific reports, 5*, 16770. doi :10.1038/srep16770
- Fontan, O., Berry, A., Ferrat, M., Portalier, J., Tamokoué Kamga, P.H. & Amalou, C. (2019). *Agir en cohérence avec les ambitions - Rapport annuel Neutralité Carbone 2019.* Premier rapport annuel du Haut Conseil pour le Climat. Retrieved from https://www.strategie.gouv.fr/sites/strategie.gouv.fr/files/atoms/files/hcc_rapport_annuel_2019.pdf
- Forzieri, G., Feyen, L., Rojas, R., Flörke, M., Wimmer, F. & Bianchi, A. (2014). Ensemble projections of future streamflow droughts in Europe. *Hydrology and Earth System Sciences, 18*(1), 85.
- Frihy, O. & El-Sayed, M.K. (2013). Vulnerability risk assessment and adaptation to climate change induced sea-level rise along the Mediterranean coast of Egypt. *Mitigation and Adaptation Strategies for Global Change, 18*, 1215-1237. doi.org/10.1007/s11027-012-9418-y
- Galil, B.S., Marchini, A. & Occhipinti-Ambrogi, A. (2018). East is east and West is west? Management of marine bioinvasions in the Mediterranean Sea. *Estuarine, Coastal and Shelf Science, 201*, 7-16.
- Ganteaume, A., Camia, A., Jappiot, M., San-Miguel-Ayanz, J., Long-Fournel, M. & Lampin, C. (2013). A review of the main driving factors of forest fire ignition over Europe. *Environmental Management, 51*(3), 651-662.
- García-Nieto, A.P., Geijzendorffer, I.R., Baró, F., Roche, P.K., Bondeau, A. & Cramer, W. (2018). Impacts of urbanization around Mediterranean cities: Changes in ecosystem service supply. *Ecological Indicators, 91*, 589-606.
- Garner, A., Weiss, J., Parris, A., Kopp, R., Horton, R., Overpeck, J. & Horton, B. (2018). Evolution of 21st Century Sea-level rise Projections. *Earth's Future 6*(11), 1603-1615. doi.org/10.1029/2018EF000991
- Garrabou, J., Coma, R., Bensoussan, N., Bally, M., Chevaldonné, P., Cigliano, M., Díaz, D., Harmelin, J-G., Gambi, M.C. & Kersting, D.K. (2009) Mass mortality in Northwestern Mediterranean rocky benthic communities: effects of the 2003 heat wave. *Global Change Biology 15*, 1090-1103.
- Gattuso, J.P., Magnan, A., Billé, R., Cheung, W.W., Howes, E.L., Joos, F., Allemand, D., Bopp, L., Cooley, S.R. & Hoegh-Guldberg, O. (2015). Contrasting futures for ocean and society from different anthropogenic CO_2 emissions scenarios. *Science, 349*(6243).
- Gauquelin, T., Michon, G., Joffre, R., Duponnois, R., Génin, D., Fady, B., Dagher-Kharrat, M.B., Derridj, A., Slimani, S. & Badri, W. (2016). Mediterranean forests, land use and climate change: a social-ecological perspective. *Regional Environmental Change, 18*(3), 623-636.
- Gea-Izquierdo, G., Nicault, A., Battipaglia, G., Dorado-Liñán, I., Gutiérrez, E., Ribas, M. & Guiot, J. (2017). Risky future for Mediterranean forests unless they undergo extreme carbon fertilization. *Global Change Biology, 23*(7), 2915-2927.
- Gera, A., Pagès, J. F., Arthur, R., Farina, S., Roca, G., Romero, J. & Alcoverro, T. (2014). The effect of a centenary storm on the long-lived seagrass *Posidonia oceanica. Limnology and Oceanography, 59*(6), 1910-1918.
- Giuliani, S., Virno Lamberti, C., Sonni, C. & Pellegrini, D. (2005) Mucilage impact on gorgonians in the Tyrrhenian sea. *Science of the Total Environment, 353*, 340-349.
- Gómez, F. (2003). The toxic dinoflagellate Gymnodinium catenatum: an invader in the Mediterranean Sea. *Acta Botanica Croata, 62*(2), 65-72.
- González-Alemán, J.J., Pascale, S., Gutierrez-Fernandez, J., Murakami, H., Gaertner, M.A. & Vecchi, G.A. (2019). Potential increase in hazard from Mediterranean hurricane activity with global warming. *Geophysical Research Letters, 46*(3), 1754-1764. doi:10.1029/2018GL081253
- Goodwin, C., Rodolfo-Metalpa, R., Picton, B. & Hall-Spencer, J.M. (2014). Effects of ocean acidification on sponge communities. *Marine Ecology, 35*, 41-49.
- Gouveia, C.M., Trigo, R.M., Beguería, S. & Vicente-Serrano, S.M. (2017). Drought impacts on vegetation activity in the Mediterranean region: An assessment using remote sensing data and multi-scale drought indicators. *Global and Planetary Change, 151*, 15-27.
- Gualdi, S. et al (2013) Future Climate Projections. In A., Navarra & L., Tubiana (Ed(s)). *Regional Assessment of Climate Change in the Mediterranean.* Vol. 50, Springer Verlag, 125.
- Guiot, J. & Cramer, W. (2016). Climate change: The 2015 Paris Agreement thresholds and Mediterranean basin ecosystems. *Science, 354*, 465-468.
- Hallegatte, S., Green, C., Nicholls, R. J. & Corfee-Morlot, J. (2013). Future flood losses in major coastal cities. *Nature Climate Change, 3*(9), 802-806.
- Hall-Spencer, J.M., Rodolfo-Metalpa, R., Martin, S., Ransome, E., Fine, M., Turner, S.M., Rowley, S.J., Tedesco, D. & Buia, M-C.. (2008). Volcanic carbon dioxide vents show ecosystem effects of ocean acidification. *Nature, 454*, 96-99.
- Handmer, J., Honda, Y., Kundzewicz, Z.W., Arnell, N., Benito, G., Hatfield, J., Mohamed, I.F., Peduzzi, P., Wu, S., Sherstyukov, B., Takahashi, K. & Yan, Z. (2012). Changes in impacts of climate extremes: Human systems and ecosystems. In C.B., Field, V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.K. Plattner, S.K. Allen, M. Tignor & P.M. Midgley (Ed(s)). *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change (IPCC)* (pp. 231-290). Cambridge, United Kingdom and New York, NY: Cambridge University Press.
- Hanson, S., Nicholls, R., Ranger, N., Hallegatte, S., Corfee-Morlot, J., Herweijer, C. & Chateau, J. (2011). A global ranking of port cities with high exposure to climate extremes. *Climatic Change, 104*, 89-111.
- Hassoun, A.E.R., Fakhri, M., Raad, N., Abboud-Abi Saab, M., Gemayel, E. & De Carlo, E. H. (2019). The carbonate system

of the Eastern-most Mediterranean Sea, Levantine Sub-basin: Variations and drivers. *Deep Sea Research Part II: Topical Studies in Oceanography, 164*, 54-73. doi:10.1016/j.dsr2.2019.03.008
- Hassoun, A.E.R., Gemayel, E., Krasakopoulou, E., Goyet, C., Saab, M.A.-A., Guglielmi, V., Touratier, F. & Falco C. (2015). Acidification of the Mediterranean Sea from anthropogenic carbon penetration. *Deep Sea-Research Part I: Oceanographic Research Papers, 102*, 1-15.
- Hermoso, V. & Clavero, M. (2011). Threatening processes and conservation management of endemic freshwater fish in the Mediterranean basin: a review. *Marine & Freshwater Research, 62*(3), 244-254.
- Hyndes, G.A., Heck Jr, K.L., Vergés, A., Harvey, E.S., Kendrick, G.A., Lavery, P.S., McMahon, K., Orth, R.J., Pearce, A. & Vanderklift, M. (2016). Accelerating Tropicalization and the Transformation of Temperate Seagrass Meadows. *BioScience, 66*(11), 938-948. doi:10.1093/biosci/biw111
- Iglesias, A., Garrote, L., Quiroga, S. & Moneo, M. (2012). A regional comparison of the effects of climate change on agricultural crops in Europe, *Climatic Change, 112*(1), 29-46. doi: 10.1007/s10584-011-0338-8
- IMO. (2015). *Third IMO GHG Study 2014*. London: International Maritime Organization. Retrieved from http://www.imo.org/en/OurWork/Environment/PollutionPrevention/AirPollution/Documents/Third%20Greenhouse%20Gas%20Study/GHG3%20Executive%20Summary%20and%20Report.pdf
- Ingrosso, G., Manuel Bensi, M., Cardin, V. & Giani, M. (2017). Anthropogenic CO_2 in a dense water formation area of the Mediterranean Sea. *Deep-Sea Research Part I, 123*, 118-128. doi:10.1016/j.dsr.2017.04.004
- IPCC. (2014). *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.* [Barros, V.R., C.B. Field, D.J. Dokken, M.D. Mastrandrea, K.J. Mach, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (Ed(s))]. Cambridge, United Kingdom and New York, NY: Cambridge University Press.
- IPCC. (2018). Summary for Policymakers. In: *Global warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty*. [Masson-Delmotte V et al (Ed(s))]. Geneva, Switzerland: World Meteorological Organization.
- IPCC. (2019a). *Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems.* Geneva, Switzerland. In press.
- IPCC. (2019b). IPCC *Special Report on the Ocean and Cryosphere in a Changing Climate.* [H.-O. Pörtner, D.C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, M. Nicolai, A. Okem, J. Petzold, B. Rama, N. Weyer (Ed(s))]. In press.
- Jacob, D., Kotova, L., Teichmann, C., Sobolowski, S.P., Vautard, R., Donnelly, C., Koutroulis, A.G., Grillakis, M.G., Tsanis, I.K. & Damm, A. (2018). Climate impacts in Europe under +1.5°C global warming. *Earth's Future, 6,* 264-285.
- Jacob, D., Petersen, J., Eggert, B., Alias, A., Christensen, O.B., Bouwer, L.M., Braun, A., Colette, A., Déqué, M., Georgievski, G., Georgopoulou, E., Gobiet, A., Menut, L., Nikulin, G., Haensler, A., Hempelmann, N., Jones, C., Keuler, K., Kovats, S., Kröner, N., Kotlarski, S., Kriegsmann, A., Martin, E., van Meijgaard, E., Moseley, C., Pfeifer, S., Preuschmann, S., Radermacher, C., Radtke, K., Rechid, D., Rounsevell, M., Samuelsson, P., Somot, S., Soussana, J., Teichmann, C., Valentini, R., Vautard, R., Weber, B. & Yiou, P. (2014). EURO-CORDEX: New high-resolution climate change projections for European impact research. *Regional Environmental Change, 14*(2), 563-578.
- Jordà, G. & Gomis, D. (2013). On the interpretation of the steric and mass components of sea level variability: The case of the Mediterranean basin. *Journal of Geophysical Research: Oceans, 118*(2), 953-963.
- Jordà, G., Marbà, N. & Duarte, C.M. (2012). Mediterranean seagrass vulnerable to regional climate warming. *Nature Climate Change, 2*(11), 821-824.
- Kapsenberg, L., Alliouane, S., Gazeau, F., Mousseau, L. & Gattuso, J.P. (2017). Coastal ocean acidification and increasing total alkalinity in the northwestern Mediterranean Sea. *Ocean Science, 13,* 411-426.
- Karaca, M. & Nicholls, R. (2008). Potential Implications of Accelerated Sea-Level Rise for Turkey. *Journal of Coastal Research, 24*(2): 288-298. doi.org/10.2112/07A-0003.1
- Kelley, C.P., Mohtadi, S., Cane, M.A., Seager, R. & Kushnir, Y. (2015). Climate change in the Fertile Crescent and implications of the recent Syrian drought. *Proceedings of the National Academy of Sciences, 112*(11), 3241-3246.
- Klausmeyer, K.R. & Shaw, M.R. (2009). Climate change, habitat loss, protected areas and the climate adaptation potential of species in Mediterranean ecosystems worldwide. *PLoS ONE 4*(7), e6392.
- Krasakopoulou, E., Rapsomanikis, S., Papadopoulos, A. & Papathanassiou, E. (2009). Partial pressure and air-sea CO_2 flux in the Aegean Sea during February 2006. *Continental Shelf Research, 29*(11), 1477-1488.
- Kroeker, K.J., Micheli, F., Gambi, M.C. & Martz, T.R. (2011). Divergent ecosystem responses within a benthic marine community to ocean acidification. *Proceedings of the National Academy of Sciences, 108*(35), 14515-14520.
- Laabir, M., Jauzein, C., Genovesi, B., Masseret, E., Grzebyk, D., Cecchi, P., Vaquer, A., Perrin, Y. & Collos, Y. (2011). Influence of temperature, salinity and irradiance on the growth and cell yield of the harmful red tide dinoflagellate *Alexandrium catenella* colonizing Mediterranean waters. *Journal of Plankton Research, 33*(10), 1550-1563.
- Lane, A., Chatain, B. & Roque D'Orbcastel, E. (2018). Aquaculture in Occitanie, France. *World Aquaculture, 49*(1), 12-17.
- Lee, K., Sabine, C.L., Tanhua, T., Kim, T.W., Feely, R.A. & Kim, H.C. (2011). Roles of marginal seas in absorbing and storing

fossil fuel CO_2. *Energy & Environmental Science, 4*(4), 1133-1146. doi:10.1039/C0EE00663G
- Lejeusne, C., Chevaldonné, P., Pergent-Martini, C., Boudouresque, C.F. & Perez, T. (2010). Climate change effects on a miniature ocean: The highly diverse, highly impacted Mediterranean Sea. *Trends in Ecology and Evolution, 25*(4), 250-260.
- Lelieveld, J., Hadjinicolaou, P., Kostopoulou, E., Giannakopoulos, C., Pozzer, A., Tanarhte, M. & Tyrlis, E. (2014). Model projected heat extremes and air pollution in the eastern Mediterranean and Middle East in the twenty-first century. *Regional Environmental Change, 14*(5), 1937-1949.
- Lian, J.J., Xu, K. & Ma, C. (2013). Joint impact of rainfall and tidal level on flood risk in a coastal city with a complex river network: a case study of Fuzhou City, China. *Hydrology and Earth System Sciences, 17*(2), 679-689.
- Licandro, P., Conway, D.V.P., Daly Yahia, M.N., Fernandez de Puelles, M.L., Gasparini, S., Hecq, J.H., Tranter, P. & Kirby, R.R. (2010). A blooming jellyfish in the northeast Atlantic and Mediterranean. *Biology Letters, 6*(5), 688-691.
- Linares, C., Vidal, M., Canals, M., Kersting, D.K., Amblas, D., Aspillaga, E., Cebrián, E., Delgado-Huertas, A., Díaz, D. & Garrabou, J. (2015). Persistent acidification drives major distribution shifts in marine benthic ecosystems. *Proceedings of the Royal Society B: Biological Sciences, 282*(1818), 20150587.
- Lionello, P. & Scarascia, L. (2018). The relation between climate change in the Mediterranean region and global warming. *Regional Environmental Change, 18*(5), 1481-1493
- Lionello, P., Conte, D., Marzo, L. & Scarascia, L. (2016, April). Climate change impacts of marine storminess along the coast of the Mediterranean sea: ensemble multi-model and multi-scenario projections. In EGU General Assembly Conference Abstracts (Vol. 18).
- Macias, D., Garcia-Gorriz, E. & Stips, A. (2013). Understanding the causes of recent warming in Mediterranean waters. How much could be attributed to climate change? *PLoS ONE, 8*(11), e81591.
- Magnan, A.K., Colombier, M., Billé, R., Joos, F., Hoegh-Guldberg, O., Pörtner, H-O., Waisman, H., Spencer, T. & Gattuso, J-P. (2016). Implications of the Paris agreement for the ocean. *Nature Climate Change, 6*(8), 732-735.
- Mannino, A.M., Balistreri, P. & Deidun, A. (2017). The Marine Biodiversity of the Mediterranean Sea in a Changing Climate: The Impact of Biological Invasions. In B., Fuerst-Bjeliš (Ed). *Mediterranean Identities Environment, Society, Culture.* doi: 10.5772/intechopen.69214
- Marbà, N., Jorda, G., Agustí, S., Girard, S.C. & Duarte, C.M. (2015). Footprints of climate change on Mediterranean Sea biota. *Frontiers in Marine Science, 2*, 56.
- Martin, S., Richier, S., Pedrotti, M. L., Dupont, S., Castejon, C., Gerakis, Y., Kerros, M-E., Oberhänsli, F., Teyssié, J-L., Jeffreee, R. & Gattuso, J.P. (2011). Early development and molecular plasticity in the Mediterranean sea urchin Paracentrotus lividus exposed to CO_2-driven acidification. *Journal of Experimental Biology, 214*(8), 1357-1368.
- Médail, F. (2017). The specific vulnerability of plant biodiversity and vegetation on Mediterranean islands in the face of global change. *Regional Environmental Change, 17*(6), 1775-1790.
- Meier, K.J.S., Beaufort, L., Heussner, S. & Ziveri, P. (2014). The role of ocean acidification in *Emiliania huxleyi* coccolith thinning in the Mediterranean Sea. *Biogeoscience Discussions, 11*, 2857-2869.
- MerMex Group. (2011). Marine ecosystems' responses to climatic and anthropogenic forcings in the Mediterranean. *Progress in Oceanography, 91*(2), 97-166.
- Michaelis, A.C., Willison, J., Lackmann, G.M. & Robinson, W.A. (2017). Changes in winter North Atlantic extratropical cyclones in high-resolution regional pseudo-global warming simulations. *Journal of Climate, 30*(17), 6905-6925. doi:10.1175/JCLI-D-16-0697.1
- Muñoz-Rojas, M., Jordán, A., Zavala, L.M., De la Rosa, D., Abd-Elmabod, S.K. & Anaya-Romero, M. (2015). Impact of land use and land cover changes on organic carbon stocks in Mediterranean soils (1956-2007). *Land Degradation & Development, 26*(2), 168-179.
- Nicholls, S. & Amelung, B. (2008). Climate change and tourism in northwestern Europe: Impacts and adaptation. *Tourism Analysis, 13*(1), 21-31.
- OECD/ITF. (2018a). *Decarbonising Maritime Transport-Pathways to zero-carbon shipping by 2035.* Retrieved from https://www.itf-oecd.org/sites/default/files/docs/decarbonising-maritime-transport.pdf
- OECD/ITF. (2018b). *Reducing Shipping Greenhouse Gas Emissions - Lessons from Port-Based Initiatives.* Retrieved from https://www.itf-oecd.org/sites/default/files/docs/reducing-shipping-greenhouse-gas-emissions.pdf
- OIF/IFDD (2018). *Guide to the negotiations COP 24*. Katowice, December 2018. Retrieved from https://www.ifdd.francophonie.org/ressources/ressources-pub-desc.php?id=754
- Olesen, J.E., Trnka, M., Kersebaum, K.C., Skjelvåg, A.O., Seguin, B., Peltonen-Sainio, P., Rossi, F., Kozyra, J. & Micale, F.. (2011). Impacts and adaptation of European crop production systems to climate change. *European Journal of Agronomy, 34*(2), 96-112.
- Palmiéri, J., Orr, J.C., Dutay, J-C., Béranger, K., Schneider, A., Beuvier, J. & Somot, S.. (2015). Simulated anthropogenic CO_2 storage and acidification of the Mediterranean Sea. *Biogeosciences, 12*, 781-802.
- Parravicini, V., Mangialajo, L., Mousseau, L., Peirano, A., Morri, C., Montefalcone, M., Francour, P., Kulbicki, M. & Bianchi, C.N. (2015). Climate change and warm-water species at the north-western boundary of the Mediterranean Sea. *Marine Ecology, 36*(4), 897-909.
- Paz, S. & Tourre, Y.M. (2010, September). West African Climate and Linkages with the Atlantic Ocean, the Mediterranean Basin and Eurasia. In 10th EMS Annual Meeting, 10th European Conference on Applications of Meteorology (ECAM)

