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Table of Content

Table of figures

Table of Tables

1 Draft Chapter 1: Socio-economic drivers and trends

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This chapter seeks to provide updated information on the drivers of environmental, social and economic changes in the Mediterranean region. Whereas other chapters tend to consider the Mediterranean region as a separate and largely uniform entity, this introductory chapter acknowledges both important interactions with continents beyond Mediterranean boundaries, and subregional contrasts or "complementary differences" among countries and subregions.

In order to establish a comparative report of the dynamics of development from a geopolitical, social and economic standpoint, this first chapter considers the Mediterranean not as a unitary space defined using pre-established borders (State, institutional, cultural, bioclimatic borders, etc.), but as a multi-faceted and sometimes fragmented space composed of numerous "micro-regions"[i] or sub-groups located in specific yet interconnected areas. This geographical approach focuses on the spatial and relational dimension of socio-economic phenomena, representing them at the various meaningful levels from the global to the local level[ii]. Concepts such as scales, spaces, territories, networks, mobilities and flows are used to understand changes within a region at a time when globalisation and technological progress are accelerating connections between individuals and certain strategic locations (large cities, airports, industrial and logistics zones), including some much more inconspicuous spaces[iii].

Among other recent trends, the emergence of regional and international powers, including China, repositions the Mediterranean at the centre of transnational influences and flows[iv]. The widespread urbanisation and other shared phenomena occurring at varying levels of intensity (economic growth, centralisation/decentralisation and liberalisation of public action, demographic transition, migrant "crisis", increased social mobilisation at various levels and the local empowerment of populations) have also profoundly changed the context and lifestyles of societies around this shared sea.

Finally, it is important to remember that the Mediterranean has been identified as a global hotspot for climate change and biodiversity. The acceleration of ecosystem degradation due to human activities (discussed in the following chapters) requires that crucial environmental issues are addressed by interlinking or even blurring scales of time and space. In this Anthropocene era[v], where human civilisation has become the biggest driver of geophysical disruption to the Earth's system, most likely since the industrial revolution, nothing is exclusively global or local. Any economic or social development policy becomes simultaneously and mutually global and local in its potential ecological impact.

1.1 Flows, nodes and powers: Mediterranean territories in the global system

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[vi]? 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 globalisation? 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?

1.1.1 Trade: continued North-South asymmetry but 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 account for just 11% of world trade ($2,000 billion of a total of $18,000 billion in 2017)[vii]. Exports between Mediterranean countries fell slightly between 2001 and 2016 (from 31% to 29%)[viii]. 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-Herzegovina, Croatia, Montenegro) respectively hold a 10.1%, 8.4% and 2% share of regional import and export flows.

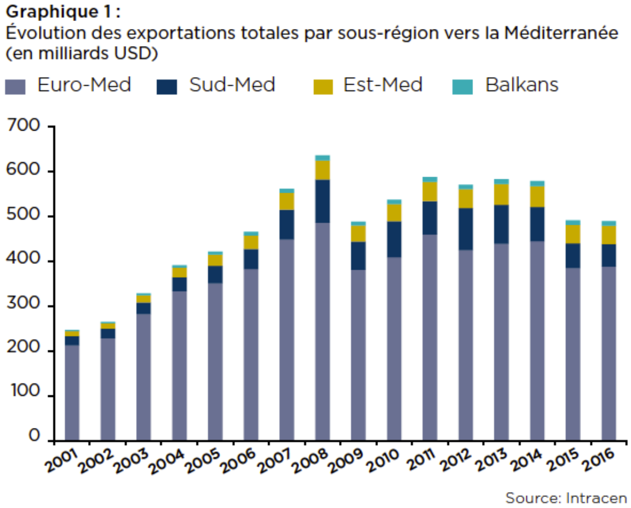


Figure 1 Total exports by sub-region towards the Mediterranean region, in billions of USD (Source: Intracen)
[English version pending]

The amount, origin and destination of Foreign Direct Investment (FDI) show effects of dual geographical marginalisation. FDI in the Mediterranean increased by 23% between 2012 and 2016, significantly below the global average increase of 39%. Despite the net growth of FDIs recorded over the same period by Turkey (+87%, 20th country in the ranking of economies attracting the most FDIs in 2015), Egypt (+49%) and Morocco (+46%), and the significant decline in some countries like Greece (- 42%) and Portugal (-24%), 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[ix], and the low level of intra- and extra-Mediterranean trade integration. The first reason is structural, as the economic structure of Southern and Eastern Mediterranean Countries (SEMC) 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 measures such as taxes, anti-dumping measures, quotas, etc. primarily targeting agricultural produce and the steel and iron industry. However, the supposed virtues of free trade seem to have failed to provide the desired socio-economic effects.

Moreover, since the 2000s, there has been a clear trend towards an economic diversification of SEMCs. The industrialisation policy of boosting the manufacturing sectors[x] 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 technologies (ICT). Tunisian and Moroccan ICT exports to European countries (primarily Spain, Italy and France) rose from around 10%-15% between 2000 and 2007 to 25%-30% of their total exports between 2012 and 2016. It is no longer rare to find cars manufactured in Turkey or Turkish brand electrical goods on the European and Arab markets.

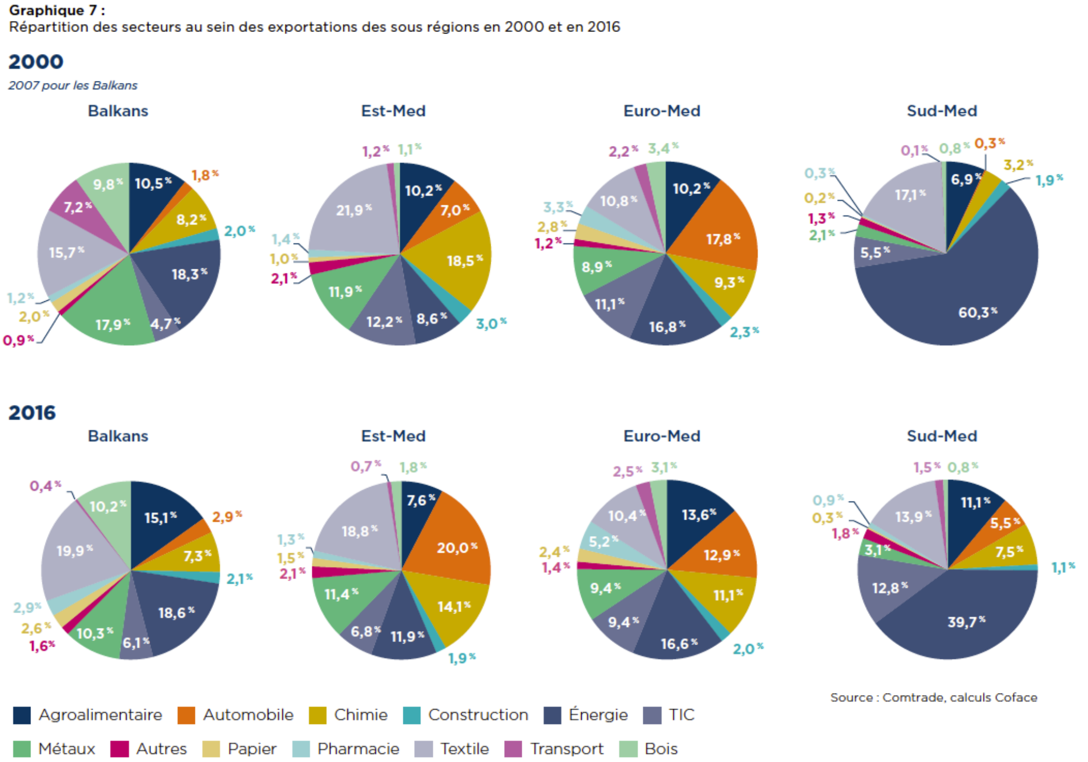


Figure 2 Breakdown of product categories in exports from sub-regions in 2000 and 2016 (Source: Comtrade and Coface) [English version pending]

1.1.2 Strong growth of maritime transport and concentration of airport traffic around new hubs

Recent data on goods shipping, 90% of which travels around the world on container ships, also shows the geostrategic location of the Mediterranean as a crossroads, securely positioned within international trade flows. 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[xi]. International trade alone represents over 70% of maritime traffic in the Mediterranean. Flows generally follow an East-West trajectory, starting at the Suez Canal that connects the Red Sea and links the Mediterranean with Asian markets. After extension works in 2015 allowing 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).[xii] Ships then head towards the Strait of Gibraltar to reach the Atlantic Ocean or North European ports. The Dardanelles strait and Bosporus strait (which may soon face competition from the "Kanal İstanbul" project[xiii]) provide access to the Black Sea and the bordering countries (Russia, Ukraine, Bulgaria, Romania, Georgia) and have received 50,000 foreign commercial ships between 2010 and 2015[xiv].

However, this decade has primarily witnessed an intensification of sub-regional coastal shipping over shorter distances, with trade, industrial, sailing and tourist routes (see Chapter 4). This intra-Mediterranean connectivity is particularly prevalent in the Aegean Sea, Adriatic Sea, the Balearic Islands and in the Levantine Sea, and has increased through the upsurge of ports in Southern and Eastern Mediterranean countries. The largest ports are still mainly located in the North. The Southern Mediterranean is home to just three (Arzew-Bethioua, Izmit and Alexandria) of the 12 largest ports in terms of tonnage (the others being 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 significant public/private investments, and are located in Turkey (in Marmara, Izmir and Mersin), Egypt (Port Said/ Alexandria/ Damietta/ Sokhna) and Morocco (Tanger-Med/ Casablanca/ Agadir). These multi-site complexes combine activities such as container transhipment, roll-on roll-off traffic, petrochemical and logistics facilities, and, increasingly, large urban touristic developments (Galataport in Istanbul, renovation of seafronts in Casablanca, Algiers, Beirut, etc.).

Figure 3 Snapshot of real-time air traffic on 15 July 2019 (Source: https://www.flightradar24.com/)

The key characteristics of the air transport geography in the Mediterranean are the increase in intercontinental flights in Europe (over 1 billion passengers travelled within the European Union in 2017, representing a rise of 39% from 2009[xv]) and the ongoing North-South direction of most tourist travel. However, the centre of gravity is increasingly moving towards the East following the establishment of Istanbul and Dubai as two key international airport hubs. In 2017, those hubs received 44.2 million and 87.7 million foreign passengers respectively, and are ranked in the world's top 20 airports (Dubai has first place and Istanbul is 11th)[xvi]. With the inauguration of a third airport in 2018, which is the biggest in Europe, Istanbul now has capacity for 90 million passengers every year, and is aiming for 200 million by 2023[xvii] thanks to the 250 international destinations that it aims to serve in the long term. More generally, this infrastructure megaproject is designed as a super-connector between Asia, the Near-East, Europe and Africa, reflecting the redefinition of influential air transport areas in the Mediterranean. While airports in North Africa and the Balkans remain primarily focused on Europe, the preferred destinations from airports in the Eastern Mediterranean are the Gulf and the Near East countries. For example, European destinations come in 5th place at Cairo airport[xviii].

1.1.3 Densification of the submarine cable network: a means of reducing the digital divide 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 globalisation. 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 (audio-visual media, social media, cloud storage, etc.). For the main global telecom 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 globalised 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 reorganisation of its urban economy around digital activities.

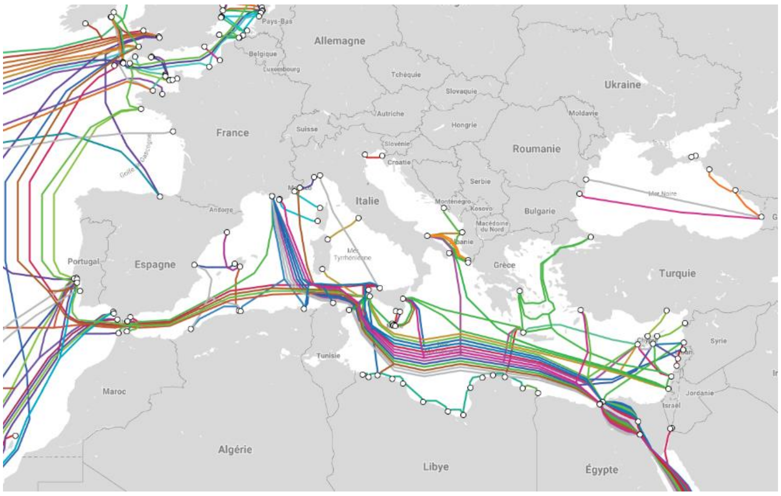


Figure 4 Submarine Cable Map of the Mediterranean in 2019 (Source: TeleGeography; https://www.submarinecablemap.com/ and International Telecommunications Union, www.itu.int)

The imbalanced deployment of submarine cables, which promotes the connection of the most developed regions of the world, maintains a digital divide in the 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 Syria, 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 organising local activities. These events demonstrated the power of the effects of a social transformation, particularly among the younger generations, due to the digitalisation of developing economies, and highlighted the influence of these social and material dynamics.

Table 1 Deployment of Information and Communication Technologies in SEMCs, 2017 (Source: Measuring the Information Society Report, Vol.2, 2018, ITU Publications and https://www.internetworldstats.com)

Key ICT Indicators	World	Europe	Africa	Algeria	Egypt	Lebanon	Libya	Morocco	Syria	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 + 1,125%	719 M + 585%	525 M +11,533%	21 M +41,900%	49.2 M +10,800%	5.5M	3.8M +37,000%	22.5M +22,467%	6.3M	7.8M +7,798%	69.1M
Number of Facebook Subscribers – 2017	2146 M	340 M	204 M	19 M	35 M	3.6M	3.5M	15 M	4.9M	6.4M	44 M

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 could reach 8% by 2025. 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[xix]. Given the 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.).

1.1.4 Increase in electricity and natural gas demand in the SEMCs: towards a new geopolitical approach to the carbon-based energy sectors

In 1989 and 2005, two foresight reports by Plan Bleu already underlined the fact that the overall increase in energy consumption in the Mediterranean would be primarily driven by economic[xx] and demographic growth in SEMCs. History has confirmed these projections. In fact, the same could be said again, since it is now estimated that primary energy demand will increase by 50% in the Southern Mediterranean by 2040. If nothing changes, this date will mark a turning point because, for the first time, energy demand will be higher in the Southern than in the Northern Mediterranean.

In this context, it is easy to understand why the political priority given by SEMCs to energy security for their national economy has created a race for fossil fuel supplies, which largely dominate the energy mix now, but also 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 effectively consumed in the European Union.

The new geopolitical realities created by the increase in electricity needs in the 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[xxi];
- 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) has been 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 should provide the EU with access to the 16 billion m^3 of gas extracted by Azerbaijan in the Caspian Sea every year.
- a genuine "black gold rush" for offshore exploration, with intensive prospection of gas fields over the past ten years. Current exploration licenses cover around 23% of the Mediterranean Sea, and could reach over 45% with the opening of new exploration/extraction zones[xxii]. Although increasing the risk of ecological disasters (pollution, oil spills, explosion of platforms due to high seismic activity in the region), deepwater drilling is the technique now used to reach hitherto unexplored depths. It has enabled the discovery of six enormous gas fields in the sediment of the Levantine Sea (Tamar in 2009 and Leviathan in 2010 off the Israel/Lebanon coast, Aphrodite in 2011, and Calypso and Glaucus in 2019 to the south of Cyprus, and Zohr in 2015 in Egyptian territorial waters). The challenge of extracting and sharing these resources has challenged diplomatic dialogue.

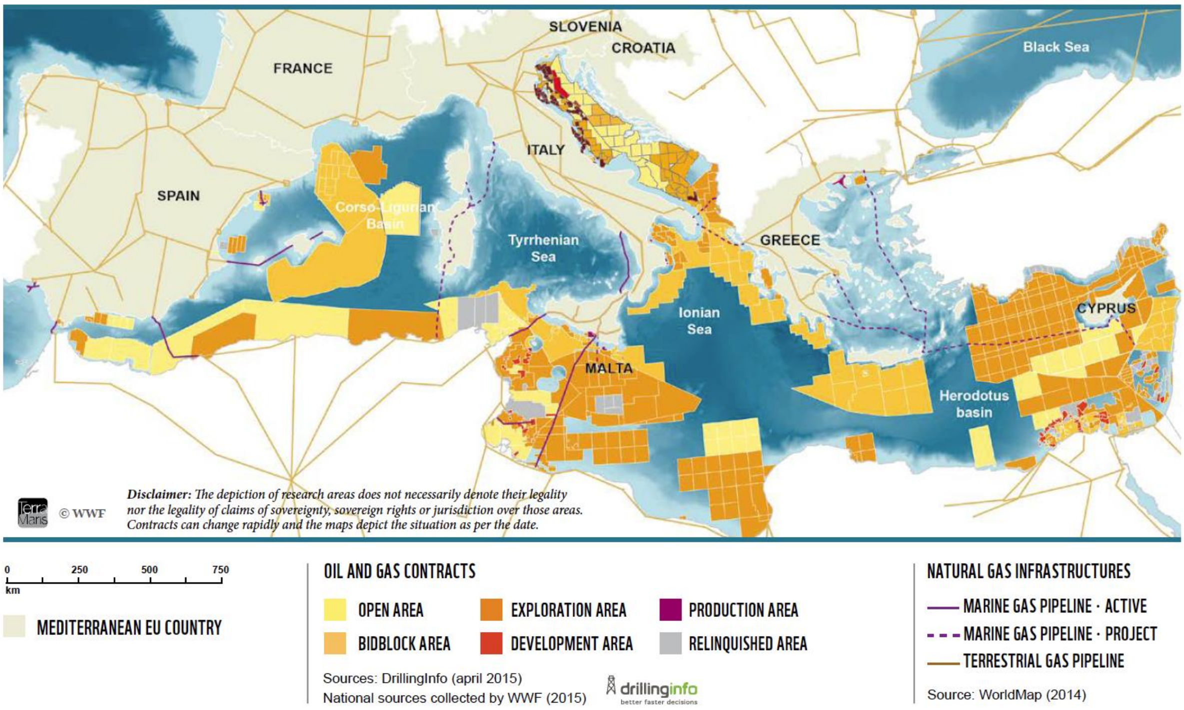


Figure 5 Oil and gas exploration and production activities (Source: Piante, C., Ody, D., "Blue Growth in the Mediterranean Sea: the challenge of Good Environmental Status", WWF-France, 2015)

Box 1 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". The ambition of this large-scale regional cooperation project led since 2008 by the Union for the Mediterranean and supported by the EU, 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 between 20 and 30% lower than current tariffs – by installing large thermal and photovoltaic solar power stations there. 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, while 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. However, just a few years after it was launched, and despite some isolated initiatives, the Mediterranean Solar Plan is at a standstill[xxiii]. Today the Desertec project is attempting to reinvent itself following the withdrawal of its founders-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 Med-TSO association bringing 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…[xxiv]), 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 territorialisation of electricity grids, historically built on a national scale. In other words, the hope that SEMCs would become aligned with the liberalised functioning of European energy markets has come up against different management models, basically dominated by state enterprises in a situation of national monopoly and the maintenance of price subsidies. This calls international stakeholders responsible for promoting development of green technologies for further taking into account the specificities of the local contexts in which they intend to apply these technologies.

1.1.5 The Mediterranean region as 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[xxv] under its New Silk Roads Belt and Road Initiative (BRI), the Mediterranean nevertheless remains a shipping zone of strategic importance. Accordingly, Chinese policy in the Mediterranean mainly takes the form of port investments, whether for construction of new infrastructures (El Hamdania in Algeria, Venice-Offshore-Onshore Port Systems in Italy), modernisation of container terminals (Port-Said in Egypt) or acquisition of existing ports (Piraeus in Greece, Valencia in Spain, Damiette and the Suez Canal in Egypt). It is already envisaged that Chinese state enterprises will invest in the ports of Zarzis (Tunisia), Rijeka (Croatia) and in Italy on the Adriatic coast. In this way China is seeking to develop a "mesh of platforms[xxvi]" enabling to redistribute and accelerate the penetration of its products into the growing markets of Europe and the Middle East.

Box 2 The New Silk Roads – the Chinese Belt and Road Initiative

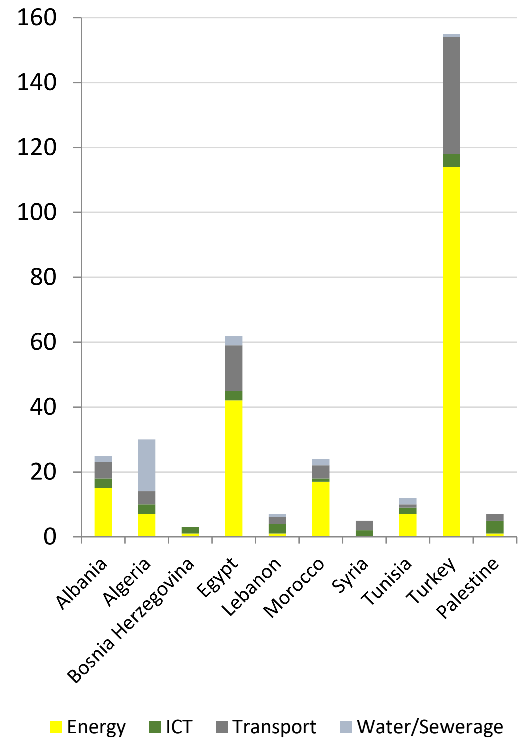
The "Belt and Road Initiative" (BRI, referred to as "one belt, one road" between 2013 and 2017) was incorporated into the constitution of the Chinese Communist Party in 2017. It expresses a long-term strategic vision, reactivating the ancient imagery of the old Silk Roads, aiming to place China at the 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 sea 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 is initially being 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, and since 2018 the creation of new trade links in Africa, South America and via the Arctic Ocean is also on the agenda. The BRI project gives institutional form to a pre-existing economic expansion strategy taking many different forms (bilateral and multilateral free trade agreements, transnational networks[xxvii]) which has enabled China to become the world leader in 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 $70 billion, of which $50 billion concern the energy sector (RES or thermal power plants, electricity grids, pipelines), $15 billion in transport (airports, ports, motorways) and $10 billion in digital[xxviii].

Figure 6 New Silk Roads project: a worldwide tool for China to use, acquire and build roads, ports and pipelines (Source: MERICS Interactive Maps, https://www.merics.org/en/bri-tracker/interactive-map)

Table 2 Chinese Shipping and Rail Investments in Mediterranean countries (Source: China Global Investment Tracker and Hache, et al., 2017[xxix])

Country	Year	Investors, Acquisition and Amount
France	2013	China Merchant bought 49% of CMA CGM having activities with its affiliate Terminal Link in Marseille, Malta, Tangier and Casablanca ports – 530 M $
Spain	2017	China Ocean Shipping bought 51% of Noatum Ports (Valencia) – 230 M $
Morocco	2008	China Railway Construction won a contract to build two highways – 260 M $
Algeria	2009	China Railway Construction won a contract to build two major railway project – 2,570 M $
	2016	CSCEC (China State Construction Corporation) and CHEC (China Harbour Engineering Company) will be part of the construction of the new El Hamdania port (70km away from Algiers) and will own 49% of the operating company – 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 line between Misrata and Wadi Shatti near Sebha, an area rich in iron ore deposits – 2,600 M $
Egypt	2005	Cosco acquires 40% of the Maersk port terminal in Port-Said
	2007	China Shipping takes 20% of the Damiette terminal Cosco takes a participation in the container terminal of the Suez Canal
	2008	China Harbour Engineering Company and China Communication Construction Company sign construction contracts for the Eastern terminal of Port-Saïd and Al-Abadya port, at the South entry of the Suez Canal – 380 M $
	2011	290 M $ invested in Egyptian Shipping sector (no details found)
	2015	China Railway Construction has been awarded a 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 into Cairo’s surrounding districts – 1,240 M $
Israel	2014	China Communications Construction won the bid to build a new port in Ashod – 950 M $
	2015	Shanghai International Port Group won the right to manage the newly built port in Haïfa 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’s red line – 400 M $
	2017/ 2018	Two rail contracts won by Chinese companies (no details found) - 880 M $
Turkey	2005	China National Machinery Import and Export Corporation and China Railway Construction Corporation won the bid to implement Turkey's High-Speed Ankara-Istanbul Railway
	2015	Cosco and China Merchant Holding acquired 65% of shares in the Kumport port (3rd Turkish container airport, located in Istanbul)
Greece	2008	Exploitation concession of pier n°2 of Piraeus is given to Cosco for 35 years – 5,800 M $
	2015	Cosco acquires 67% of parts of Piraeus entirely privatised – 420 M $
Italy	2015	A Chinese consortium won the bid to build Venice-Offshore-Onshore Port Systems, which will serve three Italian ports, one in Slovenia and one in Croatia
	2016	Cosco took the control of 49,9% of Vado Terminal in North Italy.

However, the Chinese mobilisation on infrastructures in the Mediterranean region should be looked at in its context. When the origin of 1994-2018 investments in infrastructure of low and medium-income Mediterranean countries is analyzed, a massive influx of Chinese capital has not taken place. On the contrary, it is clear not only that the main investors in the energy, transport and water/sewerage sectors are national governments or European companies, but also that Chinese companies are faced with strong competition from the Gulf states, and to a lesser extent from Russia and Turkey; they too are seeking to increase their sphere of influence in the region[xxx]. Over the last few years, a number of countries initially involved in the BRI have expressed concern about the level of their debt incurred with Chinese financial bodies and about the predominant role China is playing. A number of alternative initiatives have emerged: Japan presented in 2015 the “Expanded Partnership for Quality Infrastructure”, Japan also launched together with India the “Asia-Africa Growth Corridor” in 2017. Russia also creates its own project called “Greater Eurasia” with the aim to include member states of the Commonwealth of Independent States, the Shanghai Cooperation Organization, and potentially ASEAN countries.



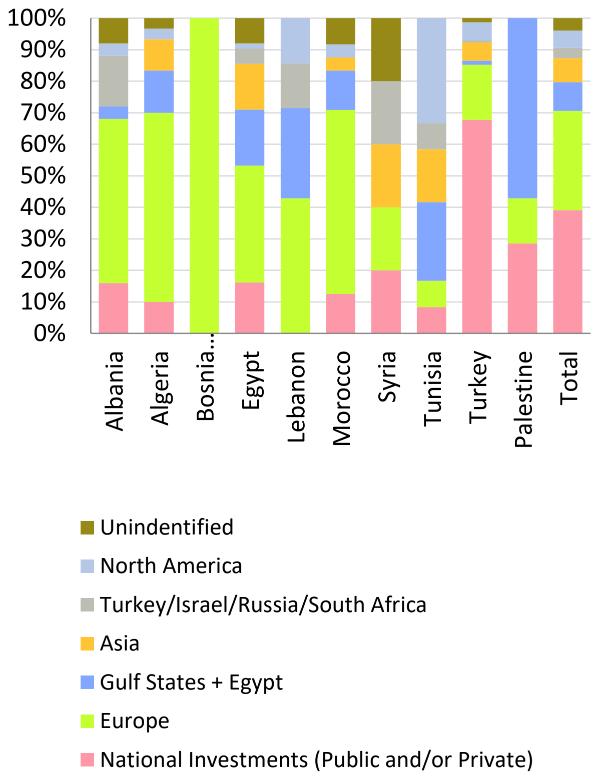


Figure 7 Left: Private Participation in Infrastructure: number of operations by sector between 1994 and 2018 in some Mediterranean countries, Right: Origin of infrastructure investments: 1994-2018 (Source: PPI Database, World Bank)

Another limit on 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 on the scale of the Mediterranean Basin. The WWF has nonetheless expressed its concerns about the threats of environmental damage posed by the project at the global scale relating to biodiversity and natural resources within the different corridors for land and sea-based transport defining the initial project. Based on a spatial analysis, the study in question[xxxi] demonstrates that:

- BRI corridors overlap with the range of 265 threatened animal species
- 1739 key Biodiversity areas and 46 Global 200 Ecoregions
- 32% of the total area of all protected areas in 64 countries crossed by BRI corridors are potentially affected
- BRI enhances pressure on water-related ecosystem services and associated risks of large floods

1.1.6 Population flows in the Mediterranean region

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

Among others, environmental and climatic changes are important drivers of migration, especially for water-scarce countries, in vulnerable areas e.g. rainfed farmland, water-contaminated sites, and urban slums. Although a direct causality is controversial, 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[xxxii].

Box 3 Mediterranean geopolitics have been shaken by tensions and instabilities and the region has become a global hotspot of forced displacement of people

Throughout the last decade, a number of countries witnessed disruptive social and political transformations. In NMCs, the rise of populist claims has turned the threat of fragmentation of the European Union into a plausible future scenario (among others). The rise of democratic aspirations of large parts of the population in SEMCs and the upsurge of extremism, leading to a series of turmoil and upheavals, with severe consequences and uncertainties for the region's economies and societies. Tensions exacerbated in several areas of the region, such as in Libya and Syria, where civil uprisings unfolded into ongoing international armed conflicts[xxxiii].

In this context, forced displacement has made the Mediterranean a global hotspot of refugees, with three worldwide records[xxxiv]:

- Turkey hosts the highest number of refugees worldwide, estimated at 3.54 million people, and counts more than 300 thousand asylum seekers;
- Lebanon has the highest proportion of refugees in the world (16.4% of total population); and
- Syria is the country from which the highest number of refugees originates in the world, with an estimated 34.5% of its population having left the country.

An unprecedented peak in the number of refugees and migrants entered Europe via Western (Spain), Central (Italy) and Eastern (Greece) Mediterranean routes in 2015; with more than 1 million arrivals that year. Major countries of origin include Syria, Palestine, Maghreb countries, as well as sub-Saharan African countries. In European Mediterranean countries, immigration flows range from 8,400 new international migrants per year in Malta to 332,600 in France[xxxv]. This inflow of migrants has led to dialogue between countries and institutional capacity challenges[xxxvi], with the EU facing difficulty to find a satisfactory common response to this ongoing refugee crisis.

The Figure below shows net migration in 2012 and 2017 in Mediterranean countries and the share of immigrants in national population. Net migration is clearly negative in the case of Syria and to a lesser extent in Libya as a result of crises and positive in the case of Lebanon and Turkey who have received high numbers of immigrants. The stock of immigrants as a percentage of total population is particularly high in Lebanon (many immigrants from forced displacement), but even more so in Monaco (generally not from forced displacement)[xxxvii]. 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 sensitively raise the share of migrants with regard to the countries' population in some countries.

Availability and comparability of data on refugees is difficult in the region. If available, data on refugees are often based on successful asylum applications, thus not considering those who have not been granted refugee status, or those not registered through UNHCR, the UN Refugiees Agency, or UNRWA, United Nations Relief and Works Agency for Palestine Refugees in the Near East.

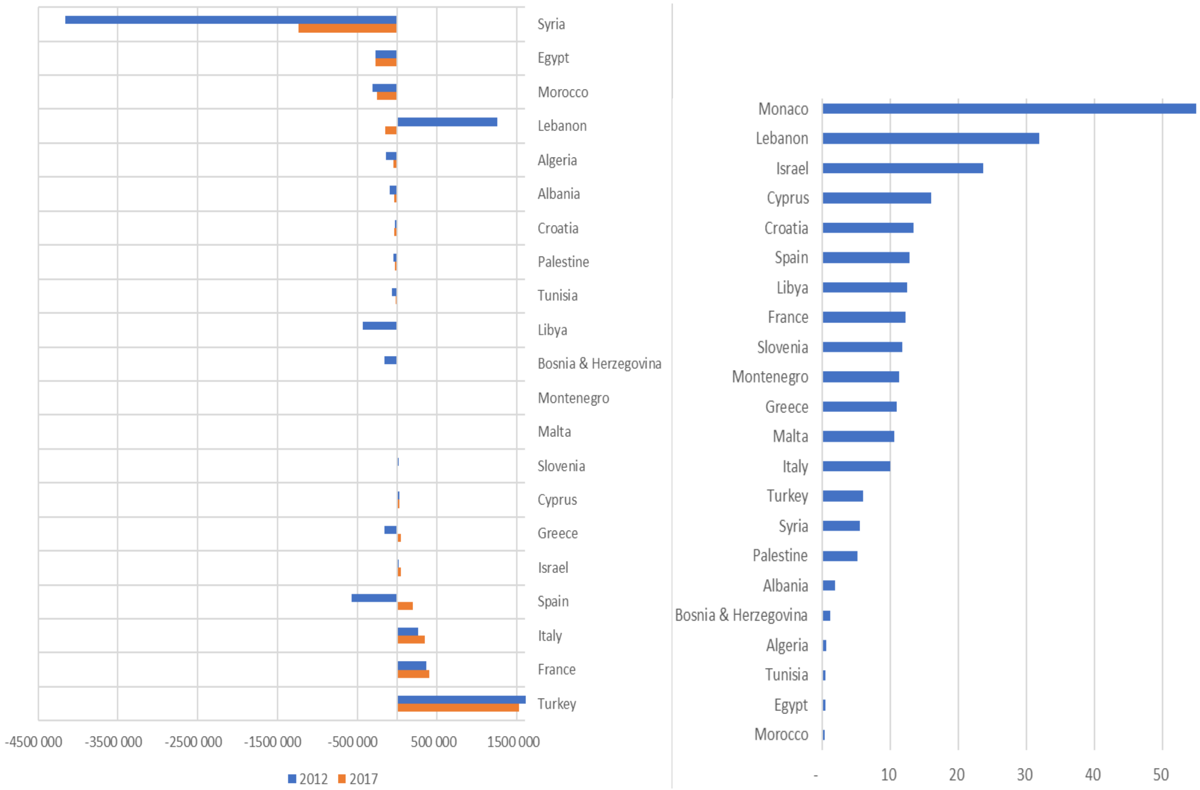


Figure 8 Left: Net migration, 2012 and 2017 (CMI elaboration based on UNDESA, 2018), Right: stock of immigrant in% of total population, 2018 (CMI elaboration based on UNDESA, 2018)

1.2 A region of socio-economic inequalities

1.2.1 Different demographic dynamics

The population of the Mediterranean riparian countries[xxxviii] amounts to approximately 510 million people in 2017[xxxix], representing 6.8% of the world population. While population has been stabilizing in the North since 1980, population in the South and East of the basin has more than doubled over the same period (from 152 million in 1980 to 311 million in 2017) and is expected to increase by an additional 130 million inhabitants by 2050. In 2017, 39% of the Mediterranean countries' population live on the northern shore and 61% on the southern and eastern shores. In decreasing order, population growth rates in the past decades are highest in Palestine, Lebanon, Israel, Egypt, Algeria and Syria. The most populated country is Egypt with 98 million people in 2017, followed by Turkey (70 million) and France (67 million). 2017 population density is highest in Monaco, Malta and Palestine, and lowest in Libya (ranging from 4 to almost 20,000 people per km^2)[xl].

Demographic transition has been completed in two thirds of Mediterranean countries and is underway in the remaining ones. The demographic convergence with northern Mediterranean countries (NMC) 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 south-eastern Mediterranean countries (SEMCs) show a fertility rate at or above the replacement rate of 2.1, leading to population growth, except Lebanon (1.7). In Egypt, Israel and Palestine, fertility rates exceed the symbolic threshold of three children per woman. Fertility is below replacement rate in all NMCs, leading to population decrease and aging. Migration does however impact these dynamics.

Box 4 Stagnation or increase in fertility in Algeria, Egypt, Israel and Tunisia

Visible since the 1960s, the fertility decline dynamics in the SEMCs seemed sufficiently strong to scientifically support the thesis of an ongoing demographic transition. Data from different international institutions all agreed on 2020-2025 as horizon of reaching a fertility rate similar to that of the NMCs, that is to say around the renewal threshold of two children per women. Until the mid-2000s, the forecasts turned out to be more in keeping with reality, with spectacular decreases in fertility recorded in Algeria, Egypt, Libya, Morocco, Syria 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 they seem to consider this inflection as temporary, below is a summary of some arguments put forward to understand this "counter-transition".

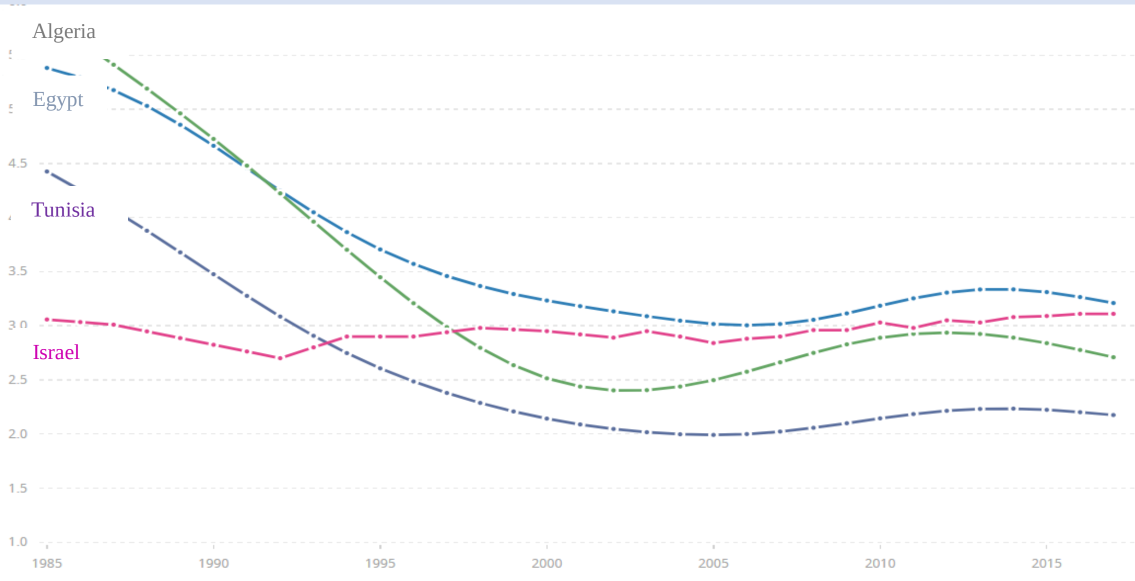


Figure 9 Fertility rates in Algeria, Egypt, Israel and Tunisia, 1985-2017 (Source: United Nations Population Division. World Population Prospects: 2017 Revision)

In the case of Egypt, fertility rates rose from almost 3.0 in 2006 to almost 3.4 in 2013 and 2014 in a country particularly struck by limited living space, accelerating natural resource depletion and a difficult situation of the labor market. 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 female workforce on the labor market leading to earlier motherhood (without necessarily having more children than older generations), economic support from expatriate Egyptians working in Gulf countries making having a higher number of children economically feasible, etc.

The reasons that may 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 tends to stabilize around 30 years since 2000; and (ii) the stabilization, or decrease in the Tunisian case, 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 more strongly educated women, including in rural areas, as fertility of the highest educated women in Algeria increased from 1.4 children per woman in 2001 to 2.8 in 2007.

In Israel, fertility rates are stagnating at around 3 children per woman.

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 more than 10 years younger than in the North. The average median age in SEMCs ranges from 20 to 31, and in NMCs between 34 and 45 years of age.

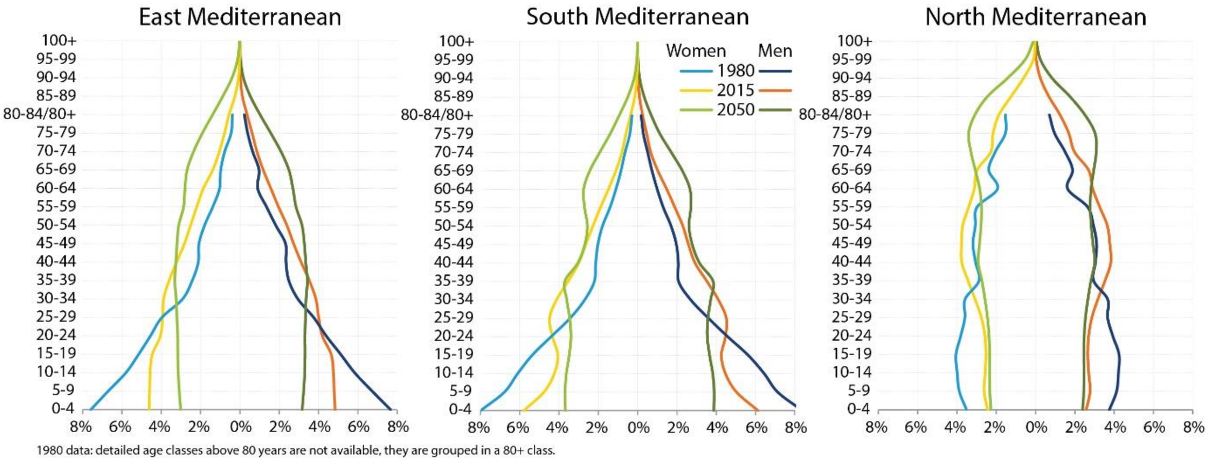


Figure 10 Age distribution of population in the East Mediterranean, South Mediterranean and North Mediterranean, 1980, 2015 and projection of 2050 (Source: World Population Prospects, 2017)

Around 70% of Mediterranean population lives in urban areas. Urban population has continued to increase throughout the region in the last decade with more than half of the population being urban in 2017 in all countries except for Egypt (57% rural population) and Bosnia Herzegovina (52%). A new phenomenon is the decline in absolute numbers of the rural population 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. The continuing urbanisation comes with an increase in the number of inhabitants in Mediterranean metropoles, which challenges urban planning, including transport and environmental infrastructure.

In Mediterranean countries, one out of three persons lives in a Mediterranean coastal region[xli]. 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 more than 337 million international tourist arrivals (ITAs) per year, about 27% of world tourism in 2016[xlii], largely concentrated in coastal zones and summer months.

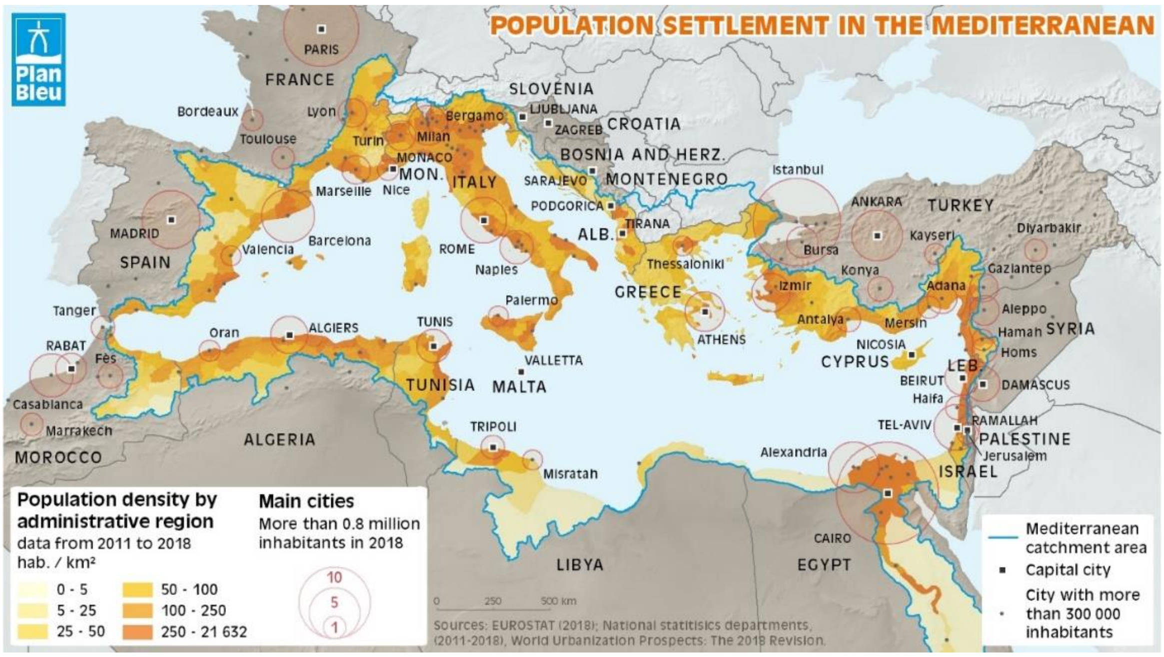


Figure 11: Population density by administrative region and main cities in the Mediterranean catchment area (Source: EUROSTAT, 2018; National statistics departments, 2011-2018, World Urbanization Prospects: The 2018 Revision)

1.2.2 Disparities in human development

The levels of development as measured by the human development index (HDI) in the region reflects the geographic and economic divide between NMCs and SEMCs, with Israel being the exception. In

EU countries, higher income coupled with social security systems and investment in education have enabled to increase life expectancy at birth and years of schooling. The EU candidates are in an intermediate position - even if Albania and Bosnia & Herzegovina have lower GDP per capita than Algeria, Lebanon or Libya.

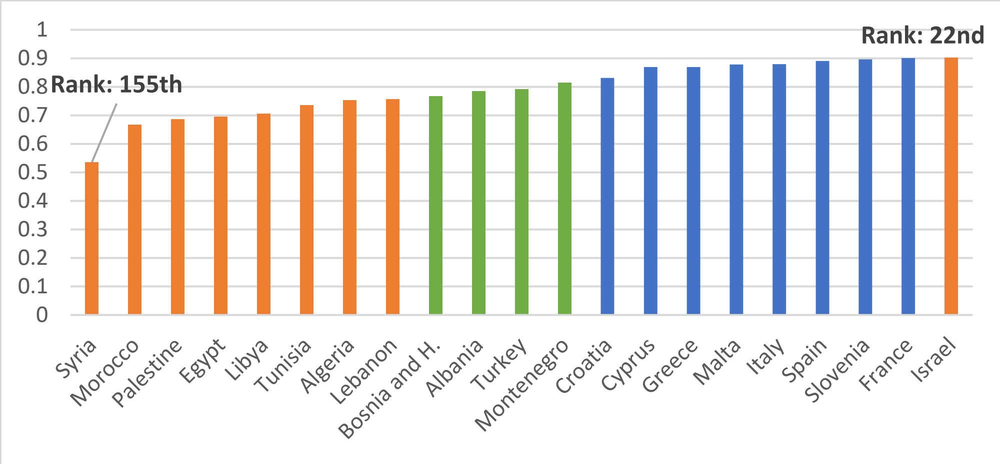


Figure 12 Human Development Index scores of Mediterranean countries, 2018 (Source: Human Development Report 2018 Update)

Most SEMCs have conducted policies to generalize access to education in primary and secondary schools. Expected 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 of the enrolment rate in primary and secondary schools in most Mediterranean countries.

However, 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 of South Mediterranean countries are lagging behind, as indicated in the Figure below.

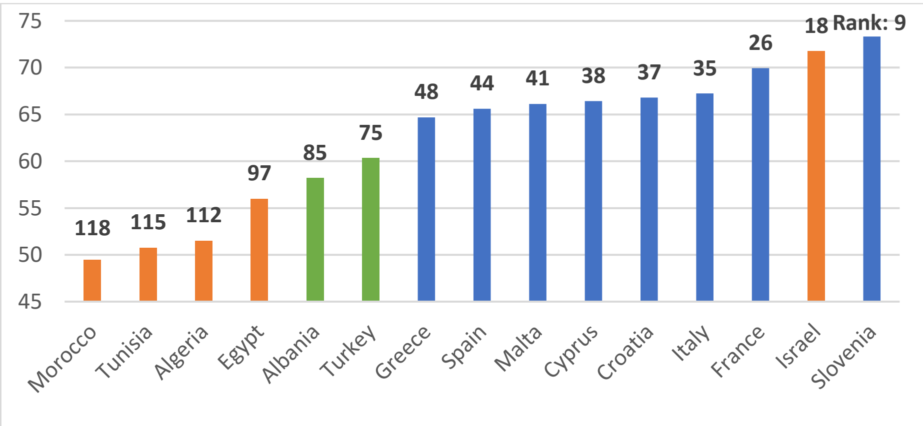


Figure 13 Human Capital Score Index and rank/130 (Source: World Economic Forum)

1.2.3 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 labor force. Unemployment rates vary from 4% in Malta to 30% in the State of Palestine and the number of unemployed is up to 3 million in Egypt, Turkey and Spain. Comparatively to 1995, the total rate of unemployment decreased in 15 countries mainly in Algeria and Montenegro (-20% and -14% respectively) and increased in 6 countries mainly in Palestine and Greece (+16% and 10% respectively).

Youth unemployment is a major issue in all Mediterranean countries. In most cases, the youth unemployment rate is between double to triple the total rate. In 2018, the youth unemployment rate is varying from 7% in Israel to 47% in Palestine.

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 Organization (ILO), unemployment rates among individuals having advanced education (in the tertiary cycle) go higher than national averages and reach 42% in Tunisia in 2013, 30.8% in Egypt in 2016, 54% in the State of Palestine in 2017.

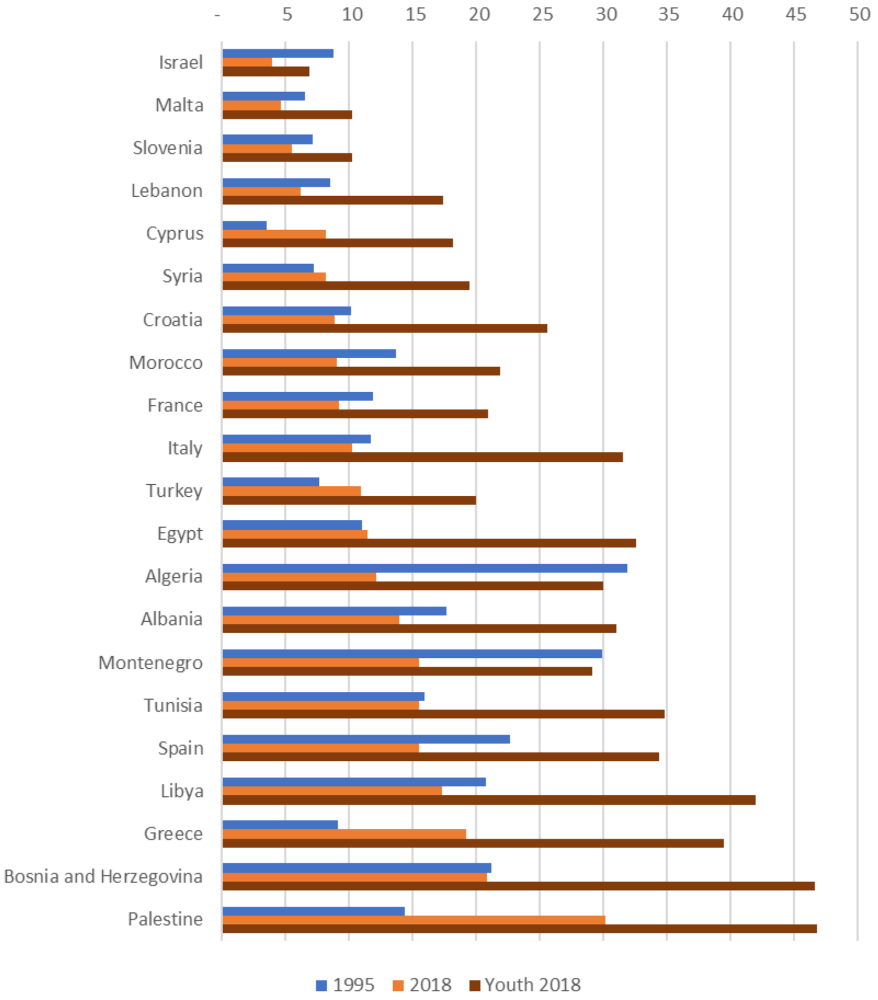


Figure 14 Unemployment rates 1995-2018 and youth unemployment rates in 2018, in percentage (Source: World Development Indicators, World Bank)

The situation for women on the labor market varies between countries. In 2017, the female unemployment rate is higher than the male unemployment rate in most Mediterranean countries except in France and Albania. The situation is very diverse from less than 5% in Malta and Israel (similar to the male rate) to 47% in Palestine (more than the double of the male rate). The share of female in the labor force in NMCs and Israel is above 33% and below 33% in SEMCs, having slightly increased in almost all countries over the last decade.

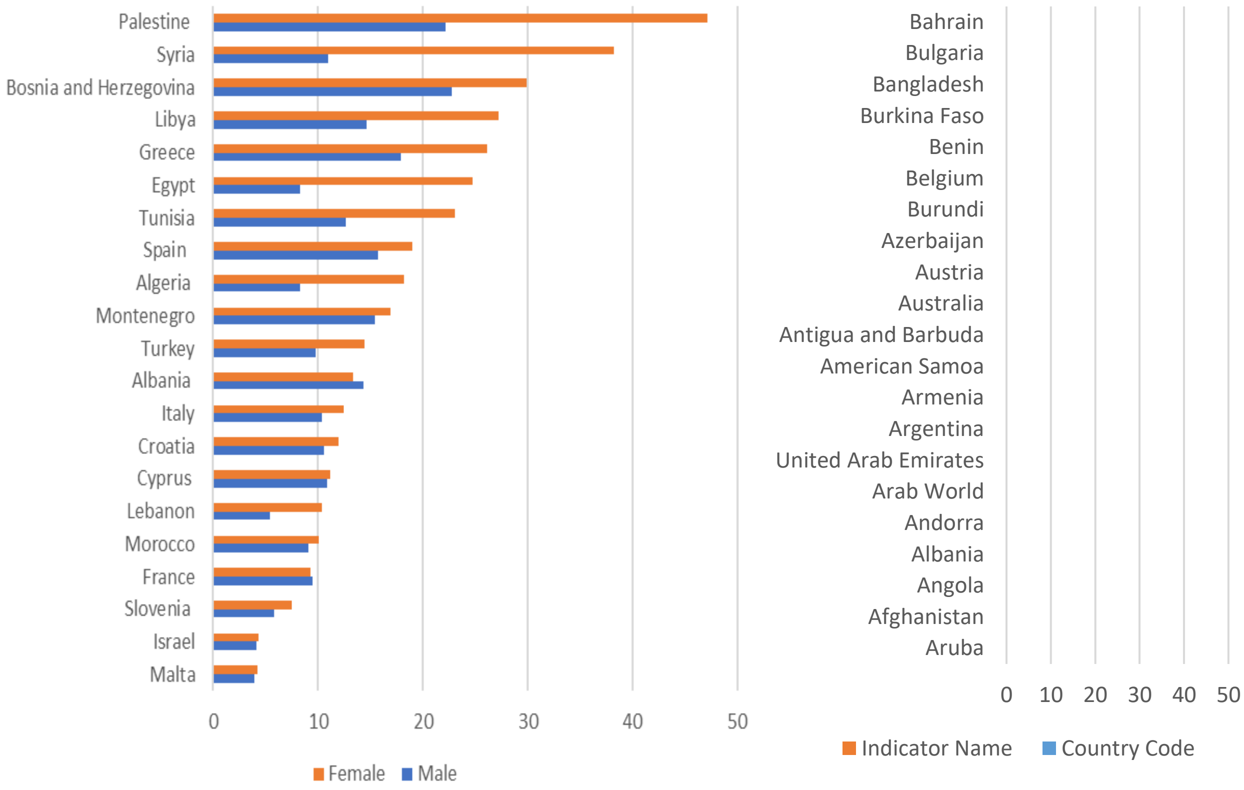


Figure 15 Left: Female and male unemployment rates in Mediterranean countries, 2017 (Source: International Labor Organization) Right: Female Labor force, in % of total labor force (Source: World Development Indicators, World Bank, 2019)

1.2.4 *Disparities in economic wealth*

Economic wealth creation, as expressed in Gross Domestic Product (GDP), varies largely among Mediterranean countries, presenting a persisting gap between NMCs and SEMCs. In fact, the EU Mediterranean countries count for 60% of total GDP generated by Mediterranean countries. In 2017, the average GDP per capita in SEMCs is three times lower than the average income in the EU Mediterranean countries. The Mediterranean countries' economy has grown 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. Concomitantly, the share of the Mediterranean population remains constant in the world population with about 7%.

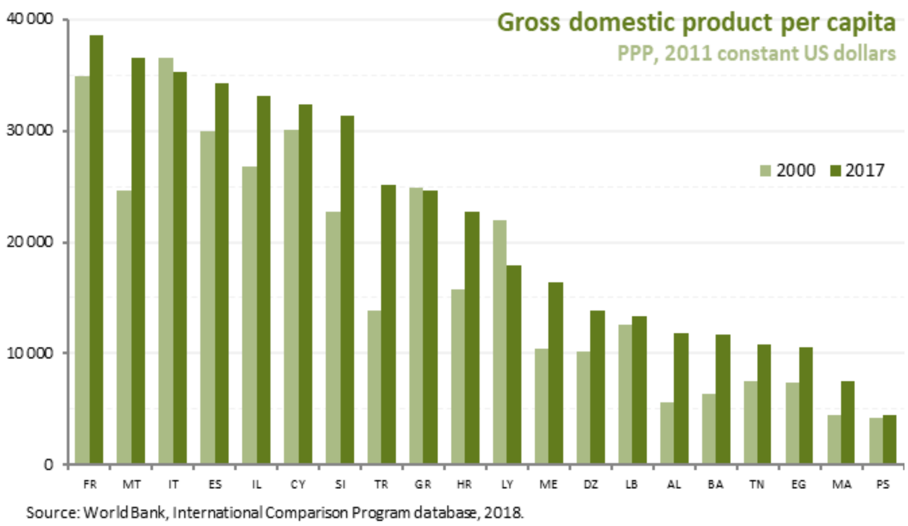


Figure 16 Gross domestic product (GDP) per capita, 2000 and 2017, PPP in 2011 constant US dollars (Source: World Bank, 2018)

The last decade was marked by a number of economic instabilities. The 2008 financial crisis has not affected all Mediterranean countries equally. Members of the European Union (EU) went through a double dip recession, first due to the 2008 crisis and then linked to the Euro 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 their pre-level crisis and unemployment remains high especially among youth (particularly in Spain and Greece). In the western Balkans and Turkey, economies also plummeted in 2008, whereas they were less hit by the 2012 crisis since they were not part of the EU but still felt the negative spill-overs from their weakened partners. South 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 2-3% which is far from enough to resorb high levels of unemployment given their demographic dynamics.

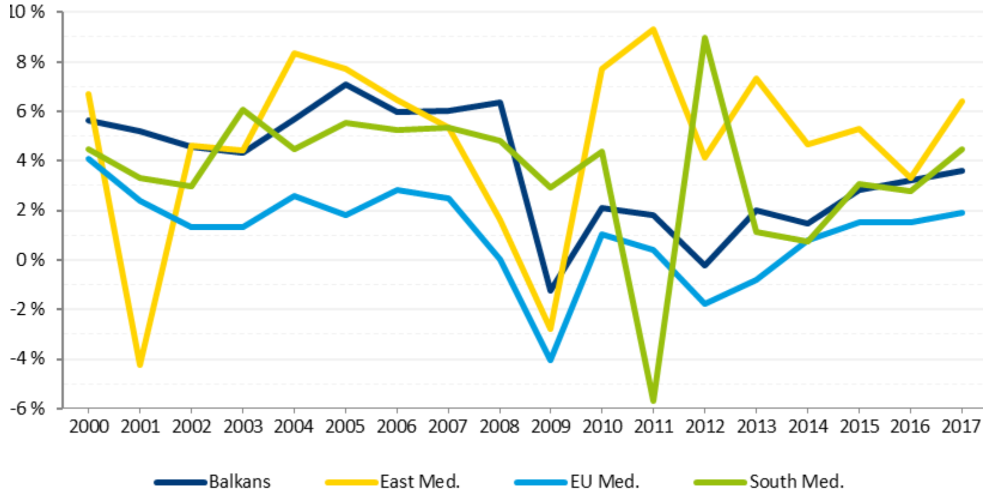


Figure 17 GDP growth by country group in the Mediterranean, 2000-2017 (Source: World Bank, 2019)

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 have followed did not work as expected to stabilize government debt because of their recessionary effect. For other Mediterranean countries, the individual situations are mixed, but levels of government debt (Figure 18) have generally increased and now represent a challenge for their ability to engage needed public investments in education, health, infrastructure and environmental transition.

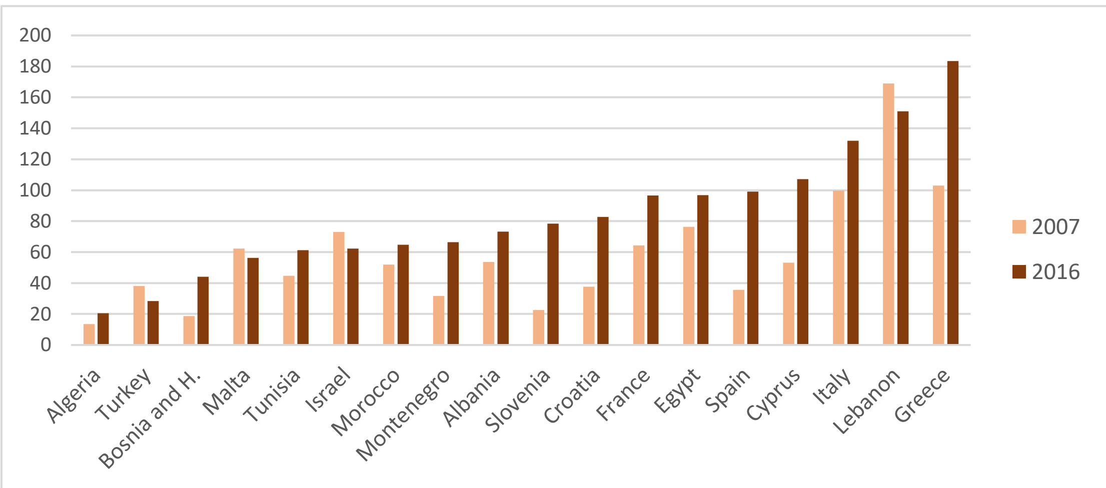


Figure 18: General Government Gross Debt, % of GDP, 2007 and 2016 (Source: IMF World Economic Outlook)

1.2.5 Mediterranean economies continue their tertiarization with inequal opportunities for growth

Mediterranean countries have continued to decrease the share of agricultural and industrial value-added in their national economies to the benefit of services, however, significant disparities between countries remain. The contribution of the agricultural sector to GDP continues to be very heterogeneous among Mediterranean countries (between 1 and 19% in 2017 compared to between 1.7 and 56.6% in 1995) and this contribution declined in most countries except in Algeria and to a lesser extent in Morocco.

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 Palestine, Turkey, Lebanon and, to a lesser extent, in Morocco. Only Algeria has seen this contribution increase significantly. In Balkan countries, the share of agricultural VA in GDP has fallen. Albania is the country where agriculture contributes the most to GDP, with a share of 56.5% in 1995, and still 19% in 2017. In Bosnia-Herzegovina and Montenegro, the share in 2017 is between 5% and 7%. In Mediterranean EU countries, the share of agriculture in GDP in 2017 is between 1 and 3.5% with a strong decrease in most countries and especially in Cyprus and Malta (less than half compared to 1995).

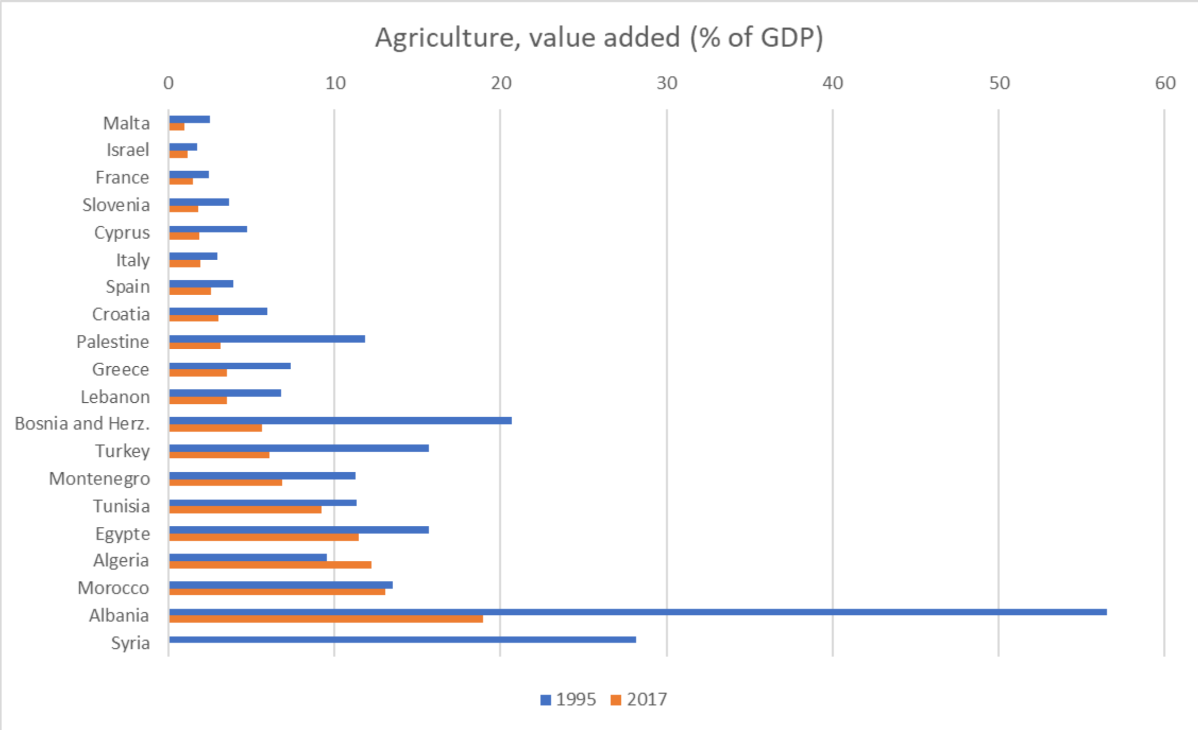


Figure 19 Contribution of agricultural sector value added to GDP in 1995 and 2017 (Source: WDI World Bank) Note: Israel, Palestine and Tunisia (2016 data)

The share of industrial value-added in GDP fell in most Mediterranean countries over the period 1995-2017 except in Egypt. In SEMCs, Algeria (with a highly gas and oil-dependent economy), Egypt (the only Mediterranean country having experienced a notable increase of the contribution of industry to GDP) and Turkey have an industry contribution to GDP around, or greater than, 30% in 2017. Israel and Lebanon are the SEMCs where industry contributes the least to GDP (19% and 12%), illustrating rather service-oriented economies in 2017. In the Balkans, industry accounts for 24% of value added in GDP in Bosnia-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 highest decline: 2 times less than 20 years ago.