Abstracts, held Sept. 13-17, 2010 in Zürich, Switzerland. http://meetings. copernicus. org/ems2010/, id. EMS2010-531.
- Peltonen-Sainio, P., Jauhiainen, L., Trnka, M., Olesen, J.E., Calanca, P., Eckersten, H., Eitzinger, J., Gobin, A., Kersebaum, K.C. & Kozyra, J. (2010). Coincidence of variation in yield and climate in Europe. *Agriculture, Ecosystems & Environment, 139*(4), 483-489.
- Peñuelas, J., Sardans, J., Estiarte, M., Ogaya, R., Carnicer, J., Coll, M., Barbeta, A., Rivas-Ubach, A., Llusià, J. & Garbulsky, M. (2013). Evidence of current impact of climate change on life: a walk from genes to the biosphere. *Global Change Biology, 19*(8), 2303-2338.
- Peñuelas, J., Sardans, J., Filella, I., Estiarte, M., Llusià, J., Ogaya, R., Carnicer, J., Bartrons, M., Rivas-Ubach, A., Grau, O., Peguero, G., Margalef, O., Pla-Rabés, S., Stefanescu, C., Asensio, D., Preece, C., Liu, L., Verger, A., Barbeta, A., Achotegui-Castells, A., Gargallo-Garriga, A., Sperlich, D., Farré-Armengol, G., Fernández-Martínez, M., Liu, D., Zhang, C., Urbina, I., Camino-Serrano, M., Vives-Ingla, M., Stocker, B.D., Balzarolo, M., Guerrieri, R., Peaucelle, M., Marañón-Jiménez, S., Bórnez-Mejías, K., Mu, Z., Descals, A., Castellanos, A., Terradas, J. (2017) Impacts of global change on Mediterranean forests and their services. *Forests, 8*(12), 463.
- Pistocchi R., Cangini M., Totti C., Urbani R., Guerrini F., Romagnoli T., Sist P., Palamidesi S., Boni L., Pompei M. (2005). Relevance of the dinoflagellate Gonyaulax fragilis in mucilage formations of the Adriatic Sea. *Science of the Total Environment 353* (2005) 307 - 316
- Plan Bleu. (2019). *Outsmart climate change: Work with nature! - Enhancing the Mediterranean's climate resilience through Nature-based Solutions - Policy Paper.* Retrieved from http://planbleu.org/sites/default/files/publications/policy_brief_nbs_en_final_light_0.pdf
- Préfecture du Département de l'Hérault, France. (2018). Communiqué de presse : *Conchyliculture -Soutien aux conchyliculteurs touchés par l'épisode du phénomène naturel appelé la « Malaïgue » sur l'étang de Thau : Évaluation des pertes.*
- Rambal, S., Lempereur, M., Limousin, J. M., Martin-StPaul, N. K., Ourcival, J. M. & Rodríguez-Calcerrada, J. (2014). How drought severity constrains gross primary production (GPP) and its partitioning among carbon pools in a Quercus ilex coppice? *Biogeosciences, 11*(23), 6855.
- Regional Climate Change Adaptation Framework for the Mediterranean Marine and Coastal Areas. UN Environment/MAP Athens, Greece (2017).
- Reimann, L., Vafeidis, A. T., Brown, S., Hinkel, J. & Tol, R.S. (2018). Mediterranean UNESCO World Heritage at risk from coastal flooding and erosion due to sea-level rise. *Nature Communications, 9*(1), 4161.
- Ridgwell, A., Schmidt, D.N. (2010). Past constraints on the vulnerability of marine calcifiers to massive carbon dioxide release. *Nature Geoscience, 3*(3), 196-200.
- Rilov, G. (2016). Multi-species collapses at the warm edge of a warming sea. *Scientific Reports, 6*, 36897. doi:10.1038/srep36897
- Rivetti, I., Fraschetti, S., Lionello, P., Zambianchi, E. & Boero, F. (2014). Global warming and mass mortalities of benthic invertebrates in the Mediterranean Sea. *PLoS ONE, 9*(12), e115655.
- Rodrigues, L.C., Van Den Bergh, J.C., Massa, F., Theodorou, J.A., Ziveri, P. & Gazeau, F. (2015). Sensitivity of Mediterranean bivalve mollusc aquaculture to climate change, ocean acidification, and other environmental pressures: findings from a producer survey. *Journal of Shellfish Research, 34*(3), 1161-1176.
- Rohr, J. R., Dobson, A.P., Johnson, P., Kilpatrick, A.M., Paull, S., Raffel, T.R., Ruiz-Moreno, D., Thomas, M.B. (2011). Frontiers in climate change-disease research. *Trends Ecol. Evol. 26*, 270-277.
- Rubio, J., Safriel, U., Daussa, R., Blum, W. & Pedrazzini, F. (Ed(s)). (2009). *Water Scarcity, Land Degradation and Desertification in the Mediterranean Region: Environmental and Security Aspects.* Springer Science & Business Media.
- Ruffault, J., Moron, V., Trigo, R.M. & Curt, T. (2016). Objective identification of multiple large fire climatologies: an application to a Mediterranean ecosystem. *Environmental Research Letters, 11*(7), 075006.
- Sachs, J., Schmidt-Traub, G., Kroll, C., Lafortune, G. & Fuller, G. (2019). *Sustainable development report 2019.* New York, NY: Bertelsmann Stiftung and Sustainable Development Solutions Network (SDSN).
- Salem, Z. & Osman, O.M. (2017). Use of major ions to evaluate the hydrogeochemistry of groundwater influenced by reclamation and seawater intrusion, West Nile Delta, Egypt. *Environmental Science and Pollution Research, 24*(4), 3675-3704. doi.org/10.1007/s11356-016-8056-4
- Sanchez-Vidal, A., Canals, M., Calafat, A.M., Lastras, G., Pedrosa-Pàmies, R., Menéndez, M., Medina, R., Company, J.B., Hereu, B., Romero, J. (2012). Impacts on the deep-Sea ecosystem by a severe coastal storm. *PLoS ONE, 7*(1), e30395.
- Santonja, M., Fernandez, C., Proffit, M., Gers, C., Gauquelin, T., Reiter, I.M., Cramer, W. & Baldy, V. (2017). Plant litter mixture partly mitigates the negative effects of extended drought on soil communities and litter decomposition in a Mediterranean oak forest. *Journal of Ecology, 105*(3), 801-815.
- Satta, A., Venturini, S., Puddu, M., Firth, J. & Lafitte, A. (2015). *Strengthening the Knowledge Base on Regional Climate Variability and Change: Application of a Multi-Scale Coastal Risk Index at Regional and Local Scale in the Mediterranean*. Plan Bleu Report.
- Savva, I., Bennett, S., Roca, G., Jordà, G. & Marbà, N. (2018). Thermal tolerance of Mediterranean marine macrophytes: Vulnerability to global warming. *Ecology and Evolution, 8*(23), 12032-12043. doi:10.1002/ece3.4663
- Schiavina, M., Freire, S., Macmanus, K. (2019). *GHS population grid multitemporal (1975, 1990, 2000, 2015).* European Commission, Joint Research Centre.

- Schleussner, C., Pfleiderer, P. & Fischer, E.M. (2017). In the observational record half a degree matters. *Nature Climate Change, 7*(7), 460-462.
- Schleussner, C-F., Lissner, T.K., Fischer, E.M., Wohland, J., Perrette, M., Golly, A., Rogelj, J., Childers, K., Schewe, J. & Frieler, K. (2016). Differential climate impacts for policy-relevant limits to global warming: the case of 1.5°C and 2°C. *Earth System Dynamics, 7*, 327-351.
- Schneider, A., Tanhua, T., Körtzinger, A. & Wallace, D.W. (2010). High anthropogenic carbon content in the eastern Mediterranean. *Journal of Geophysical Research: Oceans, 115*(C12).
- Settele, J., Scholes, R., Betts, R.A., Bunn, S., Leadley, P., Nepstad, D., Overpeck, J., Taboada, M.A., Fischlin, A. & Moreno, J.M.. (2014) Terrestrial and Inland Water Systems. In C.B., Field, Barros, V.R., Dokken, D.J., Mach, K.J., Mastrandrea, M.D., Bilir, T.E.,Chatterjee, M., Ebi, K.L., Estrada, Y.O., Genova, R.C., Girma, B., Kissel, E.S., Levy, A.N., MacCracken, S., Mastrandream P.R. & White, L.L. (Ed(s)). *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel of Climate Change* (pp. 271-359). Cambridge, United Kingdom and New York, NY: Cambridge University Press.
- Shaltout, M., Tonbol, K. & Omstedt, A. (2015). Sea-level change and projected future flooding along the Egyptian Mediterranean coast. *Oceanologia, 57*(4), 293-307. doi.org/10.1016/j.oceano.2015.06.004
- Skuras, D. & Psaltopoulos, D. (2012). *A broad overview of the main problems derived from climate change that will affect agricultural production in the Mediterranean area. Building resilience for adaptation to climate change in the agriculture sector.* Proceedings of a Joint FAO/OECD Workshop, 23-24 April 2012.
- Slangen, A.B., Church, J.A., Agosta, C., Fettweis, X., Marzeion, B. & Richter, K. (2016). Anthropogenic forcing dominates global mean sea-level rise since 1970. *Nature Climate Change, 6*(7), 701-705.
- Snoussi, M., Ouchani, T. & Niazi, S. (2008). Vulnerability assessment of the impact of sea-level rise and flooding on the Moroccan coast: The case of the Mediterranean eastern zone. *Estuarine, Coastal and Shelf Science 77*(2), 206-213. doi.org/10.1016/j.ecss.2007.09.024
- Staehli, A., Schaerer, R., Hoelzle, K. & Ribi, G. (2009). Temperature induced disease in the starfish *Astropecten jonstoni. Marine Biodiversity Records, 2.*
- Stocker, T.F., Qin, D., Plattner, G-K., Tignor, M., Allen, S.K., Boschung, J., Nauels, A., Xia, Y., Bex, V. & Midgley, P. (2013). Technical Summary. In Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (Ed(s)). *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 33-115). Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press.
- Strobl, E. (2012.) The economic growth impact of natural disasters in developing countries: Evidence from hurricane strikes in the Central American and Caribbean regions. *Journal of Development economics, 97*(1), 130-141. doi:10.1016/j.jdeveco.2010.12.002
- Thibaut, T., Blanfuné, A. & Verlaque, M. (2013). Mediterranean *Lithophyllum byssoides* (Lamarck) Foslie rims: chronicle of a death foretold. *Rapports et PV des réunions de la Commission Internationale pour l'Exploration Scientifique de la Méditerranée, 40*, 656.
- Tolba, M.K. & Saab, N.W. (Ed(s)). (2009). *Arab environment: Climate change. Impact of climate change in Arab countries*. Beirut, Lebanon: Arab Forum for Environment and Development. ISBN: 9953-437-28-9
- Toreti, A. & Naveau, P. (2015). On the evaluation of climate model simulated precipitation extremes. *Environmental Research Letters, 10*(1), 014012.
- Toreti, A., Naveau, P., Zampieri, M., Schindler, A., Scoccimarro, E., Xoplaki, E., Dijkstra, H.A., Gualdi, S. & Luterbacher, J. (2013). Projections of global changes in precipitation extremes from Coupled Model Intercomparison Project Phase 5 models. *Geophysical Research Letters, 40*(18), 4887-4892.
- Touratier, F., Goyet, C., Houpert, L., De Madron, X.D., Lefèvre, D., Stabholz, M. and Guglielmi, V. (2016). Role of deep convection on anthropogenic CO_2 sequestration in the Gulf of Lions (northwestern Mediterranean Sea). *Deep Sea Research Part I: Oceanographic Research Papers, 113*, 33-48.
- Transport & Environment. (2017). *Statistical analysis of the energy efficiency performance (EEDI) of new ships built in 2013-2017.* Retrieved from: https://www.transportenvironment.org/sites/te/files/publications/Statistical%20analysis%20of%20the%20energy%20efficiency%20performance%20%28EEDI%29%20of%20new%20ships.pdf
- Travers, A., Elrick, C. & Kay, R. (2010). *Climate Change in Coastal Zones of the Mediterranean.* Technical Paper, Ed. Priority Actions Programme.
- Tsimplis, N.,Calafat , F.M., Marcos , M. Jordà , G., Gomis , D., Fenoglio-Marc, L., Struglia, M.V., Josey, S.A. & Chambers, D.P. (2013). The effect of the NAO on sea level and on mass changes in the Mediterranean Sea. *Journal of Geophysical Research: Oceans, 118*(2), 944-952.
- Turco, M., Llasat, M.C., von Hardenberg, J. & Provenzale, A. (2014). Climate change impacts on wildfires in a Mediterranean environment. *Climate Change, 125*(3-4), 369-380.
- UNEP/MAP PAP/RAC. (2015). *Guidelines for adapting to climate variability and change along the Mediterranean Coast.* Split, Croatia: Priority Actions Programme.
- UNFCCC. (2019). *GHG Data from UNFCCC*. Retrieved from https://unfccc.int/process-and-meetings/transparency-and-reporting/greenhouse-gas-data/ghg-data-unfccc/ghg-data-from-unfccc

- Varela, M.R., Patrício, A.R., Anderson, K., Broderick, A.C., DeBell, L., Hawkes, L.A., Tilley, D., Snape, R.T.E., Westoby, M.J. & Godley, B.J. (2019). Assessing climate change associated sea-level rise impacts on sea turtle nesting beaches using drones, photogrammetry and a novel GPS system. *Global Change Biology, 25*(2), 753-762. doi:10.1111/gcb.14526
- Vautard, R., Gobiet, A., Sobolowski, S., Kjellström, E., Stegehuis, A., Watkiss, P., Mendlik, T., Landgren, O., Nikulin, G. & Teichmann, C. (2014). The European climate under a 2°C global warming. *Environmental Research Letters, 9*(3), 034006.
- Vergés, A., Doropoulos, C., Czarnik, R., McMahon, K., Llonch, N. & Poore, A. G. (2018). Latitudinal variation in seagrass herbivory: Global patterns and explanatory mechanisms. *Global Ecology and Biogeography, 27*(9), 1068-1079. doi:10.1111/geb.12767
- Vergés, A., Tomas, F., Cebrian, E., Ballesteros, E., Kizilkaya, Z., Dendrinos, P., Karamanlidis, A.A., Spiegel, D. & Sala, E. (2014). Tropical rabbitfish and the deforestation of a warming temperate sea. *Journal of Ecology, 102*(6), 1518-1527.
- Vermeer, M. & Rahmstorf, S. (2009). Global sea level linked to global temperature. *Proceedings of the National Academy of Sciences USA, 106*(51), 21527-21532.
- Vezzulli, L., Previati, M., Pruzzo, C., Marchese, A., Bourne, D. G., Cerrano, C. & VibrioSea Consortium. (2010). Vibrio infections triggering mass mortality events in a warming Mediterranean Sea. *Environmental Microbiology, 12*(7), 2007-2019.
- Vicente-Serrano, S.M., Lopez-Moreno, J.I., Beguería, S., Lorenzo-Lacruz, J., Sanchez-Lorenzo, A., García-Ruiz, J. M., Azorin-Molina, C., Morán-Tejeda, E., Revuelto, J., Trigo, R., Coelho, F. & Espejo, F. (2014). Evidence of increasing drought severity caused by temperature rise in southern Europe. *Environmental Research Letters, 9*(4), 044001.
- Williams, A.P., Allen, C.D.,Macalady, A.K., Griffin, D., Woodhouse, C.A., Meko, D.M., Swetnam, T.W., Rauscher, S.A., Seager, R., Grissino-Mayer, H.D. (2013). Temperature as a potent driver of regional forest drought stress and tree mortality. *Nature Climate Change, 3*(3), 292-297.
- World Bank. (2019a). *World Development Indicators.* Retrieved from http://datatopics.worldbank.org/world-development-indicators/
- World Bank. (2019b). *World Bank Open Data.* Retrieved from https://data.worldbank.org
- Zacharias, I. & Zamparas, M. (2010). Mediterranean temporary ponds. A disappearing ecosystem. *Biodiversity & Conservation, 19*(14), 3827-3834.
- Zappa, G., Shaffrey, L.C. & Hodges, K.I. (2013). The ability of CMIP5 models to simulate North Atlantic extratropical cyclones. *Journal of Climate, 26*(15), 5379-5396.
- Zittis, G., Hadjinicolaou, P., Fnais, M. & Lelieveld, J. (2016). Projected changes in heat wave characteristics in the eastern Mediterranean and the Middle East. *Regional Environmental Change 16*(7), 1863-1876.

References Chapter 3

- Abdul Malak, D., Schröder, C. Guitart, C., Simonson, W., Ling, M., Scott, E., Brown, C., Flink, S., Franke, J., Fitoka, E., Guelmami, A., Hatziiordanou, L., Hofer, R. Mino, E., Philipson, P., Plasmeijer, A., Sánchez, A., Silver, E., Strauch, A., Thulin, S. & Weise, K. (2019). *Enhanced wetland monitoring, assessment and indicators to support European and global environmental policy.* SWOS Technical publication. Retrieved from https://www.swos-service.eu/wp-content/uploads/2019/03/SWOS_Report_web.pdf
- Achurra, A. & Rodriguez, P. (2008). Biodiversity of groundwater oligochaetes from a karst unit in northern Iberian Peninsula: ranking subterranean sites for conservation management. *Hydrobiologia, 605*, 159. doi:10.1007/s10750-008-9331-2
- Acosta, A. (2015). *European Red List of Habitats. B1.3b Mediterranean and Black Sea shifting coastal dune.*
- Alberto, F., Massa, S., Manent, P., Diaz-Almela, E., Arnaud-Haond, S., Duarte, C.M. & Serrao, E.A. (2008). Genetic differentiation and secondary contact zone in the seagrass Cymodocea nodosa across the Mediterranean-Atlantic transition region. *Journal of Biogeography, 35*(7), 1279-1294.
- Álvarez-Rogel, J., Jiménez-Cárceles, F.J., Roca, M.J. & Ortiz, R. (2007). Changes in soils and vegetation in a Mediterranean coastal salt marsh impacted by human activities. *Estuarine, Coastal and Shelf Science, 73*(3-4), 510-526. doi:10.1016/j.ecss.2007.02.018
- Bahri-Sfar, L., Lemaire, C., Ben Hassine, O. K. & Bonhomme, F. (2000). Fragmentation of sea bass populations in the western and eastern Mediterranean as revealed by microsatellite polymorphism. Proceedings of the Royal Society of London. *Series B: Biological Sciences, 267*(1446), 929-935.
- Bazzichetto, M., Malavasi, M., Acosta, A.T.R. & Carranza, M.L. (2016). How does dune morphology shape coastal EC habitats occurrence? A remote sensing approach using airborne LiDAR on the Mediterranean coast. *Ecological Indicators, 71*, 618-626. https://doi.org/10.1016/j.ecolind.2016.07.044
- Bernard, G., Boudouresque, C.F. & Picon, P. (2007). Long term changes in Zostera meadows in the Berre lagoon (Provence, Mediterranean Sea). *Estuarine, Coastal and Shelf Science, 73*(3-4), 617-629.
- Bianchi, C.N. & Morri, C. (2000). Marine biodiversity of the Mediterranean Sea: situation, problems and prospects for future research. *Marine Pollution Bulletin, 40*(5), 367-376.
- Binet, T., Diazabakana, A. & Hernandez, S. (2015). *Sustainable financing of Marine Protected Areas in the Mediterranean: a financial analysis.* Vertigo Lab, MedPAN, SPA/RAC, WWF Mediterranean. 114 pp.

- Black, E. (2009). The impact of climate change on daily precipitation statistics in Jordan and Israel. *Atmospheric Science Letters, 10*(3), 92-200.
- Boero F. (2015). The future of the Mediterranean Sea Ecosystem: towards a different tomorrow. Rendiconti Lincei. *Scienze fisiche e naturali, 26*, 3-12.
- Boero, F. (2013). *Review of jellyfish blooms in the Mediterranean and Black Sea.* FAO/GCFM Studies and Reviews no. 92. ISBN 978-92-5-107457-2.
- Boudouresque, C.F. (2004). Marine biodiversity in the Mediterranean: status of species, populations and communities. *Travaux Scientifiques du Parc National de Port-Cros, 20*, 97-146.
- Boudouresque, C.F., Bernard, G., Pergent, G., Shili, A. & Verlaque, M. (2009). Regression of Mediterranean seagrasses caused by natural processes and anthropogenic disturbances and stress: a critical review. *Botanica Marina, 52*(5), 395-418.
- Boudouresque, C.F., Pergent, G., Pergent-Martini, C., Ruitton S., Thibaut T. & Verlaque M. (2016). The necromass of the Posidonia oceanica seagrass meadow: fate, role, ecosystem services and vulnerability. *Hydrobiologia, 781*(1), 25-42.
- Bradshaw, S.D., Dixon, K.W., Hopper, S.D., Lambers, H. & Turner, S.R. (2011). Little evidence for fire-adapted plant traits in Mediterranean climate regions. *Trends in Plant Science, 16*(2), 69-76.
- Caló, F., Notti, D., Galve, J.P., Abdikan, S., Görüm, T., Pepe, A. & Balik Şanli, F. (2017). Dinsar-based detection of land subsidence and correlation with groundwater depletion in Konya plain, Turkey. *Remote Sensing, 9*(1), 83.
- Campagne, C. S., Salles, J. M., Boissery, P. & Deter, J. (2015). The seagrass Posidonia oceanica: ecosystem services identification and economic evaluation of goods and benefits. *Marine Pollution Bulletin, 97*(1-2), 391-400.
- Chappuis, E., Gacia, E. & Ballesteros, E. (2011). Changes in aquatic macrophyte flora over the last century in Catalan water bodies (NE Spain). *Aquatic Botany, 95*, 268-277. doi: 10.1016/j.aquabot.2011.08.006
- Chemello, R. & Otero, M.M. (2015). *European Red List of Habitats. 2.7x Biogenic habitats of Mediterranean mediolittoral rock.*
- Choudury, B.C., Pandav, B., Tripathy, B. & Andrews, H.V. (2003). Sea turtle conservation: Eco (turtle) friendly coastal development. A GOI-UNDP project manual. Tamil Nadu, India: Centre for Herpetology/Madras Crocodile Bank Trust. 44 pp.
- CIESM. (2003). *Mare Incognitum ? Exploring Mediterranean deep-sea biology.* CIESM. Workshop Monographs n°23, 128 pages, Monaco.
- CIHEAM & Plan Bleu. (2009). *MediTERRA 2009: Repenser le développement rural en Méditerranée.* Paris: Presses de Sciences Po.
- Claudet J. & Fraschetti, S. (2010). Human-driven impacts on marine habitats: a regional meta-analysis in the Mediterranean Sea. *Biological Conservation, 143*(9), 2195-2206.
- Coll, M., Piroddi, C., Steenbeek, J., Kaschner, K., Lasram, F.B.R., Aguzzi, J., Ballesteros, E., Bianchi, C.N., Corbera, J. & Dailianis, T. (2010). The Biodiversity of the Mediterranean Sea: Estimates, Patterns, and Threats. *PLoS ONE, 5*(8), e11842.
- Croitoru, L. (2007). How much are Mediterranean forests worth? *Forest Policy and Economics, 9*(5), 536-545. https://doi.org/10.1016/j.forpol.2006.04.001
- Custodio, E. (2018). Consequences of Seawater Intrusion in Mediterranean Spain. Project SASMIE. In: M. Calvache, C. Duque & D. Pulido-Velazquez (Ed(s)). *Groundwater and Global Change in the Western Mediterranean Area.* Environmental Earth Sciences. Springer, Cham.
- Dalin, C., Wada, Y., Kastner, T. & Puma, M. (2017). Groundwater depletion embedded in international food trade. *Nature, 543*, 700-704.
- Daly-Hassen, H. (2017). *Valeurs économiques des services écosystémiques du Parc National de l'Ichkeul, Tunisie.* Gland, Switzerland and Malaga, Spain: IUCN. 104pp.
- De Rigo, D., Bosco, C., San-Miguel-Ayanz, J., Houston Durrant, T., Barredo, J.I., Strona, G., Caudullo, G., Di Leo, M. & Boca, R. (2016). Forest resources in Europe: an integrated perspective on ecosystem services, disturbances and threats. In J., San-Miguel-Ayanz, D., de Rigo, G., Caudullo, T., Houston Durrant & A., Mauri (Ed(s)). *European atlas of forest tree species* (pp. 8-19). Luxembourg: Publication Office of the European Union. https://doi.org/10.2788/038466
- Dreyfus P. (2007). Les dynamiques en cours et l'impact des pratiques sylvicoles. *Forêt Méditerranéenne, 28*(4), 419-426. http://www.foret-mediterraneenne.org/upload/biblio/FORET_MED_2007_4_419-426.pdf
- Drius, M., Bongiorni, L., Depellegrin, D., Menegon, S., Pugnetti, A. & Stifter, S. (2019). Tackling challenges for Mediterranean sustainable coastal tourism: An ecosystem service perspective. *Science of the Total Environment, 652*, 1302-1317. https://doi.org/10.1016/j.scitotenv.2018.10.121.
- Duarte, B., Naranjo, E., Redondo Goméz, S., Marques, J. & Caçador, I. (2018). Cordgrass Invasions in Mediterranean Marshes: Past, Present and Future. In A., Queiroz & S., Pooley. (Ed(s)). *Histories of Bioinvasions in the Mediterranean*. Environmental History, vol 8. Springer, Cham.
- Dudley, N. (Ed). (2008). Guidelines for Applying Protected Area Management Categories. Gland, Switzerland: IUCN.
- Dulvy, N. & Walls, R. (2015). Leucoraja melitensis. The IUCN Red List of Threatened Species 2015: e.T61405A48954483. http://dx.doi.org/10.2305/IUCN.UK.2015 1.RLTS.T61405A48954483.en. Downloaded on 06 February 2019.
- Dulvy, N.K., Allen, D.J., Ralph, G.M. & Walls, R.H.L. (2016). The conservation status of Sharks, Rays and Chimaeras in the Mediterranean Sea [Brochure]. Malaga, Spain: IUCN.
- Estreguil, C., Caudullo, G., de Rigo, D. & San Miguel, J. (2013). *Forest landscape in Europe: pattern, fragmentation and connectivity.* JRC Scientific and Policy Report No. JRC 77295 / EUR 25717 EN. Luxembourg: Publications Office of the European Union. 18 pp. https://doi.org/10.2788/77842