The share of value-added generated by services has been increasing or remained stable over the last 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%), Morocco

(51%); to 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 2/3 of their national GDP, with particularly high rates in Lebanon and Malta (both 75%) and Monaco (more than 80%).

At first sight, the passage to a mainly service-based economy may seem to be a development that favours less resource and material consumption and less pollution. But service-based economies continue to rely on significant and varying amounts of resources and emit different types of pollution, as shown in the following section. The relationship between tertiarization and environmental impact is in reality complex and ambiguous.

1.3 A socio-economic system with an unsustainable ecological footprint, relying on resource consumption and fossil fuels

In the Mediterranean region in 2015, the energy intensity is varying from 1.8 MJ/US dollars 2011 PPP in Malta to 4.6 MJ/US dollars 2011 PPP in Slovenia and 8.7 MJ/US dollars 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 is less than half that of 1997 in Malta while it increased in Algeria, Bosnia and Herzegovina and Palestine. Whilst a decrease of the energy intensity of Mediterranean countries is a positive development on the way towards an environmental transition of the regional economy, this must be put into perspective with the dominant consumption of fossil fuels. In fact, Mediterranean economies remain highly dependent on fossil fuels, reaching more than 90% of the total fuel consumption of Mediterranean countries (World Bank WDI, consulted 2019).

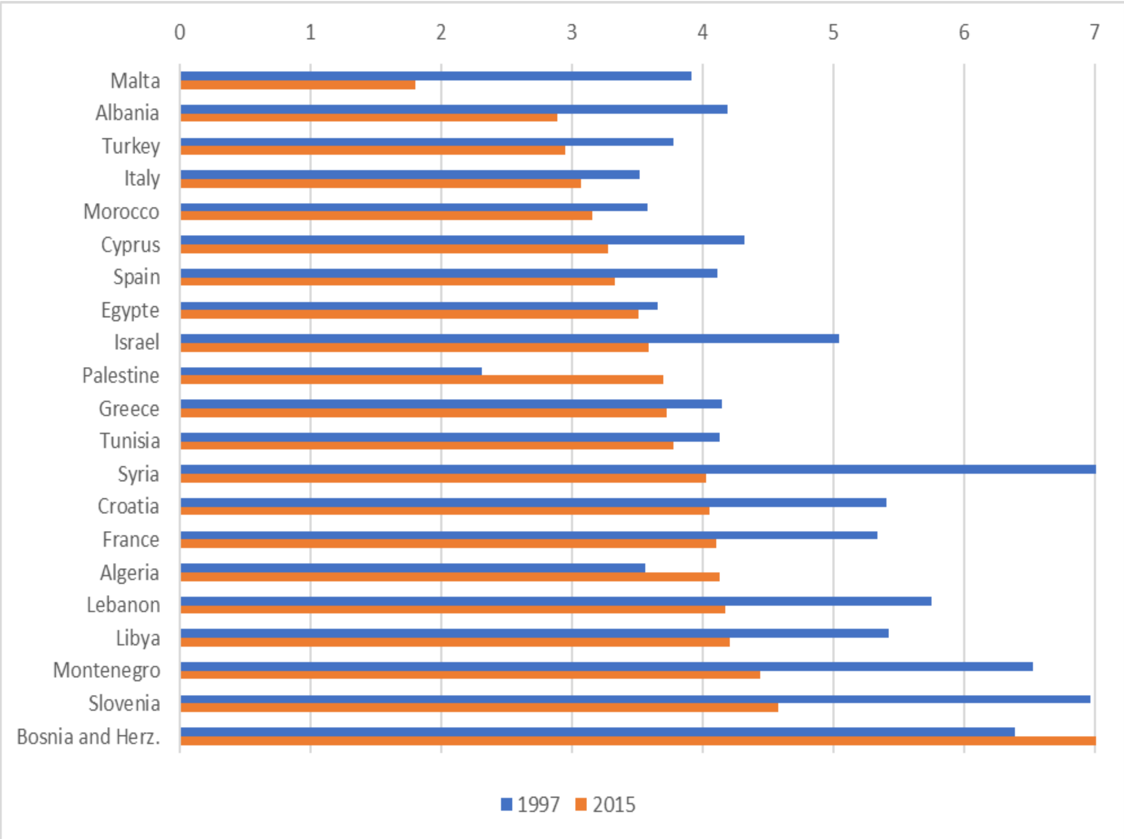


Figure 20 Evolution of energy intensity (ratio of energy supplied to GDP in PPP) between 1997 and 2015 in MJ / GDP in USD, 2011 PPP (Source: World Development Indicators, World Bank)

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 period 2000–2017: income or GDP of most Mediterranean countries increased faster than the amount of used materials (Global Materia Flows Database). This is however not the case in Algeria, Libya and Syria where material consumption per unit of GDP increased significantly over the same period. In Albania, Bosnia and Herzegovina, Lebanon and Turkey it is less clear whether a relative decoupling has been achieved or not.

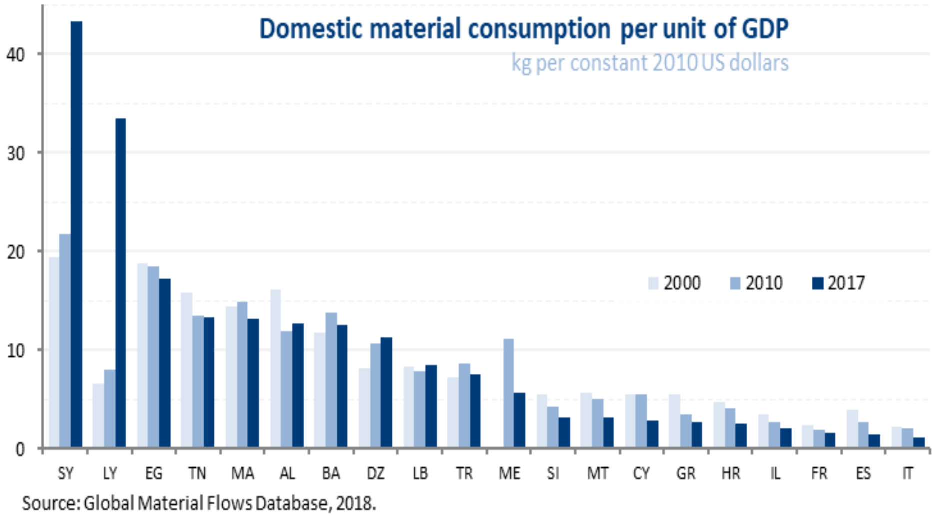


Figure 21 Domestic material consumption per unit of GDP, in kg per constant 2010 US dollars, 2000, 2010, 2017 (Source: Global Material Flows Database, 2018)

From 2010 to 2014, the Ecological Footprint per capita decreased in most of Mediterranean countries. However, the Mediterranean Ecological Footprint (3.2 gha/cap) is higher than the global Ecological Footprint (2.8 gha/cap) and the Mediterranean's Ecological Deficit (2.02 gha/cap) is twice as high as the world's Ecological Deficit (1.1 gha/cap).

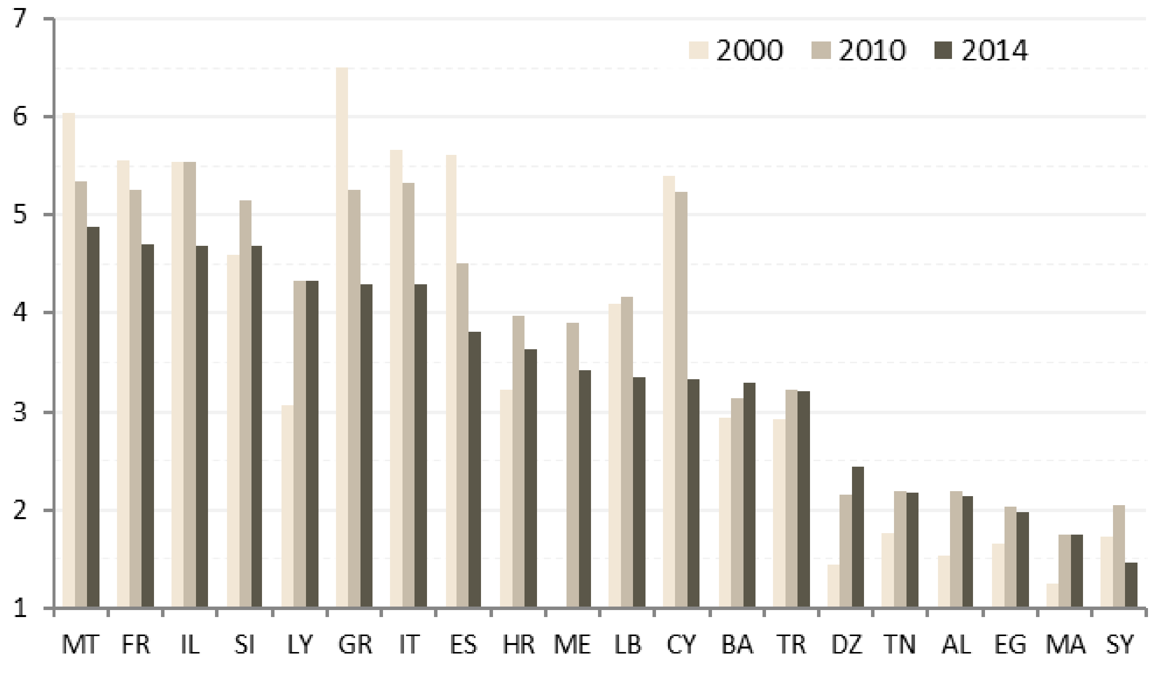


Figure 22 Ecological Footprint per capita, 2000 – 2014 in Global ha/inhabitant (Source: Global Footprint Network, 2018)

The Ecological Footprint of the northern Mediterranean countries has been decreasing in recent years (from 5 gha/cap in 2010 to 4.2 gha/cap 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 dollars in most of northern countries except in the Balkan countries (316 in Bosnia- Herzegovina). In the southern countries the maximum values are for Libya (254 gha per million dollar) and Lebanon (231)

2 Draft Chapter 2: Climate Change

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Climate change is exacerbating already existing environmental fragilities and degradations in the Mediterranean. The region is considered a hotspot for climate change, struck, in particular by more rapid warming in the air and the ocean than the global average and by changes in water regimes in an already partly water scarce region. CO_2-induced ocean acidification is further threatening marine ecosystems. The region is also very vulnerable to sea level rise with extremely dense human settlements, infrastructure and heritage sites situated on the shoreline coupled with often limited adaptive capacity. Mediterranean countries are engaging into a multitude of efforts to mitigate and adapt to climate change, at the international, regional, national and local level. These efforts need to be urgently implemented, effectively enforced and their ambition further strengthened in a multi-stakeholder context, to minimize and adapt to climate change-related “multiple stresses and systemic failures” announced for the Mediterranean (IPCC, 2014).

2.1 Introduction: Greenhouse gas emissions fall behind global ambitions

Carbon dioxide (CO_2) is the most prominent greenhouse gas (GHG), which - along with other GHG, such as nitrous oxide and methane - is important in sustaining a habitable temperature on earth. Since the Industrial Revolution, however, consumption of fossil fuels has led to a rapid increase in CO_2 emissions, disrupting the global carbon cycle and leading to a planetary warming impact. The CO_2 emissions of the Mediterranean countries accounted for 5% (1954 Mt)[1] of the annual world emissions in 2014, while the total population of Mediterranean rim countries represents around 6.8% of the world population.

As portrayed in Figure 23, NMCs are responsible for higher CO_2 emissions than SEMCs, however emissions have reached a peak in 2005 in NMCs and decreased since then. Contrarily, CO_2 emissions of the SEMCs, driven by population growth and economic development, have been increasing continuously since the 1960s, and are catching up with those of NMCs; both tending toward an annual emission of 1 Gt of CO_2 in 2014.

[1] World Bank, 2019

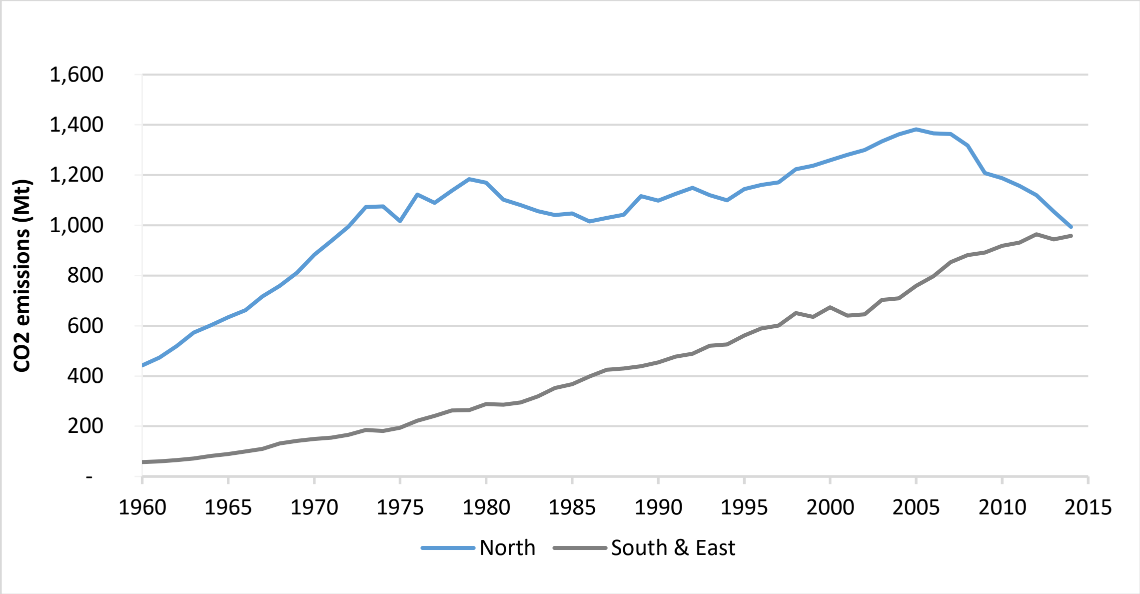


Figure 23 CO_2 emissions by Northern and South-Eastern Mediterranean countries (Source: Carbon Dioxide Information Analysis Center, Environmental Sciences Division, Oak Ridge National Laboratory, Tennessee, United States)

CO_2 emissions vary greatly among Mediterranean countries, with the highest CO_2 emissions (higher than 100 kt in 2014) in Turkey, Italy, France, Spain, Greece and Algeria in decreasing order (Figure 25). Between 2000 and 2014, emissions have decreased in EU Mediterranean countries and the Syrian Arab Republic, and increased in all other Eastern and Southern Mediterranean countries.

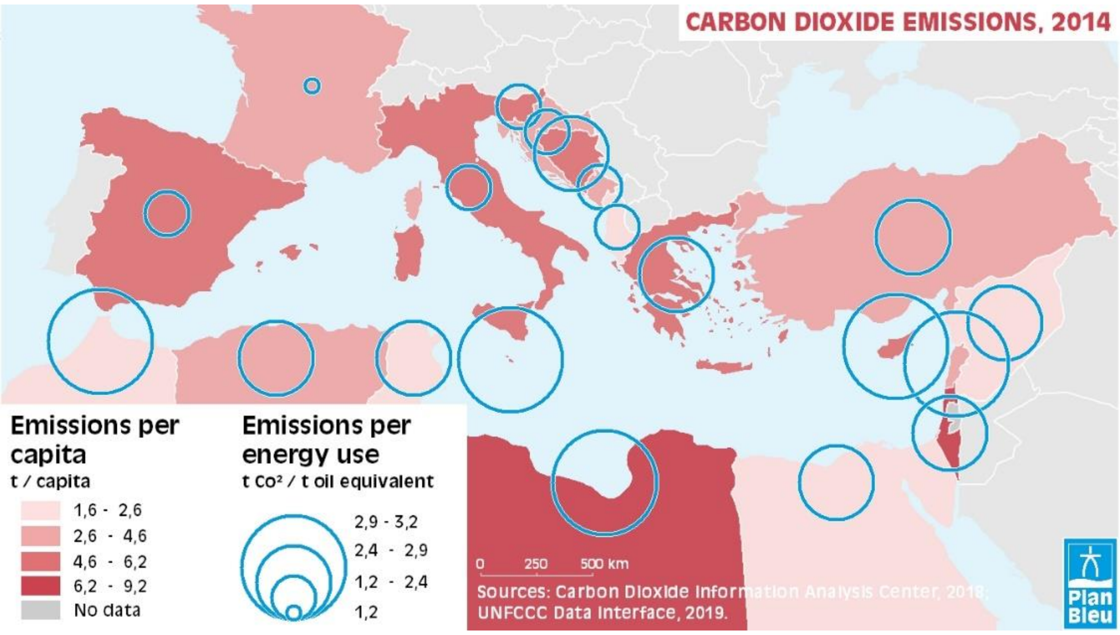


Figure 24 Carbon dioxide emissions of Mediterranean countries, 2014 (Sources: Carbon Dioxide Information Analysis Center, 2018, UNFCCC Data Interface, 2019)

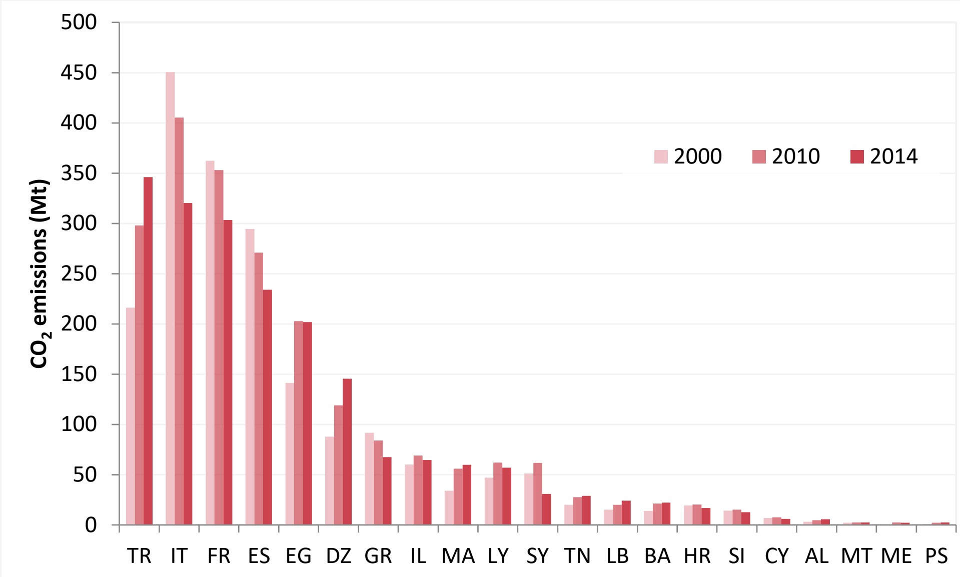


Figure 25 - CO_2 emissions by country in 2000, 2010 and 2014. Country acronyms refer to ISO 3166-2 international norm (Source: Carbon Dioxide Information Analysis Center, Environmental Sciences Division, Oak Ridge National Laboratory, Tennessee, United States)

Annual CO_2 emissions per capita average around 4 tons, ranging between 0.5 t per capita in the State of Palestine to 9.2 t per capita in Libya in 2014 (Figure 26).

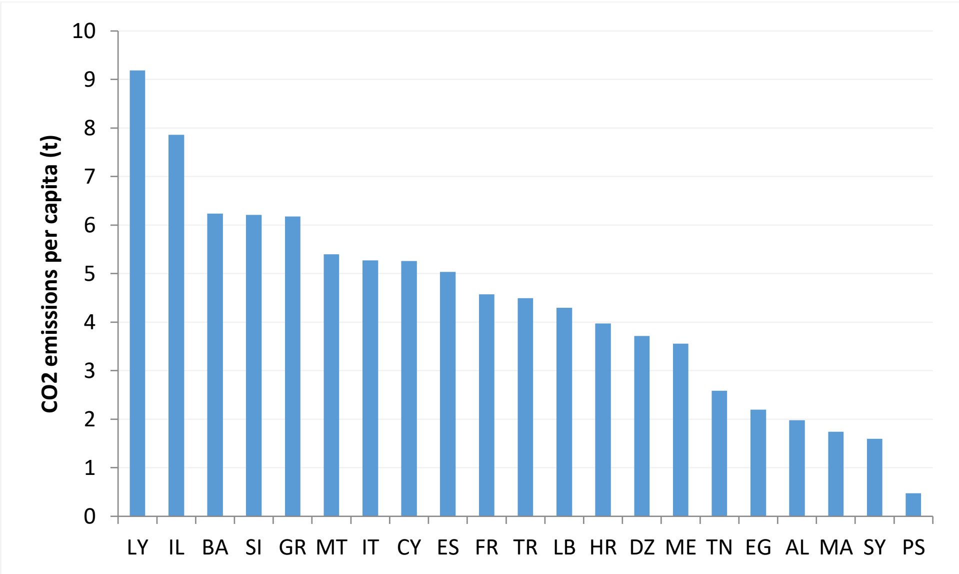


Figure 26 - CO_2 emissions per capita by country in 2014 (Source: Plan Bleu calculations based on country CO_2 emissions and population estimates)

Globally, CO_2 emissions from fuel combustion derive principally from the electricity and heat production sector (50%), followed by transport (20%), and manufacturing industries & construction (20%). 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 chapter 1), as a result of an increase in the relative share of renewables, improved energy and technology efficiency and increasing capacity of renewable energy sources. Even if showing a 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.

Box 5 The contribution of maritime transport to climate change

Shipping contributes to around 2.6% of total global GHG emissions, a share that could more than triple by 2050 (3rd IMO GHG study, 2014). According to the International Transportation Forum (ITF), carbon emissions from global shipping are projected to reach approximately 1090 million tons by 2035 under a baseline scenario with no new policy measure. This would represent a 23% growth from 2015 to 2035 (OECD/ITF, 2018). Figure 27 below visualizes CO_2 emissions' projections across shipping routes in 2015.

An ITF study (OECD/ITF, 2018b) identified measures that could decarbonize international shipping by 2035:

- 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 co-ordination 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 procurements or shore power facilities

Figure 27 - Visualisation of CO_2 emissions' projections across shipping routes in 2015 (Source: ITF - Decarbonising Maritime Transport - Pathways to Zero-Carbon Shipping by 2035 — OECD/ITF 2018)

At the global level, no GHG sector emission reduction target has been established for maritime transportation, under the United Nations Framework Convention on Climate Change (UNFCCC), unlike other sectors. In 2011, 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 the regulation, 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 at providing robust data to base future policy decisions on additional reductions. In April 2018, IMO adopted a strategy to reduce GHG emissions. Under this strategy, IMO members' level of ambition is to reduce the total annual GHG 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 GHG emissions reduction measures will be supported by international technical cooperation projects, such as the IMO GloMEEP Partnership Project (https://glomeep.imo.org).

2.2 Climate change impacts, vulnerabilities and risks

2.2.1 The Mediterranean Basin – a climate change hot spot

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 are hot and dry summers, creating water-stressed conditions that allow vegetation development only due to 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 the summer. These particular conditions occur only in few regions of the World, besides the Mediterranean Basin.

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 the ocean. The trend towards drier conditions is unequivocal, 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. Human economic activities (agriculture, fisheries, tourism, etc.) and supporting infrastructures (cities, ports, agriculture in low-lying river deltas, etc.) are tightly tuned to recent climatic and environmental conditions, notably the precise current level of the sea surface, making Mediterranean countries highly vulnerable to changes in these conditions. Finally, a large number of Mediterranean countries (in the South and the East) are living under high economic pressure with little budgets available for adaptation. All these factors together make the Mediterranean Basin a climate change hot spot. 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) above pre-industrial values, the Mediterranean region approaches 1.6 °C (Fig.6, 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[2].

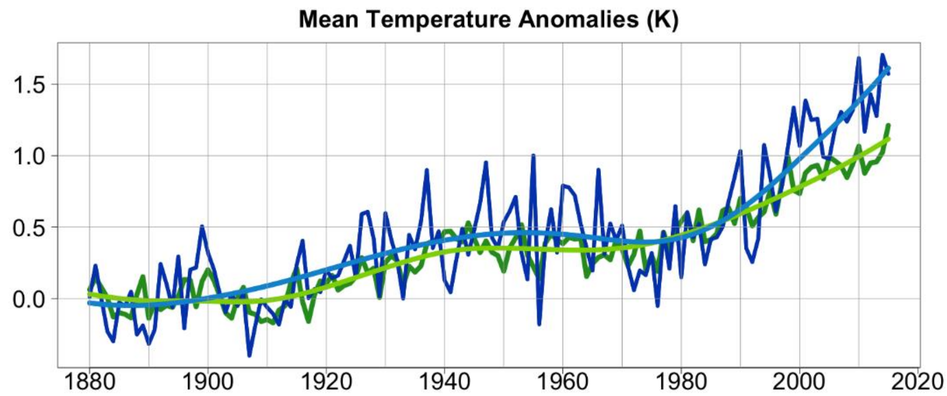


Figure 28 Historic warming of the atmosphere, globally and in the Mediterranean Basin. Annual mean air temperature anomalies are shown with respect to the period 1880-1899, with the Mediterranean Basin (blue) and the globe (green) presented with and without smoothing (Source: Data from Berkeley Earth available at *http://berkeleyearth.org/ (Cramer et al, 2018)***)**

Since the mid-20th century, the major cause of air temperature increase in the Mediterranean region is anthropogenic forcing[3] (Adloff *et al.* 2015). This also includes the observed increases in hot extremes and decreases in cold extremes (Bindoff *et al.* 2013, Schleussner *et al.* 2017). Summer months have warmed more than 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, heat waves occur more frequently since 1960 and the increase is also stronger than at the global level (Jacob *et al.* 2014). In the eastern Mediterranean, heat wave return-periods (mean time interval between two occurrences) have changed from once every 2 years to multiple occurrences per year (Zittis *et al.* 2014). The summer amplification of daily temperature ranges is further amplified in cities by the "urban heat island"[4] effect, as shown in the Figure 29 below. This figure shows

[2] Daytime maxima.

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

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

that the probability distributions of temperatures in most of the Mediterranean cities at the end of the 20th and 21st centuries are completely separated, implying that the present warmest years are colder than the future coldest ones (with a scenario of 600 ppmv in 2100).

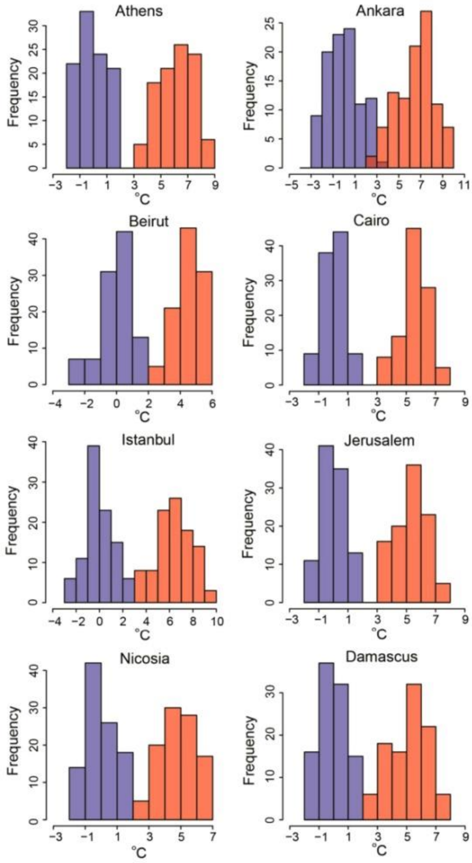


Figure 29 - Recent (1961-1990) and expected end-of-century (2070-2099) temperature anomalies for selected cities in the Mediterranean region. Model calculated frequencies (%) of summer daytime maximum temperature anomalies relative to the period 1961-1990, based on the A1B scenario which assumes a rapid economic growth with CO_2 concentration increasing to 600 ppmv in 2100 (current concentration is about 400 ppmv). Blue bars for the period 1961-1990 (hence centered around 0°C) and orange bars for the period 2070-2099 (Lelieveld et al. 2013).

2.2.1.2 Precipitation: towards dryer conditions and heavy rainfall events

Observed precipitation varies very strongly from year to year and also between regions – it is therefore difficult to conclude about an observed basin-wide reduction in rainfall. 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).

A 2 °C global warming will likely be accompanied by a reduction in summer precipitation of about 10-15% in Southern France, Northwestern Spain and the Balkans and up to 30% in Turkey (Vautard *et al.* 2014, Jacob *et al.* 2018). Even warmer scenarios with 2 to 4 °C temperature 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 *et al.* 2018) (Figure 30), 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 summer (Toreti *et al.* 2013; Toreti & Naveau 2015), although these projections are less certain than those for the temperature extremes.

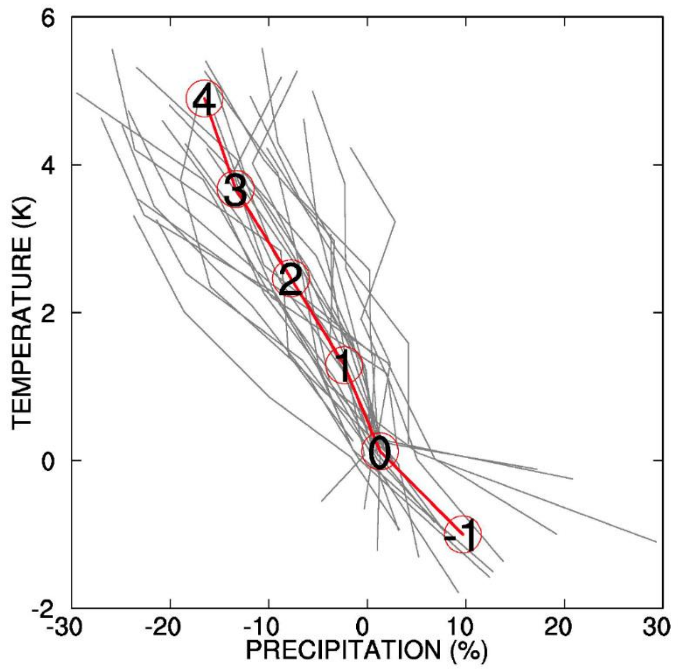


Figure 30 - Evolution of the Mediterranean regional climate towards warmer and drier conditions (temperature anomalies in function of precipitation anomalies). The grey lines represent the evolution of the individual models (28 CMIP5 global simulations) and the red line represents the mean evolution (the ensemble mean as 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)

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 *et al.* 2013). Anthropogenic forcing is the major determinant for 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 31) and hot spots expected to the east of Spain and in the eastern Mediterranean.