- Fabri, M-C., Pedel, L., Beuck, L., Galgani, F., Hebbeln, D. & Freiwald, A. (2014). Megafauna of vulnerable marine ecosystems in French mediterranean submarine canyons: Spatial distribution and anthropogenic impacts, *Deep Sea Research Part II: Topical Studies in Oceanography, 104*, 84-207. https://doi.org/10.1016/j.dsr2.2013.06.016.
- FAO & Plan Bleu. (2018). *State of Mediterranean Forests 2018*. Rome, Italy: FAO and Marseille, France: Plan Bleu. 308 pp.
- FAO. (2015). *Global forest resources assessment 2015: Desk reference.* Rome, Italy: FAO. 244 pp.
- FAO. (2016). *La situation mondiale de l'alimentation et de l'agriculture.* Rome, Italy: FAO. ISBN 978-92-5-209374-9. Retrieved from http://www.fao.org/3/a-i6030f.pdf
- Frey, D., Arrigo, N., Granereau, G., Sarr, A., Felber, F. & Kozlowski, G. (2015). Parallel declines in species and genetic diversity driven byanthropogenic disturbance: a multispecies approach in a French Atlantic dune system. *Evolutionary Applications, 9*(3), 479-488.
- Fritsch, C. (1895). Uber die auffindung einer marinen Hydrocharidee im Mittelmeer. Verh. Zool. Bot. Ges. Wien, 45, 104-106.
- Furlani, S., Pappalardo, M., Gómez-Pujol L. & Chelli, A. (2014). Chapter 7 The rock coast of the Mediterranean and Black seas. *Geological Society, London, Memoirs, 40*; 89-123.
- Gaget, E., Galewski, T., Jiguet, F. & Le Viol, I. (2018). Waterbird Communities Adjust to Climate Warming According to Conservation Policy and Species Protection Status. *Biological Conservation, 227*, 205-212. https://doi.org/10.1016/j.biocon.2018.09.019
- Galewski, T. (in prep.)
- Gattuso, J.P., Magnan, A., Billé, R., Cheung, W.W., Howes, E.L., Joos, F., Allemand, D., Bopp, L., Cooley, S.R. & Hoegh-Guldberg, O. (2015). Contrasting futures for ocean and society from different anthropogenic CO_2 emissions scenarios. *Science, 349*(6243), aac4722.
- Geijzendorffer, I.R., Galewski, T., Guelmami, A., Perennou, C., Popoff, N. & Grillas, P. (2018). Mediterranean Wetlands: a Gradient from Natural Resilience to a Fragile Social- Ecosystem. In M., Schröter, A., Bonn, S., Klotz, R., Seppelt & C., Baessler (Ed(s)). *Atlas of Ecosystem Services: Drivers, Risks, and Societal Responses.* Springer.
- Genovesi, P. & Shine, C. (2004). *European strategy on invasive alien species. Convention on the Conservation of European Wildlife and Habitats (Bern Convention).* Nature and environment, No. 137. Council of Europe Publishing.
- Gianni, M. (2004). *High Seas Bottom Trawl Fisheries and Their Impacts On The Biodiversity Of Vulnerable Deep-Sea Ecosystems.* IUCN, Conservation International, Natural Resources Defense Council (NRDC), US WWF. Retrieved at: https://portals.iucn.org/library/node/12434
- Green, E.P., Short, F.T. & Frederick, T. (2003). *World Atlas of Seagrasses.* Prepared by the UNEP World Conservation Monitoring Centre. Berkeley, CA: University of California Press.
- Grenon, M. & Batisse, M. (1989). *Futures for the Mediterranean basin: The Blue Plan.* Oxford University Press, Oxford.
- Griebler C. & Avramov M. (2015). Groundwater ecosystem services: a review. *Freshwater Science, 34*(1): 355-367.
- Grove, D. (2012), The Physical Geography of the Mediterranean. Jamie Woodward (Ed.). 2009. Oxford University Press, Oxford Regional Environments Series, 704 pp., ISBN 978-0-19-926803-0, USD299 (hardcover). *Geoarchaeology, 27*, 186-187. doi:10.1002/gea.21400
- GWP. (2000). *Integrated Water Resources Management.* TAC Background Papers, No. 4.
- Hall-Spencer, J.M., Rodolfo-Metalpa, R., Martin, S., Ransome, E., Fine, M., Turner, S.M., Rowley, S.J., Tedesco, D. & Buia, M-C. (2008) Volcanic carbon dioxide vents show ecosystem effects of ocean acidification. *Nature, 454*, 96-99.
- Hansen, M.C., Potapov, P.V., Moore, R., Hancher, M., Turubanova, S.A., Tyukavina, A., Thau, D., Stehman, S.V., Goetz, S.J. & Loveland, T.R.. (2013). High-resolution global maps of 21st-century forest cover change. *Science, 342*(6160), 850-853. https://doi.org/10.1126/science.1244693
- Hewitt, C.L. & Campbell, M.L. (2010). *The relative contribution of vectors to the introduction and translocation of invasive marine species.* Commissioned by The Department of Agriculture, Fisheries and Forestry (DAFF), Canberra, 56.
- Hoff, H. (2013). Vulnerability of Ecosystem Services in the Mediterranean Region to Climate Changes in Combintation with Other Pressures. In A., Navarra & L., Tubiana (Ed(s)). *Regional Assessment of Climate Change in the Mediterranean. Volume 2: Agriculture, Forest and Ecosystem Services and People.* Advances in Global Change Research 51, Springer.
- IUCN SSC Invasive Species Specialist Group. (2000). IUCN guidelines for the prevention of biodiversity loss caused by alien invasive species. Retrieved from https://portals.iucn.org/library/efiles/documents/Rep-2000-052.pdf
- IUCN. (2018). The IUCN Red List of Threatened Species. Version 2018-2. http://www.iucnredlist.org. Downloaded on 14 December 2018.
- Jacoby, D. & Gollock, M. (2014). *Anguilla anguilla.* The IUCN Red List of Threatened Species 2014: e.T60344A45833138. http://dx.doi.org/10.2305/IUCN.UK.2014-1.RLTS.T60344A45833138.en
- Kapsenberg, L., Alliouane, S., Gazeau, F., Mousseau, L. & Gattuso, J.P. (2017). Coastal ocean acidification and increasing total alkalinity in the northwestern Mediterranean Sea. *Ocean Science, 13*, 411-426.
- Katsanevakis, S., Wallentinus, I., Zenetos, A., Leppakoski, E., Çinar, M.E., Ozturk, B., Grabowski, M., Golani, D. & Cardoso, A.C. (2014). Impacts of marine invasive alien species on ecosystem services and biodiversity: a pan-European review. *Aquatic Invasions, 9*, 391-423. https://doi.org/10.3391/ai.2014.9.4.01
- Keenan, T., Maria Serra, J., Lloret, F., Ninyerola, M. & Sabate, S. (2011). Predicting the future of forests in the Mediterranean under climate change, with niche-and process-based models: CO_2 matters! *Global Change Biology, 17*(1), 565-579. https://doi.org/10.1111/j.1365-2486.2010.02254.x

- Kløve, B., Allan, A., Bertrand, G., Druzynska, E., Ertürk, A., Goldscheider, N.,Henry, S., Karakaya, N., Karjalainen, T.P., Koundouri, P., Kupfsberger, H., Kværner, J., Lundberg, A., Muotka, T., Preda, E., Pulido-Velazquez, M. & Schipper, P. (2011). Groundwater dependent ecosystems. Part II. Ecosystem services and management in Europe under risk of climate change and land use intensification. *Environmental Science and Policy, 14*(7), 782-793. https://doi.org/10.1016/j.envsci.2011.04.005
- Kroeker, K.J., Micheli, F., Gambi, M.C. & Martz, T.R. (2011). Divergent ecosystem responses within a benthic marine community to ocean acidification. *Proceedings of the National Academy of Science USA, 108*, 14515-14520.
- Kundzewicz, Z.W. & Döll, P. (2009). Will groundwater ease freshwater stress under climate change?. *Hydrological Sciences Journal, 54*(4), 665-675.
- Lelièvre, F., Sala, S. & Volaire, F. (2010). Climate change at the temperate-Mediterranean interface in Southern France and impacts on grasslands production. In: C., Porqueddu & S., Ríos (Ed(s)). *The contributions of grasslands to the conservation of Mediterranean biodiversity* (pp. 187-192). Zaragoza, Spain: CIHEAM. Retrieved from http://om.ciheam.org/om/pdf/a92/00801240.pdf
- Linares, C., Vidal, M., Canals, M., Kersting, D.K., Amblas, D., Aspillaga, E., Cebrián, E., Delgado-Huertas, A., Díaz, D. & Garrabou, J. (2015). Persistent acidification drives major distribution shifts in marine benthic ecosystems. *Proceedings of the Royal Society B: Biological Sciences, 282*(1818), 20150587.
- Maes, J., Egoh, B., Willemen, L., Liquete, C., Vihervaara, P., Schägner, J.P., Grizzetti, B., Drakou, E.G., La Notte, A. & Zulian, G. (2012). Mapping ecosystem services for policy support and decision making in the European Union. *Ecosystem Services, 1*(1), 31-39.
- MAPAMED. (2017, November). MAPAMED, the database on Sites of interest for the conservation of marine environment in the Mediterranean Sea. MedPAN, UNEP/MAP/SPA-RAC. November 2017 release.
- Marbà, N. & Duarte, C. M. (2010). Mediterranean warming triggers seagrass (Posidonia oceanica) shoot mortality. *Global Change Biology, 16*(8), 2366-2375.
- Martínez de Arano, I., Garavaglia, V. & Farcy, C. (2016). Forests: facing the challenges of global change. In: CIHEAM & FAO (Ed(s)). *Mediterra 2016. Zero waste in the Mediterranean. Natural resources, food and knowledge* (pp. 113-133). Paris, France: Presses de Sciences Po.
- Martín-Ortega, P., García-Montero, L., Pascual, C., García-Robredo, F., Picard, N. & Bastin, J.F. (2017). Global drylands assessment using Collect Earth tools and opportunities for forest restoration: results in the Mediterranean region. *Forêt Méditerranéenne, 38*(3), 259-266.
- Massó, S., Blanché, C., Barriocanal, C., Martinell, M. C. & López-Pujol, J. (2016). How habitat fragmentation affects genetic diversity? The case of a sand dune plant (Stachys maritima) in the Iberian Peninsula. *Advances in Genetic Research, 65*.
- McNeely, J.A., Miller, K.R., Reid, W.V., Mittermeier, R.A. & Werner, T.B. (1990). *Conserving the World's Biological Diversity*. Gland, Switzerland: International Union for Conservation of Nature and Natural Resources/World Resources Institute/Conservation International/World Wildlife Fund/US. World Bank.
- MedPAN, UNEP/MAP SPA/RAC, ACCOBAMs, Conservatoire du littoral, French MPA Agency, GFCM, IUCN Mediterranean & WWF Mediterranean. (2016). *The 2016 status of Marine Protected Areas in the Mediterranean: Main findings.* Brochure MedPAN & UN Environment/MAP-SPA/RAC.
- Meier, K.J.S., Beaufort, L., Heussner, S. & Ziveri, P. (2014). The role of ocean acidification in Emiliania huxleyi coccolith thinning in the Mediterranean Sea. *Biogeoscience, 11*, 2857-2869.
- Melaku Canu, D.M., Ghermandi, A., Nunes, P. A., Lazzari, P., Cossarini, G. & Solidoro, C. (2015). Estimating the value of carbon sequestration ecosystem services in the Mediterranean Sea: An ecological economics approach. *Global Environmental Change, 32*, 87-95. https://doi.org/10.1016/j.gloenvcha.2015.02.008
- MIO-ECSDE. (2013). *Aliens in the Mediterranean. Invasions of alien species pose a serious threat to the unique Mediterranean biodiversity.* Athens, Greece: MIO-ECSDE.
- Monbrison D., Rais C., Lopez A., Romani M. (2016). Updated Mediterranean MPA roadmap. MedPAN, SPA/RAC, Turkish General Directorate of Natural Assets Protection, UNDP Turkey/GEF project, Haut Commissariat aux Eaux et Forets et à la Lutte contre la Désertification 56 p.
- Montefalcone, M., Albertelli, G., Morri, C. & Bianchi, C.N. (2010). Patterns of wide-scale substitution within meadows of the seagrass Posidonia oceanica in NW Mediterranean Sea: invaders are stronger than natives. *Aquatic Conservation: Marine and Freshwater Ecosystems, 20*(5), 507-515.
- MWO (Mediterranean Wetlands Observatory). (2014). Land cover - Spatial dynamics in Mediterranean coastal wetlands from 1975 to 2005. Thematic Collection, 2, Tour du Valat, Arles, France, 48p.
- MWO (Mediterranean Wetlands Observatory). (2018). Mediterranean Wetlands Outlook 2. Solutions for sustainable Mediterranean wetlands. Tour du Valat/ MedWet, Arles, France, 16p + factsheets.
- Nesshöver, C., Assmuth, T., Irvine, K.N., Rusch, G.M., Waylen, K.A., Delbaere, B., Haase, D., Jones-Walters, L., Keune, H., Kovacs, E., Krauze, K., Külvik, M., Rey, F., van Dijk, J., Vistad, O.I., Wilkinson, M.E. & Wittmer, H. (2017). The science, policy and practice of nature-based solutions: An interdisciplinary perspective. *Science of the Total Environment, 579*, 1215-1227. https://doi.org/10.1016/j.scitotenv.2016.11.106
- Nikula, R. & Väinölä, R. (2003). Phylogeography of Cerastoderma glaucum (Bivalvia: Cardiidae) across Europe: A major break in the Eastern Mediterranean. *Marine Biology, 143*(2), 339-350.
- Orth, R.J., Carruthers, J.B., Dennison, W.C., Duarte, C.M., Fourqurean, J.W., Heck, K.L., Randall Hughes, A., Kendrick, G.A.,

Judson Kenworthy, W., Olyarnik, S., Short, F.T., Waycott, M. & Williams, S.L. (2006). A Global Crisis for Seagrass Ecosystems. *BioScience, 56*(12), 987-996. https://doi.org/10.1641/0006-3568(2006)56[987:AGCFSE]2.0.CO;2
- Otero, M., Cebrian, E., Francour, P., Galil, B. & Savini, D. (2013). *Monitoring marine invasive species in Mediterranean marine protected areas (MPAs): a strategy and practical guide for managers.* Malaga, Spain: IUCN.
- Otero, M.M. (2016a). *European Red List of Habitats - Marine: Mediterranean Sea Habitat: A2.25: Communities of Mediterranean mediolittoral sands.* 10pp. https://forum.eionet.europa.eu/european-red-listhabitats/library/marine-habitats/mediterranean-sea
- Otero, M.M. (2016b). E*uropean Red List of Habitats - Marine: Mediterranean Sea Habitat: A1.34: Communities of sheltered Mediterranean lower mediolittoral rock.* 10pp. Malaga, Spain: IUCN. Retrieved from https://forum.eionet.europa.eu/european-red-list-habitats/library/marine-habitats/mediterranean-sea
- Otero, M.M., Numa, C., Bo, M., Orejas, C., Garrabou, J., Cerrano, C., Kružic´, P., Antoniadou, C., Aguilar, R., Kipson, S., Linares, C., Terron-Sigler, A., Brossard, J., Kersting, D., Casado-Amezua, P., Garcia, S., Goffredo, S., Ocana, O., Caroselli, E., Maldonado,M., Bavestrello, G., Cattaneo-Vietti, R. & Ozalp, B. (2017). Overview of the conservation status of Mediterranean anthozoans. Malaga, Spain: IUCN.
- Otero, M.M., Simeone, S., Aljinovic, B., Salomidi, M., Mossone, P., Giunta Fornasin M.E., Gerakaris, V., Guala, I., Milano, P., Heurtefeux H.,Issaris, Y., Guido, M. & Adamopoulou, M. (2018). *Governance and management of Posidonia beach-dune system.* POSBEMED Interreg Med Project. 66pp + Annexes.
- Palmiéri, J., Orr, J.C., Dutay, J-C., Béranger, K., Schneider, A., Beuvier, J. & Somot, S. (2015) Simulated anthropogenic CO_2 storage and acidification of the Mediterranean Sea. *Biogeosciences, 12*, 781-802.
- Palumbi, S.R. (2003). Population genetics, demographic connectivity, and the design of marine reserves. *Ecological Applications, 13*(sp1), 146-158.
- Peñuelas, J., Ogaya, R., Boada, M. & Jump, A.S. 2007. Migration, invasion and decline: changes in recruitment and forest structure in a warming-linked shift of European beech forest in Catalonia (NE Spain). *Ecography, 30*(6), 829-837. https://doi.org/10.1111/j.2007.0906-7590.05247.x
- Perennou C. & Guelmami A. (in prep.)
- Pergent, G., Bazairi, H., Bianchi, C.N., Boudouresque, C.F., Buia, M.C., Clabaut, P., Harmelin-Vivien, M., Mateo, M.A., Montefalcone, M., Morri, C., Orfanidis, S., PergentMartini C., Semroud R., Serrano O. & Verlaque M. (2012). Mediterranean Seagrass Meadows: Resilience and Contribution to Climate Change Mitigation, A Short Summary. Gland, Switzerland and Málaga, Spain: IUCN. 40pp.
- Pergent, G., Bazairi, H., Bianchi, C.N., Boudouresque, C.F., Buia, M.C., Calvo, S., Clabaut, P., Harmelin-Vivien, M., Mateo, M., Montefalcone, M., Morri, C., Orfanidis, S., Pergent-Martini, C., Semroud, R., Serrano, O., Thibaut, T., Tomasello, A. & Verlaque, M. (2014). Climate change and Mediterranean seagrass meadows: a synopsis for environmental managers. Mediterranean Marine Science, 15(2), 462-473.
- Pilczynska, J., Cocito, S., Boavida, J., Serrão, E. & Queiroga, H. (2016). Genetic diversity and local connectivity in the mediterranean red gorgonian coral after mass mortality events. *PLOS ONE, 11*(3), e0150590. doi:10.1371/journal.pone.0150590
- Popoff, N. et al. (in prep.). Waterbird conservation: a strong deficiency of Ramsar sites designation in the Mediterranean countries.
- Ramsar. (2011). *Wetland Ecosystem Services.* Retrieved from http://archive.ramsar.org/cda/en/ramsar-pubs-info-ecosystem-services/main/ramsar/1-30-103%255E24258_4000_0__
- Ramsar. (2014). *Zones humides et agriculture, cultivons le partenariat ! Brochure de la journée mondiale des zones humide*. February 2, 2014, 16pp. Retrieved from www.ramsar.org.
- Ramsar. (2018). *Global Wetland Outlook: State of the World's Wetlands and their Services to People*. Gland, Switzerland: Ramsar Convention Secretariat.
- Rodrigues, L.C., Van Den Bergh, J.C., Massa, F., Theodorou, J.A., Ziveri, P. & Gazeau, F. (2015). Sensitivity of Mediterranean bivalve mollusc aquaculture to climate change, ocean acidification, and other environmental pressures: findings from a producer survey. *Journal of Shellfish Research, 34*(3), 1161-1176.
- Sabatier, F., Anthony, E.J., Héquette, A., Suanez, S., Musereau, J., Ruz, M.H. & Regnauld, H. (2009). Morphodynamics of beach/dune systems: examples from the coast of France. *Géomorphologie: Relief, Processus, Environnement, 15*(1). doi:10.4000/geomorphologie.7461
- San-Miguel-Ayanz, J., Durrant, T., Boca, R., Libertà, G., Branco, A., de Rigo, D., Ferrari, D., Maianti, P., Vivancos, T.A., Costa, H., Lana, F., Löffler, P., Nuijten, D., Ahlgren, A.C. & Leray, T. (2018). Forest fires in Europe, Middle East and North Africa 2017. EUR 29318 EN, ISBN 978-92-79-92831-4, doi: 10.2760/663443.
- Scheffer, M., Carpenter, S., Foley, J. A., Folke, C. & Walker, B. (2001). Catastrophic shifts in ecosystems. *Nature, 413*(6856), 591-596. https://doi.org/10.1038/35098000
- Shili, A., Maïz, N.B., Boudouresque, C.F. & Trabelsi, E.B. (2007). Abrupt changes in Potamogeton and Ruppia beds in a Mediterranean lagoon. *Aquatic Botany, 87*(3), 181-188.
- Simeone, S. & De Falco, G. (2012). Morphology and composition of beach-cast Posidonia oceanica litter on beaches with different exposures. *Geomorphology, 151*, 224-233. doi:10.1016/j.geomorph.2012.02.005
- Soldo, A. (2016). European Red List of habitats. A2.31 Communities of Mediterranean mediolittoral mud estuarine. Retrieved from https://forum.eionet.europa.eu/european-red-list-habitats/library/marine-habitats/mediterranean-sea