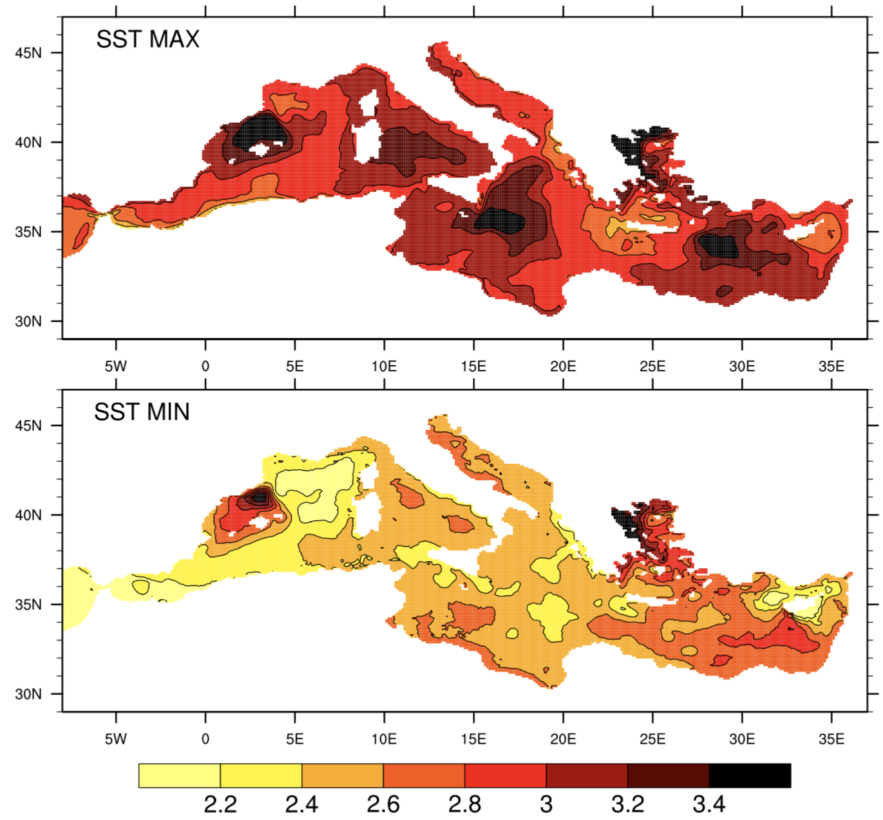


Figure 31 - Composite of sea surface temperature anomalies maxima (top) and minima (bottom) for the 2070–2099 period (vs. 1961–1990). The largest (maxima) or smaller (minima) anomaly out of the 6 scenario simulations is represented at each grid point. Units are in °C (Source: Adloff et al., 2015)

2.2.1.4 Sea level: uncertain scenarios, with potential serious concerns

Globally, mean sea level has been rising since the late 19th century, with an acceleration in the last two decades (1993-2014) to 2.6-2.9 mm per year (Church *et al.* 2013, Watson *et al.* 2015). The main contributions to this rise are from thermal expansion, from glacier and ice-sheet mass loss and from freshwater storage on land, caused primarily by anthropogenic forcing since 1970 (Slangen *et al.* 2016). Current estimates of future sea-level rise range from 52 to 190 cm above present levels by 2100 (Church *et al.* 2013, Vermeer & Rahmstorf 2009). The instabilities in both the Greenland and Antarctic ice sheets could result in multi-meter rises in sea level on centennial to millennial timescales and research is currently ongoing to enhance knowledge and provide new estimates in this regard. Any global rise will impact the Mediterranean Sea through the transport of water through the Strait of Gibraltar (Jorda & Gomis 2013, Adloff *et al.* 2018). In the Mediterranean, sea-level has recently risen by about 3 cm per decade (Tsimplis *et al*. 2013), a rate comparable to global trends. This is a sharp increase compared to the period 1945-2000 (0.7 mm per year, Calafat & Gomis 2009) and to 1970-2006 (1.1 mm per year, Meyssignac *et al.* 2011).

For Mediterranean coasts, regional changes in river runoff, resultant salinity changes and also significant land movements in the Eastern basin affect the regional circulation pattern (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. In Southern Italy, substantial coastal inundation is expected by 2100 (Aucelli *et al.* 2017). Significant shoreline modifications are also expected elsewhere, such as in the Balearic Islands (Enriquez *et al.* 2017).

2.2.1.5 Ocean acidification: following global trends

About 30% of CO_2 emitted by human activities have been absorbed by the ocean where it has combined with water to drive ocean acidification (Stocker *et al.* 2013). Ocean pH has decreased by 0.1 pH units since the pre-industrial period, a change unprecedented during 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). Similar rates must be expected for the

Mediterranean (Palmiéri *et al.* 2015), which is currently estimated to acidify by 0.018 to 0.028 pH units per decade (Meier *et al.* 2014; Kapsenberg *et al.* 2017).

2.2.2 Impacts of climate change on the terrestrial environment

Land ecosystems are affected by numerous environmental parameters, and climate (temperature, rainfall, and the variability of these over short and long time-scales) is a key factor impacting terrestrial ecosystems. The distribution of ecosystems in the Mediterranean Basin reflects, in part, the main climatic gradients (including those between coastal and inland, 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 the world forest areas, they contain 290 woody species, twice as much as the entire 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 highly 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. Indeed, a large share of Mediterranean biodiversity has actually arisen as 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 vigor 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 survival at risk if certain thresholds are passed. The expected continuation of the current increase in aridity, due to reduced precipitation but also warming (see 1.2.1), is likely to be one of the most important threats to Mediterranean land ecosystems (Duguy *et al.* 2013; Peñuelas *et al.* 2013; 2017; Williams *et al.* 2013; Gouveia *et al.* 2017; Santonja *et al.* 2017). Under an optimistic climate scenario (global temperatures below +1.5°C to +2 °C with respect to preindustrial values), western Mediterranean forests largely resist to future climate in most locations, except for some sites dominated by conifers. With more warming, many 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. More generally, 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.

Forests, wetlands and coastal ecosystems in the Mediterranean Basin will also 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, severe fires are expected as a result of increasing heat waves in combination with drought and land use change (Duguy *et al.* 2013; Turco *et al.* 2014; Ruffault *et al.* 2016) (

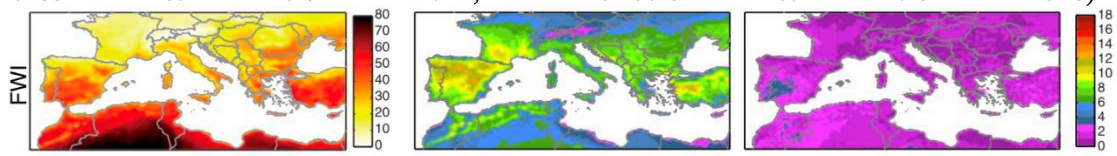


Figure 32).

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 heat waves, have caused record maxima of burnt area in some Mediterranean countries during the last decades (Ganteaume *et al.* 2013; Ruffault *et al.* 2016). These risks are projected to 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).

Since also other components of global change, such as the expansion of high intensity land use, pollution and overexploitation of resources, continue or even accelerate, decreases in ecosystem integrity, biodiversity, carbon storage capacity must be 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). An important consequence of forest loss would be a reduction of their role as carbon sink, especially during drought years (Rambal *et al.* 2014; Munoz-Rojas *et al.* 2015).

The agricultural sector has already been experiencing negative impacts in the Mediterranean area (Peltonen-Sainio *et al.* 2010; Olesen et al., 2011) which will eventually result in overall crop productivity reduction in large parts of the southern Mediterranean over the next decades (Iglesias *et al.* 2012; Olesen *et al.* 2011). Depending on crop type and region, there will be significant sub-regional differences in terms of yield increase or decrease (Skuras & Psaltopoulos 2012). UNEP/MAP PAP/RAC reports a decrease (in value terms) of 21% by 2080 for the whole Mediterranean agricultural production, with peaks of an almost 40% decrease in Morocco and Algeria (UNEP/ MAP PAP/RAC, 2015).

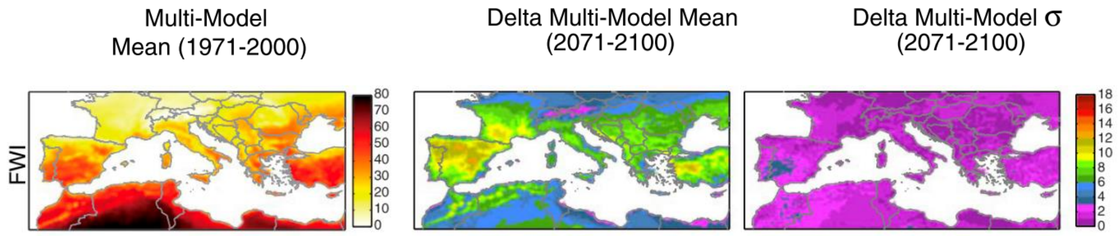


Figure 32 - Control (1971–2000) and future projections (delta and standard deviation, 2071–2100,) of the FWI (Canadian Fire Weather Index) (Source: Bedia et al, 2014)

2.2.3 Impacts of climate change on the coastal environment

The Mediterranean coastal environment is home to about 150 million people. Sea level rise and other oceanic climate change result in salinization, flooding and erosion and 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 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 only the most striking example. Coastal zones frequently offer the ideal growing conditions for a range of valuable crops (e.g. vegetables, olives, and grapes) besides 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.

2.2.3.1 Past and current changes affect in particular delta regions

Loss of arable lands due to coastal erosion and salinization due to sea level rise and flooding begins to be observed and starts to affect agricultural production in coastal areas of the Mediterranean. Attribution to climate change is not always simple. All major river deltas are affected by reduced sedimentation rates, caused by dams and changed irrigation systems upstream. In Egypt, about 30% of the irrigated farmlands are affected by salt intrusion (Hegasi et al. 2005). Of the Northern cultivated land and both Middle and Southern Delta regions, 60% and 20%, respectively, are considered salt-affected soils (Rubio *et al.* 2009). This environmental degradation pushes Egypt's increasing population into more and more concentrated areas (ACSAD report 2000).

2.2.3.2 Risks for the future: on cities, infrastructure and heritage sites

The effects of sea-level rise are expected to be high for most low-lying coasts of the Mediterranean basin, even in the expected case of reduced marine storminess in some parts (Gualdi *et al.* 2013; Lionello *et al.* 2016). Marine storms and related storm surges represent a major issue at the local scale for the assessment of coastal risk. The uncertainty in the likelihood of disastrous events is one of the key factors 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 risk. The joint effect of extreme precipitation with storm surges are forcing factors of coastal flooding (Lian *et al.* 2013). Precipitation runoff collected by drainage systems flows directly or is pumped into the sea or into the water plains. Inland flooding, caused by extreme precipitation, has an influence on the drainage capability leading also to backward flow, which increases the negative effects of coastal flooding generated by marine storms. All these factors may enhance coastal erosion which occurs where beaches that have been supplied with sediment carried down to the coast by rivers are depleted following a reduction in sediment yield to river mouths as a result of reduced runoff. Also, the reduction of river flow due to droughts results in coastal erosion (Bird & Lewis 2015).

Potential socio-economic consequences of climate variability and change vary for the different key coastal sectors in the Mediterranean sub-regions. Inundation related to accelerated sea-level rise increases the risk of infrastructure damage including the flooding of roads, railways, houses. Storms may impact maritime transport and ports (Travers 2010). Increasing risk for wave overtopping in Northern Mediterranean ports is manifest (Rohr *et al.* 2011; Paz *et al.* 2010). These coastal risks may be even higher along the Southern and Eastern shores, 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 (Hanson *et al.* 2011; Hallegatte *et al.* 2013). These cities are at risk of witnessing severe storm-surge flooding, rising sea and local land subsidence (Nicholls *et al.* 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 of the 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, Palestine, and Syria (Satta et al. 2017). Those include countries presently subject to political instability and thus less able to deal with the additional environmental pressures and associated relocation or reconversion challenges. In North African countries, 1 m sea-level rise would impact approximately 41,500 km² of land and at least 37 million people (Tolba & Saab 2009). It is currently not 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.

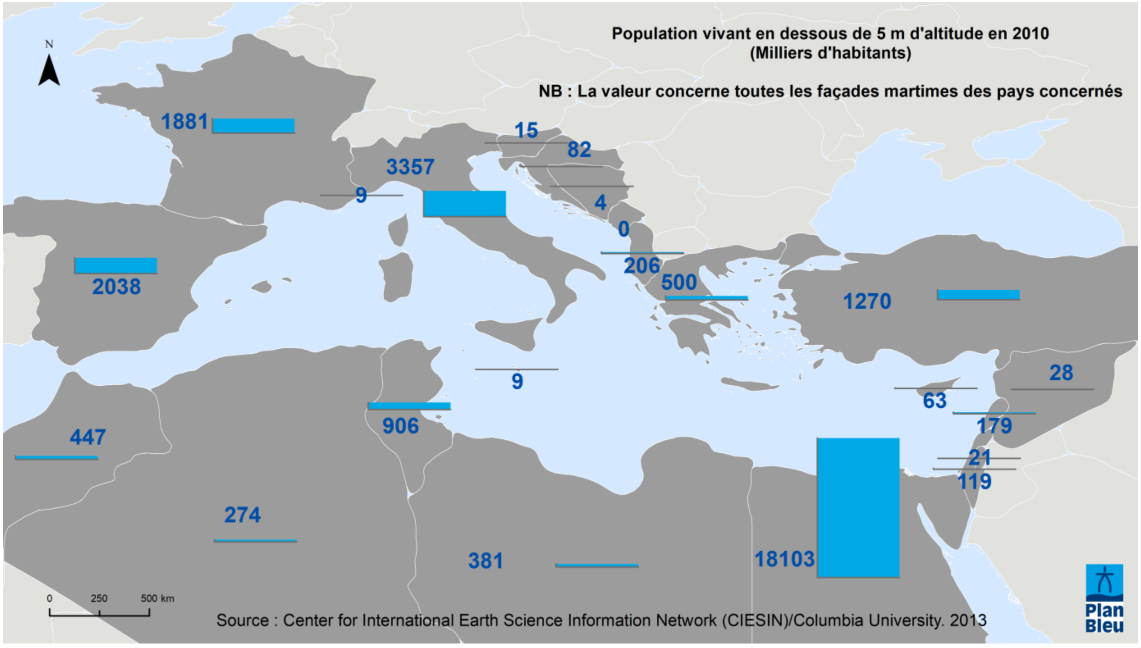
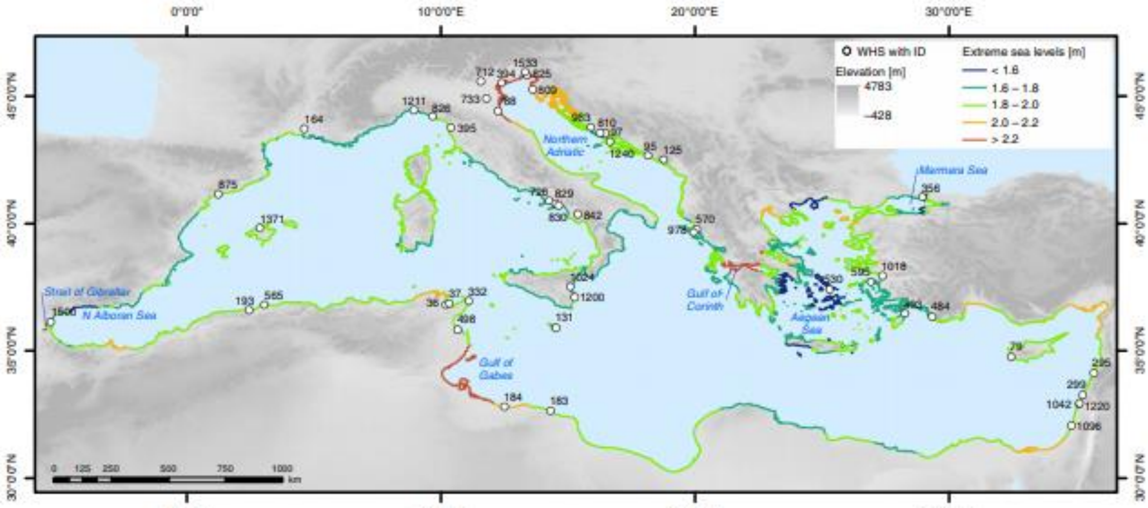


Figure 33 Population living under 5m altitude, including all maritime façades of concerned countries (Source: CIESIN/Columbia University, 2013) [English version pending]

With more than 30 million people living within 5m from sea level, the exposure of the Mediterranean countries to coastal risk of flooding and erosion is a major challenge, in particular in Egypt (Nile Delta) and Italy (Venice lagoon).



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 Aquileia
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 34 Location of UNESCO cultural World Heritage sites in the Mediterranean Low Elevation Coastal Zone. (Source: Reimann et al., 2018)

Moreover, coastal erosion and flooding will generate loss of coastal land where important cultural heritage sites are located. A recent research of Reimann et al. (2018) evaluated the flood risk index and erosion risk index of UNESCO cultural World Heritage sites along the Mediterranean coastline (Figure 33).

2.2.4 Impacts of climate change on the marine environment

The Mediterranean Sea is a hotspot of biodiversity. It hosts 4-18% of all identified marine species of the world, while the Mediterranean Sea only accounts for 0.82% of the global ocean surface (Coll *et al.* 2010). The Mediterranean has also 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

Such as the surrounding lands and the islands, the Mediterranean Sea is one of the most vulnerable areas to the impacts of climate change (Mannino *et al.* 2017). The combined impacts of sea warming, ocean acidification and marine storms already affect marine biodiversity and human activities.

Increased water temperature has led to mass mortality events, especially in coralligenous (Coma et al., 2009), but also in sponges and molluscs (Garrabou *et al.* 2009). Coralligenous 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 almost every year mass mortality events concerning different species have been reported in the Mediterranean (Rivetti *et al.* 2014). Seagrass is vulnerable to seawater warming (Jorda et al. 2012) and heat waves. The 2003 heat wave resulted in large-scale mortality of the seagrass *Posidonia oceanica* during flowering (Díaz-Almela *et al.* 2007). More frequent and longer summer heat waves will put large coastal areas at risk of hypoxia or anoxia.

Ocean warming already influences marine native species causing a ‘meridionalisation’[5] of the biota, by favoring the most thermophilic native species and the arrival of foreign species (Calvo *et al.* 2011) at the expense of cold-water species. This is well illustrated by the recent changes in the geographic distribution of many native species. Due to recent warming, Mediterranean thermophylic 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 et al. 2011). Over the last several decades, the extent and intensity of jellyfish outbreaks have increased, probably in part due to warming, in particular outbreaks of *Pelagia noctiluca*, a planktonic predator of fish larvae and of their zooplankton prey (Licandro et al. 2010).

The effects of global 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).

The spread of alien species represents another ongoing additional stress factor on marine ecosystems (Mannino *et al.* 2017). More than 1,000 non-indigenous marine plant and animal species have been recorded so far in the Mediterranean (UNEP-MAP, 2017), many of which favored by the warmer conditions (Marbà *et al.* 2015, Azzurro *et al.* 2011). 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 through the Suez Canal increases, representing more than 50% of non-indigenous species in the Mediterranean (Figure 35). The widening of the Suez Canal and the transport of alien species through ballast water from ships increase dissemination. The Eastern Mediterranean is the area displaying the most severe environmental effects of invasive species. Some tropical invasive species have important consequences on ecosystems, such as the tropical rabbitfish (*Siganus* spp) devastating algal forests (Vergés *et al.* 2014).

[5] Meridionalisation refers to a northward range expansion of marine native species due to warming.

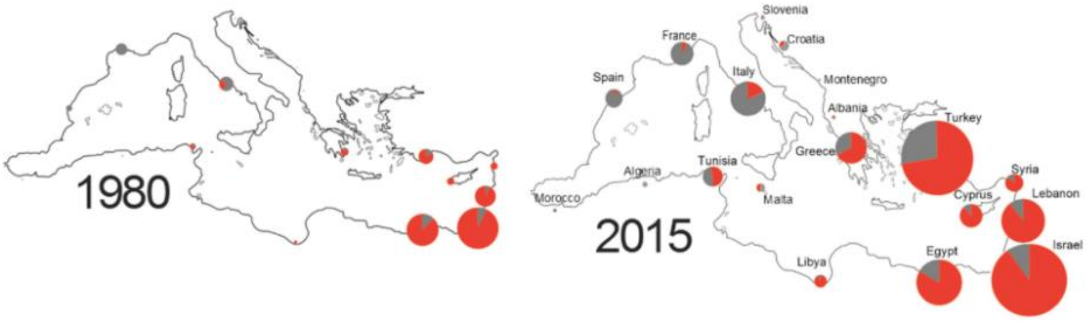


Figure 35 Non-indigenous species (NIS) in the Mediterranean Sea: size of pie charts proportional to number of NIS in a country; proportion of Lessepsian species in red (Galil et al. 2018)

Ocean acidification begins to impact a wide array of organisms producing carbonate shells and skeletons (Palmiéri *et al.* 2015; Kapsenberg *et al.* 2017). These effects are biological (e.g. early stage survival) as well as ecological (e.g. loss in biodiversity, changes in biomass and trophic complexity) processes (Gattuso *et al.* 2015). Recent acidification in the Mediterranean Sea has led to a decrease in the thickness of coccolith, calcareous plates harbored 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 calcifying species to non-carbonated species (e.g., erect macroalgae) were 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 coccolithophorids (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% from 2000 to 2050 due to water warming and decreased oxygenation (Cheung *et al.* 2013).

Box 6 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) coupled with no wind have led to radically reduced oxygen levels (anoxia) in the Thau lagoon close to Montpellier on the French Mediterranean coast. These climatic conditions induced a high mortality of shellfish cultivated in the lagoon, with mortality rates between 30% and more than 60% of oysters depending on the zone in the lagoon, and 100% of cultivated mussels. The losses represented 2,703 tons of oysters, equivalent to 4.73 million € and 1,218 tons of mussels, equivalent to 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 percent of the total French Pacific oyster Crassostrea gigas production, involves around 500 companies, and provides direct employment for about 1,700 people (Lane et al., 2018). To adapt to the projected prolonged and more frequent heatwaves in the future, aquaculture in the Thau lagoon has to reinvent itself.

According to projections, the warm-water ornate wrasse (*Thalassoma pavo*) will expand its distribution to the Western Mediterranean while the coldwater rainbow wrasse (*Coris julis*) will reduce its range (Milazzo et al 2016).

Seawater acidification in the Mediterranean will have further negative impacts on many pelagic and benthic organisms with calcareous body parts, such as corals, mussels, pteropods, sponges and coccolithophores (Bramanti et al. 2013, CIESM 2008, Goodwin et al. 2014, Meier et al. 2014) (Figure 37). 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 the kelp *Laminaria rodriguezii* replace the otherwise dominant habitats (i.e. coralligenous outcrops 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 became irrelevant below 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 dependent on a stable or only slightly rising sea level. Today, these algal rims have begun to be submerged and seem to be condemned in the future (Thibaut *et al.* 2013).

Surface water warming in the Mediterranean and the consequent increase of water column stability may favor the coalescence 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. Mucilage is a threat to gorgonians, 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 cavolinii*) and white *gorgonian* (*Eunicella singularis*) while *A. crinita* mainly affects the purple gorgonian (*Paramuricea clavata*), which colonizes greater depths (Giuliani *et al.* 2005).

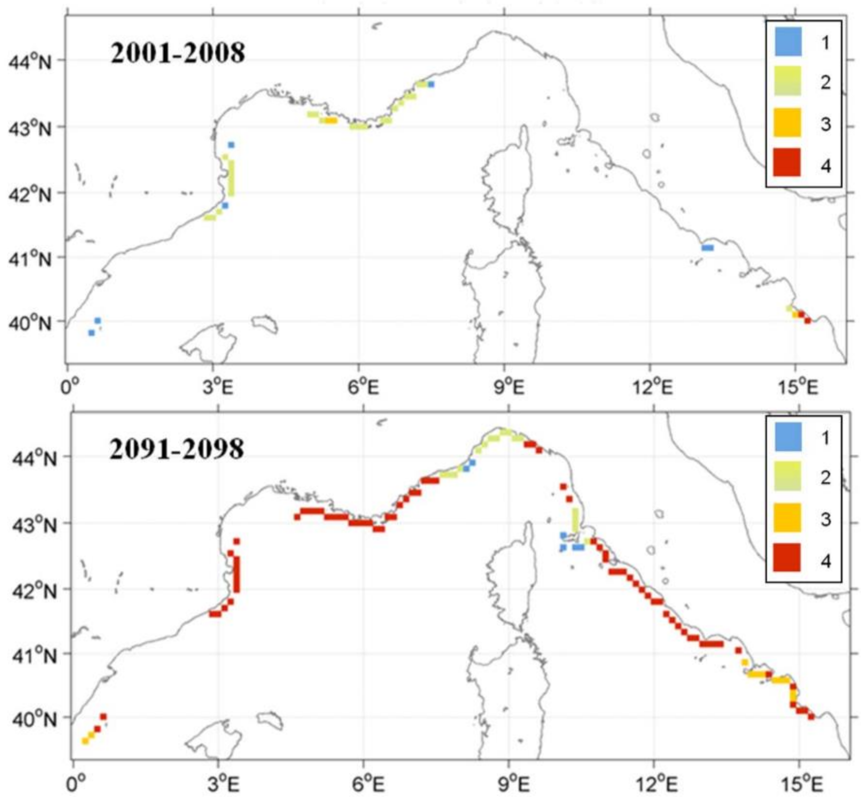


Figure 36 - Impact mapping on the risk of mortality outbreak for the purple gorgonian (Paramuricea clavata) at the beginning (Top) and end (Bottom) of the 21st century along the continental coastal stripe north of 39°N in the NW-Mediterranean Sea. The color scale, from 1 to 4, corresponds to sub-lethal, moderate, high and extreme lethal impacts respectively (Source: Bensoussan et al., 2013)

Several species of toxic dinophytes are thermophilic, therefore their distribution range and abundance increase with the increase of water temperature in the Mediterranean, like *Gymnodinium catenatum* (Gomez 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 thereby respiratory problems and irritations. To date, the most extensive sanitary events occurred in Italy (2005-2006), Spain (2004), Algeria (2009) and France (2006–2009) (Ben-Gharbia *et al.* 2016), presenting not only a risk for local populations but also for economic activities, such as tourism.

Introduction and spread of a pathogenic *Vibrio* might have been promoted by climate warming. The infectious origin of the disease outbreak (*Vibrio*) has been demonstrated for gorgonians (Bally & Garrabou 2007, Vezzulli *et al.* 2010). In temperature induced disease cases 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 is the result of complex interactions between environmental factors, use of resources and economic drivers (Daw et al., 2009). Most fish stocks of commercial value are over-exploited 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 important commercial species of gastropods, bivalves and crustaceans.

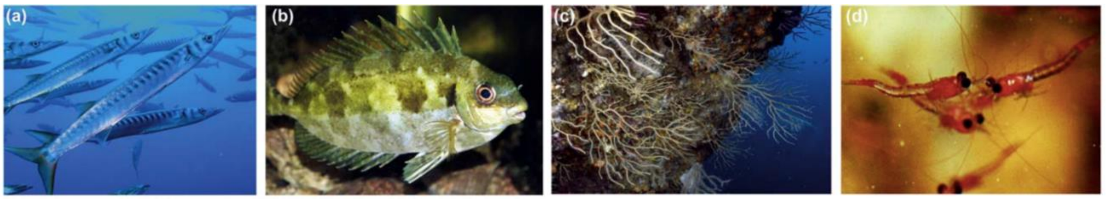


Figure 37 - Representative examples of marine species responding to climate change in the Mediterranean. (a) The barracuda Sphyraena viridensis greatly increased its natural distribution range over the last 30 years; (b) the Lessepsian herbivorous rabbitfish Siganus rivulatus is affecting the eastern Mediterranean ecosystems, and is increasing its introduced range area. It was found in 2008 in the Gulf of Lions (Carry-le-Rouet, France); (c) a seascape of dead seafans Paramuricea clavata after the 2003 thermal anomaly in the NWM; (d) the crustacean mysids Hemimysis spp. are a classical example of a species shift in relation 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)

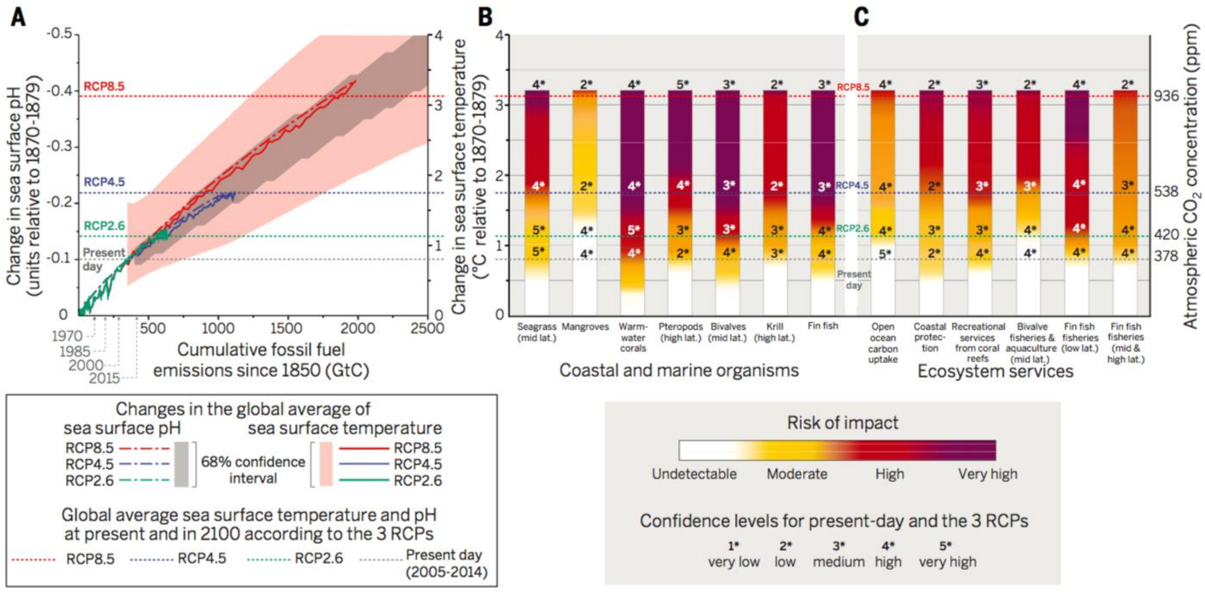


Figure 38 - Observed impact and risk scenarios of global ocean warming and acidification for important organisms and critical ecosystem services. "Present- day" (gray dotted line) corresponds to the period from 2005 to 2014. Impact levels are for the year 2100 under the different projections shown and do not consider genetic adaptation, acclimatization, or human risk reduction strategies (mitigation and societal adaptation). (A) Changes in global average SST and pH versus cumulative fossil fuel emissions. (B) Risk of impacts resulting from elevated CO_2 on key organisms that are well documented in the literature. (C) Risk of impacts resulting from elevated CO_2 on critical ecosystem services. (Source: Gattuso et al., 2015; note that this study is at the global level, but its conclusions apply also to the Mediterranean Sea)

2.3 Responses: climate change mitigation policies

2.3.1 The global existing frameworks tackling climate change

2.3.1.1 UNFCCC: From the Kyoto Protocol to the Paris Agreement[xliii]

The United Nations Framework Convention on Climate Change (UNFCCC) was adopted in 1992 and entered into force in 1994. Establishing a framework for global climate action, 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[6]. In 1995, international negotiations were launched to implement the Convention and strengthen global climate action. In 1997[7], industrial countries formally committed in the Kyoto Protocol to reduce emissions 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)[8]. While the Doha Amendment constitutes the frame for enhanced ambition before 2020, it has not yet entered into force.

The first climate agreement bringing together all Parties to the UNFCCC was adopted in 2015 (COP 21, Paris). The main difference between the Kyoto Protocol and the Paris Agreement is a reversal of the global climate governance dynamics. Based both on a principle of reality, advocating for unified cooperation against climate change, as well as on the principle of common but differentiated responsibilities, the Agreement engages all countries to determine 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[9]. Through the aggregate effect of the NDCs, the aim is that, by 2100, the long-term goal of the Agreement is reached, 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).

Box 7 Focus on the Paris Agreement

The Paris Agreement strengthens the global response to climate change[10] in many aspects. To reach its long-term temperature goal (art. 2), it commits countries to achieve a global peaking and 'climate neutrality' in the second half of the century (art. 4), by mitigating GHG 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), implementation and compliance (art. 15). The Paris Agreement constitutes the main framework for global climate action after 2020. Countries negotiated its guiding rules from 2016 to 2018, that were adopted at COP 24 (Katowice, December 2018), to allow its full implementation.

By 2019, 85% of the Contracting Parties to the Barcelona Convention have ratified the Paris Agreement (only Lebanon, Libya, and Turkey are yet to do so)[11], of which 80% have submitted their first NDCs to the Secretariat of the UNFCCC (18 of 19 above, excluding the Syrian Arab Republic, which has ratified the Paris Agreement but not yet submitted an NDC)[12].

2.3.1.2 The Green Climate Fund (GCF) and climate finance

With the Paris Agreement, countries established the objective to make *'finance flows consistent with a pathway towards low greenhouse gas emissions and climate resilient development'* (art. 2(c)). This goal

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[6] https://unfccc.int/process/the-convention/what-is-the-convention/status-of-ratification-of-the-convention (last access April 2019)

[7] https://unfccc.int/process/the-kyoto-protocol

[8] https://unfccc.int/process/the-kyoto-protocol/the-doha-amendment

[9] https://unfccc.int/process/the-paris-agreement/nationally-determined-contributions/ndc-registry

[10] https://unfccc.int/process-and-meetings/the-paris-agreement/what-is-the-paris-agreement

[11] https://unfccc.int/process/the-paris-agreement/status-of-ratification

[12] http://www4.unfccc.int/ndcregistry/Pages/Home.aspx (last access November 2018).

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.

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 provide 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 Fund (GEF)[13] and the Adaptation Fund (AF)[14]. Over the years, the GCF should become the main UNFCCC financial mechanism. It was announced[15] at COP 15 (2009) and its first investments were made in 2015. The year 2016 was the first full year of operation of the GCF, resulting in a portfolio of 35 projects for an amount of USD 1.5 billion invested over the year[16]. 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[17], 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.

Figure 39 GCF Portfolio (July 2019)

Climate finance is critical for ambitious climate action, particularly within the 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[18]. A report of the European Commission released at COP 23 (November 2017) showed that UNFCCC's financial mechanisms approved USD 252 million of funding in 2016 in the Mediterranean countries. Most came from the GCF (USD 192m), followed by the GEF (USD 49.97m), the AF (USD 9.23m) and other financial mechanisms such as the Clean Technology Fund (CTF) and the Forest Investment Partnership (FIP). However, the report also states that these USD 252 million only represented 5% of the total funds approved the same year for climate-related projects and programs in these countries[19].

In conclusion, climate finance needs to be scaled up to address the countries' needs and to strengthen the unified climate action towards the Paris Agreement implementation over coming years. In their NDCs, Parties can highlight the financial needs associated with the implementation of their national targets. Among the Contracting Parties to the Barcelona Convention, Algeria, Egypt, Morocco and Tunisia thus indicated that they would need financial support for a full implementation of their NDCs[20].

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 – organised COP21 and COP22. Marseille and Tangier have hosted major conventions for climate action in the Mediterranean, including stakeholders from non-governmental organisations and sub-national governments, with MedCOP21 held in Marseille in June 2015 and MedCOP Climate in July 2016 in Tangier. The MedCOPs also 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 the national and regional particularities and realities in the Mediterranean to help develop a shared, inclusive and participatory action strategy (Energies 2050, 2018). At the same time, regional organisations are

[13] http://www.globalenvironmentfund.com/
[14] https://www.adaptation-fund.org/
[15] https://www.greenclimate.fund/home
[16] ENERGIES 2050, 2018a. See p. 119.
[17] https://www.greenclimate.fund/what-we-do/portfolio-dashboard (last access April 2019)
[18] Source: EIB, in ENERGIES 2050, 2018a. See p. 119.
[19] Source: European Commission, 2017. In ENERGIES 2050, 2018a. See p. 124.
[20] ENERGIES 2050, 2018b.

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 Mediterranean Action Plan, which managed the Regional Climate Change Adaptation Framework for the Mediterranean Marine and Coastal Areas (2016). Significant efforts have also been made to bring together and mobilise scientists with the creation of the MedECC Network (Mediterranean Experts on Climate and environmental Change), 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 MAP has created an important science-policy interface.

Box 8 Providing knowledge on Climate Change through a science-policy interface, the case of the Mediterranean Expert Group on Climate Change (MedECC)

Gathering, updating and consolidating the best available scientific knowledge about climate and environmental changes in the Mediterranean basin and rendering it accessible to policy-makers, 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 Conference 'Our Common Future under Climate Change' (CFCC) in Paris, (France) in July 2015 and has since evolved into an open and independent network of more than 400 scientists working towards a regional science-policy interface. Through its reports, developed with key stakeholders, MedECC has the ambition to contribute to the improvement of sustainability policies in the entire Mediterranean Basin. MedECC's work is fully oriented towards 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 at providing 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 (UN Environment/MAP Regional Activity Center) 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 built, especially with the MAP-Barcelona Convention system via the Mediterranean Commission on Sustainable Development (MCSD) and Plan Bleu Focal Points.

2.3.3 National responses to climate change mitigation

2.3.3.1 Nationally determined contribution reports (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). Submitted by the Parties to the Paris Agreement upon its ratification, the NDCs will represent a progression over time in order to achieve the Agreement's long-term goals, while recognizing the need to support developing countries for an effective implementation (art. 3).

18 Parties to the Barcelona Convention have submitted their NDCs by 2019 and all of them contain a mitigation component, aiming to limit or reduce greenhouse gas (GHG) emissions through[21]:

- 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[22] shows that a range of sectors and domains are targeted by priority policies and measures (Table 3). Measures include for example the use of market mechanisms, the development of monitoring tools, the links with the United Nations' sustainable development goals (SDGs) or other international conventions (e. g: the 1992 Rio Conventions), etc.

[21] ENERGIES 2050, 2018b.

[22] ENERGIES 2050, 2018b.

Table 3 Overview of the mitigation policies and measures indicated in the NDCs of the Parties to the Barcelona Convention by sectors. Parties to the Barcelona Convention that have indicated policies and measures in this sector within their NDCs (Source: adapted from ENERGIES 2050, 2018b)

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																							8
Construction																							
Industry																							
Agriculture																							
Transport																							
Tourism																							
Renewable energy																							8
Industry																							7
Transport																							6
Waste management																							6
Urban dev.																							6
Agriculture																							11
Forestry																							12
Other sectors																							8

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)[23]. Five Contracting Parties to the Barcelona Convention (Albania, Egypt, Montenegro, Morocco, 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 GHG emissions reduction target for 2030, the EU revised its Emissions Trading System (EU ETS), through the Directive (EU) 2018/410 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[24].

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[25]. For example, Egypt assessed the initial costs of mitigation and adaptation measures to 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.

[23] OIF/IFDD, 2018. Guide to the negotiations COP24.

[24] https://ec.europa.eu/clima/policies/ets/revision_en

[25] ENERGIES 2050, 2018b.

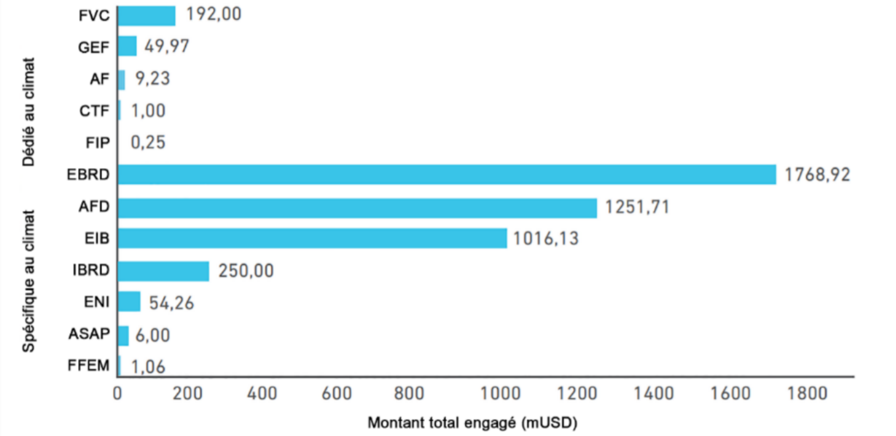

Figure 40 - Financing climate in the Mediterranean region (Source: Energies 2050, 2018c)
FVC= Fonds Vert pour le Climat, AFD= Agence Française de Développement, AF= Fonds d'adaptation, GEF=Global Environment Facility, CTF [pending], FIP=Forest Investment Partnership, IBRD=International Bank for Reconstruction and Development, EIB=European Investment Bank, ENI= European Neighbourhood Instrument, ASAP= Adaptation for Smallholder Agriculture Programme, FFEM= Fond Français pour l'Environnement Mondial

2.3.3.3 Non-state actors of climate change mitigation

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

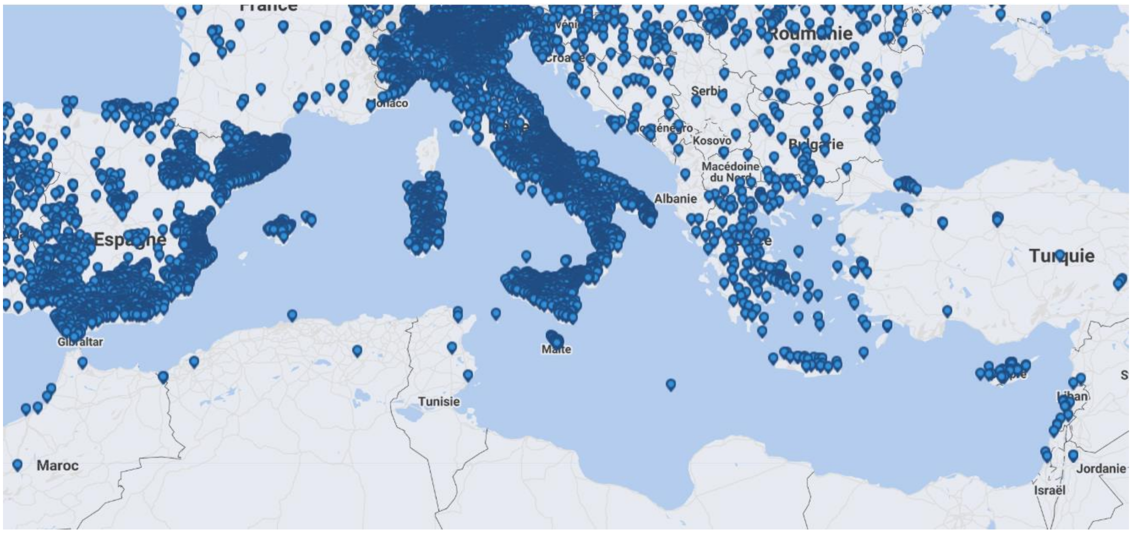

Figure 41 Climate actions taken by non-state actors in Mediterranean countries registered on the UNFCCC NAZCA database, (UNFCCC NAZCA database interactive map consulted on August 6th, 2019)

2.3.3.4 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 to reduce GHG 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 NDCs' 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 fueled by wood chips and wood waste from wood processing industry, with a total power generation capacity of 70 MW (Bosnia and Herzegovina);
- *Transport:* 20% shift from private to public transportation (Israel);
- *Waste management:* By 2020, establish landfill and recycling centers for domestic waste to the benefit of all urban areas (Morocco);
- *Urban development:* By 2030, reach an overall urban sewerage connection rate of 100% (Morocco).

2.3.3.5 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. The Agreement thus engages Parties to achieve 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 GHG, including forests (art. 5). The Paris Agreement also strengthened REDD+[26]. Another major step was achieved at UNFCC COP 23 (Fiji/Bonn, November 2017), where Parties adopted a landmark agreement on agriculture: the Koronivia joint work on agriculture (KJWA)[27]. The KJWA roadmap to 2020 addresses subjects such: 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.[28]

In their NDCs, the Parties to the Barcelona Convention also show how important ecosystem-based approaches and nature-based solutions are to achieve their mitigation goals. 12 Parties indicated policies and measures in the Agricultural sector and 13 in the Forestry sector (Table 4). 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 into 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 the following table.

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

Sectors	Examples of policies and measures
Agriculture	Mitigation measures on enteric fermentation; manure management; rice cultivation; agricultural soils; field burning of agricultural residues (Algeria); Improvement of the promotion 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 447000 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 by consolidating and increasing carbon reserves in forest and pastoral environments (Tunisia).

2.3.3.6 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 actions under this Agreement". The Algerian NDCs indicate the implementation of information, awareness and

[26] OIF/IFDD (2018). Guide to the negotiations COP24. REDD: Reducing Emissions from Deforestation and Forest Degradation

[27] Decision 4/CP.23.

[28] For more details: OIF/IFDD (2018). Guide to the negotiations COP24.

communication actions on issues and climate change challenges and implementation of an education, training and research climate change national program.

2.3.4 Priorities for action

Urgent action is required worldwide to mitigate climate change. Although the 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 translated and operationalized at the regional, national and local level, 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. However, even under ambitious mitigation scenarios, risks from adverse climate impacts remain. Therefore, anticipation of and adaptation to a wide range of climate-related risks are essential. To improve the overall resilience of the 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 pro-active, longer term and integrated planning, addressing existing aspects of unsustainable development as drivers of vulnerability. As climate risks extend well past territorial boundaries, a crossborder 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 has been 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 increase 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 the vision that by 2025 the marine and coastal areas of the Mediterranean countries and their communities have increased their resilience to the adverse impacts of climate variability and change, in the context of sustainable development. Common objectives, cooperation, solidarity, equity and participatory governance are key to achieve 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[29]. 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 (see table).

[29] Institut de la Mediterranée, ENERGIES 2050 & FEMISE (2018), "Euro-Med Sub-National Governments in the Fight against Climate Change: Framework for action, example of Région SUD Provence-Alpes-Côte d'Azur and opportunities for cooperation at the Mediterranean level", December.

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

Objectives	Areas	Measures and Results
Objective 1: Promoting action by Member States	Adoption of action plans in each MS	In 2017, 25 Member States had adopted national adaptation strategies[30]
	Governance	Improved coordination/cooperation through meetings of the working group on adaptation (with each MS having 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 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 € 80 billion) of the multiannual European financial framework allocated to climate action Over 114 billion received for climate actions from European structural and investment funds, including 56 billion from the Agricultural Fund for Rural Development and 55 billion from the European Regional Development Fund and Cohesion Fund
	Water Framework Directive	Presentation before 2015 of river basin management plans by each MS, 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[31]	EU Forest Strategy EU Biodiversity Strategy to 2020 EU Green Infrastructure Strategy EU Environment Action Programmes

This strategy is meant to complement and/or draw inspiration from the action 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 Mediterranean countries in the EU have a national adaptation strategy or plan. A broad range of funding instruments also exist to finance adaptation in Europe[32] and the 2014-2020 multiannual financial framework ensures

[30] See https://www.eea.europa.eu/airs/2017/environment-and-health/climate-change-adaptation-strategies

[31] See Interreg Report 2014

[32] European Commission, https://ec.europa.eu/clima/policies/adaptation/financing_fr. In particular, the Water Directive and Common Agricultural Policy include an important climate component.

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[33].

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

Countries	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Cyprus													
Spain													
France													
Greece													
Italy													
Malta													
Slovenia													
Turkey													

No policy
National adaptation strategy in place
National adaptation strategy and national and/or sectoral adaptation plans in place

Adaptation in Southern Mediterranean countries: focus on resilience

The INDC/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.

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

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 35 billion USD
Palestine	National adaptation plan in all sectors (energy, agriculture, etc.) with a detailed cost assessment
Tunisia	1.9 billion USD required to finance adaptation for water and coastal areas, ecosystems, agriculture and tourism.

An overview of Mediterranean commitment 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 finalised (Algeria, Israel).

Box 9 Examples of resilience actions: adaptation projects supported by UNDP (Source: ENERGIES 2050, 2018c)

UNDP supports a number of actions in Southern Mediterranean countries to improve resilience to climate change (UNDP, 2018).

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 DRR coordination centre under the authority of the Prime Minister;

[33] European Commission, [online] http://ec.europa.eu/budget/mff/index_en.cfm

- Establishment of the national emergency operations centre at a governate level and sectoral emergency response centres;
- Support for the National Council for Scientific Research (CNRS) 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 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, drought 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 organised.

Local projects

There have also been several local Euro-Mediterranean climate projects. The Institut de la Méditerranée, ENERGIES 2050 & FEMISE (2018) report presents **ClimaSouth,** which supports climate change adaptation and mitigation in 9 Southern Mediterranean countries (Algeria, Egypt, Israel, Jordan, Lebanon, Libya, Morocco, 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.

Box 10 Paris Agreement and intended adaptation measures (Source: ENERGIES 2050, 2018c)

	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 rationalising 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, Sahel 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 health 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 eco-touristic 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.

2.4.3 Priorities for action

The Regional Climate Change Adaptation Framework for the Mediterranean Marine and Coastal Areas highlights four priority strategic objectives, articulated through fourteen strategic directions, which need to be urgently implemented in a systemic approach in order to increase the Mediterranean region's resilience towards climate change:

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)

Strategic Objectives	Strategic Directions
1. Appropriate institutional and policy frameworks, increased awareness and stakeholder engagement, and enhanced capacity building and cooperation	1.1. Enhancing awareness and engagement of key stakeholders on climate adaptation
	1.2. Promoting adequate institutional and policy frameworks
	1.3. Promoting a regional approach on Disaster Risk Management
	1.4. Improving implementation and effectiveness of adaptation policies through monitoring and reviewing progress
	1.5. Integrating climate adaptation into local plans for the protection and management of areas of special interest
2. Development of best practices (including low regret measures) for effective and sustainable adaptation to climate change impacts:	2.1. Identifying adaptation needs and best practices
	2.2. Mainstreaming, exchanging and adopting best practices
3. Access to existing and emerging finance mechanisms relevant to climate change adaptation, including international and domestic instruments:	3.1. Prioritizing public spending relative to climate adaptation and mobilizing national sources of climate finance
	3.2. Accessing international financing
	3.3. Building alliances with the banking and insurance sectors
4. Better informed decision-making through research and scientific cooperation and availability and use of reliable data, information and tools:	4.1. Understanding of the vulnerability of natural and socioeconomic systems and sectors and of possible impacts
	4.2. Building capacities for and promoting the use of vulnerability and risk assessment at regional to local levels
	4.3. Strengthening Science-policy interface and accessibility of related knowledge
	4.4. Developing Regional climate information at a resolution suitable for adaptation planning

3 Draft Chapter 3: Biodiversity and ecosystem services

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Coastal and marine ecosystems of the Mediterranean region have a high level of biodiversity and endemism. The Mediterranean Sea is considered as a biodiversity hotspot, encompassing 0.3% of the global ocean volume and 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 throughout the last decades, Mediterranean biodiversity has experienced increasing human-induced pressures such as pollution, over-exploitation of biological resources, land-use change and coastal infrastructure development, changes in fluvial dynamics, increasing sea use and climate change effects, which have reduced the extent of wild areas and natural ecosystems on land and at sea and altered the ecosystems' capacity to provide ecosystem services vital to humans. Around 11% of marine species and 14% of coastal terrestrial species are threatened with extinction, most of them being endemic. Non-indigenous species are increasingly present in the Mediterranean Sea with a total number of more than 1,000 non-indigenous marine species recorded, of which more than 100 are invasive.

UNEP-MAP has made biodiversity one of the main pillars of its Ecosystem Approach, aiming at achieving Good Environmental Status of the Mediterranean Sea and supporting the development of effective action to safeguard and restore biodiversity. Such action must be undertaken urgently to avoid irreversibility linked to losses in ecosystem services and biodiversity. One measure that has been proven effective, if implemented correctly, consists in Marine Protected Areas (MPA). MPA coverage has increased throughout the last decade, however management effectiveness and enforcement remain challenging.

3.1 Introduction

During the last decades, human activities in the Mediterranean have increasingly reduced the extent of 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 offer many services to humans (e.g. flood protection, groundwater replenishment, sediment retention), have experienced a continuous loss 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 meadows 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 a 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 North zones of the Adriatic Sea.

Numerous coastal species, including endemics, 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 wide variety of hydrological and climate conditions and the existence of communication and introduction paths (Gibraltar strait, Suez Canal) for non-indigenous species (Boudouresque, 2004) determine 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 richness 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 at the global level, two species being particularly emblematic, the red coral (*Corallium rubrum*, Metazoa, Opisthochonta) and *Posidonia oceanica* (Magnoliophyta, Viridiplantae, Plantae). However, a high number of marine species are threatened of extinction, especially in France, Spain, Italy and Greece, and mostly due to fishing. There is also a large number of invasive species, mostly from 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) being better known than the deeper areas of canyons, trenches and seamounts, reaching more than 5267 m in the Ionian Sea.

Having made biodiversity the theme of its first Ecological Objective, the Ecosystem Approach (EcAp) to the management of human activities with a view to conserve natural marine heritage and protecting vital ecosystem services recognises the importance of habitats and species in achieving good environmental status.

3.2 Coastal ecosystems and biodiversity

3.2.1 Wetlands and coastal aquifers[34]

Wetlands[35] represent an estimated 6% of global land mass 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 have been assessed by the Mediterranean Wetlands Observatory[36] 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.

[34] Coastal aquifers are developed here only in the view of the biodiversity and the ecosystem services provided. The aspect on water resources is developed in chapter 6 of the report.

[35] Ramsar Convention on Wetlands define 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".

[36] Encompassing also Portugal, Andorra, Serbia, Bulgaria, Jordan and North Macedonia (FYROM).

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

The Mediterranean basin hosts 19 to 26 million hectares wetlands (MWO 2018). A sample of 400 Mediterranean wetland sites have 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%) (UNEP-WCMC 2017; Ramsar Convention on Wetlands, 2018).

Within the Mediterranean ecosystems, wetlands are of paramount importance 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 all Mediterranean ecosystems. 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 evaluated as Critically Endangered by the IUCN Red List (Jacoby and Gollock, 201'). Several coastal rivers are characterized by a high level of endemism with a number of highly range-restricted species (many freshwater mollusks and fish). River deltas host tens of millions of migratory, wintering, and breeding waterbirds travelling from as far away as the Arctic and Southern Africa. Coastal wetlands represent 70% of the 551 wetlands of international importance for waterbirds in the Mediterranean countries, by regularly hosting more than 20,000 waterbirds and/or more than 1% of the biogeographical population of at least one waterbird species (Ramsar criteria, Figure 42, in red). However, less than 10% of these coastal sites have been designated as Ramsar sites so far (Popoff *et al.* ongoing work).

Populations of fish species specialist of coastal wetlands strongly declined between 1990 and 2013 (MWO 2018; Figure 43). Conversely, waterbird populations show a general positive trend, most likely due to three reasons. First, many waterbirds have suffered massive destruction in the past, resulting in a low baseline for 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 (MWO 2018; Gaget *et al.* 2018). Third, artificial water bodies have also increased, providing additional habitat for some water birds (MWO 2018).

In the Mediterranean region, groundwater is an essential source of water supply used in many socio-economic sectors. Excessive abstraction of groundwater, for irrigated agriculture is leading to rapid depletion of aquifers (Dalin, Wada, Kastner, & Puma, 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). However, alterations of the quality (temperature, chemistry, etc.) and quantity of groundwater, as well as changes of seasonal patterns present a threat to GDEs, and consequently to their biodiversity. The most important impacts on ecological values of underground aquifers affect invertebrates namely stygobitic and oligochaetes species (Achurra and Rodríguez, 2008) as well as water quality and ecosystem goods and services provided by GDEs and connected ecosystems such as wetlands, springs lagoons, rivers, and lakes. The use of hydro-ecological approaches are essential corrective management schemes to reduce the implications of anthropogenic disturbance (Abdul Malak *et al.* 2019).

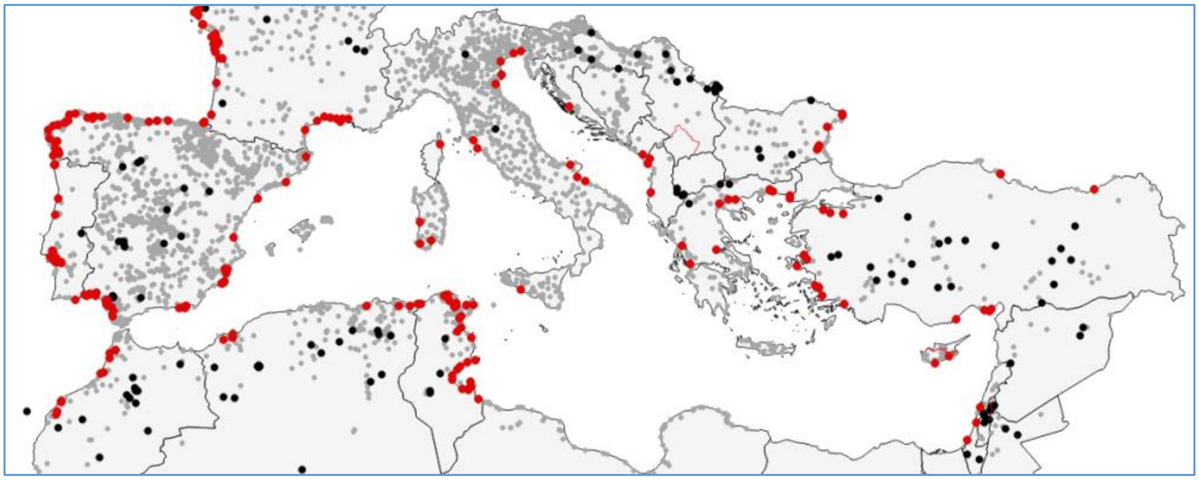

Figure 42 Wetlands of international importance for waterbirds (black and red points) which regularly host more than 20,000 waterbirds and/or more than 1% of the species population of the Mediterranean flyway (based on mid-January counts made during the 1991-2012 period). Sites in red (resp. black) are 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. ongoing work).

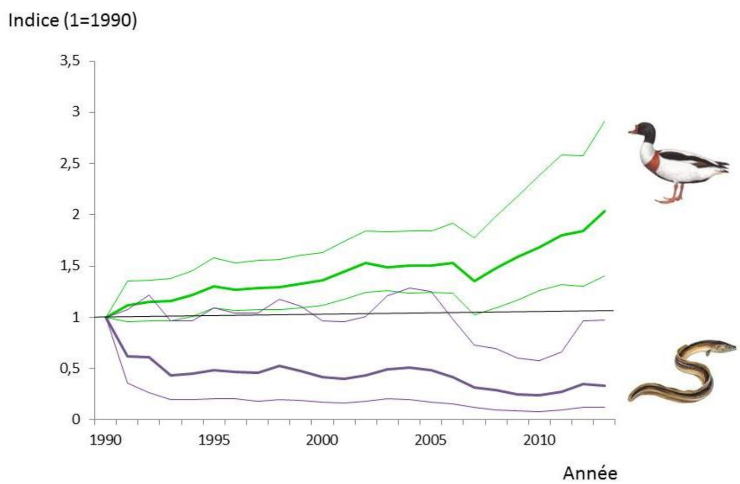

Figure 43 Living Planet Index for birds and fishes dependent on coastal wetlands in the Mediterranean basin. The index gives the relative abundance over time for populations of birds and fish for which there are data available. The value of the index is chosen to be 1 in 1990 and values lower than 1 in other years indicate a significant reduction of the general abundance of monitored species (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 (purple) is based on 2,171 time-series of 18 species (source Galewski, unpublished work).

3.2.1.2 Ecosystem services

Wetlands and coastal aquifers contribute in many different ways to the well-being of people (Ramsar Convention on Wetlands, 2011, 2018; MWO2, 2018). Examples of the ecosystem services provided include but are not limited to: 1) purification of water; 2) mitigation of floods and droughts and 3) water provision (Ramsar Convention on Wetlands, 2011; Griebler and Avramov 2015). Water availability for people and nature is of particular importance in the Mediterranean climate, but it 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, 2015).

Ecosystem services contributions from wetlands and aquifers are increasingly under pressure (MWO2, 2018; Geijzendorffer *et al.* 2018). The loss of natural wetland habitats reduces the capacity of Mediterranean wetlands to provide services, whereas the demand and use for ecosystem services has been rapidly increasing. Thanks to investments in management, facilities and accessibility, an increasing number of people visit and enjoy Mediterranean wetlands during leisure time or for educational outings. However, the continued loss of natural wetlands habitats caused e.g. by dam building or drainage creates enormous carbon emissions and reduces the availability of groundwater and its quality. Especially the capacity of wetlands to mitigate the impacts of floods has been significantly reduced (by 20% between 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 the artificialisation of flooding prone areas (MWO2, 2018).

Box 11 Ichkeul Ecosystem Services

Ichkeul National Park in northern Tunisia is a Ramsar site covering 12,600 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 impeding 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. They amounted to circa 3.2 million USD per year, or 254 USD per ha, with regulating services providing the bulk of this value (73%) whereas provisioning services (18%) and cultural services (9%) came next. 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%). Among the various habitats present, the lake had the highest value of services provided per hectare (268 USD per ha per year). The total value of annual services is almost 10 times the annual expenses for the Park management (i.e. 335,000 USD per year), which are therefore highly justified. Although the share of the total value benefitting the local population is comparatively low (11%), the actual amount per household is far from negligible and amounts in average to c. 1600 (resp. 1000) USD 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.

After Daly-Hasen, 2017

3.2.1.3 Major pressures

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

The Mediterranean Region is characterized by its water stress situation, largely derived from population increase, economic and social development, and irrigated agriculture, but also by climate change (Black, 2009) impacting coastal wetlands and aquifers. The intensive use of water in the Mediterranean catchments to meet human demand may lead to groundwater depletion and inrushing seawater. 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 –Egypt-, Cyprus Akrotiri –Cyprus) a problem that is expected to exacerbate with 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 -Rogel *et al.*, 2007, Chappuis *et al.*, 2011).

Groundwater recharge is expected to be further reduced in the Mediterranean, especially along the southern rim. The situation will aggravate further, because of water quality degradation in coastal Mediterranean aquifers and seawater intrusion, contributing to the ongoing salinization of coastal areas, wetlands and agro-ecosystems (Hoff, 2013).

Groundwater-dependent ecosystems (GDEs) are under pressure from excessive groundwater extraction and land use activities which impact the amount or seasonal patterns of groundwater flow or alter groundwater chemistry or temperature. Threats also include 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 polluting groundwater and GDEs (Kløve, *et al.*, 2011).

The most radical and frequent phenomenon affecting wetlands, including coastal ones, is habitat loss. This often starts with a conversion of natural habitat to farmland, then potentially to urban areas (MWO, 2014, 2018). The Mediterranean Wetlands Observatory 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 44) – except for farmland expansion. In both coastal and inland sites, natural wetland habitats were converted predominantly into either farmland or manmade wetlands, with conversions to other land-cover types being minimal. The south-eastern part of the basin has seen by far the largest changes in land cover, followed by the Maghreb, the Balkans and south-western Europe (MWO, 2018).

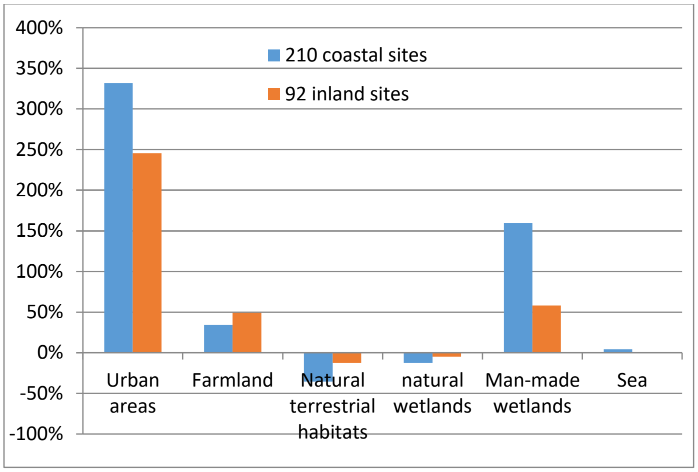

Figure 44 Rate of change between 1975-2005 of the main land-cover categories in coastal vs. inland sites (source Perennou & Guelmami, unpublished work).

Box 12 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 polluting many bodies of water, with consequences, sometimes serious and irreversible, 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: Out 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 affects natural wetlands' ecological integrity indirectly 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 (with ~ 80% of all exploited land), there is a net increase in total irrigated land area over the last 3 decades (Mediterra, 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) as well as a disruption of wet ecosystems with the introduction of exotic and potentially invasive species, often for economic and / or aesthetic reasons.

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 (Kløve, 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.

The European Mediterranean countries, through the EU Water Framework Directive (WFD), adopted an Integrated Water Resources Management (IWRM) approach principles focusing on the recovery and conservation of the ecological status of rivers, lakes, wetland and coastal waters. Furthermore, considering the interaction of underground water resources with wetlands and other water ecosystems is mandatory under this legislation, where the water cycle is considered in a holistic way (GWP, 2000). The main obligations of the WFD and its companion Directive on Groundwater Protection (EC, 2006) in relation to GDEs refer to achieving a good groundwater status and to preventing significant damage to terrestrial ecosystems that directly depend on groundwater bodies.

Overall in south-western Europe, water quality has improved in many waterbodies for nutrients and heavy metals at least, thanks to 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[37] in the MedWet countries[38] have steadily increased over time: since 1971, 397 Sites covering 6.7 million hectares have been designated. In 2017, 44% of the Mediterranean Ramsar sites had management plans, 30% of which were implemented (Perennou et al. 2016; MWO 2018).

Other measures taken to manage wetlands include the restoration of wetlands as nature-based solutions to mitigate the impacts of flooding by rivers and the sea, sustainable water use to ensure a prolonged provision of water for ecosystems during droughts, and the protection of remaining natural wetland habitats and their water quality.

Box 13 Examples of 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 (NbS) with a set of eight preliminary principles (Cohen-Shacham *et al.* 2016):

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 the scale at a landscape;
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 IUCN and other organizations, such as the European Commission and the World Bank. Despite the diversification of the concept, all come across

[37] Wetlands of International Importance

[38] 26 Mediterranean and peri-Mediterranean countries that are Parties to the Convention on Wetlands (Ramsar, Iran, 1971)

with a common goal: contribute to all dimensions of sustainability, the science, 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. All types of ecosystems can be intervened with NbS, as a wide range of NbS exists and can be adapted to any kind of ecosystem.

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

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 encourage the implementation of NbS across the Mediterranean region through two mains actions: 1) generating knowledge by collecting information from project implementation in the field and research on what benefits they can provide; 2) seeking government and stakeholder engagement through participatory processes as to achieve more integrated policies and guaranty NbS acceptance.

A collection of 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 interventions. Building an evidence base for NBS is key to support future replication and upscaling of these solutions in this rapidly changing, modern world. These evidences will provide conservation and development practitioners, policy makers, researchers, and NGO, useful basis for understanding what NBS offer in terms of benefits for humans and nature. The global standard for design and verification of NbS under development by IUCN is foreseen to be ready by 2020, and will contribute to the consolidation of this innovative approach.