• Telesca, L., Belluscio, A., Criscoli, A, Ardizzone, G., Apostolaki, E.T., Fraschetti, S., Gristina, M., Knittweis, L., Martin, C.S. & Pergent, G. (2015). Seagrass meadows (Posidonia oceanica) distribution and trajectories of change. *Scientific Reports, 5*, 12505.
• Templado, J. (2014). Future trends of Mediterranean biodiversity. In : S., Goffredo & Z., Dubinski (Ed(s)). *The Mediterranean Sea: its history and present challenges* (pp. 479-498). Dordrecht, Germany: Springer Science + Business Media.
• Tsimplis, M.N., Proctor, R. & Flather, R.A. (1995). A two-dimensional tidal model for the Mediterranean Sea. *Journal of Geophysical Research: Oceans, 100*(C8), 16223-16239. doi:10.1029/95JC01671.
• Tzonev, R. (2015a.) *European Red List of Habitats. A2.5d Mediterranean and Black Sea coastal salt marsh.* Retrieved from https://forum.eionet.europa.eu/european-red-list-habitats/library/terrestrial-habitats/b.-coastal
• Tzonev, R. (2015b). *European Red List of Habitats B3.4b Mediterranean and Black Sea soft sea cliff.* Retrieved from https://forum.eionet.europa.eu/european-red-list-habitats/library/terrestrial-habitats/b.-coastal
• UNEP/MAP. (2016). *Integrated Monitoring and Assessment Guidance.* 19th Ordinary Meeting of the Contracting Parties to the Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean and its Protocols.
• UNEP/MAP. (2017). *Mediterranean 2017 Quality Status Report (QSR 2017).* UNEP/MAP. Retrieved from www.medqsr.org
• UNEP/MAP. (2019). *Draft evaluation document of the Strategic Action Programme for the Conservation of Biological Diversity in the Mediterranean Region (SAP BIO).* UNEP/MED WG.459/3. Retrieved from http://www.rac-spa.org/cormon1/docs/wg_459_3.pdf
• UNEP/MAP/MED POL. (2004). *Transboundary Diagnostic Analysis (TDA) for the Mediterranean Sea.* Athens, Greece: UNEP/MAP, 282pp.
• UNEP-MAP & UNESCO-IH. (2015). *Final report on Mediterranean coastal aquifers and groundwater including the coastal aquifer supplement to the TDA-MED and the sub-regional action plans.* Paris, France: Strategic Partnership for the Mediterranean Sea Large Marine Ecosystem (MedPartnership).
• UNEP/MAP SPA/RAC. (2010). *The Mediterranean Sea Biodiversity: state of the ecosystems, pressures, impacts and future priorities.* By Bazairi, H., Ben Haj, S., Boero, F., Cebrian, D., De Juan, S., Limam, A., Lleonart, J., Torchia, G., and Rais, C., (Ed(s)). Tunis, Tunisia: SPA/RAC; 100 pages.
• UNEP-WCMC. (2018). Wetland Extent Trends (WET) Index -2017 Update. In Ramsar Convention on Wetlands. *Global Wetland Outlook: State of the World's Wetlands and their Services to People.* Gland, Switzerland: Ramsar.
• Valente, S., Serrão, E.A. & González-Wangüemert, M. (2015). West versus East Mediterranean Sea: origin and genetic differentiation of the sea cucumber Holothuria polii. *Marine Ecology, 36*, 485-495.
• Vergara-Chen, C., González-Wangüemert, M., Marcos, C. & Pérez-Ruzafa, A. (2010). High gene flow promotes the genetic homogeneity of the fish goby Pomatoschistus marmoratus (Risso, 1810) from Mar Menor coastal lagoon and adjacent marine waters (Spain). *Marine Ecology, 31*(2), 270-275.
• Vidale, E., Da Re, R. & Pettenella, D. (2015). *Trends, rural impacts and future developments of regional WFP market.* Project deliverable of the StarTree project (EU project 311919) D3.2, Legnaro, Italy: University of Padova.
• Vogiatzakis, I.N.; Griffiths, G.H., Cassar, L. & Morse, S. (2005). *Mediterranean Coastal Landscapes: Management Practices,-Typology and Sustainability. Project Report.* Madrid, Spain: UNEP-PAR/RAC; United Nations Environment Programme Mediterranean Action Plan.
• Werner, S., Budziak, A., van Franeker, J., Galgani, F., Hanke, G., Maes, T., Matiddi, M., Nilsson, P., Oosterbaan, L., Priestland, E., Thompson, R., Veiga, J. & Vlachogianni, T. (2016). *Harm caused by Marine Litter*. MSFD GES TG Marine Litter - Thematic Report; JRC Technical report; EUR 28317 EN. doi:10.2788/19937
• Wesselmann, M., González-Wangüemert, M., Serrão, E.A., Engelen, A. H., Renault, L., García-March, J.R., Duarte, C.M. & Hendriks, I. E. (2018). Genetic and oceanographic tools reveal high population connectivity and diversity in the endangered pen shell Pinna nobilis. *Scientific Reports, 8*(1), 4770. https://doi.org/10.1038/s41598-018-23004-2
• Zenetos, A., Çinar, M.E., Crocetta, F., Golani, D., Rosso, A., Servello, G., Shenkar, N., Turon, X. & Verlaque, M. (2017). Uncertainties and validation of alien species catalogues: The Mediterranean as an example. *Estuarine, Coastal and Shelf Science, 191*, 171-187. doi: 10.1016/j.ecss.2017.03.031.

References Chapter 4

• Abdulla, A. & Linden, O. (2008). *Maritime traffic effects on biodiversity in the Mediterranean Sea: Review of impacts, priority areas and mitigation measures.* Malaga, Spain: IUCN Centre for Mediterranean Cooperation, p. 166.
• ACCOBAMS. (2018). ASI 2018 Summer Survey. Retrieved from http://www.accobams.org/main-activites/accobams-survey-initiative-2/asi-preliminary-results/
• Addamo A.M., Laroche P., Hanke G. (2017). *Top Marine Beach Litter Items in Europe,* EUR 29249 EN, Publications Office of the European Union, Luxembourg, Joint Research Center, doi:10.2760/496717, JRC108181.
• Alleaume, S. & Guinet, C. (2011). Evaluation of the potential of collision between fin whales and maritime traffic in the north-western Mediterranean Sea in summer, and mitigation solutions. *Journal of Marine Animals and Their Ecology, 4*(1).
• Andersson, H., Tago, D. & Treich, N. (2014). Pesticides and health: A review of evidence on health effects, valuation of risks,

and benefit-cost analysis. *Preference Measurement in Health (Advances in Health Economics and Health Services Research), 24*, 203-295.
- Arvis, J-F. & Shepherd, B. (2011). *The Air Connectivity Index. Measuring Integration in the Global Air Transport Network*. Policy Research Working Paper 5722. International Trade Department, The World Bank.
- Arvis, J.-F., Vesin, V., Carruthers, R., Ducruet, C. & Peter, de L. (2019). *Maritime Networks, Port Efficiency , and Hinterland Connectivity in the Mediterranean. International Development in Focus.* Washington, DC: World Bank Publications, The World Bank Group. Retrieved from: https://doi.org/10.1596/978-1-4648-1274-3
- *Barcelona Urban Mobility Plan 2013-2018.* Retrieved from https://ajuntament.barcelona.cat/ecologiaurbana/en/what-we-do-and-why/active-and-sustainable-mobility/urban-mobility-plan
- Barra, R., Leonard, S., Whaley, C. & Bierbaum, R. (2018). *Plastics and the Circular Economy.* STAP Document, Global Environment Facility and UN Environment. doi:10.13140/RG.2.2.11515.57128
- Blanco, A.B. (2011). *Analyse de l'agriculture du littoral méditerranéen. Etude comparative entre l'Espagne, la France et l'Italie.* Retrieved from: https://www.iamm.ciheam.org/ress_doc/opac_css/doc_num.php?explnum_id=5117
- BleuTourMed. (2018). Identifying challenges and gaps towards sustainable and responsible coastal and maritime tourism in the Mediterranean. MED Sustainable Tourism Community's 1st thematic paper. Retrieved from http://planbleu.org/sites/default/files/upload/files/BTM_1st_thematic_paper_Sustainable_Tourism_2017.pdf
- Boat International. (2019). *The business of yachting - The Global Order Book.* Retrieved from https://www.boatinternational.com/yacht-market-intelligence/luxury-yachts-on-order/annual-reports/2019-global-order-book--39251
- Boissery, P. (2018). Issues of emerging pollutants in the land water interface in the Mediterranean. Presentation, Technical Conference, Marseille, 11 December 2018.
- Brouwer R., Hadzhiyska, D., Ioakeimidis, C. & Ouderdorp, H. (2017). The social costs of marine litter along European coasts. *Ocean & Coastal Management, 138,* 38-49. doi.org/10.1016/j.ocecoaman.2017.01.011
- Brun, M., Blanc, P. & Otto, H. (2016). *Global perspective of natural resources.* CIHEAM. ZERO WASTE IN THE MEDITERRANEAN, Natural Resources, Food and Knowledge, Presses de SciencesPo, 9782724619201. <hal-01620873>
- Cames, M., Graichen, J., Siemons, A. & Cook, V. (2013). *Emission Reduction Targets for International Aviation and Shipping.* IP/A/ENVI/2015-11. Retrieved from: http://www.europarl.europa.eu/RegData/etudes/STUD/2015/569964/IPOL_STU(2015)569964_EN.pdf
- CAS. (2019). *Chemical Abstract Service, American Chemical Society.* Retrieved from: https://cas.org
- CIHEAM (2017) *The Mediterranean organic route.* G7 Ministerial Meeting on Agriculture, Bergamo, 12 October 2017.
- CleanSea project (2016). *Final Report Summary.* CLEANSEA (Towards a Clean, Litter-Free European Marine Environment through Scientific Evidence, Innovative Tools and Good Governance). Retrieved from https://cordis.europa.eu/project/rcn/106632/reporting/en
- D'amato, A, Paleari, S, Pohjakallio, M, Vanderreydt, I & Zoboli, R. (2019). *Plastics Waste Trade and the Environment.* Eionet Report - ETC/WMGE 2019/5.
- Daumalin, X., Laffont-Schwob, I. (Ed(s)). (2016). *Pollution of Marseille's Industrial Calanques: the Impact of the Past on the Present.* Aix-en-Provence, France: Ref.2CEditions, 336pp.
- Dayan, U., Ricaud, P., Zbinden, R. & Dulac, F. (2017). Atmospheric pollution over the eastern Mediterranean during summer - A review. *Atmospheric Chemistry and Physics, 17*(21), 13233-13263.
- DNV-GL. (2017). *Sustainable Development Goals: Exploring Maritime Opportunities.* Retrieved from https://rederi.no/globalassets/dokumenter-en/all/fagomrader/smi/dnv-gl-sdg-maritime-report.pdf
- Ecorys. (2014). *Study in support of Impact Assessment work on Blue Biotechnology.* FWC MARE/2012706 - SC C1/2013/03 - 13 June 2014.
- EEA. (2013a). *A closer look at urban transport.* EEA Report No 11/2013. Retrieved from https://www.eea.europa.eu/publications/term-2013
- EEA. (2013b). *The impact of international shipping on European air quality and climate forcing.* EEA Technical Report no. 4/2013. doi:10.2800/75763
- EnerNETMob. (2019, October). *Project website of the Interregional Electromobility Network For The Mediterranean Coastal Areas.* Enernetmob Project. Retrieved from https://urban-transports.interreg-med.eu/news-events/news/detail/actualites/interregional-electromobility-network-for-the-mediterranean-coastal-areas-by-enernetmob-project/
- Eunomia. (2016). *Study to support the development of measures to combat a range of marine litter.* Report for the European Commission/ DG environment. 10 pp. Retrieved from: https://www.eunomia.co.uk/reports-tools/study-to-support-the-development-of-measures-to-combat-a-range-of-marine-litter-sources/
- Eurocontrol (2017). *Eurocontrol seven-years forecast. Flight movements and service units 2016-2022.* Retrieved from: https://www.eurocontrol.int/sites/default/files/content/documents/official-documents/forecasts/seven-year-flights-service-units-forecast-2016-2022-september-2016.pdf
- European Chemicals Agency (2019, February 1). ECA website. Retrieved from https://echa.europa.eu/fr/registration-statistics-infograph#
- European Commission. (2017). *EU Transport in figures - Statistical Pocketbook 2017.* Luxembourg: Publications Office of the European Union. Retrieved from https://ec.europa.eu/transport/facts-fundings/statistics/pocketbook-2017_en
- European Commission. (2019). *Report from the Commission to the European Parliament, the Council, the European Eco-*

nomic and Social Committee and the Committee of the Regions on the implementation of the Circular Economy Action Plan. COM/2019/190 final.
- FAO & Plan Bleu (2018). *State of Mediterranean Forests 2018.* Rome, Italy: FAO. Retrieved from http://planbleu.org/sites/default/files/publications/somf2018.pdf
- FAO. (1995). *Effects of riverine inputs on coastal ecosystems and fisheries resources.* FAO Fisheries Technical Paper. No. 349. Rome, Italy: FAO. 133p. Retrieved from http://www.fao.org/3/V4890E/V4890E05.htm
- FAO. (2018a). *World Food and Agriculture - Statistical Pocketbook 2018*. Rome, Italy: FAO. 254 pp.
- FAO. (2018b). *The State of Mediterranean and Black Sea Fisheries.* Rome, Italy: General Fisheries Commission for the Mediterranean, 172 pp.
- FAOSTAT. (2020). *FAOSTAT website.* Retrieved from: http://www.fao.org/faostat/en/#home
- Font, T. & Lloret, J. (2014). Biological and Ecological Impacts Derived from Recreational Fishing in Mediterranean Coastal Areas. *Reviews in Fisheries Science & Aquaculture, 22*(1), 73-85. doi:10.1080/10641262.2013.823907
- Fosse, J. & Le Tellier, J. (2017). *Sustainable Tourism in the Mediterranean: State of Play and Strategic Directions.* Plan Bleu Paper, 17.
- Fosse, J., Petrick, K., Nenci, L., Klarwein, S., Blondeau, R., Frezal, C., Roniotes, A., Scoullos, M., Vasilaki, V., Greenfild, O. & Abaza, H. (2016). *Towards a Green Economy in the Mediterranean - Assessment of National Green Economy and Sustainable Development Strategies in Mediterranean Countries.* Eco-union, MIO-ECSDE, GEC. Retrieved from http://mio-ecsde.org/wp-content/uploads/2016/12/greeneconomy-med-web.pdf
- Galli, A., Iha, K., Halle, M., El Bilali, H., Grunewald, N., Eaton, D., Capone, R., Debs, P. & Bottalico, F. (2017). Mediterranean countries' food consumption and sourcing patterns: An Ecological Footprint viewpoint. *Science of The Total Environment, 578*, 383-391. https://doi.org/10.1016/j.scitotenv.2016.10.191
- Gerstein, E.R., Blue, J.E. & Forysthe, S.E. (2006). *The acoustics of vessel collisions with marine mammals.* Extract of Proceedings of OCEANS 2005 MTS/IEEE ; 17-23 september 2005. https://doi.org/10.1109/OCEANS.2005.1639917
- GESAMP. (2016). Sources, fate and effects of microplastics in the marine environment: part two of a global assessment. In P.J., Kershaw & C.M., Rochman (Ed(s)). *IMO/FAO/UNESCO-IOC/UNIDO/WMO/IAEA/UN/ UNEP/UNDP Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection.* Rep. Stud. GESAMP No. 93, 220 p.
- Geyer, R., Jambeck, J. & Lavender Law, K. (2017). Production, use, and fate of all plastics ever made. *Science Advances, 3*(7), e170782. doi:10.1126/sciadv.1700782
- Hachem, F., Capone, R., Yannakoulia, M., Dernini, S., Hwalla, N. & Kalaitzidis, C. (2016). *Chapter 10- The Mediterranean diet: a sustainable consumption pattern.* FAO, CIHEAM, the American University of Beirut and the University Harokopio of Athens. Retrieved from https://www.ciheam.org/uploads/attachments/449/10_Mediterra2016_EN.pdf
- Hanke, G. (2016). *Marine Beach Litter in Europe - Top Items.* Technical Report by the Joint Research Centre (JRC). Retrieved from https://ec.europa.eu/jrc, 29 pp
- Hawkins, A.D. & Popper, A.N. (2016). Developing Sound Exposure Criteria for Fishes. In A., Popper & A., Hawkins (Ed(s)). *The Effects of Noise on Aquatic Life II* (pp. 431-439). Advances in Experimental Medicine and Biology, vol 875. New York, NY: Springer.
- Hildering, A., Keessen, A.M. & van Rijswick, F.M.W. (2009). Tackling pollution of the Mediterranean Sea from land-based sources by an integrated ecosystem approach and the use of the combined international and European legal regimes. *Utrecht Law Review, 5*(1), 80.
- Honey, M. & Krantz, D. (2007). *Global Trends in Coastal Tourism.* Center on Ecotourism and Sustainable Development, p. 8-9. Retrieved from https://www.responsibletravel.org/docs/Global_Trends_in_Coastal_Tourism_by_CESD_Jan_08.pdf
- IEA (2016). *Global EV Outlook 2016*. Paris, France : IEA. Retieved from https://www.iea.org/reports/global-ev-outlook-2016
- IEMed (2012). *Mediterranean Year Book.* Barcelona, Spain: IEMed. ISSN: 1697-8897.
- INERIS. (2019). *ECAMED: Technical Feasibility Study for the Implementation of an Emission Control Area (ECA) in the Mediterranean Sea*. Synthesis Report, January 11, 2019.
- International Maritime Organization (IMO). (2015). Third IMO Greenhouse Gas Study 2014 - *Executive Summary and Final Report.* London, UK: IMO.
- International Youth Foundation. (2014). *Transport Services & Their Impact on Youth Employment & Development in Jordan*. Retrieved from https://www.iyfnet.org/library/transport-services-their-impact-youth-employment-development-jordan
- ISPRA. (2019). *Rapporto Rifiuti Speciali Edizione 2019*. ISPRA Rapporti n. 309/2019.
- IUCN. (2012). *Marine mammals and sea turtles of the Mediterranean and Black Seas.* Gland, Switzerland: IUCN.
- Jambeck, J.R., Geyer, R., Wilcox, C., Siegler, T.R., Perryman, M., Andrady, A., Narayan, R. & Law, K.L. (2015). Plastic waste inputs from land into the ocean. *Science, 347*(6223), 768-771. doi:10.1126/science.1260352
- Keber, M., Ambrosio, L., Camerlenghi, A., Donda, F., Tinivella, U., Volpi, V. (2017). Deep Sea Mining: An Opportunity for the Italian Offshore Industry?. Offshore Mediterranean Conference and Exhibition, 29-31 March, Ravenna, Italy. Retrieved from https://www.onepetro.org/conference-paper/OMC-2017-761
- Lacirignola, C., Capone, R., Debs, P., El Bilali, H. & Bottalico, F. (2014). Natural resources - food nexus: food-related environmental footprints in the Mediterranean countries. *Frontiers in Nutrition, 1*, 23. doi:10.3389/fnut.2014.00023
- Le Gouvello, R. & Simard, F. (Ed(s)). (2017). *Durabilité des aliments pour le poisson en aquaculture: Réflexions et recommandations sur les aspects technologiques, économiques, sociaux et environnementaux.* Gland, Switzerland and Paris, France: IUCN. 296 pp.

- Lebreton, L., Van der Zwet, J., Damsteeq, J., Slat, B., Andrady, A. & Reisser, J. (2017). River plastic emissions to the world's oceans. *Nature Communications, 8*, 15611.
- Lenzen, M., Sun, Y.Y., Faturay, F., Ting, Y.P., Geschke, A. & Malik, A. (2018). The carbon footprint of global tourism. *Nature Climate Change, 8*(6), 522-528.
- Lloret, J., Cowx, I.G., Cabral, H., Castro, M., Font, T., Gonçalves, J.M.S., Gordoa, A., Hoefnagel, E., Matić-Skoko, S., Mikkelsen, E. (2018). Small-scale coastal fisheries in European Seas are not what they were: Ecological, social and economic changes. *Marine Policy, 98*, 176-186.
- Ludwig, W., Dumont, E., Meybeck, M. & Heusser, S. (2009). River discharges of water and nutrients to the Mediterranean and Black Sea: major drivers for ecosystem changes during past and future decades? *Progress in Oceanography, 80*, 199-217.
- Maglio, A., Pavan, G. & Castellote, M. (2016). ACCOBAMS - *Overview of the noise hot spots in the ACCOBAMS area - PART I Mediterranean Sea.*
- Mancini, M. & Galli, A. (2017). Measuring and Monitoring Sustainability Trends in the Mediterranean: The Ecological Footprint Viewpoint. *Quaderns de la Mediterrània, 25*, 119-126. Retrieved from https://www.iemed.org/observatori/arees-danalisi/arxius-adjunts/quaderns-de-la-mediterrania/qm25/monitoring_sustainability_mediterranean_Mancini_Galli_QM25_en.pdf
- Markovic, M. & Hema, T. (2016). *Action Plan on Implementing the PoM and the NAPs by integrating regional and MSFD requirements.* ActionMed Deliverable D3.3: December 2016, 83pp. Retrieved from http://actionmed.eu/wp-content/uploads/2017/12/D3.3-and-D3.7-ActionMed_Regional-PoMs-and-Action-Plans-1.pdf
- MedCruise Association. (2018). *Cruise Activities in MedCruise Ports - 2017 STATISTICS*. Retrieved from http://www.medcruise.com/sites/default/files/2018-03/cruise_activities_in_medcruise_ports-statistics_2017_final_0.pdf
- Medener. (2013). Energy efficiency trends in Mediterranean countries. Retrieved from http://medener-indicateurs.net/uk/download/094
- MedReg. (2016). S*urvey on Consumer Associations in the Mediterranean.* Working Group on Consumer Issues, Med16-21GA -4.5.2, Malta. Retrieved from http://www.medreg-regulators.org/Portals/45/documenti/160519_Survey_on_CAs_in_The_Mediterranean_final.pdf
- Mueller, N., Rojas-Rueda, D., Basagaña, X., Cirach, M., Cole-Hunter, T., Dadvand, P., Donaire-Gonzalez, D., Foraster, M., Gascon, M. & Martinez, D. (2017) Health impacts related to urban and transport planning: A burden of disease assessment. *Environmental International, 107*. doi:10.1016/j.envint.2017.07.020
- Navarre, M., Lammens, H. & ESG Analysis. (2017). *Opportunities of deep-sea mining and ESG risks.* Amundi Discussion Papers Series. DP-24-2017. August 2017.
- Nolet, V. (2017). *Understanding Anthropogenic Underwater Noise.* Report prepared for Transport Canada.
- Ocean Conservancy. (2018). The International coastal clean-ups/ clean ups reports 2003 & 2018. Retrieved from https://oceanconservancy.org/trash-free-seas/international-coastal-cleanup/annual-data-release/
- OECD & IEA. (2019). *Fossil Fuel Support and other Analysis Portal.* Retrieved from: http://www.oecd.org/fossil-fuels/data/
- OECD (2016). *The Ocean Economy in 2030.* Retrieved from https://unstats.un.org/unsd/class/intercop/expertgroup/2017/AC340-Bk8.PDF
- OECD (2017), *Tackling Environmental Problems with the Help of Behavioral Insights.* Paris, France: OECD Publishing. Retrieved from http://dx.doi.org/10.1787/9789264273887-en
- OECD. (2013). *Environment at a Glance 2013* - OECD Indicators. Paris, France: OECD Publishing. Retrieved from https://www.oecd-ilibrary.org/fr/environment/environment-at-a-glance-2013_9789264185715-en
- OECD. (2018). *Improving markets for recycled plastics.* Paris, France: OECD Publishing. Retrieved from https://doi.org/10.1787/9789264301016-en.
- OECD/ITF. (2018a). *Decarbonising Maritime Transport-Pathways to zero-carbon shipping by 2035*. Retrieved from https://www.itf-oecd.org/sites/default/files/docs/decarbonising-maritime-transport.pdf
- Olmer, N., Comer, B., Roy, B., Mao, X. & Rutherford, D.A.N. (2017). Greenhouse Gas Emissions From Global Shipping, 2013-2015. Washington, DC: ICCT.
- OME (Observatoire Méditerranéen de l'Energie). (2018). *Mediterranean energy perspectives 2018.*
- Panigada, S., Pesante, G., Zanardelli, M., Capoulade, F., Gannier, A. & Weinrich, M.T. (2006). Mediterranean fin whales at risk from fatal ship strikes. *Marine Pollution Bulletin, 52*(10), 1287-1298.
- Papaefthimiou, S., Maragkogianni, A. & Andriosopoulos, K. (2016). Evaluation of cruise ships emissions in the Mediterranean basin: The case of Greek ports. *International Journal of Sustainable Transportation, 10*(10), 985-994.
- Paul Ricard Oceanographic Institute. (2019). Website. Retrieved from https://www.institut-paul-ricard.org/en/programmes_recherche/amti/
- Pennino, M.G., Arcangeli, A., Campana, I., Pierce, G. J., Rotta, A. & Bellido, J.M. (2017). A spatially explicit risk assessment approach: Cetaceans and marine traffic in the Pelagos Sanctuary (Mediterranean Sea). *PLoS ONE, 12*(6), e0179686.
- PERSEUS. (2015). *Atlas of Riverine Inputs to the Mediterranean Sea.* UNEP/MAP Report
- Piante, C. & Ody, D. (2015). *Blue Growth in the Mediterranean Sea: The Challenge of Good Environmental Status.* MedTrends Project. WWF-France. 192 pages.
- Plan Bleu. (2016). *Guidelines for a Sustainable Tourism in the Mediterranean.*

- Plan Bleu. (2016). *Tourism and sustainability in the Mediterranean: key facts and trends.*
- Plan Bleu. (2017a). *Socio-economic tools for supporting the achievement of Good Environmental Status of Mediterranean marine waters.* Valbonne, Plan Bleu. Technical Report, 69pp. Retrieved from https://planbleu.org/sites/default/files/publications/technical_report_good_environmental_status.pdf
- Plan Bleu. (2017b). *Bio-prospecting and underwater mining.* Project Conference "A blue economy for a sustainable development of the Mediterranean region". 05/30/2017 to 05/31/2017. Retrieved from https://planbleu.org/sites/default/files/upload/files/7_Bio-prospecting_and_underwater_mining_Hall_SUT.pdf
- Plan Bleu. (2020). *Blue Economy in the Mediterranean - Case Studies Lessons and Perspectives*. Plan Bleu Paper 19, January 2020. Marseille, France: Plan Bleu. ISBN: 978-2-912081-54-4.
- Plastic Europe. (2018). *Plastics - the Facts 2018: An analysis of European plastics production, demand and waste data*. Retrieved from https://www.plasticseurope.org/fr/resources/market-data
- Polinov, S. (2018). *Historical changes in human activities in the Mediterranean Sea.* University of Haifa, p.14. Retrieved from https://www.docdroid.net/3YilKUX/semion-polinov-historical-changes-in-human-activities-in-the-mediterranean-sea-hamburg-20-22-marcons-wp1-training-school.pdf
- Randone, M., Bocci, M., Castellani, C. & Laurent, C. (2019). Safeguarding Marine Protected Areas in the Growing Mediterranean Blue Economy: Recommendations for Maritime Transport. *International Journal of Design & Nature and Ecodynamics, 14*(4), 264-274.
- Randone, M., Di Carlo, G., Costantini, M., Tzanetti, T., Haferkamp, D., Portafaix, A., Smits, M., Antoniades, V., Kachaner, N. & Osborne, A. (2017). *Reviving the Economy of the Mediterranean Sea: Actions for a Sustainable Future.* Rome, Italy: WWF Mediterranean Initiative.
- REMPEC. (2014). *Statistical analysis - Alerts and accidents database.*
- Rodrigue, J-P. (2017). *The Geography of Transport Systems* (4th ed.). New York, NY: Routledge. ISBN 978-0-367-36463-2.
- Sanchez-Jerez, P. (2013). Fish Escapes from Cage Aquaculture in the Mediterranean. World Aquaculture, 30.
- SCP/RAC (2019). *UNEP/MAP SCP/RAC website*. Retrieved from www.cprac.org
- *Sustainable Balearic Islands website* (2019, October). Retrieved from https://www.caib.es/sites/impostturisme/es/impost/
- Ten Brink, P., Schweitzer, J., Watkins, E., Janssens, C., De Smet, M., Leslie, H. & Galgani, F. (2018). Circular economy measures to keep plastics and their value in the economy, avoid waste and reduce marine litter. *Economics Discussion Papers, 2018-3*, 1-15.
- TNS political & social at the request of the European Commission, Directorate-General for Environment (2017). *Attitudes of European citizens towards the environment.* Special Eurobarometer 468 - October 2017.
- Transport & Environment (2018a). Air pollution on the rise in Spain. Retrieved from https://www.transportenvironment.org/news/air-pollution-rise-spain
- Transport & Environment (2018b). *Roadmap to decarboniting European aviation.* Retrieved from https://www.transportenvironment.org/sites/te/files/publications/2018_10_Aviation_decarbonisation_paper_final.pdf
- Transport & Environment. (2017). *Statistical analysis of the energy efficiency performance (EEDI) of new ships.*
- Turkish Ministry of Agriculture and Forestry. (2019). Fisheries Statistics 2019, Ankara Turkey.
- Turley, C.M. (1999). The changing Mediterranean Sea: a sensitive ecosystem? *Progress in Oceanography, 44,* 387-400.
- UfM. (2013). *Regional Transport Action Plan for the Mediterranean Region.* Retrieved from https://ec.europa.eu/transport/sites/transport/files/themes/international/european_neighbourhood_policy/mediterranean_partnership/docs/rtap2014_2020_en.pdf
- UfM. (2016). "Untapping the potential of the blue economy in the Mediterranean region". Retrieved from https://ufmsecretariat.org/untapping-the-potential-of-blue-economy-in-the-mediterranean-region/
- UfM. (2017). *Blue economy in the Mediterranean.* In contribution with eco-union and Sverige. Retrieved from https://ufmsecretariat.org/wp-content/uploads/2017/12/UfMS_Blue-Economy_Report.pdf
- UN Environment. (2018a). *Combating marine plastic litter and microplastics: An assessment of the effectiveness of relevant international, regional and subregional governance strategies and approaches.* First Meeting of the Ad Hoc Open Ended Expert Group established under UNEP/EA.3/Res.7
- UN Environment. (2018b). *Legal Limits on Single-Use Plastics and Micro plastics: A Global Review of National Laws and Regulations.* UN report, 138 pp.
- UNCTAD. (2016). *Review of Maritime Transport 2016.* UNCTAD/RMT/2016. United Nations Publication. ISBN 978-92-1-112904-5.
- UNCTAD. (2017a). *Review of Maritime Transport 2017.* UNCTAD/RMT/2017. United Nations Publication. ISBN 978-92-1-112922-9.
- UNCTAD. (2017b). *UNCTAD STAT - Maritime Country Profiles.* Retrieved from https://unctadstat.unctad.org/countryprofile/MaritimeProfile/en-GB/004/index.html
- UNEP/MAP - PAP/RAC. (2019). *Safeguarding Marine Protected Areas in the Growing Mediterranean Blue Economy: Cruise Sector.* PHAROS4MPAs Policy Brief.
- UNEP/MAP (2012). *State of the Mediterranean Marine and Coastal Environment.* Athens, Greece: UNEP/MAP.
- UNEP/MAP. (2015). *Marine Litter Assessment in the Mediterranean 2015.* Athens, Greece: UNEP/MAP. ISBN No: 978-92-807-3564-2.
- UNEP/MAP. (2017a). *2017 Mediterranean Quality Status Report (QSR).* Retrieved from https://www.medqsr.org
- UNEP/MAP. (2017b). *Gap Analysis on existing measures under the Barcelona Convention relevant to achieving or maintaining*

good environmental status of the Mediterranean Sea. 6th Meeting of the Ecosystem Approach Coordination Group, Athens, Greece, 2017. UNEP(DEPI)/MED WG.444/Inf.12, 68 pp
- UNEP/MAP. (2018). *Study based on a literature review on existing best practices in the Mediterranean as well as other European regional seas for the application of charges at reasonable costs and No-Special-Fee system for the use of port reception facilities*. (UNEP/MED WG.452/Inf.5).
- Universitat Autonoma de Barcelona. (2018). *Marine litter on Mediterranean beaches triples in summer.* Communication on the UAB website of 12/07/2018, consulted in October 2019: https://www.uab.cat/web/newsroom/news-detail/marine-litter-on-mediterranean-beaches-triples-in-summer-1345668003610.html?noticiaid=1345767714685
- UNWTO (2019). *Yearbook of Tourism Statistics, Data 2013-2017, 2019 Edition.* Madrid, Spain: UNWTO.
- US Energy Information Administration. (2017). World Oil Transit Chokepoints. Retrieved from https://www.eia.gov/international/analysis/special-topics/World_Oil_Transit_Chokepoints
- Van Acoleyen, M., Laureysens, I., Lambert, S., Raport, L., Van Sluis, C., Kater, B., van Onselen, E., Veiga, J. & Ferreira, M. (2014). *Marine Litter study to support the establishment of an initial quantitative headline reduction target - SFRA0025*. Final report of the European Commission DG Environment Project number BE0113.000668, 315pp. retrieved from http://ec.europa.eu/environment/marine/good-environmental-status/descriptor-10/pdf/final_report.pdf
- Van der Hal, N., Ariel A. & Angel, D. (2017). Exceptionally high abundances of microplastics in the oligotrophic Israeli Mediterranean coastal waters. *Marine Pollution Bulletin, 116*(1-2), 151-155. doi:10.1016/j.marpolbul.2016.12.052.
- Vlachogianni, T. (2017). *Understanding the socio-economic implications of marine litter in the Adriatic-Ionian macroregion*. IPA-Adriatic DeFishGear project and MIO-ECSDE. pp.70 (ISBN: 978-960-6793-26-4)
- von Schuckmann, K., Le Traon, P-Y., Smith, N., Pascual, A., Brasseur, P., Fennel, K., Djavidnia, S., Aaboe, S., Fanjul, E.A. & Autret, E. (2018). Copernicus Marine Service Ocean State Report. *Journal of Operational Oceanography, 11*(sup1), S1-S142. doi:10.1080/1755876X.2018.1489208
- Weiss, L., Ludwig, W., Estournel, C. & Sadaoui, M. (2019). *Modélisation des flux de plastiques en Méditerranée.* Conference paper to the Premières rencontres nationales du GDR Polymères et Océans Université Paris-Est Créteil, 24-26 juin 2019. Retrieved from https://po2019.sciencesconf.org/264835/document
- World Bank. (2018). *What a Waste 2.0.* Retrieved from: http://datatopics.worldbank.org/what-a-waste/
- World Bank. (2019). *World Bank Open Data.* Retrieved from: https://data.worldbank.org
- World Bank. (2020). *World Development Indicators.* Retrieved from: http://datatopics.worldbank.org/world-development-indicators/
- WTTC (2015). *Economic impact of Travel and Tourism in the Mediterranean.* World Travel and Tourism Council.
- WWF. (2001). *Tourism threats in the Mediterranean, Background Information.* Retrieved from https://www.monachus-guardian.org/library/wwftou01.pdf
- WWF. (2004). *Freshwater and Tourism in the Mediterranean.* Rome, Italy: WWF Mediterranean Programme.
- WWF. (2018). *Out of the plastic trap: saving the Mediterranean from plastic pollution.* Rome, Italy: WWF Mediterranean Marine Initiative, 28 pp.
- WWF. (2019). Solving plastics pollution through accountability. A report for WWF by Dalberg. ISBN 978-2-940529-93-3.

References Chapter 5

- Allouche, A. & Nicolas, L. (2014). Adaptation aux changements globaux dans la réserve de biosphère Camargue Grand Delta (CAMADAPT).
- Bensted-Smith, R. & Kirkman, H. (2009). *Comparison of approaches to management of large-scale marine areas.* Internal Report. Washington, DC: Fauna and Flora International and Conservation International.
- Bernardi-Tahir, N. (2016). *Mobilités en Méditerranée occidentale, la place des petites îles.* Encyclopédie PIM.
- Best, B. (2003). *Conservation and integrated coastal management: looking beyond marine protected areas.* 325-342. In S.B., Olsen (Ed). *Crafting coastal governance in a changing world* (pp. 325-342). Coastal Management Report 2241. RI, USA: Coastal Resources Management Program, US Agency for International Development, University of Rhode Island Coastal Resources Center.
- Boero, F. (2015). The future of the Mediterranean Sea Ecosystem: towards a different tomorrow. *Rendiconti Lincei. Scienze fisiche e naturali, 26*, 3-12.
- Brigand, L. (1991). *Les îles en Méditerranée, enjeux et perspectives.* PNUE - CAR/PB.
- CEC. (2008). *Green paper on territorial cohesion - turning territorial diversity into strength.* Communication from the Commission to the Council, the European Parliament, the Committee of the Regions and the European Economic and Social Committee, COM (2008) 616 final, 6.10.2008. Brussels: COM.
- Colloca, F., Cardinale, M., Maynou, F., Giannoulaki, M., Scarcella, G., Jenko, K., Bellido, J.M. & Fiorentino, F. (2013). Rebuilding Mediterranean fisheries: a new paradigm for ecological sustainability. *Fish and fisheries, 14*(1), 89-109.
- Council of Europe. (2000). *Guiding principles for sustainable spatial development of the European continent.*
- Dale, N. & Markandya, A. (2015). *Local assessment of vulnerability to climate variability and change for Šibenik-Knin Coun*ty