Examples of NBS adapted to natural ecosystems

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

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

Other marine habitats, such as seagrass meadows, are considered important habitats under the criterion of NbS. The Life Blue Natura project aims to quantify the carbon deposits and sequestration rates of marsh and seagrass meadows in the coasts of Andalusia. The project's ambition is to generate the tools necessary for designing carbon offset projects that could be incorporated into the recent 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 of greatest value blue carbon ecosystems (seagrass and coastal wetlands) will be define to implement conservation and revegetation projects - that contribute to climate change mitigation and coastal protection.

There is great potential and opportunity for the Mediterranean region of the combination of IWRM and the Integrated Coastal Areas Management (ICAM) approaches that would contribute to an integrated management of Mediterranean coastal areas and river basins (ICARM). Such solutions using holistic management approaches in Mediterranean coastal areas are political challenges that must be faced to reduce pressures on coastal wetlands and groundwater aquifers.

Regarding the management and conservation of GDEs, a holistic and effective management approach is required, that includes the prioritization of the most valuable ecosystems and services. The management of ground water and GDE should better consider the total economic value. The integration of natural and social sciences can contribute to a holistic understanding of relevant processes and problems associated with GDE management and help to design consistent policies. Such solutions using holistic management approaches in Mediterranean coastal areas are political challenges that must be faced 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 national scale has been increasing from 68 million ha in 1990 to 82 million ha in 2015 that is an increase of 0.72 percent per year over 25 years (Appendix 1). This moderate but stable trend upwards has been paralleled by an increase in growing stock (from 6.3 billion m^3 in 1990 to 9.2 billion m^3 in 2015, + 1.56 percent per year) and carbon storage (from 3.2 billion tons in 1990 to 4.6 billion tons in 2015, + 1.52% per year). The 0.86% per year net increase in forest area between 1990 and 2010 has largely been 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 (though it is trending upwards). One specificity of the Mediterranean region is the importance of other wooded lands, reflecting the importance of small trees, shrubs and bushes in these dryland ecosystems. These other wooded lands accounted in 2015 for an additional 32 million ha in Mediterranean countries. Contrary to forests, the area of other wooded lands has been constantly decreasing from 36 million ha in 1990 to 32 million ha in 2015 (─ 0.45% per year over 25 years) (Appendix 1).

Another specificity of the Mediterranean region is the importance of trees outside forests that are found in extensive agroforestry systems, urban forests and as elements of the landscape. These trees outside forests covered in 2015 more than 8.2 million ha in the Mediterranean, with an area that has been increasing between 2000 and 2010 (FAO and Plan Bleu, 2018).

Figure 45 Esterel parc, SouthEast France. Typical Mediterranean forests are composed of broadleaved species mainly oaks, both evergreen and deciduous (eg: Quercus ilex, Q.suber, Q. coccifera), and conifers (eg: P.halepensis, P;brutia, P;Pinea). The degradation of such forests has produced low-density woody vegetation known as the macchia and the garrigue.

Because forest statistics are provided at country level and not according to the biogeographical Mediterranean region, a fraction of forest growth has taken place outside the Mediterranean biome. Geo-spatial information complementing 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 Hansen *et al.*'s global maps of forest cover change (Hansen *et al.*, 2013), forests cover 9.1% of the Mediterranean countries' territory. When restricting to the Mediterranean biome, this proportion increases to 18%. When further restricting to coastal areas (here the land within 5 km of the coastline), it increases to 28% (Appendix 1). Therefore, forests are proportionally three times more widespread in Mediterranean coastal areas than at country level.

Though forest coverage is showing increasing trends in the Mediterranean region, 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 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 expansion of infrastructure. It has been estimated that 80 million ha of land in the Mediterranean – including forests – are 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 is likely to continue (Lelièvre *et al.*, 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 gradual change in climate potentially resulting in drastic switches in vegetation when a tipping point is reached (Scheffer *et al.*, 2001).

3.2.2.2 Ecosystem services

Based on an analysis of the total economic value, one specificity of the 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 of Mediterranean forests is largely unrecognized or undervalued by decision-makers, leading to the paradox that Mediterranean forests have become a sink of public resources while they may play a role as a green infrastructure to address the challenges faced by the region (Martínez de Arano *et al.*, 2016).

Mediterranean forests deliver various ecosystem services that provide benefits to humans and contribute directly or indirectly to their well-being through improving food, water and energy security, reducing risks, being instrumental for local and global economies, and being essential for cultural identity and personal development (FAO and Plan Bleu, 2018; Figure 46). Forest ecosystem services benefiting humans include for example pollination, pest control and supplying wood and non-wood forest products, which can be especially important for rural populations. Forests are important providers of recreative, cultural and aesthetic services in the proximity of urban centers. Ecosystem services provided by trees in urban areas include increasing air quality, removing pollutants, providing green spaces for open-air actives and recreational spaces in which people can socialize and relax. Trees outside forests (scattered across the landscape) also provide important ecosystem services such as ornamental and amenity trees, food production, noise and/or air pollution filters, windbreaks, rain gardens (for runoff management).

Ecosystem services	Provisioning services	Regulating services	Cultural services
Benefits	Products obtained from Mediterranean forests	Indirect benefits obtained from the regulation of Mediterranean forest 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 46 Benefits derived from Mediterranean forest ecosystem services (FAO and Plan Bleu 2018)

Awareness raising to local population on the importance of their natural and cultural heritage and conservation of these unique habitats, such as *Dehesas*, and their valuation is essential.

The recognition of the goods and services provided by Mediterranean forest ecosystems will require a fair and accurate assessment of their economic value. Participatory approaches will be key in the development of economic valuation methods. Local communities and stakeholders should be invited to participate in the valuation process itself in order to observe the method in practice, provide information and understand the results. Fair and accurate economic valuation of goods and services is key for the structuration of the value chains in the Mediterranean, especially the value chains of non-wood forest products that are currently poorly understood, with limited official information available about their added value, stakeholders and inter-linkages (Vidale *et al.*, 2015). Incentives from climate change policy (wood products as substitutes for other products with carbon footprint, adaptation to climate change) will also be key in the promotion of the ecosystem services provided by Mediterranean forests.

3.2.2.3 Major pressures

Climate change and human population growth are two overarching processes whose secondary processes (conversion from forests to shrublands, wildfires, pest and pathogen outbreaks, overgrazing and land abandonment) threaten Mediterranean forests. For instance, the area burnt by wildfires in five European Mediterranean countries has been trending downwards from 570,000 ha per year between 1980 and 1985 to a minimum of about 320,000 ha in 2014 but has been rebounding in the last four years, mainly because of increasing burnt areas in Portugal. A similar pattern of increased burnt areas in the recent years has also been observed in North Africa and the Middle East, with a total burnt area of 119,491 ha in 2017 (mostly in Algeria and Tunisia), around three times the amount recorded in 2016 (San-Miguel-Ayanz *et al.*, 2018). 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 capacity of most species to cope with fire, thus bringing forest degradation, loss of biodiversity and ecosystem services (Bradshaw *et al.*, 2011) and emissions of large quantities of CO_2.

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

The degrading impact of soil erosion is 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). Forests in Europe are generally fragmented; 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 in the Mediterranean basin's southern rim, having an enormous impact on *Cedrus atlantica* in Algeria (but also other tree species including pine, oak and juniper).

3.2.2.4 Management of forests

All Mediterranean countries have forest-related policy documents that orient the management of forests (FAO and Plan Bleu, 2018). National forest policy statements vary and range from extensive documents to declarative, long-term sectoral visions. Forest policy statements 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 be fully reflected yet in national forest policy documents.

Sustainable forest management is consistently prioritized in national forest policy programmes and statements across Mediterranean countries. However, 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 are not systematically present in all policy documents. Biodiversity is deeply rooted in forest policies throughout the region, the main focus being the biodiversity-climate change nexus (FAO and Plan Bleu 2018). Fifteen countries in the region and the European Union have an action plan or a strategy as required by the Convention on Biological Diversity. Nine countries in the region have mapped national targets against the Aichi Biodiversity Targets. Efforts on forest conservation have been achieved in the region through protected areas. Over 42% of land area in protected areas in the Mediterranean has tree cover of more than 10%, to be compared to 19% of land area in the Mediterranean biome (with 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 (through the building of green infrastructures) and increasing forest function and resilience that are essential to reduce the impact of climate change, pest outbreaks, etc.

Wildfire prevention is among major declared policy priorities in the Mediterranean. In policy documents, forest wildfires are often treated as an emergency rather than part of a continuous interaction between society and the environment in the context of climate change. In addition, at the national level, extinction generally receives much greater attention (and funding) than prevention, which can lead to over-expenditure (as more investment in prevention would reduce overall expenditure).

A number of Mediterranean countries have included pledges for forest and landscape restoration and afforestation plans into their policy documents. Forest and landscape restoration is the process of regaining ecological functionality and enhancing human well-being across deforested or degraded forest landscapes. Ten Mediterranean countries, for instance, have adopted the Agadir Commitment to support forest and landscape restoration, land degradation neutrality and biodiversity conservation efforts, with an objective on a voluntary basis to restore eight million hectares of degraded lands in the Mediterranean by 2030.

Policies and instruments on 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 ecophysiological response of forests to climate change. Policies are therefore oriented towards an adaptive approach to climate change. On the short run, revisions of forest policies are expected to take place to include the role of forests in NDCs. On 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 heavy carbon footprint) is expected to take place.

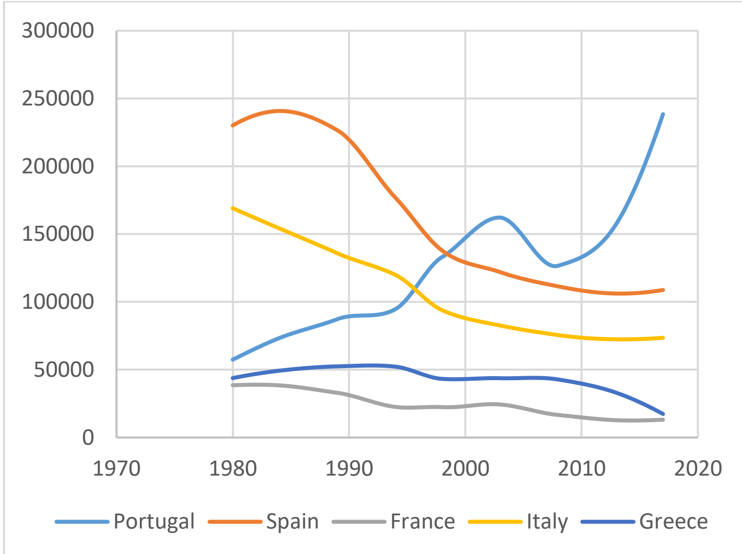

Figure 47 Area (in ha) burnt by wildfires in five European Mediterranean countries. Source: San-Miguel-Ayanz et al. (2018). Note: Annual data are smoothed using a local second-degree polynomial regression with a smoothing parameter of 0.75.

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 few cm), except for the north Adriatic Sea, the north Aegean Sea and the Gulf of Gabès where tidal amplitudes can reach 1m during spring tides (Tsimplis *et al.*, 1995).

The total length of the Mediterranean coastline is approximately 46,000 km, of which 19,000 km represent island coasts (UNEP/MAP, 2012). Approximately 54% of the Mediterranean coastline are sea cliffs and rocky shores (Furlani et al 2014), while the rest is comprised of soft sedimentary shores made of beaches, estuarine shores of fine sediment, coarse sediments (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 description describe therefore 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 and De Falco, 2012). Sand and gravel supply is made from the discharge of rivers. On those Mediterranean coasts without rivers or with low fluxes of particulate matter from land to the sea, the sand comes mostly from marine sedimentation or a result of coastal erosion processes. A particularity also found of many sandy beaches along the Mediterranean, is the deposit of large volumes of Posidonia 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 beaches less trampled some perennial plants also occur, such as the knotgrass *Polygonum maritimum* and the purple spurge *Euphorbia peplis*. It is also habited by crustaceans able to live outside water such as *Talitrids genus Orchestia*, predator insects such as the tiger beetles (some species genus *Cicindela*), algal grazers as shore flies (*Ephydridae*), beach flies (*Tethinidae*). This habitat is used for nesting by loggerhead turtle, *Caretta caretta* and green turtle, *Chelonia mydas* in parts of the Eastern Mediterranean. Adjacent coastal dunes host a highly specialized fauna and plant communities sharing relatively few of them with other close-by environments. Its dynamic nature includes an important 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 48 Cakile marítima and Caretta caretta

There is no quantitative data neither of the total area of soft sediment coastline in the Mediterranean nor of their trends. Some estimations from EU countries indicate that sandy beaches could be around 8,509 km^2 (Otero 2016a) and a loss of 30% of this particular habitat inferred from the development of harbors, dikes and others coastal structures over the last 50 years. Dams are the prime reasons 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% among countries (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), Rhône (France) and Po (Italy) while smaller, very localised pockets are present across the region (Soldo et al 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 its 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.

The majority of supralitoral rocky shores is typically characterized by diverse maritime communities of yellow and grey lichens, such as *Xanthoria parietina*, *Caloplaca marina*, *Lecanora atra* and *Ramalina spp*. The black lichen *Verrucaria maura* is also present. The higher parts of sea cliffs are colonized by disjunct assemblages of salt-tolerant, halophytic or even halo-nitrophilous crevice plants (chasmophytes) or by more or less closed salt-tolerant grasslands.

In the surf zone on the areas of bedrock, boulders and stones, associated marine species are adapted to long periods of emersion.

The Mediterranean Sea cliffs harbor numerous endemics of extremely local occurrence, in particular many plant species belonging to the genus *Limonium*, which comprises at least 43 and probably 120 to 150 Mediterranean cliff species, many of which restricted to a few localities. Several of these species are threatened, like for instance *Limonium remotispiculum* of southern Italy and *Limonium strictissimum* of Corsica and Caprera. Some stable and high coastal cliffs are inhabited by shrub communities of *Ficus carica, Colutea arborescens* and *Ulmus minor*.

At few locations along the Mediterranean coastline, unique bioconcretions 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 very restricted to the warmest part of the basin and only in specific areas where climatic, hydrological and sedimentary conditions are suitable. This particular habitat has experienced a continuing decline in spatial extent and biotic quality affecting 30% of the habitat over the past 20 years and is considered vulnerable at the EU Red list of habitats (Chemello and Otero, 2016).

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

Soft sea cliffs and rocky shores

Rocky coasts of soft materials along coastal cliffs and slopes are less common in the Mediterranean and have been less studied. The combination of local morphological settings, lithological features (e.g. cliffs on marine conglomerates, cliffs on sandstone, and cliffs on continental deposits), tectonic setting and geomorphological processes produce the diverse variability of landforms along these coastlines. Moreover, these coastlines are poorly resistant to the natural processes of erosion and landsliding and retreat rates are highly variable on the type of shore platforms formed. In general terms, there is little information on its ecological and floristic features or status. Soft rocky shores are more easily colonized by vegetation. The erosion is much quicker than hard cliffs and vegetation is therefore restricted to pioneer stages in many places. They may support scrub similar to the ones on dunes with species like *Hippophae rhamnoides*, *Juniperus* spp. and *Crataegus monogyna* as well as breeding populations of vulnerable species of birds (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 defense, mitigating and responding to natural forces like waves and storms (Drius et al 2019; Boudouresque *et al.,* 2016).

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 as well as 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 environment such as dunes in coastal defense, groundwater storage and water purification, while their importance in nutrient cycling, soil formation and climate regulation (on carbon sequestration) is less known (e.g. Bazzichetto *et al.*, 2016).

Obtaining further quantitative information for the ecosystem capacity of these types of Mediterranean ecosystems would be valuable to provide management options and relevant information for decision-making. Moreover, considering that 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: Ecosystem services provided by some coastal habitats in the Mediterranean

	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/refugia for coastal biodiversity – gastropods, small crustaceans, myriapods, 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/refugia 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 provisioning- e.g. shellfish	Nutrient cycling Storm protection Decomposition and fixing processes.	Habitat/refugia 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/refugia for coastal biodiversity - sea cliffs harbor a diversity of vegetation types with variable maritime influence	Tourism: nature watching
Hard rocky coast				
Rocky shores and cliffs	Food provisioning- Finfish and seaweeds are collected on rocky coastlines.	Sea defense	Habitat/refugia 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

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 along most of the basin mainly because of anthropogenic interventions, e.g. the proliferation of marinas and other urban and touristic 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 defense structures (Otero 2016a).

The development of coastal projects (marinas, urban and tourist infrastructures) and altered flow regimes have had a significant effect on soft sediment coasts with beaches and coastal dunes by altering the erosion-accretion dynamics of the coastal zone and their quality and quantity. 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 harbors, dikes and other coastal structures, and also from degraded water quality. Urban and industrial wastewater discharged directly into the sea in some areas and pollution with chemical contaminants have led to reduced growth of some associated species and general degradation of the habitat (Chemello and Otero, 2016).

The major threats on soft sea cliffs and rocky shores are new urbanized areas and touristic development in coastal areas, particularly the construction of homes, roads and other infrastructures in erosion-prone areas. Additionally, natural catastrophic events 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 which relate to the above-mentioned types of ecosystem landscapes at national level, EU level (Habitat and Birds Directive, MSFD and MSP) as well as within the ICZM Protocol of the Barcelona Convention. Altogether, these Mediterranean policies constitute a good umbrella for the development of national policies and coastal and marine area planning and management at national and 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 of the plant communities growing on coastal dunes lining the Mediterranean have been listed as EC Habitats of interest in Annex I of the Habitats Directive. EU countries are also encouraged to designate Natura 2000 sites and some beaches are also protected because of the presence of breeding sites of marine turtles. Even so, it is important to highlight that in many situations the coverage of Natura 2000 sites and the designation of protected areas has been focused on single habitats, while not considering the functional connectivity among continuous habitats in the land-sea interface (e.g. Otero *et al.*, 2018). Improving the integration and management of these connective habitats will reduce the fragmentation and facilitate the ecological integrity of the coastal environment.

In some Mediterranean countries, strict limits and distance from the coast for dredging of sands and gravel from beaches are in place. Additional beneficial actions could include legal protection of vulnerable habitats (dunes) in some Mediterranean countries, 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 the beach cleaning which avoid the use of heavy machinery.

For other soft sediment landscapes like muddy flats and estuarine environment or deltas, management and mitigation measures could be improved and prioritized to diminish land- and marine-based pollution sources such as reduce the problems of untreated wastewater discharges, e.g. from industrial effluents and agricultural runoff.

Hard and soft rocky shores and cliffs

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

Beneficial priority actions could include those which improve water quality and the regulation of coastal development in order to avoid both direct and indirect damage. Moreover, establishing new protected sites and restoring degraded coastal areas are also important.

3.2.2. 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 buffer species 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 on these ecosystems frequently experience strong selective pressures and constrictions on gene flow, which could contribute to increase genetic divergence among populations (Vergara-Chen *et al.*2010). However, if natural populations consist of reduced numbers of individuals, 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.

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 few studies on genetic diversity for Mediterranean coastal species, an example on such a case with low genetic diversity levels is the plant *Stachys maritima*. It is a typical species of coastal dunes that has been subjected to severe fragmentation during the last century (Masso et al 2016). Therefore, management programmes with the objective to enhance the conservation status of the specie need to consider connectivity patterns and gene exchange among populations in its planning (Palumbi 2003).

Currently, more than 6 000 species including all vertebrates and an important number of invertebrates and plants have been recorded from the Mediterranean region into the IUCN Red List of Threatened Species (IUCN RLTS). About 1 247 species of them are recorded as being native and occurring in coastal terrestrial habitats and 253 of them are endemic to the Mediterranean region.

At least 168 (14%) of the coastal species assessed in the IUCN RLTS (101 of them endemics) are threatened with extinction at 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 making up for 84 threatened species.

Table 10: Conservation status of species habiting Mediterranean coastal habitats based on the results of the extinction risk assessments of the IUCN Red List at global and Mediterranean regional level. IUCN Red List categories CR, EN and VU correspond to the number of species in 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.

Taxonomic Group	CR	EN	VU	NT	LC	DD	RE	EX	Total of coastal threatened taxa	Total coastal taxa assessed	% coastal threatened species 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 Fishes	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 molluscs	0	2	1	1	21	6	0	0	3	31	12%

Freshwater crabs, scrayfish 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%

***Mid-point (CR + EN + VU) / (assessed – EX – DD)**

Spain, France, Italy and Morocco have in this order 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 fishes, occur in Spain and 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 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

Coastal threatened taxa in the Mediterranean region												
Countries	Amphibians	Aves	Reptiles	Mammals	Freshwater Fishes	Freshwater Molluscs	Freshwater crabs, shrimps and crayfishes	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
Syria		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
Palestine	1	9		2		1					3	16
Cyprus		12		2							1	15
Libya		10	1	1					1		1	14
Monaco		4		2								6

3.2.3.5 Major pressures to coastal biodiversity

The analysis of the threats affecting 163 Mediterranean coastal species in 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 49).

In coastal lowlands, the Mediterranean have experienced urbanization and development associated with tourism for decades (Grenon & Batisse, 1989; Vogiatzakis *et al.*, 2005). These include the reduction in plant diversity and 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 species. Water-related leisure activities damage aquatic plant communities (sea grass and coralligenous species) and nesting areas of marine turtles.

The prospects of short-term financial gain from tourism are often winning over the long-term security of biodiversity and maintenance of ecosystem services. Further, 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, and so increases their vulnerability.

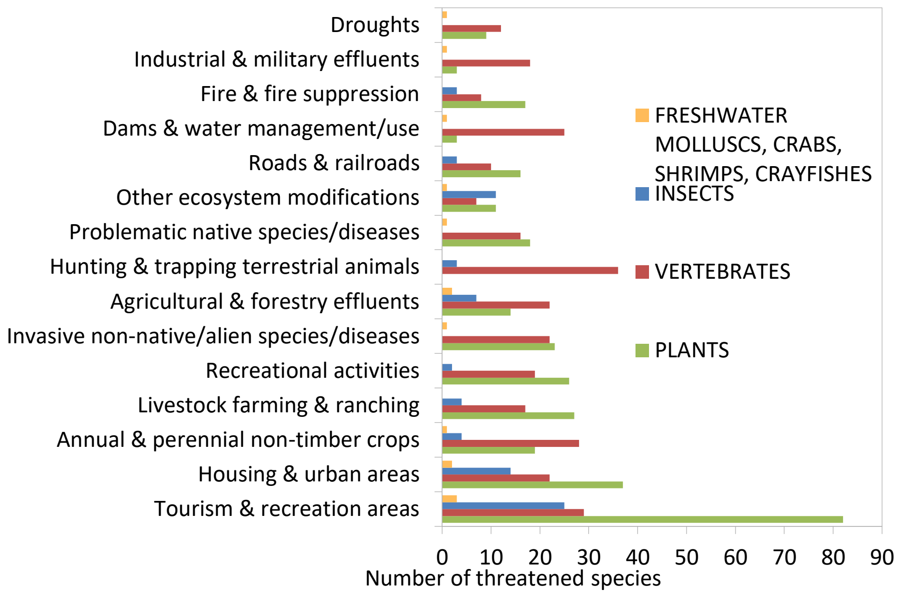

Figure 49 Main threats affecting coastal species in risk of extinction (IUCN Red List Categories CR, EN and VU) in the Mediterranean region

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 which are naturally more vulnerable to modifications in their habitats. Climate change is also expected to amplify biological invasions and proliferation of pathogens and diseases, fostered by the rise in temperature of the marine waters.

3.2.3. Invasive species in coastal ecosystems

Invasive Alien Species (IAS), introduced species which out-compete native species and cause economic and ecological damage by spreading in natural ecosystems (IUCN SSC Invasive Species Specialist Group, 2000), have been recognized as the second cause of species disappearance at global level, behind habitat loss and deterioration, affecting above all 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 and caused detrimental ecological impacts (Genovesi and 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, however, 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 rat, *Rattus norvegicus*, with strong negative effects on native fauna, particularly on islands; the redeared slider turtle *Trachemys scripta elegans* in ponds or the Cordgrass *Spartina patens* and *S. densiflora* in Mediterranean marshes (MIO-ECSDE 2013; Duarte *et al.* 2018).

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, vertebrates and invertebrates, are also today affecting freshwater communities in the Mediterranean, imperiling 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 one of 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 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 55-77% of Atlantic species (present in the Atlantic and the Mediterranean), 3-10% of pan-tropical species (species from the globe's hot seas), 5% of Lessepsian species (species from the Red Sea which entered the Mediterranean via the Suez Canal) and between 20 and 30% of endemics. This ratio of endemism, relatively high compared to other seas and oceans, varies according to taxonomic group (Tab 5). It is 18% for decapodal crustaceans, 27% for hydras, 40% for Rhodobionta (Plantae), 46% for sponges, 50% for ascidians, 90% for nesting sea birds (Metazoa) (Zenetos *et al.*, 2002; Boudouresque, 2009). These are basically neo-endemics like the *Cystoseira* genus (Chromobionta, *Stramenopilous*) with over thirty species known in the Mediterranean, 20 of them endemic, and to a lesser extent, paleo-endemics like species of the *Rodriguezella* genus (Rhodobionta, Plantae), the red coral *Corallium rubrum* (Metazoa, Opisthochonta) and *Posidonia oceanica* (Magnoliophyta, Viridiplantae, Plantae) (UNEP-MAP RAC/SPA 2010).

Figure 50 Corallium rubrum and Posidonia oceanica

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

Phylum	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
Echiuria	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**

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 the coralligenous in the circa-littoral stage (Zenetos *et al.*, 2002; Boudouresque, 2004). Added to these habitats are the 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 to deep seas in the open ocean) are among the components that are considered particularly representative of the 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 organisations and 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 neighboring 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 100 to 1,500 million €/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

Pergent *et al.* (2012) provided a comprehensive compilation of the available data on seagrass meadows in the Mediterranean. There are five species of strictly marine Magnoliophyta in the Mediterranean Sea, one is endemic (*Posidonia oceanica*), three are also found in the Atlantic Ocean (*Cymodocea nodosa*, *Zostera mari*na and *Zostera noltii*) and one is a Lessepsian migrant (*Halophila stipulacea*).

3.3.2.1 Status and trends of seagrass meadows

Posidonia oceanica meadows are declining at alarming rates, the regression being widespread throughout the Mediterranean Sea and amounting to over 30% in the last 50 years (Telesca *et al.* 2015). Current spatial extent of *P. oceanica* is estimated at 1,224,707 ha, with data gaps especially in the South-Eastern part of the basin. The most extensive meadows are found in the Gulf of Gabès (Tunisia), 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).

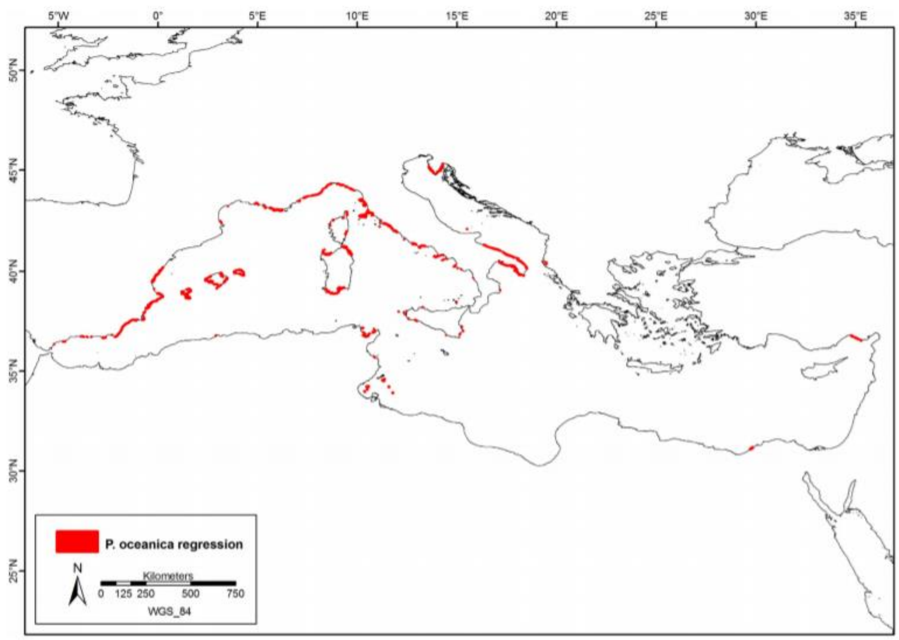

Figure 51 Coastline regression of Posidonia oceanica meadows over the last 50 years (Source: Telesca et al. 2015)

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; therefore 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, 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, Syria and Egypt) (UNEP-MAP RAC/SPA 2010). This species demonstrates high resilience, however cases of regression have been reported and related to modifications in salinity or nutrient enrichment (Ben Maiz & Shili 2007; Bernard *et al*. 2007).

Halophila stipulacea entered the Mediterranean after the opening of the Suez Canal (Fritsch, 1895). Since then, it has colonized a large part of the eastern Mediterranean basin.

3.3.2.2 Ecosystem services

Seagrass meadows are used as a material when dried for roof isolation, industrial waste absorbent, food for farmed animals or compost and bioindicator, and offer 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 they act 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 Magnoliophyta meadows recorded in the Mediterranean are related to shores restructuring, 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. More recently, the rising temperature of the water and the rise in the sea level could explain certain regressions (Marbà & Duarte, 2010). These regressions primarily concern the emblematic species *Posidonia oceanica*, though other species are also affected by anthropogenic impacts (Boudouresque *et al.*, 2009).

The ecological characteristics of seagrass species in the Mediterranean enable them to cover a wide spectrum of abiotic conditions, and their sensitivity to anthropogenic pressures is also very different (Boudouresque *et al.*, 2009). While *Posidonia oceanica* constitutes the "climax" species for a large part 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.*, 2006). Furthermore, when environmental conditions become unfavorable 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 opportunistic "introduced" species (Montefalcone *et al.*, 2010). Furthermore, 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 over the last 20 years to protect seagrass meadows by the Mediterranean countries, especially the endemic and emblematic species *P. oceanica*. Seagrass meadows 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 of SPA/RAC) and European level (1992 Habitat Directive and 2000 Water Framework Directive). Fishing restrictions and sustainable alternative techniques for mooring have set up in parts of the basin, however stricter regulations and controls on trawling and mooring, especially at sea, is 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* meadows 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

3.3.3.1 State and trends of coralligenous and associated biodiversity

The Coralligenous assemblages are biological formations among the most representative components of the Mediterranean marine biodiversity. These are biogenic constructions present in many Mediterranean areas. The most recent estimates of their extent show that the coralligenous outcrops cover about 2,760 km^2 and the maërl beds, another coralligenous component, cover about 1,655 km^2. Knowledge about the distribution, species composition and functioning of coralligenous and other calcareous bio-concretion remained fragmentary for a long time. However, recent technical advances have made it possible to acquire more data on the coralligenous. Thus, several sites rich in coralligenous have been identified and inventoried as areas of conservation interest. 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 theses assemblages (Barcelona and Bern Conventions, EU Habitat Directive).

3.3.3.2 Ecosystem services

The coralligenous assemblages contribute to carbon sequestration and 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 as well as endangered or threatened species.

Furthermore, being attractive for scuba diving activities, they support, 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 gear used for fishing, such as bottom trawls or gill nets, as well as from boat anchoring systems (anchors and anchor chains) that exert a 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 its normal development and thus caused the regression of its assemblages. Among these invasive species there are some algae such as *Womersleyella setacea*, *Acrothamnion preissii*, *Asparagopsis taxiformis* and *Caulerpa taxifolia*.

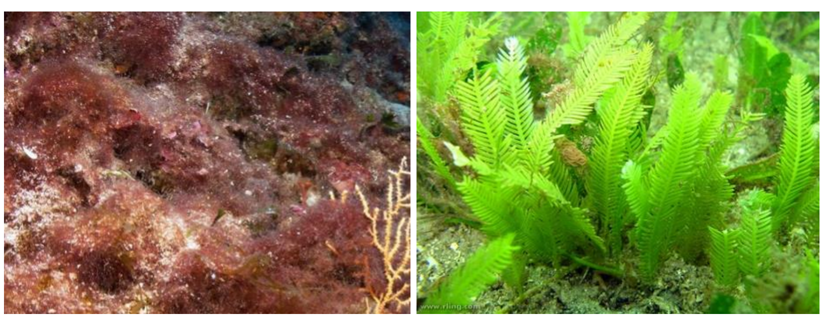

Figure 52 Womersleyella setacea and Caulerpa taxifolia

As with the rest of the marine environment, coralligenous assemblages are affected by pollution and climate change. Massive mortalities of species related to these environments were reported in recent years in depths of 30 to 40 m and were attributed by scientists to disturbances in the position of the thermocline, under the influence of marine waters warming.