coastal zone. PAP/RAC. Technical Report, September 2015. Retrieved from http://pap-thecoastcentre.org/pdfs/LAV%20Sibenik.pdf
- Doze, E. *L'appréhension juridique du risque inhérent aux espaces naturels littoraux.* Thèse de doctorat en Droit public 2016. Aix Marseille Université. Retrieved from https://tel.archives-ouvertes.fr/tel-01420355/document
- EC. (2015). *Cross border cooperation within the European Neighbourhood Instrument (ENI) Mediterranean Sea basin programme 2014-2020.* Retrieved from https://interreg-med.eu/about-us/cooperation-area/
- Eggermont, H., Balian, E., Azevedo, J.M.N., Beumer, V., Brodin, T., Claudet, J., Fady, B., Grube, M., Keune, H., Lamarque, P. (2015). Nature-based Solutions: New Influence for Environmental Management and Research in Europe. GAIA - *Ecological Perspectives for Science and Society, 24*(4), 243-248.
- Emmanouilidou, P. (2015). *Le statut juridique des îles de la Méditerranée : un droit fragmenté.* -hal-01385765-.
- EU. (2007). *Treaty of Lisbon Amending the Treaty on European Union and the Treaty Establishing the European Community*. 13 December 2007. 2007/C 306/01.
- EU. (2011). *Territorial Agenda of EU 2020: Towards an Inclusive, Smart and Sustainable Europe of Diverse Regions.* EU 2011 Hu.
- European Commission (2010). *Europe 2020: A strategy for smart, sustainable and inclusive growth.* COM (2010) 2020 final.
- FAO. (2015). *Mediterranean Coastal Lagoons: Sustainable Management and Interactions Among Aquaculture, Capture Fisheries and The Environment.* FAO Studies and Reviews no. 95. ISBN: 978-92-5-108792-3.
- FAO. (2018). *The State of Mediterranean and Black Sea Fisheries.* Rome, Italy: General Fisheries Commission for the Mediterranean, 172 pp.
- Gentili, M. & Hoekstra, J. (2018). Houses without people and people without houses: a cultural and institutional exploration of an Italian paradox. *Housing Studies*, 1-23.
- Gomei, M. & Di Carlo, G. (2012). *Making marine protected areas work - Lessons learned in the Mediterranean.* WWF Mediterranean. 56 pages.
- Grasland, C. & Van Hamme, G. (2010). La relocalisation des activités industrielles : une approche centre-périphérie des dynamiques mondiale et européenne. *L'Espace Géographique, 39*(1), 1-19. doi:10.3917/eg.391.0001
- Hughes, J.D. & Thirgood, J.V. (1982). Deforestation, erosion, and forest management in ancient Greece and Rome. *Journal of Forest History, 26*(2), 60-75.
- IEMed (2017). *IEMed Mediterranean Yearbook 2017.* Retrieved from iemed.org
- IPCC. (2018). Summary for Policymakers. In Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (Ed(s)). *Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty.* Geneva, Switzerland: World Meteorological Organization.
- Kolodny, E-Y. & Edisud. (1974). La population des îles de la Grèce, essai de géographie insulaire en Méditerranée orientale. In *Méditerranée, 2*(15), 111-112.
- Lambert, M-L. *Risques littoraux : évolution du droit et prospective.* Jourénée Eccorev - changements climatiques et littoraux, 21 juin 2013. Retrieved from https://www.eccorev.fr/IMG/pdf/MLLambert_-_CC_et_littoraux_Eccorev_juin_13.pdf
- MedCruise Association. (2018). *Cruise Activities in MedCruise Ports* - 2017 STATISTICS. Retrieved from http://www.medcruise.com/sites/default/files/2018-03/cruise_activities_in_medcruise_ports-statistics_2017_final_0.pdf
- Millennium Ecosystem Assessment. (2005). *Ecosystems and Human Well-being: Synthesis.* Washington, DC: Island Press. Retrieved from: https://www.millenniumassessment.org/documents/document.356.aspx.pdf
- Ministère de la Transition Ecologique et Solidaire. (2019). L'Environnement en France 2019. *Rapport de synthèse.* ISBN: 978-2-11-157057-3. Retrieved from https://www.vie-publique.fr/sites/default/files/rapport/pdf/271417.pdf
- Moser, S.C., Jeffress Williams, S. & Boesch, D.F. (2012). Wicked challenges at land's end: Managing coastal vulnerability under climate change. *Annual Review of Environment and Resources, 37*, 51-78.
- Nori M., (2018). Rural migrations and Mediterranean agricultural systems. IEMed.
- OECD (2015). *OECD Affordable Housing Database - HC3.1 Homeless population.* Retrieved from http://www.oecd.org/els/family/HC3-1-Homeless-population.pdf
- Piante, C. & Ody, D. (2015). *Blue Growth in the Mediterranean Sea: The Challenge of Good Environmental Status.* MedTrends Project. WWF-France. 192 pages.
- Pranzini, E. (2018). Shore protection in Italy: from hard to soft engineering… and back. *Ocean and Coastal Management, 156,* 43-57.
- Ramieri, E., Mourmouris, A., Addis, D. & Bocci, M. (2018). *Recommendations to support common understanding on a regional scale on MSP, including synergic implementation of regionally relevant policy instruments.* EU Project Grant No.: EASME/EMFF/2015/1.2.1.3/02/SI2.742101. Supporting Implementation of Maritime Spatial Planning in the Western Mediterranean region (SIMWESTMED). Priority Actions Programme Regional Activity Centre (PAP/RAC). 52pp. DOI: 10.5281/zenodo.2592049
- *Regional Climate Change Adaptation Framework for the Mediterranean Marine and Coastal Areas.* UN Environment/MAP Athens, Greece (2017).
- Rochette, J., du Puy-Montbrun, G., Wemaëre, M. & Billé, R. (2010). *Coastal setback zones in the Mediterranean: A study on Ar-*

ticle 8-2 of the Mediterranean ICZM Protocol. Analyses vol. 5. Retrieved from https://www.iddri.org/sites/default/files/import/publications/an_1005_article-8-2-iczm-protocol.pdf
- Satta, A., Venturini, S., Puddu, M., Firth, J. & Lafitte, A. (2015). *Strengthening the Knowledge Base on Regional Climate Variability and Change: Application of a Multi-Scale Coastal Risk Index at Regional and Local Scale in the Mediterranean*. Plan Bleu Report.
- Shipman, B. (2012). *iCZM 2.0 - a new ICZM for an era of uncertainty.* Keynote address at Littoral 2012, Oostende.
- Tempesta M. & Otero, M. (2013). Guide for quick evaluation of management in Mediterranean MPAs. WWF Italy, IUCN. 68 pp.
- UNDESA. (2010). *World Population Prospects the 2010 Revision.* Volume 1. New York, NY: United Nations., 405p.
- UNDESA. (2019). *World Population Prospects 2019.* Retrieved from https://population.un.org/wpp/
- UNEP/MAP. (2008). *Protocol on Integrated Coastal Zone Management in the Mediterranean.* Retrieved from: https://web.unep.org/unepmap/8-iczm-protocol
- UNEP/MAP. (2017). Mediterranean 2017 Quality Status Report (QSR 2017). UNEP/MAP. Retrieved from www.medqsr.org
- UNEP/MAP/PAP. (2015). *Guidelines for Adapting to climate variability and change along the Mediterranean coasts. Priority Actions Programme Regional Activity Centre* (PAP/RAC), Split, 2015.
- UNEP-GRID. (2017). Evolution of the built-up area in coastal zones of Mediterranean countries between 1975 and 2015. PAP/RAC. Retrieved from http://iczmplatform.org//storage/documents/zniei2qlFKHKukOZDs9Y6RpajhxsNEq3YLlCJWaG.pdf
- UNESCO. (2011). *Recommendation on the Historic Urban Landscape.* Paris, 10 November 2011. Retrieved from https://whc.unesco.org/uploads/activities/documents/activity-638-98.pdf
- UN-HABITAT. (2015). *Issue Paper n°22: informal settlements.* Retrieved from http://habitat3.org/wp-content/uploads/Habitat-III-Issue-Paper-22_Informal-Settlements-2.0.pdf
- UN-HABITAT. (2016). *World Cities Report 2016: Urbanization and Development - Emerging Futures*. New York, NY: United Nations. doi:10.18356/d201a997-en.
- Vasilakopoulos, P., Maravelias, C. D. & Tserpes, G. (2014). The alarming decline of Mediterranean fish stocks. *Current Biology, 24*(14), 1643-1648.
- World Bank. (2019). *World Development Indicators.* Retrieved from: http://datatopics.worldbank.org/world-development-indicators/

References Chapter 6

- Abis, S. (2015). *Géopolitique du blé. Un produit vital pour la sécurité mondiale.* Armand Colin.
- AFD & CIHEAM. (2019). *Mediterra: Migrations and inclusive rural development in the Mediterranean.* Paris, France: Presses de Sciences Po.
- Agropolis Fondation. (2011). *Sécurité alimentaire en Méditerranée à l'horizon 2030 : aspects qualitatifs et quantitatifs.* Retrieved from http://www.agropolis.org/pdf/Rapport-SAMAQQ.pdf
- Alary, V., Moulin, C-H., Lasseur, J., Aboulnaga, A.M. & Sraïri, M.T. (2017). *The future of Mediterranean Livestock Farming Systems: Opportunity and efficiency of Crops - Livestock Integration.* Final report CLIMED. Projet Arimnet-Union Européenne, 60pp.
- Andreu, J., Capilla, J. & Sanchis, E. (1996) Aquatool: a generalized decision-support system for water resources planning and operational management. *Journal of Hydrology, 177*(3-4), 269-291.
- Arbex de Castro Vilas Boas, A., Page, D., Giovinazzo, R., Bertin, N. & Fanciullino, A-L. (2017). Combined effects of irrigation regime, genotype, and harvest stage determine tomato fruit quality and aptitude for processing into puree. *Frontiers in Plant Science, 8*, 1725.
- Arthington, A.H., Bhaduri, A., Bunn, S.E., Jackson, S.E., Tharme, R.E., Tickner, D., Young, B., Acreman, M., Baker, N., Capon, S. Horne, A.C., Kendy, E., McClain, M.E., Poff, N.L., Richter, B.D. & Ward, S. (2018). The Brisbane declaration and global action agenda on environmental flows (2018). *Frontiers in Environmental Science, 6*, 45.
- Asensio, D., Peñuelas, J., Ogaya, R. & Llusia, J. (2007) Seasonal soil and CO_2 exchange rates in a Mediterranean holm oak forest and their responses to drought conditions. *Atmospheric Environment, 41*, 2447-2455.
- Aureli, A., Ganoulis, J. & Margat, J. (2008). *Groundwater Resources in the Mediterranean Region: Importance, Uses and Sharing.* Water in the Mediterranean, Med 2008.
- Ayadi, I., Abida, H., Djebbar, Y. & Raouf Mahjoub, M. (2010). Sediment yield variability in central Tunisia: a quantitative analysis of its controlling factors. *Hydrological Sciences Journal, 55*(3), 446-458.
- Barbagallo, R.N., Di Silvestro, I. & Patanè, C. Yield, physicochemical traits, antioxidant pattern, polyphenol oxidase activity and total visual quality of field-grown processing tomato cv. Brigade as affected by water stress in Mediterranean climate. *Journal of the Science of Food and Agriculture, 93*, 1449-1457.
- Bazilian, M., Rogner, H., Howells, M., Hermann, S., Arent, D., Gielen, D., Steduto, P., Mueller, A., Komor, P., Tol, R.S.J. & Yumkella, K.K. (2011). Considering the energy, water and food nexus: Towards an integrated modeling approach. *Energy Policy, 39*(12), 7896-7906.

- Ben Rais Lasram, F., Guilhaumon, F., Albouy, C., Somot, S., Thuiller, W. & Mouillot, D. (2010). The Mediterranean Sea as a 'cul-de-sac' for endemic fishes facing climate change. *Global Change Biology, 16*, 3233-3245. doi:10.1111/j.1365-2486.2010.02224.x
- Bernués, A., Ruiz, R., Olaizola, A., Villalba, D. & Casasus, I. (2011). Sustainability of pasture-based livestock farming systems in the European Mediterranean context: Synergies and trade-offs. *Livestock Science, 139*(1-2), 44-57.
- Blinda, M. (2018). *Contribution pour le groupe d'experts sur le thème « Nexus eau - sécurité alimentaire - énergie dans la zone côtière méditerranéenne » suite à l'atelier « Quels enjeux majeurs dans les zones marines et côtières en Méditerranée ? Données et tendances ».* Marseille, France, 12-13/12/2017.
- Bucak, T., Trolle, D., Andersen, H.E., Thodsen, H., Erdoğan, S., Levi, E.E., Filiz, N., Jeppesen, E. & Beklioğlu, M. (2017). Future water availability in the largest freshwater Mediterranean lake is at great risk as evidenced from simulations with the SWAT model. *Science of the Total Environment, 581-582*, 413-425.
- Caló, F., Notti, D., Galve, J. P., Abdikan, S., Görüm, T., Pepe, A. & Balik Șanli, F. (2017). Dinsar-based detection of land subsidence and correlation with groundwater depletion in konya plain, turkey. *Remote Sensing, 9*(1), 83.
- Cerdan, O., Govers, G., Le Bissonnais, Y., Van Oost, K., Poesen, J., Saby, N., Gobin, A., Vacca, A., Quinton, J., Auerswald, K., Klik, A., Kwaad, F.J.P.M., Raclot, D., Ionita, I., Rejman, J., Rousseva, S., Muxart, T., Roxo, M.J. & Dostal, T. (2010). Rates and spatial variations of soil erosion in Europe: a study based on erosion plot data. *Geomorphology, 122*(1-2), 167-177.
- Cheung, W.W.L., Jones, M.C., Reygondeau, G., Stock, C.A., Lam, V.W.Y., Frölicher, T.L. (2016). Structural uncertainty in projecting global fisheries catches under climate change. *Ecological Modelling, 325*, 57-66. doi:10.1016/j.ecolmodel.2015.12.018
- CIHEAM. (2018). *Strengthening the role of women. Obstacles and opportunities in rural and agricultural areas.* Watch Letter Number 40. Joint publication between CIHEAM and UfM. Retrieved from https://www.ciheam.org/uploads/attachments/853/WL40_CIHEAM_UfM_Working_Document_Med_Women_Rural_May_2018_2.pdf
- Collet, L., Ruelland, D., Borrell-Estupina, V., Dezetter, A. & Servat, E. (2013). Integrated modelling to assess long-term water supply capacity of a meso-scale Mediterranean catchment. *Science of the Total Environment, 461*, 528-540.
- Cook, B.I., Anchukaitis, K.J., Touchan, R., Meko, D.M. & Cook, E.R. (2016). Spatiotemporal drought variability in the Mediterranean over the last 900 years. Journal of Geophysical Research Atmospheres, 121, 1-15. doi:10.1002/2015JD023929.
- Curiel-Yuste, J.C., Peñuelas, J., Estiarte, M., Garcia-Mas, J., Mattana, S., Ogaya, R., Pujol, M. & Sardans, J. (2011) Drought-resistant fungi control soil organic matter decomposition and its response to temperature. *Global Change Biology, 17*, 1475-1486.
- Custodio, E. (2018). Consequences of Seawater Intrusion in Mediterranean Spain. Project SASMIE. In M., Calvache, C., Duque & D., Pulido-Velazquez (Ed(s)). *Groundwater and Global Change in the Western Mediterranean Area.* Environmental Earth Sciences. Springer, Cham.
- Custodio, E., Andreu-Rodes, J.M., Aragón, R., Estrela, T., Ferrer, J., García-Aróstegui, J.L., Manzano, M., Rodríguez-Hernández, L., Sahuquillo, A. & del Villar, A. (2016). Groundwater intensive use and mining in south-eastern peninsular Spain: hydrogeological, economic and social aspects. *Science of the Total Environment, 559*, 302-316.
- Dalin, C., Wada, Y., Kastner, T. & Puma, M. J. (2017). Groundwater depletion embedded in international food trade. *Nature, 543*(7647), 700-704.
- De Châtel, F. (2014) The role of drought and climate change in the Syrian uprising: untangling the triggers of the revolution. *Middle Eastern Studies, 50*(4), 521-535. https://doi.org/10.1080/00263206.2013.850076
- De Dato, G.D., De Angelis, P., Sirea, C. & Beier, C. (2010) Impact of drought and increasing temperatures on soil CO_2 emissions in a Mediterranean shrubland (Gariga). *Plant and Soil, 327,* 153-166.
- de Fraiture, C., Cai, X., Amarasinghe, U., Rosegrant, M. & Molden, D. (2004). *Does international cereal trade save water?: the impact of virtual water trade on global water use.* Comprehensive Assessment Research Report 4. Colombo, Sri Lanka: Comprehensive Assessment Secretariat.
- De Jalón, D.G., Bussettini, M., Rinaldi, M., Grant, G., Friberg, N., Cowx, I.G., Magdaleno, F. & Buijse, T. (2017). Linking environmental flows to sediment dynamics. *Water Policy, 19*(2), 358-375.
- Deryng, D., Elliott, J.. Folberth, C., Müller, C., Pugh, Thomas A.M., Boote, K.J., Conway, D., Ruane, A.C., Gerten, D., Jones, J.W., Khabarov, N., Olin, S., Schaphoff, S., Schmid, E., Yang, H. & Rosenzweig, C. (2016). Regional disparities in the beneficial effects of rising CO 2 concentrations on crop water productivity. *Nature Climate Change, 6*(8), 786-790.
- Diamantini, E., Lutz, S. R., Mallucci, S., Majone, B., Merz, R. & Bellin, A. (2018). Driver detection of water quality trends in three large European river basins. *Science of the Total Environment, 612,* 49-62.
- Dury, S., Alpha, A. & Bichard, A. (2015). The negative side of the Agricultural-Nutrition impact pathways: a literature review. *World Food Policy, 2*(1), 78-100.
- EEA. (2018). Ecological Status of Surface Water Bodies. Retrieved from: https://www.eea.europa.eu/themes/water/european-waters/water-quality-and-water-assessment/water-assessments/ecological-status-of-surface-water-bodies
- Emmett, B.A., Beier, C., Estiarte, M., Tietema, A., Kristensen, H.L., Williams, D., Peñuelas, J., Schmidt, I. & Sowerby, A. (2004). The response of soil processes to climate change: results from manipulation studies of shrublands across an environmental gradient. *Ecosystems, 7*, 625-637.
- European Commission. (2019). Global Surface Water Explorer. Retrieved from: https://global-surface-water.appspot.com/
- Fader, M., Shi, S., Von Bloh, W., Bondeau, A. & Cramer, W. (2016). Mediterranean irrigation under climate change: more efficient irrigation needed to compensate increases in irrigation water requirements. *Hydrology and Earth System Science, 20*, 953-973.

- FAO & ITPS. (2015). *Status of the World's Soil Resources (SWSR) - Main Report.* Rome, Italy: FAO and Intergovernmental Technical Panel on Soils.
- FAO & World Bank. (2018), *Water Management in Fragile Systems: Building Resilience to Shocks and Protracted Crises in the Middle East and North Africa.* Cairo, Egypt: World Bank/FAO.
- FAO, (2014b). *The Water-Energy-Food Nexus. A new approach in support of food security and sustainable agriculture*. Rome, Italy: FAO. Retrieved from http://www.fao.org/nr/water/docs/FAOnexusconcept.pdf
- FAO, IFAD, UNICEF, WFP & WHO. (2018). *The State of Food Security and Nutrition in the World 2018. Building climate resilience for food security and nutrition.* Rome, Italy: FAO. Retrieved from http://www.fao.org/3/i9553en/i9553en.pdf
- FAO. (2014a). *The Water-Energy-Food Nexus at FAO. Concept Note.* Rome, Italy: FAO.
- FAO. (2015). *Revised World Soil Charter.* Rome, Italy: FAO. Retrieved from http://www.fao.org/3/a-i4965e.pdf
- FAO. (2016a). *AQUASTAT Main Database.* Data Updated 2016, and accessed 11/01/2019. Retrieved from http://www.fao.org/nr/water/aquastat/main/index.stm
- FAO. (2016b). *Livestock contribution to food security in the Near East and North Africa.* FAO regional conference for the Near East, 33rd Session, Beirut, Lebanon, 18-22 April 2016.
- FAO. (2017). *Regional overview of food security and nutrition. Building resilience for food security and nutrition in times of conflict and crisis: a perspective from the Near East and North African (NENA) region.* Cairo, 62 pp.
- FAO. (2017). *Voluntary Guidelines for Sustainable Soil Management.* Rome, Italy: FAO. Retrieved from http://www.fao.org/3/a-bl813e.pdf.
- FAO. (2018a). *World Food and Agriculture - Statistical Pocketbook 2018.* Rome, Italy: FAO. 254 pp. Licence: CC BY-NC-SA 3.0 IGO.
- FAO. (2018b). *The future of food and agriculture - Alternative pathways to 2050.* Rome, Italy: FAO. 224 pp.
- FAO. (2019). *Incorporating environmental flows into "water stress" indicator 6.4.2. Guidelines for a minimum standard method for global reporting.* Rome, Italy: FAO. Retrieved from http://www.fao.org/3/CA3097EN/ca3097en.pdf
- FAOSTAT. (2017, 2019). *FAOSTAT Food and Agriculture Data.* Retrieved from: http://www.fao.org/faostat/en/#home
- FAO. (2020). *AQUASTAT Main Database.* Accessed 02/05/2020.
- FAO-UNESCO. (2020). *Digital Soil Map of the World.* Accessed 10/06/2020.
- Fernandez, S. (2007). *L'eau virtuelle dans les pays méditerranéens : un indicateur pour contribuer à l'analyse des questions de gestion et de répartition de l'eau en situation de pénurie ?* Rapport d'étude régionale du Plan Bleu.
- Fernando, N., Panozzo, J., Tausz, M., Norton, R., Fitzgerald, G., Khan, A. & Seneweera, S. (2015). Rising CO_2 concentration altered wheat grain proteome and flour rheological characteristics. *Food Chemistry, 170*, 448-454.
- Fitzgerald, G.J., Tausz, M., O'Leary, G., Mollah, M.R., Tausz-Posch, S., Seneweera, S., Mock, I., Löw, M., Partington, D.L., McNeil, D. & Norton, R.M. (2016). Elevated atmospheric [CO_2] can dramatically increase wheat yields in semi-arid environments and buffer against heat waves. *Global Change Biology, 22*, 2269-2284. doi:10.1111/gcb.13263
- Forzieri, G., Feyen, L., Rojas, R., Flörke, M., Wimmer, F. & Bianchi, A. (2014). Ensemble projections of future streamflow droughts in Europe. *Hydrology and Earth System Sciences, 18*(1), 85.
- Fraga, H., García de Cortázar Atauri, I., Malheiro, A.C. & Santos, J.A. (2016). Modelling climate change impacts on viticultural yield, phenology and stress conditions in Europe. *Global Change Biology, 22*, 3774-3788.
- Funes, I., Aranda, X., Biel, C., Carbó, J., Camps, F., Molina, Antonio A.J., Herralde, F. de, Grau, B. & Savé, R. (2016). Future climate change impacts on apple flowering date in a Mediterranean subbasin. *Agricultural Water Management, 164*(1), 19-27. ISSN 0378-3774.
- Gabaldón-Leal, C., Ruiz-Ramos, M., de la Rosa, R., León, L., Belaj, A., Rodríguez, A., Santos, C. & Lorite, I.J. (2017). Impact of changes in mean and extreme temperatures caused by climate change on olive flowering in southern Spain. *International Journal of Climatology, 37*, 940-957. doi:10.1002/joc.5048
- García-Ruiz, J.M., López-Moreno, J.I., Vicente-Serrano, S.M., Lasanta-Martínez, T. & Beguería, S., (2011). Mediterranean water resources in a global change scenario. *Earth-Science Reviews, 105*, 121-139.
- Gerten, D. (2013). Global climate change impacts on freshwater availability - an overview of recent assessments. In E., Boegh, E., Blyth, D.M., Hannah, H., Hisdal, H., Kunstmann, B., Su, K.K., Yilmaz (Ed(s)). *Climate and Land Surface Changes in Hydrology* (vol. 359, pp. 47-52). Gothenburg, Sweden: IAHS.
- Gleick, P.H. & Heberger, M. (2014). Water and conflict. In P.H., Gleick (Ed). *The World's Water Series* (pp. 159-171). https://doi.org/10.5822/978-1-61091-483-3
- Global Water System Project. (2019). G*lobal Reservoirs and Dams database.* Retrieved from: http://globaldamwatch.org/grand/
- Gonçalvès, J., Petersen, J., Deschamps, P., Hamelin, B. & Baba-Sy, O. (2013). Quantifying the modern recharge of the "fossil" Sahara aquifers. *Geophysical Research Letters, 40*(11), 2673-2678.
- Gössling, S., Peeters, P., Hall, C.M., Ceron, J.P., Dubois, G, Lehmann, L.V. & Scott, D. (2012). Tourism and water use: supply, demand, and security. An international review. *Tourism Management, 33*(1), 1-15.
- Gudmundsson, L. & Seneviratne, S.I. (2016). Anthropogenic climate change affects meteorological drought risk in Europe. *Environmental Research Letters, 11*(4), 044005. doi:10.1088/1748-9326/11/4/044005
- Gudmundsson, L., Seneviratne, S.I. & Zhang, X. (2017). Anthropogenic climate change detected in European renewable freshwater resources. *Nature Climate Change, 7*(11), 813-816. doi:10.1038/nclimate3416