Ocean acidification impacts a wide array of organisms producing carbonate shells and skeletons (Palmieri *et al*, 2015; Kapsenberg *et al*, 2017). These effects are biological (e.g. early stage survival) as well as ecological (e.g. loss in biodiversity, changes biomass and trophic complexity) processes (Gattuso *et al*, 2015). Effects of recent acidification in the Mediterranean Sea have led to a significant decrease in the thickness of coccolith, calcareous plates harbored 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 calcifying species to non-carbonated species (e.g. erect macroalgae) were reported even under moderate decrease in pH (Hall-Spencer *et al*, 2008; Kroeker *et al*, 2011; Linares *et al*, 2015). 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).

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

3.3.3.4 Management of 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 the 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 the Mediterranean countries about the occurrence of invasive species having the potential to negatively impact the coralligenous.

As part of the implementation of the Action Plan for the conservation of Coralligenous and other Calcareous Bio-concretions in the Mediterranean, adopted by the Contracting Parties to Barcelona Convention, the following conservation and management activities were undertaken during the last five years:

- Elaboration of a reference list of species that are found in coralligenous outcrops,
- Promoting taxonomic identification of species constituting these assemblages through an inventory of taxonomist experts and researchers/institutions working in the field,
- Elaboration of standardised methods for the inventory and the monitoring of coralligenous assemblages,
- Mapping of sites with coralligenous formation with the view 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 among the fragile components of the Mediterranean marine biodiversity. They occur in deep zones as well as in areas with a very limited luminosity and are usually associated to 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 herbivorous, 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 foraminifers *Xenophyophora*, the sponges *Hexactinellidae*, the sea-cucumber of the *Elasopodida* order, etc.) (Zenetos *et al.*, 2002; WWF-IUCN, 2004). Mediterranean deep-sea life forms are essentially eurybathic (wide depth range) species. Other faunistic groups (decapodal crustaceans, mysidaceae, echinoderms and gastropods) are weakly represented in the deep sea. The macrofauna of the Mediterranean deep sea is dominated by fishes 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 RAC/SPA 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 WWF and IUCN (WWF/IUCN, 2004) draws the broad outlines of deep-sea ecosystems in the Mediterranean. The bathyal and abyssal domains cover respectively about 60% and 10% of the total surface area of the Mediterranean Sea (UNEP-MAP RAC/SPA 2010). Deep-sea Mediterranean habitats include: underwater canyons, chemosynthetic communities, cold water corals, seamounts and deep hypersaline habitats (UNEP-MAP RAC/SPA 2010).

Underwater canyons are of major importance in the Mediterranean since they represent, for many species, places for reproduction and feeding (fishes, cetaceans like *Grampus griseus* and *Physeter macrocephalus*). Also, they represent a remarkable reservoir of endemism in the Mediterranean (jellyfish, *polychaetes*).

Chemosynthetic communities are communities of the hydrothermal springs characterized by symbiosis between invertebrates and chemotrophic bacteria which, using the energy freed by the chemical transformation of certain compounds of the hydrothermal fluid, in particular hydrogen sulphide, can synthesize the first organic molecules from carbonic gas and nutritive salts. Their interest lies in their originality and rarity in the Mediterranean. These habitats are found in southern Crete, southern Turkey (Anaximander Seamounts) and off Egypt and Gaza (ICSEMS, 2004).

Cold water corals are habitats of great ecological value but that are threatened by deep sea trawling and by the effects of global warming (CIEMS, 2004).

Seamounts are underwater mountains that emerge from the seabed and constitute singular habitats in the marine environment. They represent essential habitats for the life-cycles of several species and contain high density levels of macro- and megafauna. Seamounts are characterized by a high rate of endemism (i.e. hydrozoa). They are also feeding places for many species of fish and cetacean. In the Mediterranean, the Sea of Alboran (Spain), the Balearic Sea (Spain), the Gulf of Lions (France) and the abysses of the Ionian Sea are of special interest for these habitats.

Deep hypersaline habitats, known as brine pools are deep-sea habitats of high biodiversity importance, particularly to extremophilic bacteria and metazoan meiofaunal assemblages (IUCN-WWF, 2004). Little data exists on these habitats but they are considered to be important environments because of their specific Mediterranean feature (CIEMS, 2004).

3.3.4.2 Ecosystem services

Besides their importance as natural heritage, dark habitats provide valuable services in particular through the support to 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 among the main paths for the surface/bottom transfers of energy and matter.

3.3.4.3 Major pressures

Land-based sources of pollution and of other kind of pressures generate the major impacts on dark habitats that may reach even those located in the deeper zone. The coastal river inputs significantly contribute in nutrient enrichment, marine acidification and the local disturbance in sea water temperature recorded in some dark habitats. The increasing oil and gas activities in Mediterranean deep zones constitute other sources of pressures for the dark habitats mainly the 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 wastes, including lost or abandoned fishing gear and plastic containers/debris from terrestrial origin.

3.3.4.4 Management of Dark habitat ecosystems

During decades the dark habitats – in particular those located in deep sea zones of the Mediterranean-remained without any conservation or management measures. However, following alerts from scientists and from several conservation organisations, there is a growing awareness of the need to preserve such environments. One of the concrete measures taken was the banning decided by the General Fisheries Commission for the Mediterranean (GFCM) concerning the use of towed fishing gears in depth beyond 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 being underway for others.

Nevertheless, preserving dark habitats remains for the Mediterranean Sea a crucial challenge whose success requires further 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

Today the Mediterranean Sea is known to host more than 17,000 marine species and contributes to an estimated 4 to 18% of the world´s marine biodiversity (Bianchi and Morri, 2000; Coll *et al.* 2010). About 694 of the species assessed for the IUCN Red List in the Mediterranean are recorded as being native and occurring 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 genetic structure of species due to changes in environmental conditions across time (Coll *et al.* 2010). Differences between the Western and Eastern basins of the Mediterranean Sea, with the latter being 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 *et al.* 2017), fish (Bahri-Sfar et al 2000), sea cucumbers (Valente *et al.* 2015), and bivalves (Nikula and Väinölä 2003).

Recovery from fragmentation or events of mass mortality, either natural or human induced, may be critical for some species in the Mediterranean Sea. This is the case of the pen shell *Pinna nobilis*, a listed endangered species of the Mediterranean Sea (Barcelona Convention, protocol SPA/BD Annex 2) that recently is experiencing a mass mortality across the Mediterranean Sea[39]. The high genetic diversity and low inter-population differentiation have strong consequences for conservation of this species, as directly influence how could be naturally recovered 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 them endemics) are threatened with extinction at global or regional level in the Mediterranean region (Table 13). Cartilaginous fishes 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 fishes have the highest percentages of threatened species (75% and 65% of species) followed by marine mammals (64%).

Table 13 Conservation status of species habiting Mediterranean marine habitats based on the results of the extinction risk assessments of the IUCN Red List at global and Mediterranean regional level. IUCN Red List categories CR, EN and VU correspond to the number of species in 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.

Taxonomic Group	CR	EN	VU	NT	LC	DD	EX	Total of marine threatened taxa	Total marine taxa assessed	% estimated marine threatened species in Mediterranean region (Mid-point)
Anthozoa	1	9	7	10	40	69	0	17	138	25%
Marine fishes (Bony fishes)	1	3	7	8	316	120	0	11	455	3%

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

Marine fishes (Cartilaginous fishes)	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%**

***Mid-point (CR + EN + VU) / (assessed – EX – DD)**

France, Spain, Italy and Greece have in this order the highest number of threatened species living in marine habitats in the entire region. Most of the threatened cartilaginous and bony fishes are found in France. The highest number of threatened anthozoa is recorded in Greece, while a high number of threatened marine mammals are found in Spain and Morocco (Table 14). Notably, although the assessed species represent an important percentage of the Mediterranean biodiversity, there is no certainty that the regions and countries which show high numbers of threatened species exactly coincide with the true distribution of the different taxa in the Mediterranean, and rather could be a reflection of the research efforts in certain regions.

Table 14 Number of threatened species by country. The highest number of threatened species by taxonomic group in bold

	Marine threatened taxa in Mediterranean region					
Countries	Anthozoa	Marine Fishes (Bony fishes)	Marine Fishes (cartilaginous fishes)	Marine Mammals	Marine Reptiles	Total
France	13	11	60	6	2	92
Spain	15	10	38	7	2	72
Italy	15	9	37	6	1	68
Greece	17	8	33	6	1	65
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
Syria	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
Palestine			12	3		15

3.3.5.1 Major pressures to marine biodiversity

The analysis of the threats affecting 77 Mediterranean marine species in risk of extinction in the IUCN Red List (categories CR, EN and VU) (IUCN 2018) showed that fishing (overfishing, bycatch and damage impacts on habitats) is the main driver increasing the species extinction risk. Other important threats are urbanization, pollution and climate change (Figure 53). 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 for the decline of the Maltese skate, *Leucoraja melitensis* or the bamboo coral, *Isidella* elongata by 80%, making both native species as Critically Endangered of extinction (Dulvy andWalls, 2015; Dulvy *et al.* 2016; Otero et al 2017).

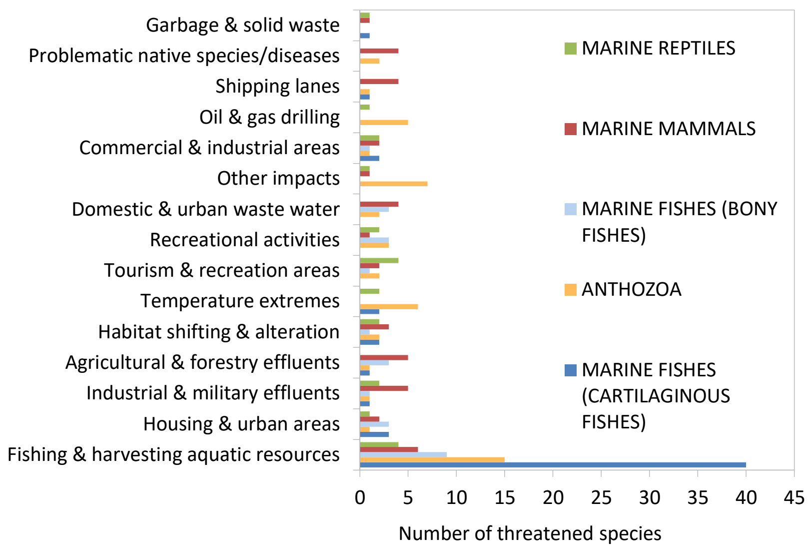

Figure 53 Main threats affecting Mediterranean marine species in risk of extinction (IUCN Red List Categories CR, EN and VU) in the Mediterranean region

3.3.5.2 Management

Under the Convention on Biological Diversity, EBSAs (Ecologically or Biologically Significant Areas) are marine areas deserving management, warranting their sustainability using seven scientific criteria. These criteria 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 realized in the Mediterranean and has provided a list of 17 areas defined of which 15 have been agreed upon by the countries for official listing in CBD Repository (

[40] CBD Decision IX/20, Annex I

Table 15/Figure 54). The decision for conservation efforts or special management measures remains the responsibility of each country surrounding the area, alone or together.

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

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	Lebanon, Syria
Gulf of Sirte	Libya
Nile Delta Fan	Egypt
Hellenic Trench	Greece, Turkey
North-East Levantine Sea	Greece, Turkey, Cyprus, Syria
Le Golfe de 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

Figure 54 Ecologically or Biologically Significant Marine Areas (EBSA) considered by the CBD Conference of the Parties in the Mediterranean Sea

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 (FAO) is developing the process for identifying, recording, declaring and managing VMEs in the region. A list of species that may contribute to form VMEs has been prepared and a protocol has been proposed for VME encounter and registration.

Concerning habitats, 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 (2016-2017) developed by the European Union was covering the Mediterranean waters of European countries and has provided a provisional evaluation of the existing benthic habitats on the continental platform (0-200m). For the 47 habitats considered, the study indicates that none are critically endangered, 5 endangered, 10 vulnerable, 5 near threatened, 4 of least concern and 23 data deficient. This last figure confirms that the knowledge about the Mediterranean is still limited and that any evaluation does not represent the full reality, supporting a precautionary approach.

Some specialized organisations, such as the ACCOBAMS, for cetaceans' conservation, have or are developing their own system for identifying critical habitats for the survival of species, considering the threats. The Cetacean Critical Habitats (CCH) have been described in the Mediterranean and are helping the countries in reducing 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 evaluated and, where necessary, amended through a process based on the expertise available at national level as well as with the relevant IGOs and NGOs. The most recent amendment to these lists[41] concerns endangered and threatened species in the Mediterranean, including 163 species (Mammalia, Aves, Reptiles, Pisces, Echinodermata, Crustacea, Mollusca, Bryozoa, Cnidaria, Porifera, Rhodophyta, Heterokontophyta, Chlorophyta, Magnoliophyta).

Box 14 The ACCOBAMS survey initiative, a Mediterranean large-scale survey for collecting new data on cetaceans, marine macro fauna and marine litter

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

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

During the summer 2018, an unprecedented large-scale synoptic survey combining visual and passive acoustic monitoring methods was conducted across the whole Mediterranean. The ASI Survey has represented a considerable logistical and administrative challenge: over 100 scientists from the region and beyond were involved, 6 ships and 8 aircrafts were mobilized, and more than 30 national and international partners have collaborated in this very unique effort. The ASI survey followed a multispecies approach, with cetaceans as primary targets, collecting data on elasmobranches, sea turtles, seabirds and other mega-vertebrates but also on anthropic pressure such as marine litter.

An analysis of the ASI data is 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 lead to confirm existing areas of interest for cetaceans' conservation and potentially identify new ones (Cetacean Critical Habitats, Important Marine Mammals Areas). 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

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

conservation and for the reinforcement of national capacities around the Mediterranean. For the first time, all Mediterranean countries have collaborated for implementing this unique biodiversity conservation effort.

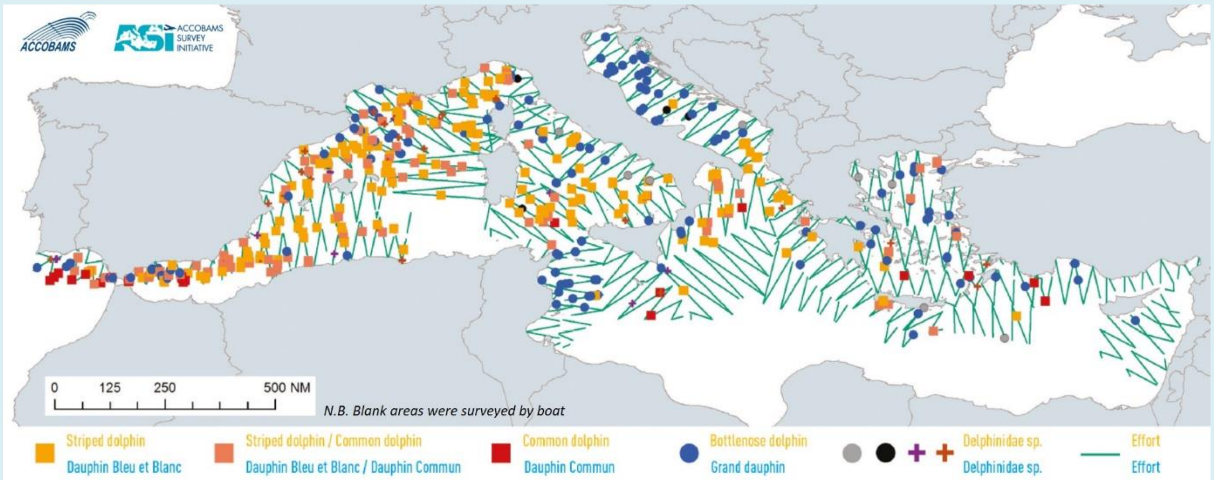

Figure 55 ASI aerial observations of small cetaceans (summer 2018)

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

- *Tropicalization*: Non-indigenous species of warm water affinity (tropical) become increasingly established;
- *Meridionalization*: The species that usually thrive in the southern part of the basin expands 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, the cold engines might fail renewing deep Mediterranean waters, with vast consequences on Mediterranean Sea ecosystems;
- *Changes in the phenology of species*: reproductive patterns are modified by different thermal conditions: 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 in deeper waters, their surface populations having already suffered severe mass mortalities, with a risk of extinction though some of them may adapt to the new conditions (Boero *et al.*, 2013);
- *Less fish, more jellyfish and jellyfish eaters*: the fish-jellyfish transition is already happening at a world scale, with possible prediction of an increase of predators like sun fish and marine 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 infrastructures) greatly contribute to habitat destruction (Claudet et Fraschetti, 2010).

3.3.6 Invasive species in marine ecosystems

The Ecosystem Approach (EcAp) recognises that to achieve good environmental status “non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystem”. A total number 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 Straits of Gibraltar. The increase in introduction rate goes back to the last decades and is attributed by specialists to the intensification of some human activities, such as shipping, and also to the global changes that started to result in more favourable conditions that facilitated the settlement in the Mediterranean of viable populations of alien tropical marine species.

Some of these non-native species proved to be invasive in the meaning of the CBD definition[42]. 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 the natural communication openings, but there is scientific evidence that most of the alien species recorded in the Mediterranean entered through the Suez Canal. Other introduction paths were also identified in particular ballast waters and aquaculture.

Besides their impacts on the ecosystems, several macroalgae (eg: *Codium fragile fragile*, *Gracilaria vermiculophylla*, *Grateloupia turuturu*, *Sargassum muticum*, *Undaria pinnatifida*) were reported to cause negative economic impacts on aquaculture and fishing through fouling of shellfish aquaculture facilities, invading shellfish beds and obstructing dredges and other towed fishing gears. Cases of decline in commercial stocks due to direct predation or competition for resources by invasive species were also reported and concerned several groups of 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 *Pictada imbricata* radiate) and gastropods (*Urosalpinx cinerea* and *Rapana venosa*).

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)

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		

Management of invasive species

Given the seriousness of the issue of biological invasion by marine non-indigenous species, the riparian countries to the Mediterranean Sea adopted in 2003, under the Barcelona Convention, the Action Plan on Introductions of Species and Invasive Species. To assist countries in implementing the Action Plan, SPA/RAC elaborated in consultation with Mediterranean experts, two technical tools: “Guidelines for controlling the vectors of introduction into the Mediterranean of non-indigenous species and invasive marine species”, and “Guide for risk analysis assessing the impacts of the introduction of non-indigenous species”.

Furthermore, REMPEC and SPA/RAC collaborated to elaborate the Mediterranean strategy for the management of ballast waters whose objective is to facilitate the implementation in the Mediterranean of the relevant provisions of the International Convention for the Control and Management of Ships’ Ballast

[42] 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.

Water and Sediments (BWM Convention) adopted in 2004 under the auspices of the International Maritime Organisation (IMO).

Box 15 Introduction of alien species via maritime transportation

Shipping is a pathway for non-indigenous species introduction in the Mediterranean Sea via both ships’ ballast water and ships’ hull biofouling. Translocation via ships’ ballast water and sediments has been the focus area of action, and with the recent entry into force of IMO mandatory regulations there is an expectation that introduction of such invasive species will be minimised 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 was estimated that at least 55% of the 1780 recognised 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 the Figure 56 below.

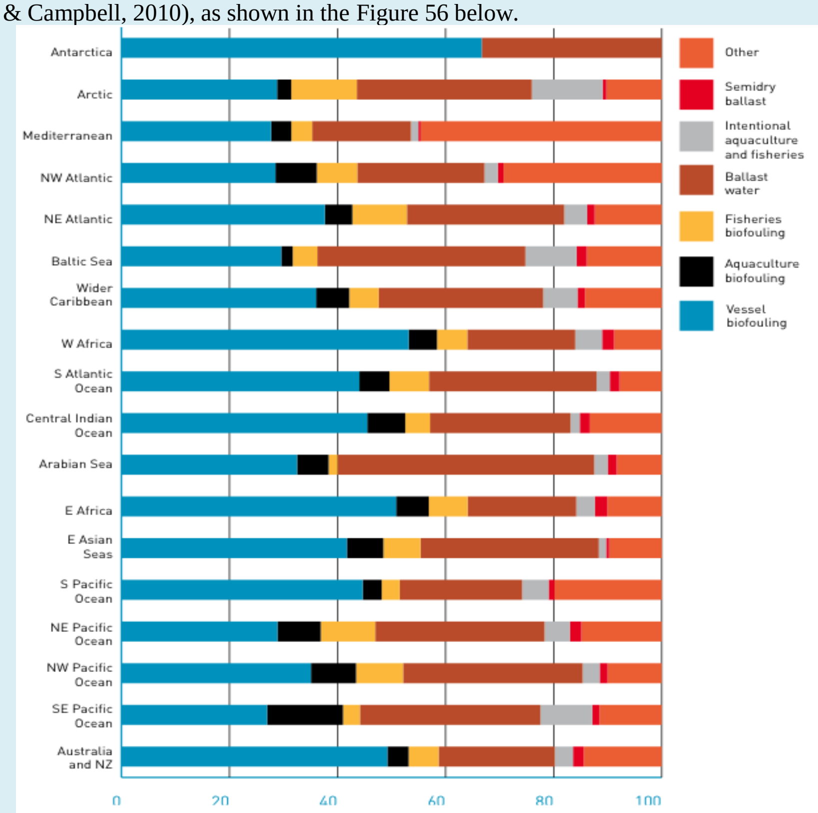

Figure 56 Percentage of marine bio-invasions by regions according to contribution of specified transport mechanisms. Source: Hewitt & Campbell (2010)

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 Guidelines on biofouling (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 good will of countries and the industry. However, 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.

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 (cf. 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 (cf. section 3.2.2.4)
- Legal provisions and policies such as the ICZM Protocol which limits the use of coastal areas for protecting soft sediment coasts and rocky and soft cliffs and shores (cf. section 3.2.3.4),
- For marine ecosystems, an action Plan for the conservation of Coralligenous and other Calcareous Bio-constructions (cf. section 3.3.3.4), fishing restrictions by the GFCM (cf. 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, a classification of the status of ecosystems by IUCN, the SPA/BD Protocol for protecting marine biodiversity, and the ACCOBAMS survey initiative (cf. section 3.3.5)
- For fighting invasive species, the Action Plan on Introductions of Species and Invasive Species and associated SPA/RAC technical tools, the Mediterranean strategy for the management of ballast waters, and guidelines on biofouling (cf. 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 the Aïchi 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, the 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 environment, fisheries, ICZM, marine spatial planning or other legal tools, allowing a better implementation of the 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 presently revising it. Some 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 target value Aichi 11 and SDG 14. Based on MAPAMED (Box 16), considering all the categories/labels, national and international designations, and Other Effective area-based Conservation Measures (OECMs), the number of MPAs and OECMs in the Mediterranean has reached 1233. In terms of areas covered, it includes the national declarations (about 82,600 km^2), the Natura 2000 declarations for the European countries (about 59,700 km^2), the Pelagos sanctuary concerning three countries (France, Italy and Monaco, about 87,300 km^2), the Strait of Bonifacio Particularly Sensitive Sea Area (IMO) concerning two countries

(France and Italy, about 11,000 km^2), the Fisheries Restricted Areas (GFCM) with an objective of conservation of ecosystems or species concerning three countries (Cyprus, Egypt and Italy, about 15,700 km^2), the Ramsar sites (about 3,300 km^2), the World Heritage Sites (UNESCO, about 200 km2), the Biosphere Reserves (UNESCO, about 1,600 km^2) and the SPAMIs (UN Environment/MAP-Barcelona Convention, about 90,000 km^2). Values are not cumulative since several areas have multiple designations.

Strong boost towards the Aichi target value 11 and SDG 14 reaching was done in 2018 through the declaration on 30 June 2018 of the Spanish Cetacean Corridor along East coast of Spain, embracing 42,262.82 km². That way, the marine area covered by conservation measures (MPAs and OECMs) nearly reached 223,000 km^2, representing more than 8,9% of the Mediterranean Sea surface. The over eight-fold enlargement of Cabrera National Park and SPAMI approved on January 2019, also in Spain, with 807.73 km² of open sea, including deep sea, renders a Mediterranean national designation increase of 43,070.55 km², summing a total Mediterranean surface up to just over 9%. Assuming the January 2019 coverage as 226,665 km², 25,025 km² are additionally needed by 2020 to reach target value Aichi 11 and SDG 14, regardless of management effectiveness or whether regulations are implemented, challenging but not impossible.

Box 16 The MAPAMED Database

MAPAMED, the Mediterranean database and 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 the SPA/RAC and MedPAN to assist the countries in the registration and spatial description of MPAs and OECMs in the region. As a database on sites of interest for the conservation of the marine environment in the Mediterranean Sea, MAPAMED can be used by the countries for preparing reports and evaluating 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".

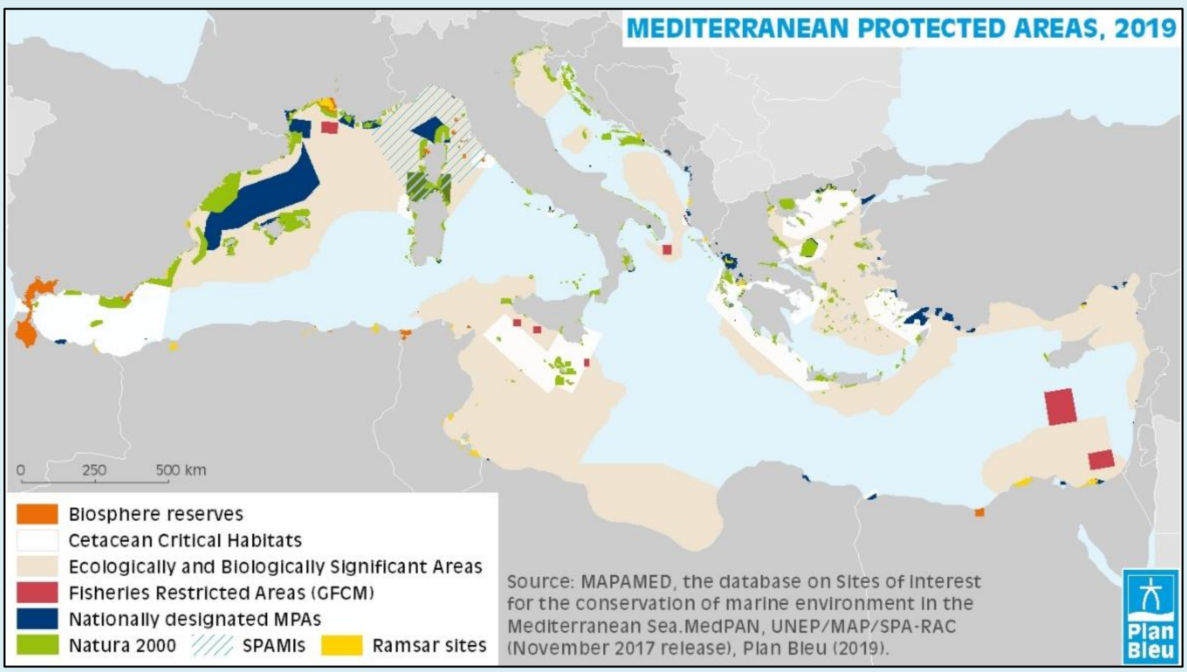

Figure 57 Marine protected areas, 2017 (Source: MAPAMED, 2017, Plan Bleu 2019)

The national fisheries reserves (more than 120 in the Mediterranean) that have, in addition to a sustainable use of fishing resources, an objective of conservation of species or ecosystems have not been considered, as it is necessary to review each site declaration text for identifying their specific objectives.

For the coming years, numerous areas are proposed (by experts) or considered by countries in their strategies for the declaration as MPAs or OECMs, representing 118 sites in 12 countries. The national fisheries reserves with an objective of 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 of participation of all stakeholders in the different aspects of development and conservation, in particular for MPAs or OECMs are taken into consideration by all countries, usually under the Environmental Impact Assessment process, respecting the principles of the UNECE Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters (Aarhus Convention).

Most of the countries have included in their legislation the obligation of adoption, implementation and revision of management plans for protected areas. In some countries, specific administrations have been identified for this purpose, and others for training the national staff on management, enforcement or regulations. Nevertheless, management remains one of the weakest points in the Mediterranean, where it is estimated that only about 10% of existing MPAs or OECMs[43] have a 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[44], as well as of skilled staff and to 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 during the past 20 years, and in particular with the Tangier Declaration and the updated 2020 Mediterranean MPA Roadmap[45] prepared during the Mediterranean MPA Forum of 2016, where all the concerned stakeholders have joined efforts for a continuous improvement of the conservation and sustainable use of marine resources in the region, the following elements seem to be key for the future of Mediterranean region:

- Continuous efforts have to be made in specific countries and outside territorial waters using all the 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, different steps have to be taken, including:

[43] MedPAN *et. al.* 2016. The 2016 status of Marine Protected Areas in the Mediterranean: Main findings. Brochure MedPAN & UN Environment/MAP - SPA/RAC

[44] 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.

[45] 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.

- the assessment of the legislation, not only the environmental one, but also looking at the fisheries, tourism, maritime transport and enforcement (police, coast guard, navy, using modern technologies) sectors. All these elements are important for allowing both the administration and MPA managers to fulfil their enforcement duties,
- the training of nationals at all levels, including administrations, field staff, local stakeholders, as well as public awareness and education,
- the development of co-management mechanisms, first between 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 MPAs creation and management;
- work towards creating a win-win relationship of 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 sub-regional) are and will be essential for achieving the above targets. Knowledge and capacity building, for a range of subjects, have been facilitated by MedPAN. The network of managers for marine protected areas has been developing a series of trainings, 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, aiming at 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 complement 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 Assessment Programme (IMAP). Through this process, 11 ecological objectives and 27 indicators were identified to monitor the 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).

Table 17: Ecological Objectives under the Mediterranean EcAp

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 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
EO7 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 coastal and marine environment
EO 11 Energy including underwater noise	Noise from human activities cause no significant impact on marine and coastal ecosystems

Figure 58 EcAp description of ecological objectives (Source: UNEP/MAP, 2016)

The EU Marine Strategy Framework Directive, 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 methodological standards of the MSFD. An important effort was made to harmonise the EcAp process of the Barcelona Convention with the implementation of MSFD.

The Protocol on 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 on 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, on Coralligenous and other Calcareous Bio-concretions, and on the Conservation of the Monk Seal and Turtles have been developed and are being implemented by the Contracted 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 the RAC/SPA announcing a 15 years programme to promote the diagnosis, consultation and assessment of Mediterranean biodiversity at national and regional level, and was then extended to 2020 to match the CBD Strategic Plan for Biodiversity 2011-2020.

The fifth Meeting of National Correspondents of the 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 main difficulties for implementation (Draft evaluation document of the SAP BIO, UNEP/MAP, 2019). RAC/SPA currently coordinates the elaboration of the new phase of SAP BIO (2021-2030).

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

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 recurrent 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. All of which affect protected area performance, limiting the setting up and implementation of management plans. Establishing sustainable financing for MPAs is thus essential to help MPA reach an effective management. Strategic objective 4 of the 2016 roadmap towards 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, main financial resources for MPAs come from national and local public funds and multilateral (GEF) and bilateral cooperation (FFEM…). Other financial resources are: sub-regional projects (MAVA Foundation…), European financing instruments (LIFE, INTERREG MED, ENI MED…), but also private funds (foundations, sponsorship…), local financing mechanism and self-financing.

The 2016 Mediterranean MPA Forum Tangier declaration:

- Encourage leverage mechanisms to support the Contracting Parties to the Barcelona Convention and other relevant organisations 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.
- 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.

Box 17 M2PA – The association for the sustainable financing of Mediterranean MPAs

The 2020 Mediterranean MPA Forum (Antalya, Turkey) highlights 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 mechanism.

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

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, UICN Med, Mediterranean Small Islands organization, Critical Ecosystem Partnership Fund).

The association is currently supported by the French Facility for Global Environment (FFEM), the Government of Monaco, the GEF, the 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 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.

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 alignment with IMAP.

The 2017 MED QSR also identified several knowledge gaps (Box 18). On coastal and marine biodiversity, for example, data on marine habitats are still scare, fragmented and discounted in time and would gain from a complete mapping of the most significant marine habitats for being able to direct management measures.

Box 18 Difficulties in monitoring of indicators of good ecological status

Concerning the habitat distribution and the state of species and communities (CI1/EO1), there are significant gaps in 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. However, in the absence of at least an equivalent effort in 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 countries in 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 (CO5 / 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 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 studies (SEA). 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 sub-regional (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 almost systematically and 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.

3.4.5 Priorities for action

The analysis of the status and trends, ecosystem services, major pressures and management of Mediterranean coastal and marine ecosystems throughout this report lead to the definition of the following priorities for action:

- In the initial phase of IMAP (2016-2019), it is important that the countries adopt monitoring programs 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;
- Proper development and implementation of management plans for MPAs and OECMs should be supported, namely by increasing 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 Management of Mediterranean Coastal Areas and River Basins (ICARM), would help limiting the degradation and loss of these ecosystems;
- The functioning of wetlands, coastal aquifers and other coastal ecosystems being strongly impaired by land activities, there is a need to mind the connectivity among 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 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 19 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 (LMS) screening 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.