- GWP. (2000). *Integrated Water Resources Management.* Stockholm, Sweden: Global Water Partnership TAC Background Paper No. 4.
- GWP-Med. (2018). *Concept Note.* 1st Nexus Roundtable in the MENA and wider Mediterranean, 26-28 November 2018, Beirut, Lebanon, Hilton Beirut Metropolitan Palace Hotel. Retrieved from https://www.gwp.org/globalassets/global/gwp-med-files/list-of-programmes/sida-matchmaker/beirut-nexus-roundtable-oct-2018/beirut-nexus-roundtable---concept-note---en.pdf
- Hachem, F., Capone, R., Yannakoulia, M., Dernini, S. Hwalla N. & Kalaitzidia, C. (2016). The Mediterranean diet: a sustainable consumption pattern. In FAO/CIHEAM. *Mediterra 2016. Zero Waste in the Mediterranean. Natural Resources, Food and Knowledge.* Paris, France: Presses de Sciences Po.
- Hermoso, V. & Clavero, M. (2011). Threatening processes and conservation management of endemic freshwater fish in the Mediterranean basin: a review. *Marine & Freshwater Resources, 62*(3), 244-254.
- Hernandez, I., Alegre, L. & Munné-Bosch, S. (2004). Drought-induced changes in flavonoids and other low molecular weight antioxidants in Cistus clussi grown under Mediterranean field conditions. *Tree Physiology, 24*, 1303-1311.
- Herrero, M. & Thornton, P.K. (2013). Livestock and global change: Emerging issues for sustainable food systems. *Proceedings of the National Academy of Sciences USA, 110,* 20878-20881.
- Herrero, M., Havlík, P., Valin, H., Notenbaert, A., Rufino, M.C., Thornton, P.K., Blümmel, M., Weiss, F., Grace, D. & Obersteiner, M. (2013). Biomass use, production, feed efficiencies, and greenhouse gas emissions from global livestock systems. *Proceedings of the National Academy of Sciences USA, 110*, 20888-20893.
- Hoekstra, A.Y., Chapagain, A.K., Aldaya, M.M. & Mekonnen, M.M. (2011). *The Water Footprint Assessment Manual: Setting the Global Standard.* London, UK: Earthscan.
- Hueso, S., Hernández, T. & García, C. (2011) Resistance and resilence of the soil microbial biomass to severe drought in semiarid soils: The importance of organic amendments. *Applied Soil Ecology, 50*, 27-36.
- IBM. (2009). *Water. A Global Innovation Outlook Report.* Retrieved from http://www.cdn.giweh.ch/2015/2/7/1-15-6-1-1.pdf
- IGRAC & UNESCO-IHP. (2015). *Transboundary Aquifers of the World* [map]. Edition 2015. Delft, Netherlands: IGRAC, 2015. Retrieved from http://ihp-wins.unesco.org/layers/geonode:tba_map2015. Accessed 28-01-2019.
- IPEMED. (2019). *Reuse of treated waste water in the Mediterranean and impacts on territories.* Retrieved from: http://www.ipemed.coop/adminIpemed/media/fich_article/1521051262_palimpseste-n19-en.pdf
- Jägerskog, A. & Swain, A. (2016). *Water, migration and how they are interlinked.* Working paper 27. Stockholm, Sweden: SIWI. Retrieved from https://www.siwi.org/wp-content/uploads/2016/07/2016-Water-Report-Chapter-1-FINAL-Web.pdf
- Jiménez Cisneros, B.E., Oki, T., Arnell, N.W., Benito, G., Cogley, J.G., Döll, P., Jiang, T. & Mwakalila, S.S. (2014). Freshwater resources. In: Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L.White (Ed(s)). *Climate Change 2014: Impacts,Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Chang*e (pp. 229-269). Cambridge, United Kingdom and New York, NY: Cambridge University Press.
- Jobbins, G., Langdown, I. & Bernard., G. (2018). Water and sanitation, migration and the 2030 Agenda for Sustainable Development. Overseas Development Institute and Swiss Development Cooperation.
- Jones, M.C. & Cheung, W.W.L. (2015). Multi-model ensemble projections of climate change effects on global marine biodiversity. *ICES Journal of Marine Science, 72*, 741-752. doi:10.1093/icesjms/fsu
- Kara, M.H., Lacroix, D., Sadek, S., Blancheton, J.P., Rey-Valette, H. & Kraiem, M. (2016). Vingt ans d'aquaculture en Afrique du Nord : évolutions, bilan critique et avenir. *Cahiers Agricultures, 25*(6), 1-9. doi:10.1051/cagri/2016044
- Kelley, C.P., Mohtadi, S., Cane, M.A., Seager, R. & Kushnir, Y. (2015). Climate change in the Fertile Crescent and implications of the recent Syrian drought. *Proceedings of the national Academy of Sciences USA, 112*(11), 3241-3246.
- Koutroulis, A.G., Grillakis, M.G., Daliakopoulos, I.N., Tsanis, I.K. & Jacob, D. (2016). Cross sectoral impacts on water availability at +2°C and +3°C for east Mediterranean island states: The case of Crete. *Journal of Hydrology, 532,* 16-28. doi:10.1016/j.jhydrol.2015.11.015
- Kovats, R.S., Valentini, R., Bouwer, L.M., Georgopoulou, E., Jacob, D., Martin, E., Rounsevell, M. & Soussana, J-F. (2014). Europe. In: Barros, V.R., C.B. Field, D.J. Dokken, M.D. Mastrandrea, K.J. Mach, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (Ed(s)). *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 1267-1326). Cambridge, United Kingdom and New York, NY: Cambridge University Press.
- Lahmar, R. & Ruellan, A. (2007). Dégradation des sols et stratégies coopératives en Méditerranée : la pression sur les ressources naturelles et les stratégies de développement durable. *Cahiers Agricultures, 16,* 318-323.
- Lehner, B., Liermann, C.R., Revenga, C., Vörösmarty, C., Fekete, B., Crouzet, P., Döll, P., Endejan, M., Frenken, K., Magome, J., Nilsson, C., Robertson, J.C., Rödel, R., Sindorf, N. & Wisser, D. (2011). *Global reservoir and dam (grand) database.* Technical Documentation, Version, 1.1-14.
- Link, P.M., Kominek, J. & Scheffran, J. (2012). Impacts of sea-level rise on the coastal zones of Egypt. *Mainzer Geographische Studien, 55,* 79-94. Working paper CLISEC-25.
- Ludwig, W. & Montreuil, O., (2013). *SES land-based runoff and nutrient load data (1980-2000).* PERSEUS Project Deliverable

no 4.3. Retrieved from http://www.perseus-net.eu/site/content.php?artid=675

- Ludwig, W., Bouwman, A.F., Dumont, F. & Lespinas, F. (2010). Water and nutrient fluxes from major Mediterranean and Black Sea rivers: Past and future trends and their implications for the basin- scale budgets. *Global Biogeochemical Cycles, 24*(4), GB0A13.
- Maetens, W. (2013) Effectiveness of land use and soil conservation techniques in reducing runoff and soil loss in Europe and the Mediterranean. KU Leuven Thesis/Dissertation.
- Malagò, A. & Bouraoui, F. (2017, November). Water Quality Modeling in the Mediterranean River Basins. In A., Kallel, M., Ksibi, H., Ben Dhia & N., Khélifi (Ed(s)). *Recent Advances in Environmental Science from the Euro-Mediterranean and Surrounding Regions* (pp. 77-80). EMCEI 2017. Advances in Science, Technology & Innovation (IEREK Interdisciplinary Series for Sustainable Development). Springer, Cham.
- Margat, J. & Treyer, S. (2004). *L'eau des méditerranéens : situations et perspectives.* MAP Technical Report Series 158, 366 pp.
- Martinez-Mena, M., Lopez, J., Almagro, M., Boix-Fayos, C. & Albaladejo, J. (2008). Effect of water erosion and cultivation on the soil carbon stock in a semiarid area of South-East Spain. *Soil and Tillage Research, 99*(1), 119-129.
- Marx, A., Kumar, R., Thober, S., Rakovec, O., Wanders, N., Zink, M., Wood, E.F., Pan, M., Sheffield, J. & Samaniego, L. (2018). Climate change alters low flows in Europe under global warming of 1.5, 2, and 3°C. *Hydrology and Earth System Sciences, 22*(2), 1017-1032. doi:10.5194/hess-22-1017-2018.
- Marzin J., Bonnet P., Bessaoud O. & Ton Nu, C. (2016). *Study on small-scale agriculture in the Near East and North Africa region (NENA): overview.* Rome, Italy: FAO. 138 p. retrieved from http://www.iamm.ciheam.org/ress_doc/opac_css/index.php?lvl=notice_display&id=37319
- MED-Amin. (2016). *The cereal situation in the Mediterranean area.* Retrieved from http://www.minagric.gr/images/stories/docs/agrotis/Dimitriaka/MED_Amin_PolicyBrief_1_English-2016.pdf
- MED-EUWI WG. (2007). *Mediterranean Groundwater Report: Technical report on groundwater management in the Mediterranean and the Water Framework Directive.* The Mediterranean Groundwater Working Group (MED-EUWI WG on Groundwater).
- Mekonnen, M.M. & Hoekstra, A.Y. (2011). *National water footprint accounts: the green, blue and grey water footprint of production and consumption.* Value of Water Research Report Series No. 50, Delft, the Netherlands: UNESCO-IHE.
- Milano, M., Ruelland, D., Dezetter, A., Fabre, J., Ardoin-Bardin, S. & Servat, E. (2013b). Modeling the current and future capacity of water resources to meet water demands in the Ebro basin. *Journal of Hydrology, 500*, 114-126.
- Milano, M., Ruelland, D., Fernandez, S., Dezetter, A., Ardoin-Bardin, S., Fabre, J., Thivet, G. & Servat, E. (2013a). Current state of Mediterranean water resources and future trends under climatic and anthropogenic changes. *Hydrological Sciences Journal, 58*(3), 498-518.
- Milano, M., Ruelland, D., Fernandez, S., Dezetter, A., Fabre, J. & Servat, E. (2012). Facing climatic and anthropogenic changes in the Mediterranean basin: what will be the medium-term impact on water stress? *Comptes Rendus Geoscience, 344*, 432-440.
- Munné-Bosch, S. & Alegre, L. (2000). Changes in carotenoids, tocopherols and diterpenes during drought and recovery, and the biological significance of chlorophyll loss in Rosmarinus officinalis plants. *Planta, 210*, 925-931.
- Nikolaidis, N.P., Bidoglio, G., Bouraoui, F. & Cardoso, A. (2014). Water Quality of the Mediterranean. In S., Ahuja, M.C., Larsen, J.L., Eimers, C.L., Patterson, S., Sengupta & J.L., Schnoor. (Ed(s)). *Comprehensive water quality and purification*. Amsterdam, the Netherlands: Elsevier. JRC89768. ISBN: 9780123821829. Retrieved from http://publications.jrc.ec.europa.eu/repository/handle/JRC89768
- OECD/FAO. (2018). *OECD-FAO Agricultural Outlook 2018-2027.* Paris, France: OECD Publishing and Rome, Italy: FAO.
- Orgiazzi, A., Lumini, E., Nilsson, R.H., Girlanda, M., Vizzini A, Bonfante, P. & Bianciotto, V. (2012). Unravelling soil fungal communities from different Mediterranean land-use backgrounds. *PLoS One, 7*, e34847.
- Panagos, P., Borrelli, P., Poesen, J., Ballabio, C., Lugato, E., Meusburger, K., Montanarella, L. & Alewell, C. (2015). The new assessment of soil loss by water erosion in Europe. *Environmental Science & Policy, 54*, 438-447. ISSN 1462-9011.
- Pekel, J-F., Cottam, A., Gorelick, N. & Belward A-S. (2016). High-resolution mapping of global surface water and its long-term changes. *Nature, 540*, 418-422.
- Perera, B.J.C., James, B. & Kularathna, M.D.U. (2005). Computer software tool REALM for sustainable water allocation and management. *Journal of Environmental Management, 77*(4), 291-300.
- Plan Bleu. (2003). *Threats to Soils in Mediterranean Countries.* Document Review. ISBN: 2-912081-14-9. Retrieved from http://www.prosodol.gr/sites/prosodol.gr/files/Threats%20of%20soils%20Med.pdf
- Plan Bleu. (2011). *Efficience d'utilisation de l'eau et approche économique : études nationales.* Retrieved from http://planbleu.org/publications/eau.html
- Poloczanska, E.S., Burrows, M.T., Brown, C.J., Garcia Molinos, J., Halpern, B.S., Hoegh-Guldberg, O., Kappel, C.V., Moore, P.J., Richardson, A.J., Schoeman, D.S. & Sydeman, W.J. (2016). Responses of marine organisms to climate change across oceans. *Frontiers in Marine Science, 3*, 62. doi:10.3389/fmars.2016.00062
- Ponti, L., Gutierrez, A.P., Ruti, P.M. & Dell'Aquila, A. (2014). Fine-scale ecological and economic assessment of climate change on olive in the Mediterranean Basin reveals winners and losers. *Proceedings of the Natioanl Academy of Sciences USA, 111*(5), 5598-5603.
- Ps-Eau. (2018). *The Sustainable Development Goals for Water and Sanitation Services. Interpreting the Targets and Indicators*. Retrieved from www.pseau.org/en/agenda-2030

- Renaud, A., Poinsot Balaguer, J., Cortet, J. & Le Petit, J. (2004). Influence of four soil maintenance practices on Collembola communities in a Mediterranean vineyard. *Pedobiologia, 48*(5-6), 623-630.
- Roson, R. & Sartori, M. (2014). Climate change, tourism and water resources in the Mediterranean: A general equilibrium analysis. *International Journal of Climate Change Strategies and Management, 6*(2), 212-228.
- Rossi, A., Biancalani, R. & Chocholata, L. (2019). *Change in water-use efficiency over time (SDG indicator 6.4.1): Analysis and interpretation of preliminary results in key regions and countries.* Rome, Italy: FAO.
- Rubio, J.L. & Recatala, L. (2006). The relevance and consequences of Mediterranean desertification including security aspects. In W.G., Kepner, J.L., Rubio, D.A., Mouat & F., Pedrazzini (Ed(s)). *Desertification in the Mediterranean Region. A Security Issue.* NATO Security Through Science Series, vol. 3. Dordrecht, Germany: Springer.
- Rubio, J.L. (2007). Mecanismos de Retroalimentación entre Desertificación y Cambio Climático. In S., Grisolia (Ed). *Cambio Climático y sus Consecuencias.* Generalitat Valenciana, Spain: Presidencia de la Generalitat Valenciana. ISBN: 978-84-482-4771-3
- Sadoff, C.W., Borgomeo, E. & de Waal, D. (2017). *Turbulent Waters: Pursuing Water Security in Fragile Contexts.* Washington, DC: World Bank.
- Sardans, J. & Peñuelas, J. (2005). Drought decreases soil enzyme actiyity in a Mediterranean holm oak forest. *Soil Biology and Biochemistry, 37*, 455-461.
- Sardans, J., Peñuelas, J., Estiarte, M. & Prieto, P. (2008). Warming and drought alter C and N concentration, allocation and accumulation in a Mediterranean shrubland. *Global Change Biology, 14*, 2304-2316.
- Schleussner, C-F., Lissner, T.K., Fischer, E.M., Wohland, J., Perrette, M., Golly, A., Rogelj, J., Childers, K., Schewe, J. & Frieler, K. (2016). Differential climate impacts for policy-relevant limits to global warming: the case of 1.5°C and 2°C. *Earth System Dynamics, 7*, 327-351.
- Strobl, R.O., Somma, F., Evans, B.M. & Zaldívar, J.M. (2009). Fluxes of water and nutrients from river runoff to the Mediterranean Sea using GIS and a watershed model. *Journal of Geophysical Research: Biogeosciences, 114*(G3).
- Tal, A. (2018). *Addressing Desalination's Carbon Footprint: The Israeli Experience.* Department of Public Policy, Tel Aviv, Israel: Tel Aviv University.
- Tanasijevic, L., Todorovic, M., Pereira, L. S., Pizzigalli, C. & Lionello, P. (2014). Impacts of climate change on olive crop evapotranspiration and irrigation requirements in the Mediterranean region. *Agricultural Water Management, 144,* 54-68.
- Thober, S., Kumar, R., Wanders, N., Marx, A., Pan, M., Rakovec, O., Samaniego, L., Sheffield, J., Wood, E.F. & Zink, M. (2018). Multi-model ensemble projections of European river floods and high flows at 1.5, 2, and 3 degrees global warming. *Environmental Research Letters, 13*(1), 014003. doi:10.1088/1748-9326/aa9e35
- Tsanis, I.K., Koutroulis, A.G., Daliakopoulos, I.N. & Jacob, D. (2011). Severe climate-induced water shortage and extremes in Crete. *Climatic Change, 106*(4), 667-677.
- UN-COMTRADE. (2020). *International trade statistics database.* Retrieved from: https://comtrade.un.org/
- UNESCO-IGRAC. (2016). *TWAP viewer.* Retrieved from https://ggis.un-igrac.org/ggis-viewer/viewer/twap/public/default]. http://ihp-wins.unesco.org/layers/geonode:twap_cs_ga1_1l_1
- UNSD. (2019). *United Nations Statistics Division*. Retrieved from: https://unstats.un.org/home/
- UN-Water. (2013). *Water Security & the Global Water Agenda - A UN-Water Analytical Brief.* Hamilton, Canada: United Nations University.
- Wada, Y., van Beek, L.P.H. & Bierkens, M.F.P. (2012). Nonsustainable groundwater sustaining irrigation: a global assessment. *Water Resources Research, 48*(6). doi:10.1029/2011WR010562
- Weindl, I., Lotze-Campen, H., Popp, A., Müller, C., Havlík, P., Herrero, M., Schmitz, C. & Rolinski, S. (2015). Livestock in a changing climate: production system transitions as an adaptation strategy for agriculture. *Environmental Research Letters, 10,* 094021 (2015).
- Weinthal, E., Zawahri, N. & Sowers, J. (2015). Securitizing water, climate, and migration in Israel, Jordan, and Syria. *International Environmental Agreements: Politics, Law and Economics, 15*(3), 293-307.
- Wessel, W.W., Tietema, A., Beier, C., Emmett, B.A., Peñuelas, J. & Riis-Nielsen, T. (2004) A qualitative ecosystem assessment for different shrublands in western Europe under impact of climate change. *Ecosystems, 7,* 662-671.
- WHO & UNICEF. (2017). *Progress on Drinking Water, Sanitation and Hygiene: 2017 Update and SDG Baselines.* Geneva, Switzerland: World Health Organization (WHO) and the United Nations Children's Fund (UNICEF).
- World Bank Group. (2014). *Turn Down the Heat: Confronting the New Climate Normal.* Washington, DC: World Bank. Retrieved from https://openknowledge.worldbank.org/handle/10986/20595
- World Bank. (2016). *The World Bank Climate Change Knowledge Portal for Development Practitioners and Policy Makers*. Retrieved from http://sdwebx.worldbank.org/climateportal/index.cfm?page=downscaled_data_download&menu=historical
- World Bank. (2018). *Beyond Scarcity: Water Security in the Middle East and North Africa.* MENA Development Report;. Washington, DC: World Bank. Retrieved from: https://openknowledge.worldbank.org/handle/10986/27659
- World Bank. (2019). *World Development Indicators.* Retrieved from: http://datatopics.worldbank.org/world-development-indicators/
- WTO. (2017). *World Trade Statistical Review.* Geneva, Switzerland: WTO. Retrieved from https://www.wto.org/english/res_e/statis_e/wts2017_e/wts2017_e.pdf
- Yates, D., Sieber, J., Purkey, D. & Huber-Lee, A. (2005). WEAP21 - A Demand-, Priority-, and Preference-Driven Water Plan-

ning Model. Part 1: Model Characteristics. *Water International, 30*(4), 487-500.
- Zdruli, P. (2014). Land resources of the Mediterranean: status, pressures, trends and impacts on future regional development. *Land Degradation & Development, 25*(4), 373-384. doi:10.1002/ldr.2150

References Chapter 7

- Ansal, A., Bardet, J.P., Bray, J., Cetin, K.O., Durgunoglu, T., Erdik, M., Kaya, A., Ural, D., Yilmaz, T. & Youd, T.L. (1999). *Initial Geotechnical Observations of the August 17, 1999, Izmit Earthquake.* Earthquake Engineering Research Center. A Report of the Turkey-US Geotechnical Reconnaissance Team, September 3, 1999, citing the Turkish Prime Ministry Crisis Management Center.
- Arthur, J.L. (2006). *Health environment nexus-the case of developing countries.* http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.529.2591&rep=rep1&type=pdf
- Ayres, J. G., Forsberg, B., Annesi-Maesano, I., Dey, R., Ebi, K. L., Helms, P. J., Medina-Ramón, M., Windt, M. & Forastiere, F. (2009). Climate change and respiratory disease: European Respiratory Society position statement. *European Respiratory Journal, 34*(2), 295-302. doi:10.1183/09031936.00003409
- Baccini, M., Kosatsky, T., Analitis, A., Anderson, H.R., D'Ovidio, M., Menne, B., Michelozzi, P., Biggeri, A. & PHEWE Collaborative Group. (2011). Impact of heat on mortality in 15 European cities: attributable deaths under different weather scenarios. *Journal of Epidemiology and Community Health, 65*, 64-70.
- Bowen, R., Depledge, M., Carlarne, C. & Fleming L.E. (Ed(s)). (2014). Seas, Society and Human Wellbeing. UK: Wiley.
- Cecchi, L., D'Amato, G., Ayres, J.G., Galan, C., Forastiere, F., Forsberg, B., Gerritsen, J., Nunes, C., Behrendt, H., Akdis, C., Dahl, R. & Annesi-Maesano, I. (2010). Projections of the effects of climate change on allergic asthma: the contribution of aerobiology. *Allergy, 65*(9), 1073-1081.
- Corbett, J.J., Winebrake, J.J., Green, E.H., Kasibhatla, P., Eyring, V. & Lauer, A. (2008). Mortality from Ship Emissions: A Global Assessment. Environmental Science & Technology, 41(24), 8512-8518.doi:https://doi.org/10.1021/es071686z
- Cramer, W., Guiot, J., Fader, M., Garrabou, J., Gattuso, J-P., Iglesias, A., Lange, M.A., Lionello, P., Llasat, M.C., Paz, S., Peñuelas, J., Snoussi, M., Toreti, A., Tsimplis, M.N. & Xoplaki, E. (2018). Climate change and interconnected risks to sustainable development in the Mediterranean. *Nature Climate Change, 8*(11), 972-980.
- D'Amato, G., Cecchi, L., Bonini, S., Nunes, C., Annesi-Maesano, I., Behrendt, H., Liccardi, G., Popov, T. & van Cauwenberge, P. (2007). Allergenic pollen and pollen allergy in Europe. *Allergy, 62*(9), 976-990.
- D'Amato, G., Holgate, S.T., Pawankar, R., Ledford, D.K., Cecchi, L et al (2015). Meteorological conditions, climate change, new emerging factors, and asthma and related allergic disorders. A statement of the World Allergy Organization. *World Allergy Organization Journal, 8*(1), 25
- Depledge, M.H., Harvey, A.J., Brownlee, C., Frost, M., Moore, M.N. & Fleming, L.E. (2013). Changing views of the interconnections between the Oceans and Human Health in Europe. *Microbial Ecology, 65*(4), 852-859.
- EEA. (2019). European bathing water quality in 2018. EEA Report no. 3/2019. ISSN 2315-1846/1977-844. Retrieved from: https://www.eea.europa.eu/publications/european-bathing-water-quality-in-2018
- EGSA. (2016). *What are the effects of sulphur oxides on human health and ecosystems?*. Retrieved from http://www.egcsa.com/technical-reference/what-are-the-effects-of-sulphur-oxides-on-human-health-and-ecosystems/
- Eureau. (2017). *Europe's water in figures. An overview of the European drinking water and waste water sectors.* Brussels, Belgium: Eureau. Retrieved from: http://www.eureau.org/resources/publications/1460-eureau-data-report-2017-1/file
- European Commission. (2019). Copernicus Atmosphere Monitoring Service. Retrieved from https://atmosphere.copernicus.eu/
- European Seismological Commission. (2003). *European-Mediterranean seismic hazard map.* Retrieved from http://preventionweb.net/go/10049
- FAO. (2008). *Disaster risk management systems analysis. A guidebook.* Rome, Italy: FAO. Retrieved from http://www.fao.org/3/i0304e/i0304e00.htm
- Ferrante, M., Conti, G.O., Fiore, M., Rapisarda, V. & Ledda, C. (2013). Harmful Algal Blooms in the Mediterranean Sea: Effects on Human Health. EuroMediterranean Biomedical Journal, 8(6), 25-34. doi:10.3269/1970-5492.2013.8.6
- Fleming, L.E., McDonough, N., Austen, M., Mee, L., Moore, M., Hess, P., Depledge, M.H., White, M., Philippart, K., Bradbrook, P. & Smalley, A. (2014). Oceans and Human Health: A rising tide of challenges and opportunities for Europe. *Marine Environmental Research, 99*, 16-19.
- Fouillet, A., Rey, G., Wagner, V., Laaidi, K., Empereur-Bissonnet, P., Le Tertre, A., Frayssinet, P., Bessemoulin, P., Laurent, F., De Crouy-Chanel, P., Jougla, E. & Hémon, D. (2008). Has the impact of heat waves on mortality changed in France since the European heat wave of summer 2003? A study of the 2006 heat wave. *International Journal of Epidemiology, 37*(2), 309-317.
- Gardner, M. (2018). *The National Chemical Investigations Programme 2015-2020.* London, UK: UKWIR.
- Gascon, M., Zijlema, W., Vert, C., White, M.P. & Nieuwenhuijsen, M.J. (2017). Outdoor blue spaces, human health and well-being: a systematic review of quantitative studies. *International Journal of Hygiene and Environmental Health, 220*(8), 1207-1221.
- Gaw, S., Thomas, K. V. & Hutchinson, T. H. (2014). Sources, impacts and trends of pharmaceuticals in the marine and coast-

al environment. *Philosophical Transactions of the Royal Society B: Biological Sciences, 369*(1656), 20130572.
- Grenni, P., Ancona, V. & Caracciolo, A.B. (2018). Ecological effects of antibiotics on natural ecosystems: A review. Microchemical Journal, 136, 25-39.
- Grigorakis K & Rigos, G. (2011). Aquaculture effects on environmental and public welfare—the case of Mediterranean mariculture. *Chemosphere, 85*, 899-919. doi:10.1016/j.chemosphere.2011.07.015
- IHME. (2018, 2019). I*HME Data for Egypt.* Retrieved from http://www.healthdata.org/egypt
- Kuglitsch, F.G., Toreti, A., Xoplaki, E., Della-Marta, P.M., Zerefos, C.S., Türkeș, M. & Luterbacher, J. (2010). Heat wave changes in the eastern Mediterranean since 1960. Geophysical Research Letters, 37(4), L04802.
- Kümmerer, K. (2009). Antibiotics in the aquatic environment: a review. *Chemosphere, 75,* 417-434. doi:10.1016/j.chemosphere.2008.11.086
- Landrigan, P.J., Wright, R.O., Cordero, J.F., Eaton, D.L., Goldstein, B.D., Henning, B., Maier, R.M., Ozonoff, D.M., Smith, M.T. & Tukey, R.H. (2015). The NIEHS Superfund research Program: 25 years of translational research for public health. *Environmental Health Perspectives, 123*(10), 909-918. doi:10.1289/ehp.1409247.
- Leduc, C., Pulido-Bosch, A. & Remini, B. (2017). Anthropization of groundwater resources in the Mediterranean region: processes and challenges. *Hydrogeology Journal, 25*(6), 1529-1547.
- Lloret, J. (2010). Human health benefits supplied by Mediterranean marine biodiversity. *Marine Pollution Bulletin, 60*(10), 1640-1646.
- Lloret, J., Rätz, H., Lleonart, J. & Demestre, M. (2016). Challenging the links between seafood and human health in the context of global change. *Journal of the Marine Biological Association of the United Kingdom, 96*(1), 29-42. doi:10.1017/S0025315415001988
- Malta Environment and Resources Authority (2020). *Data from Air Monitoring Stations.* Retrieved from: https://era.org.mt/en/Pages/Data-from-Air-Monitoring-Stations.aspx
- Meschis, M., Roberts, G. P., Mildon, Z. K., Robertson, J., Michetti, A. M. & Walker, J. F. (2019). Slip on a mapped normal fault for the 28th December 1908 Messina earthquake (Mw 7.1) in Italy. *Scientific Reports, 9*(1), 1-8.
- Messeri, A., Morabito, M., Messeri, G., Brandani, G., Petralli, M., Natali, F., Grifoni, D., Crisci, A., Gensini, G. & Orlandini, S. (2015). Weather-related flood and landslide damage: a risk index for Italian regions. *PLoS One, 10*(12), e0144468.
- Michelozzi, P., Accetta, G., De Sario, M., D'Ippoliti, D., Marino, C., Baccini, M., Biggeri, A., Anderson, H.R., Katsouyanni, K., Ballester, F., Bisanti, L., Cadum, E., Forsberg, B., Forastiere, F., Goodman, P.G., Hojs, A., Kirchmayer, U., Medina, S., Paldy, A., Schindler, C., Sunyer, J., Perucci, C.A. & PHEWE Collaborative Group. (2009). High temperature and hospitalizations for cardiovascular and respiratory causes in 12 European cities. *American Journal of Respiratory Critical Care, 179*, 383-389.
- Nader, M.R., Indary, S. & Boustany, L.E. (2012). The Puffer Fish *Lagocephalus sceleratus* (Gmelin, 1789) in the Eastern Mediterranean. FAO Eastmed Technical Documents no. 10. Retrieved from http://www.fao.org/3/a-ap967e.pdf
- OECD. (2013). *Environment at a Glance 2013 - OECD Indicators.* OECD Publishing. Retrieved from https://www.oecd-ilibrary.org/fr/environment/environment-at-a-glance-2013_9789264185715 -en
- Oudin Åström, D., Schifano, P., Asta, F., Lallo, A., Michelozzi, P., Rocklöv, J. & Forsberg, B. (2015). The effect of heat waves on mortality in susceptible groups: a cohort study of a Mediterranean and a northern European City. *Environmental Health, 14,* 30.
- Paravantis, J., Santamouris, M., Cartalis, C., Efthymiou, C. & Kontoulis, N. (2017) Mortality associated with high ambient temperatures, heatwaves, and the urban heat island in Athens, Greece. *Sustainability, 9*(4), 606.
- Paz, S., Negev, M., Clermont, A., Green, M.S. (2016). *Health Aspects of Climate Change in Cities with Mediterranean Climate, and Local Adaptation Plans.* Int J Environ Res Public Health.13(4):438, doi: 10.3390/ijerph13040438.
- Pesaresi, M., Ehrlich, D., Kemper, T., Siragusa, A., Florczyk, A.J., Freire, S. & Corbane, C. (2017). *Atlas of the Human Planet 2017: Global Exposure to Natural Hazards.* EUR 28556 EN, doi:10.2760/19837.
- Prüss-Üstün, A., Wolf, J., Corvalán, C., Bos, R. & Neira, M. (2016). *Preventing disease through healthy environments: a global assessment of the burden of disease from environmental risks.* World Health Organization.
- Roche, B., Léger, L., L'Ambert, G., Lacour, G., Foussadier, R., Besnard, G., Barré-Cardi, H., Simard, F. & Fontenille, D. (2015). The spread of Aedes albopictus in metropolitan France: contribution of environmental drivers and human activities and predictions for a near future. *PLoS One, 10*(5), e0125600
- Rodriguez-Arias, M.A., Chlif, S., Wolf, T., Rodo, X., Ben Salah, A. & Menne, B. (2008). *A literature review on climate-sensitive infectious diseases in the Mediterranean region.* Technical Report January 2008. GOCE 036961 CIRCE.
- Rodríguez-Navas, C., Björklund, E., Bak, S.A., Hansen, M., Krogh, K.A., Maya, F., Forteza, R. & Cerdà, V. (2013). Pollution pathways of pharmaceutical residues in the aquatic environment on the island of Mallorca, Spain. *Archives of Environmental Contamination and Toxicology, 65*(1), 56-66. doi:10.1007/s00244-013-9880-x)
- Roiz, D., Boussès, P., Simard, F., Paupy, C. & Fontenille, D. (2015). Autochthonous Chikungunya transmission and extreme climate events in Southern France. *PLoS Neglected Tropical Diseases, 9*(6), e0003854.
- Royé, D. (2017). The effects of hot nights on mortality in Barcelona. *International Journal of Biometeorology, 61*(12), 2127-2140.
- Samaras, A.G., Karambas, T.V. & Archetti, R. (2015). Simulation of tsunami generation, propagation and coastal inundation in the Eastern Mediterranean. *Ocean Science, 11*(4), 643-655.
- Sanz-Barbero, B., Linares, C., Vives-Cases, C., González, J.L., López-Ossorio, J.J. & Díaz, J. (2018). Heat wave and the risk

of intimate partner violence. *Science of the Total Environment, 644*, 413-419.
- Smith, K.R., Woodward, A., Campbell-Lendrum, D., Chadee, D.D., Honda, Y., Liu, Q., Olwoch, J.M., Revich, B. & Sauerborn, R. (2014). Human health: impacts, adaptation, and co-benefits. In Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel,A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L.White (Ed(s)). *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 709-754). Cambridge, United Kingdom and New York, NY: Cambridge University Press.
- Sørensen, M.B., Spada, M., Babeyko, A., Wiemer, S. & Grünthal, G. (2012). Probabilistic tsunami hazard in the Mediterranean Sea. *Journal of Geophysical Research: Solid Earth, 117*(B1).
- UNECE. (2019, May 24). *Press release: UNECE's new recommendation on fuel quality will help countries to reduce air pollution.* Retrieve from https://www.unece.org/info/media/presscurrent-press-h/transport/2019/uneces-new-recommendation-on-fuel-quality-will-help-countries-to-reduce-air-pollution/doc.html
- UNEP. (2020, May 15). *Sulphur level in diesel globally. The sulphur campaign website.* Retrieved from: https://www.unenvironment.org/explore-topics/transport/what-we-do/partnership-clean-fuels-and-vehicles/sulphur-campaign
- Uriz, M.J., Martin, D., Turon, X., Ballesteros, E., Hughes, R. & Acebal, C. (1991). An approach to the ecological significance of chemically mediated bioactivity in Mediterranean benthic communities. *Marine Ecology Progress Series 70*, 175-188.
- Vezzulli, L., Brettar, I., Pezzati, E., Reid, P.C., Colwell, R.R., Höfle, M.G. & Pruzzo, C. (2012). Long-term effects of ocean warming on the prokaryotic community: evidence from the vibrios. *The International Society for Microbial Ecology Journal, 6,* 21-30.
- Vittecoq, M., Thomas, F., Jourdain, E., Moutou, F., Renard, F. & Gauthier-Clerc, M. (2013). Risks of emerging infectious diseases: evolving threats in a changing area, the Mediterranean basin. *Transboundary and Emerging Diseases, 61,* 17-27
- WHO Regional Office for Europe. (2015). *Waste and human health: Evidence and needs. WHO Meeting Report 5-6 November 2015,* Bonn, Germany. Retrieved from http://www.euro.who.int/__data/assets/pdf_file/0003/317226/Waste-human-health-Evidence-needs-mtg-report.pdf
- WHO Regional Office for Europe. (2018). *Statement - World Antibiotic Awareness Week 2018: There is only One Health!* Consulted 8 July 2019. Retrieved from http://www.euro.who.int/en/media-centre/sections/statements/2018/statement-world-antibiotic-awareness-week-2018-there-is-only-one-health!
- WHO. (2016). *Ambient air pollution: a global assessment of exposure and burden of disease.* Geneva, Switzerland: WHO. ISBN: 9789241511353. Retrieved from https://www.who.int/phe/publications/air-pollution-global-assessment/en/
- WHO. (2018). *Disease outbreak news, 14 September 2018.* Accessed July 2019. Retrieved from https://www.who.int/csr/don/14-september-2018-cholera-algeria/en/
- WHO. (2019a). *Draft WHO global strategy on health, environment and climate change: the transformation needed to improve lives and well-being sustainably through healthy environments*. A72/15. Retrieved from https://www.who.int/docs/default-source/climate-change/who-global-strategy-on-health-environment-and-climate-change-a72-15.pdf?sfvrsn=20e72548_2
- WHO. (2019b). *WHO Global Health Observatory.* Retrieved from http://www9.who.int/gho/en/
- World Bank. (2019). *World Development Indicators.* Retrieved from http://datatopics.worldbank.org/world-development-indicators/
- WWF. (2019). *Stop the Flood of Plastic: How Mediterranean countries can save their sea.* Retrieved from wwfmmi.org
- Zwijnenburg, W. & Te Pas, K. (2015) Amidst the debris. A desktop study on the environmental and public health impact of Syria's conflict. ISBN: 978-90-70443-86-3. Retrieved from http://www.paxforpeace.nl/media/files/pax-report-amidst-the-debris-syria-web.pdf

References Chapter 8

- 19th Ordinary Meeting of the Contracting Parties to the Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean and its Protocols Athens (Greece) 9-12 February 2016. Retrieved from https://wedocs.unep.org/bitstream/handle/20.500.11822/6070/16ig22_28_athensdeclaration_eng.pdf?sequence=1&isAllowed=y
- Action Plan of the Mediterranean Strategy on ESD and the Nicosia Declaration (Cyprus, 2016). Retrieved from http://www.esdmedcyprus.pi.ac.cy
- Daumalin, X. (2018). *La création du Secrétariat permanent pour les problèmes de pollutions industrielles Fos/étang-de-Berre. Tournant environnemental ou optimisation d'une ambition industrielle* (1971-1985)? -hal-01862494-.
- European Commission. (2019). *Environmental Compliance Assurance.* Retrieved from https://ec.europa.eu/environment/legal/compliance_en.htm
- FAO. (2001). *International Plan of Action to prevent, deter and eliminate illegal, unreported and unregulated fishing.* Rome, Italy: FAO. Retrieved from http://www.fao.org/3/a-y1224e.pdf
- Fosse, J., Petrick, K., Nenci, L., Klarwein, S., Blondeau, R., Frezal, C., Roniotes, A., Scoullos, M., Vasilaki, V., Greenfild, O. & Abaza, H. (2016). *Towards a Green Economy in the Mediterranean - Assessment of National Green Economy and Sustainable Development Strategies in Mediterranean Countries.* Eco-union, MIO-ECSDE, GEC. Retrieved from http://mio-ecsde.org/wp-content/uploads/2016/12/greeneconomy-med-web.pdf

- Hildering, A., Keessen, A.M. & van Rijswick, F.M.W. (2009). Tackling pollution of the Mediterranean Sea from land-based sources by an integrated ecosystem approach and the use of the combined international and European legal regimes. *Utrecht Law Review, 5*(1), 80.
- Kacani, A. & Peri, L. (2019). Assessing forest governance in Albania. *Eurasian Journal of Forest Science, 7*(1), 30-39. doi:10.31195/ejejfs.473633
- Kingdom of Morocco. (2019). *Guide méthodologique pour l'exemplarité de l'administration en matière de développement durable.* Retrieved from http://www.mhpv.gov.ma/wp-content/uploads/2020/04/Guide-Exemplarite-Administration.pdf
- Mediterranean Strategy on Education for Sustainable Development (ESD) (Athens, 2014). Retrieved from https://ufm-secretariat.org/euro-mediterranean-cooperation-on-environment-and-climate-change-ufm-holds-ministerial-meeting-in-athens/
- Mercier, J.R. (2015). *Management of Environmental and Social Assessments for development projects, programmes and policies in the Mediterranean - Sourcebook.* Plan Bleu UNEP/MAP Regional Activity Centre.
- OECD. (2017). *Towards a G7 target to phase out environmentally harmful subsidies.* OECD Report, May 2017.
- UN Environment. (2009). *Gap analysis for the purpose of facilitating the discussions on how to improve and strengthen the science-policy interface on biodiversity and ecosystem services.* UNEP/IPBES/2/INF/1. Nairobi, Kenya.
- UNEP & Columbia University. (2017). *The status of climate change litigation: A global review.* ISBN: 978-92-807-3656-4. Job No: DEL/2110/NA. Retrieved from https://wedocs.unep.org/handle/20.500.11822/20767
- UNEP. (2019). *Sand and sustainability: Finding new solutions for environmental governance of global sand resources*. GRID-Geneva, United Nations Environment Programme, Geneva, Switzerland.
- UNEP/MAP. (2019). *Overall Findings from the General Status of the Progress in the Implementation of the Barcelona Convention and its Protocols: Analysis of the Information Mentioned in the National Reports for the 2016-2017 Biennium.* As submitted to MAP Focal Points 2019 meeting (UNEP/MED WG.468/20).
- United Nations (2019, February 13). *United Nations Treaty Collection.* Retrieved from https://treaties.un.org/
- United Nations University, RMIT University, United Nations Environment Programme (UNEP), University of the South Pacific & UNU-Global Virtual University. (2019, October). *Open online course on Environmental Impact Assessment.* Retrieved from http://www.raymondsumouniversity.com/eia-local/page118.htm
- United Nations. (1997). *Glossary of Environment Statistics.* Studies in methods, Series F, No. 67. Retrieved from https://unstats.un.org/unsd/publication/SeriesF/SeriesF_67E.pdf
- Vlachogianni, T., Roniotes, A. & Alampei, I. (2018). *Recommendations on strengthening the science-policy interface*. SWIM-H2020 SM Work Package 5.1 Deliverable. Retrieved from https://www.swim-h2020.eu/strengthening-the-research-to-policy-practice-interface/