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 sub-regional 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 sub-regional 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

Table 18 Area of forests and of 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

Country	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%
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%
Syria	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 FAO definition of forests. Forested areas are areas with tree cover ≥10%. Coastal areas are land areas within 5 km of the coastline of the Mediterranean Sea

4 Draft Chapter 4: Economic activities and linked pressures

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Current consumption and production patterns, characterized by high resource consumption combined with low recycling rates and unsatisfactory waste management are overall unsustainable 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 potential to be mitigated to a certain extent. To reach sustainability, they need to be accompanied by a more environmentally responsible overall consumer behavior as well as by 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 wellbeing. 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 (including carbon)-intense, linear (not circular) and generates numerous types of pollution, which are characteristic for market failures inherent to common goods such as the environment. Transitioning to sustainable economic activities requires urgent and coordinated efforts both on the production and the consumption side. 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 favor environmentally-friendly activities and disadvantage polluting ones. On the demand side, decision-makers need enhanced support from social and behavioral sciences to design measures that will lead to needed radical changes in consumer behavior.

4.1 Introduction: current consumption and production patterns are not sustainable

4.1.1 Resource-consumption patterns and pressures on natural ecosystems

Multiple socio-cultural, economic and demographic factors are 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 increasingly pressuring natural resources (F. Hachem et al., 2016). The drifting away from traditional diets, which use local products, has evolved into a common phenomenon in all Mediterranean countries (idem). With the acceleration of modernisation, globalisation and urbanisation, along with changes in demography and lifestyles, environmental impacts are considerable on natural ecosystems and on biodiversity (idem). 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 (C. Lacirignola et al., 2014).

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

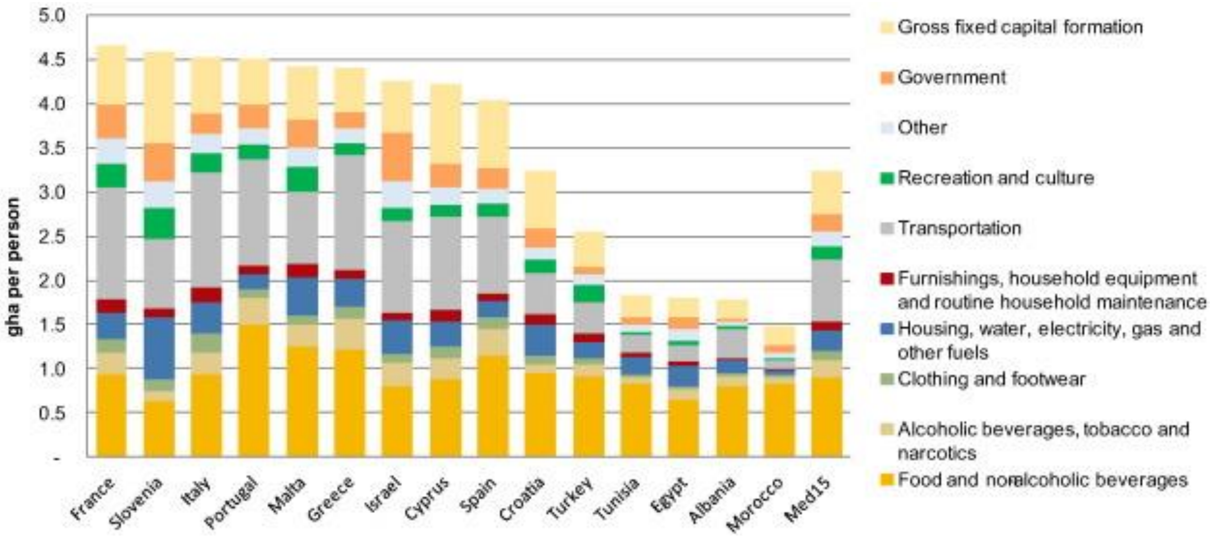

Figure 59 Ecological Footprint of consumption for 15 Mediterranean countries in 2010[46] (Source: A. Galli et al., 2017)

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 part of the pollution and intensive use of resources in the Mediterranean is also caused by inefficient industrial processes and unsustainable management of waste in current production patterns (Galli et al., 2017). Mediterranean residents place multiple pressures on ecosystems within and outside their region because 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 (C. Lacirignola et al., 2014). The environmental footprints of these patterns show a precarious and unsustainable natural resources-consumption nexus in the region that largely causes the many environmental challenges the region faces, such as land degradation, water scarcity, noise, water and air pollution, biodiversity loss as well as climate change (idem). 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). As an example, the highest quantities of plastic debris in the world (1,935 items/km2) are found in the seabed of the North-West area of the Mediterranean, nearby the coasts of France, Spain and Italy (CPRAC, 2016). To address such trends, green/blue practices have been expanding in the region tackling at once the behaviours of consumers and producers and the adaptation actions required.

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

According to United Nations Environmental Programme (UNEP), green economy aims “to improve human well-being and social equity while significantly reducing environmental risks and ecological scarcity” (eco-union, MIO-ECSDE and GEC, 2016). The Blue Economy can be considered as “Green Economy in a blue world” and is an approach promoted by the UNEP flagship report. It recognises the crucial contribution of 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 coastal population is of 150 million people and more than doubles during the tourist season (UfM, 2016). The Mediterranean accounts for 20% of “Global marine Product” in an area which makes up for 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. Moreover, 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 when it comes to oil traffic.

[46] *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 here grouped under the category “Other”.*

Furthermore, the potential of marine areas in 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 (idem).

The contribution of the green/blue economy to the regional economy is mostly due to coastal and maritime tourism. Compared to the other sectors of the Blue Economy, tourism in coastal areas has the highest Gross Value Added (GVA), of around 83% of the total blue economy GVA (EUR 169 billion), and also the highest employment, of about 79% of the total blue economy jobs (4.2 million jobs) (UfM et al., 2017). On the contrary fishery and aquaculture, unlike common perception, is the smallest sector of the Mediterranean blue economy both in GVA (less than 5%) and job creation (less than 10%) (idem).

The purpose of this chapter is to provide an overview of the main macro-economic features and indicators of key economic marine sectors of the Mediterranean region, 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 across them and of a cross-sectoral approach to deal with the assessment of certain developing strategies (UfM et al., 2017). In the following sections, each key sector of the Mediterranean region economy is assessed presenting an overview on its contributions to the economy, its impact on the environment and natural resources use, and its potential improvements towards a sustainable economy.

4.2 Agriculture, fisheries and aquaculture

The Agriculture represents a key sector within the framework of the Barcelona Convention. The socio-economic 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. Moreover, this sector reveals potentialities for a sustainable blue economy in the region reinforcing its role in achieving the objectives of the convention.

4.2.1 Agriculture

4.2.1.1 Overview of the sector

The share of agriculture[47] 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 increase in productivity per agricultural worker, is a relatively old phenomenon in northern countries and more recent in southern countries.

[47] As defined by the FAO, the term “agriculture” and its derivatives include forestry, fisheries and aquaculture.

Table 19 Agricultural GDP, employment and productivity of agricultural labor (Source: FAO, 2018, World food and agriculture - Statistical pocketbook 2018, Rome- Data World Bank)

	Agricultural GDP (in%) 2017	Employment in agriculture (%)			Productivity/worker (in constant US dollars)		
		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-Herz.	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
Spain	2,0	9	5,3	4,2	21 333	30 065	47 281
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
Palestine	3,1*				-	-	-
Slovenia	1,8	10,4	9,1	5,0	8 814	9 872	20 790
Syria	19,5**	28,4	21,2	22,8	-	-	-
Tunis	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*

With the exception of Albania, where gross agricultural production amounts to 18.9% of total GDP, in non-EU Balkan countries, this rate is of around 7.2% (Montenegro) and less than 2% in Med 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: Palestine (3.1%), Libya (1%), Lebanon (3.5%) and Israel (2.1%). Agriculture contributes at about 10% to 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.

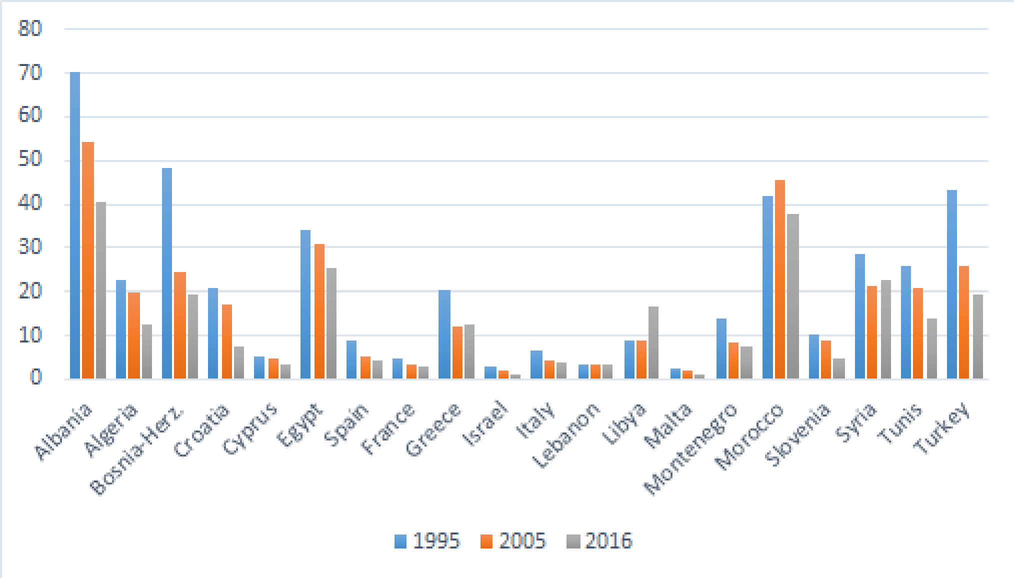

Figure 60 Employment in agriculture, in% (Source: FAO, 2018)

Between 1995 and 2016, the share of agricultural employment declined in North Africa, whether in Algeria (from 22.5% to 12.7%), in 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: the agricultural labour force has thus fallen from 43.4% in 1995 to 19.5% in 2016. A group of countries with low agricultural potential (Malta, Cyprus, Israel, Lebanon and Palestine) was also 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) indicate that Italy, which had 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.

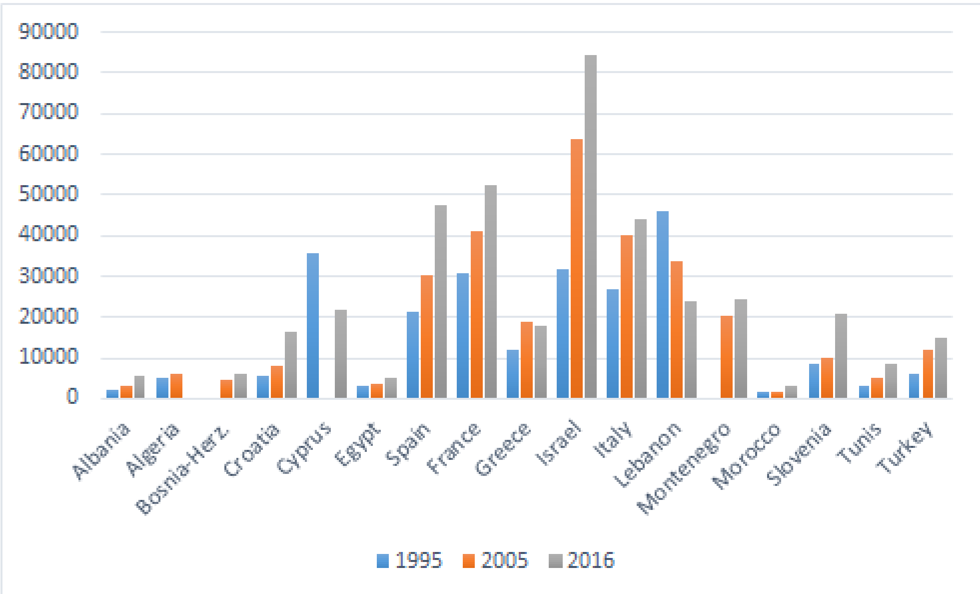

Figure 61 Productivity per worker, in constant US dollars (Source: FAO, 2018)

Especially in the northern Mediterranean countries, the economic and social transformations brought about by agricultural modernization policies, conducted in the context of a structural transition of economies (--> 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 52,472 USD / worker in France and 47,281 USD / worker in Spain, while it reaches only 3,150 USD / worker in Morocco and 5,100 USD / 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 – 84,612 USD / worker, more than 15 times that of Egypt and more than 25 times that of Morocco.

Box 20 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 raise of competing coastal activities such as coastal and maritime tourism (A.B. Blanco, 2011). Data on coastal agriculture is extremely scarce – the latest data being from the 2000's – but the trends seem to have been similar over the last two decades (idem).

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

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

4.2.1.2 Pressures on the environment

The most common pressure of agriculture to the marine and coastal environment is the runoff of agricultural substances, described in more detail below. Other agricultural pressures are resource use, mainly of water, energy and soil, as illustrated by Figure 67 (DPSIR diagram) and analysed in more detail in Chapter 6 "Water and Food Security".

Agricultural runoffs: The main impacts of agriculture on the marine environment are due to the runoff of nutrients and agrochemicals to the sea. About 80% of marine pollution comes from land-based sources, mainly, agriculture, industries, and municipal waste.[48] 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 fertilisers lead to eutrophication which in turn negatively impacts marine ecosystems. The toxins of algal blooms can also deplete local fish stocks.[49] The runoff and infiltration of pesticides to the sea affect the marine environment at a slower pace by bioaccumulation up the food chain.

The average consumption of fertilizers[50] in the Mediterranean basin has increased by 10% between 2000 and 2015 passing from 163.5 kg per hectare to 180 kg per hectare of arable land. This average is subject to significant differences, ranging from 5 kg per hectare in Syria to 646 kg per hectare in Egypt (World Bank, 2015). The average fertilizer consumption in northern Mediterranean countries is of 176 kg per

[48] 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. 5(1) *Utrecht Law Review*, p.80.

[49] https://www.um.edu.mt/library/oar/bitstream/handle/123456789/13034/Serracino-Inglott%20_%20Mifsud.pdf?sequence=1&isAllowed=y

[50] 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.

hectare, while it is at 185 kg per hectare in southern and eastern Mediterranean countries. These averages are above the global average of 138 kg per hectare of arable land (World Bank, 2015).

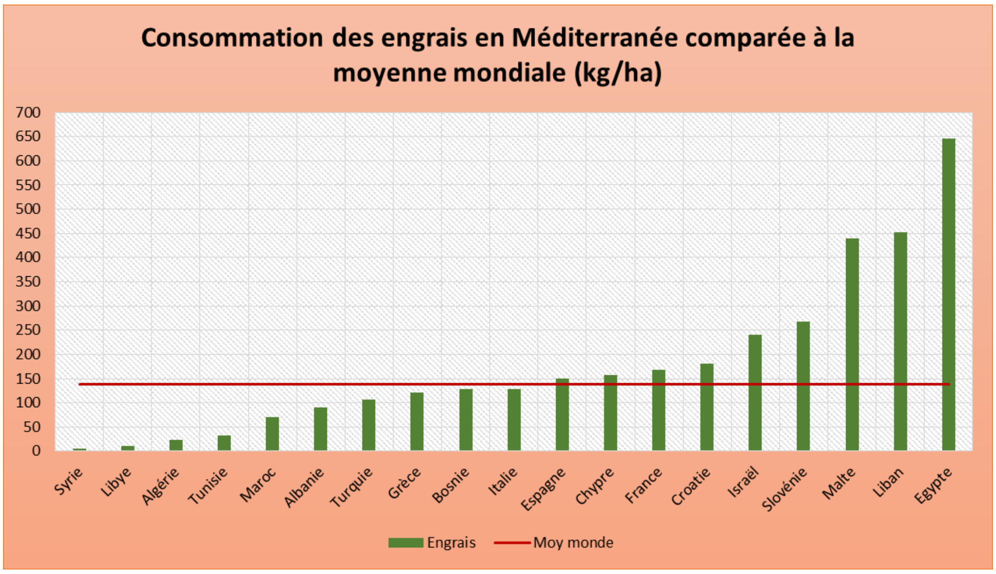

Figure 62 Fertilizer consumption in the Mediterranean, in kg per hectare of arable land (Source: World Bank, 2015)
[English version of the graph pending]

The main Mediterranean coastal areas historically affected by the inputs of nutrients are the Gulf of Lions, the Gulf of Gabès, the Adriatic, Northern Aegean and the South East Mediterranean (UNEP/MAP, 2018:18)[51]. Maps on 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.

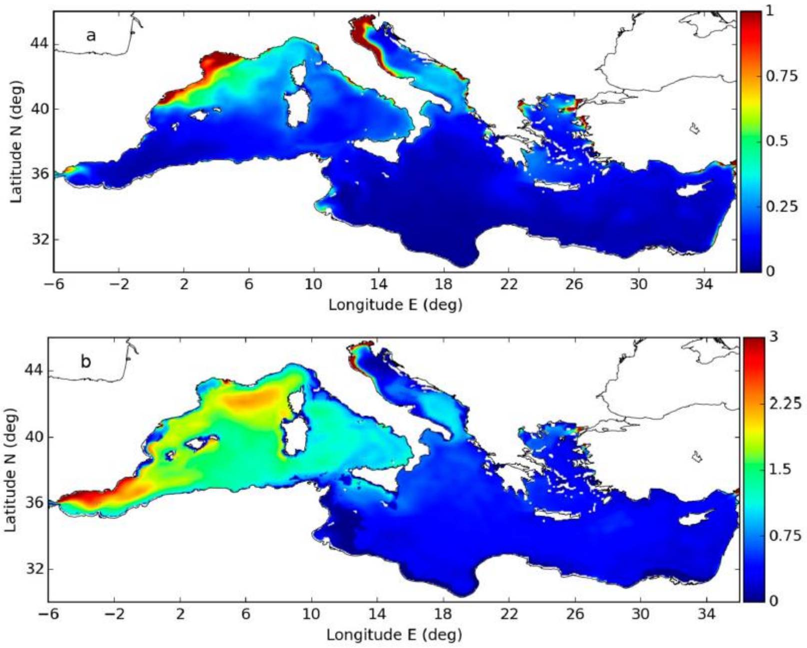

Figure 63 Surface (a) and subsurface (b, 0–150 m) maps of nitrate (mmol/m3) over the period 2002–2014. (Source: Schuckmann et al., 2018)

[51] UNEP & MAP (2018) Mediterranean 2017 Quality Status Report, UNEP/MAP, p. 18.

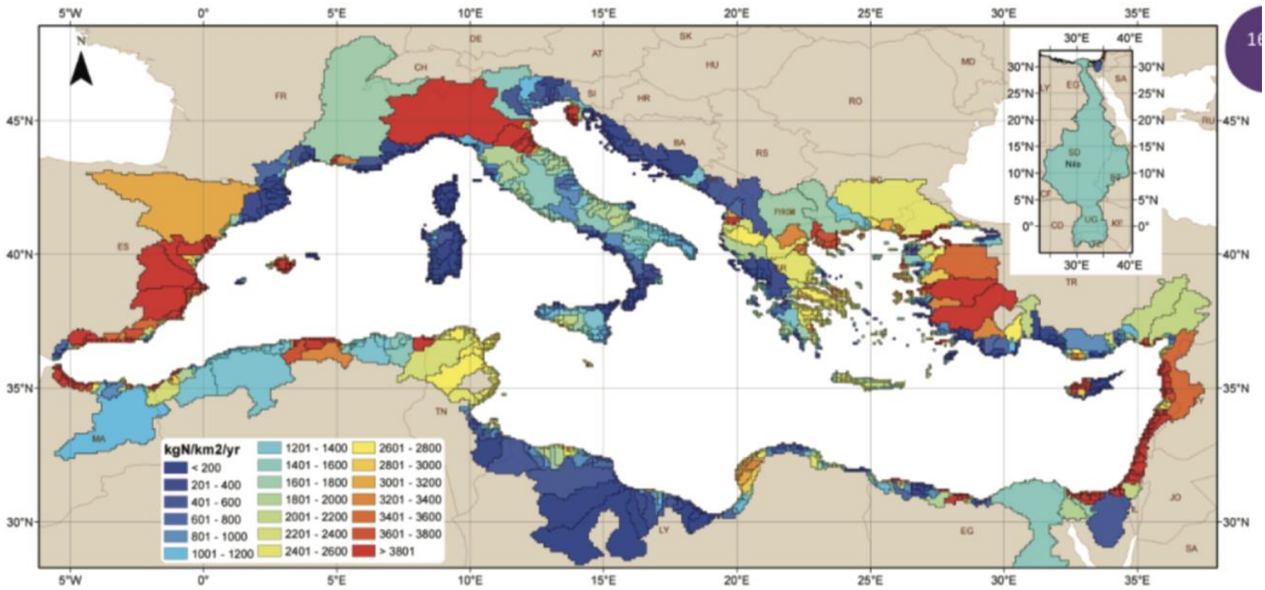

Figure 64 Nitrogen emissions by agriculture area 2000-2010, (Source: Perseus, 2015[52])

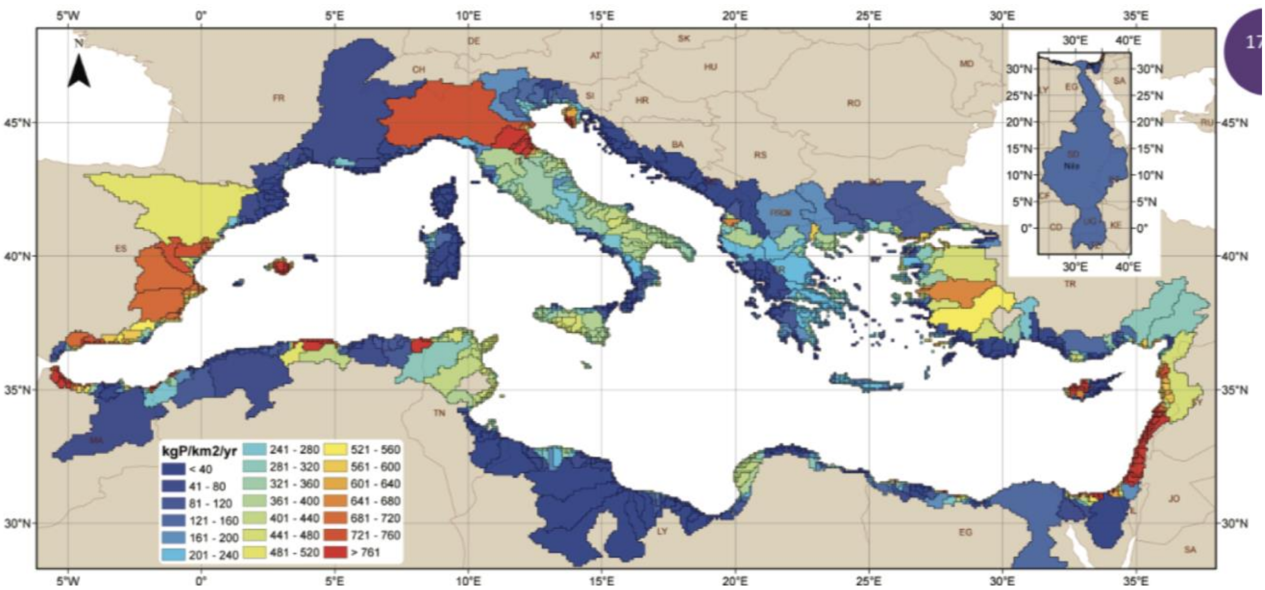

Figure 65 Phosphorus emissions by agricultural areas in 2000s, (Source: Perseus, 2015)

The consumption of pesticides[53] in the Mediterranean basin varies largely between countries. In 2016, the average use of pesticides in kg per hectare was below or around world average in most SEMCs except for Israel, Lebanon and Palestine and generally above world average in NMCs.

[52] PERSEUS – UNEP/MAP Report, (2015). *Atlas of Riverine Inputs to the Mediterranean Sea*.

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

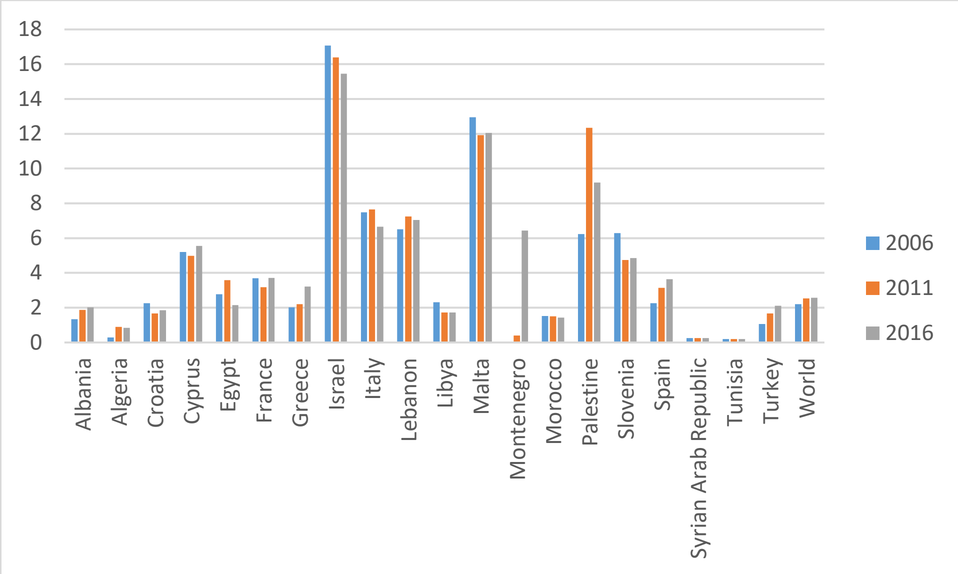

Figure 66 Pesticides use per area of cropland in Mediterranean countries, in kg/hectare, 2006, 2011 and 2016 (Source: FAOstat, 2019)

Pesticides, especially if used irrationally, can lead to animal and human health problems such as the inability to reproduce normally in certain bird species, the introduction of fetal malformations, the death of embryos, the appearance of certain cancers, and lastly, fatal poisoning **[reference to be completed]**. 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.

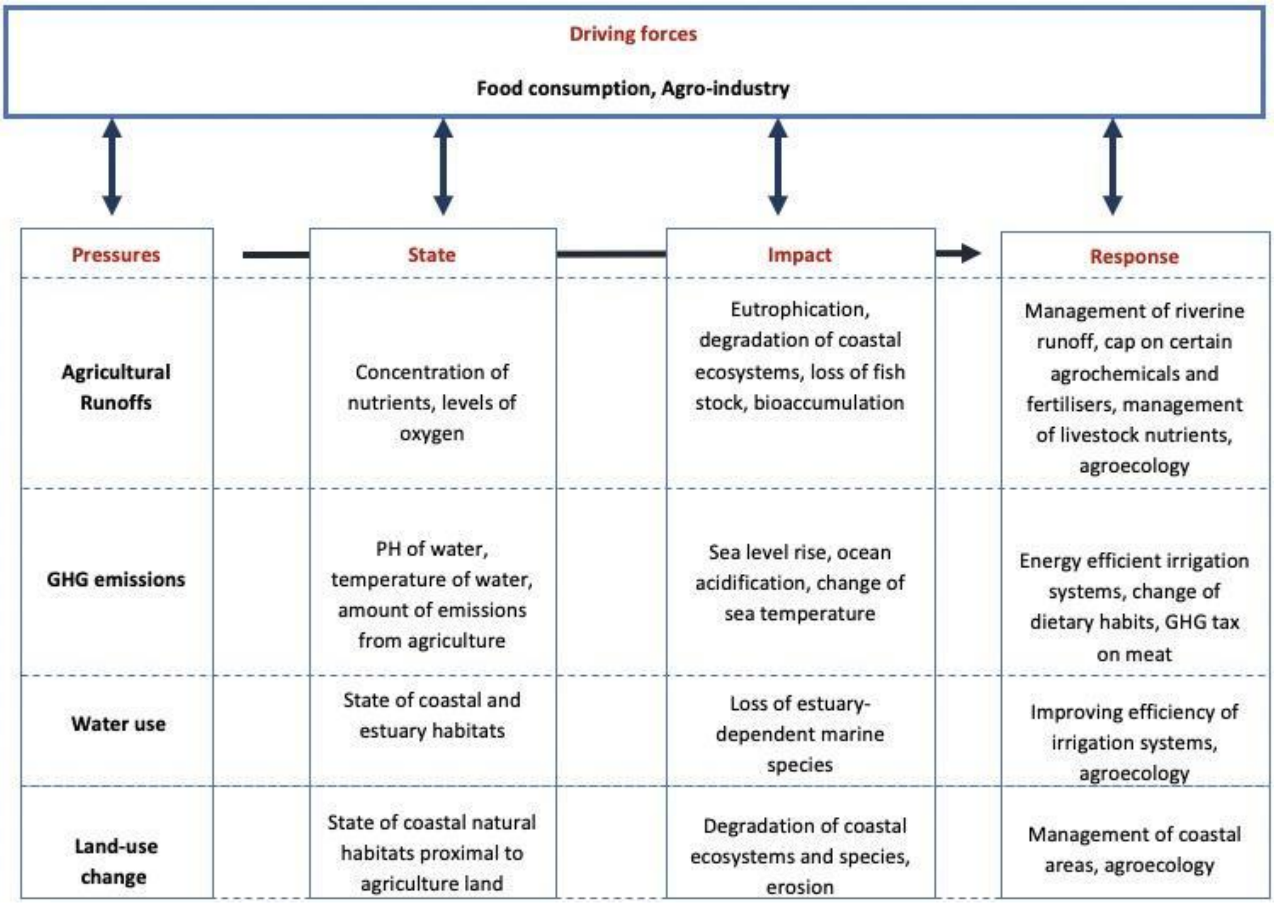

Figure 67 Assessment of pressures exerted by agriculture on the marine and coastal environment (Source: eco-union, 2019)

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, 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 (--> 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 such as the water-food-energy nexus and integrated water resources management could contribute to a more efficient use of resources (à chapters 2 and 6). Responses should also include a robust management of riverine runoffs, and lead to a gradual reduction of the use of fertilisers and pesticides, thus preventing the release of nutrients and pollutants in the watersheds and reaching the coast. Organic farming can provide a contribution to this transition. CIHEAM data shows that in non-EU CIHEAM countries (Algeria, Egypt, Lebanon, Malta, Morocco, Tunisia, Turkey, and Albania) organic agriculture land increased from over 174 000 hectares to over 744 000 hectares (CIHEAM 2017).[54]In addition, agricultural practices, such as agroecology have a significant potential to prevent negative impacts on the environment.

4.2.2 *Fisheries and aquaculture* *(pending, in partnership with GFCM)*

4.2.2.1 Overview of the sector (pending, in partnership with GFCM)

4.2.2.2 Pressures on the environment

Although Industrial fishing (e.g., bottom trawlers and dredgers, seiners, polyvalent vessels over 12 meters) account for 38% of total fishing capacity, it exerts a significantly higher toll on the environment than artisanal fishing that represents the remaining 62%. The west of the Mediterranean, including the Corso-Ligurian Basin, and the Balearic and Alboran sea are the most exploited areas followed by the Ionian Sea (Piante 2015:66). The main pressures of fisheries are overfishing, fish discard, and bottom fishing, as illustrated in Figure 71 (DPSIR diagram).

Overfishing: The FAO estimates that since 2006 over 65% of commercial fish stock are overexploited (FAO, 2018:82)[55]. The GFCM Scientific Advisory Committee concluded that over 90% of the assessed stocks are "under overexploitation, being overexploited or ecologically unbalanced" (Piante 2015:69). Overfishing can result in fish stock collapse, and thus disruption in the food chain. Effective enforcement is required to prevent fishing over established national caps. Unfortunately, the knowledge of the status of Mediterranean fish stocks is limited since assessments cover only 26% of catches and 80% of the assessed stocks are overexploited (Lleonart, 2015:280)[56]. Responses should result in the reduction of illegal fishing, and could include restriction or prohibition of non-selective techniques, and potentially a reduction of catch quotas.

Fish discard: Discard of fish catch is an extended practice in Mediterranean fisheries, which may affect around 18% of total catch. Fish discard is a practice that leads to overexploitation, as well as the disruption of food webs, reduction in spawning stock, and an increase in benthic communities. Effective enforcement is required to ensure the reduction of unintended bycatch. Bottom trawlers and non-selective fishing techniques in general, are the principal source of discard fish.[57]

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[54] CIHEAM (2017) The Mediterranean organic route. G7 Ministerial Meeting on Agriculture, Bergamo, 12 October 2017.

[55] FAO. 2018. *The State of Mediterranean and Black Sea Fisheries. General Fisheries Commission for the Mediterranean*. Rome. 172 pp.

[56] Lleonart, J. (2015) Mediterranean Fisheries. Stocks, Assessments and Exploitation Status. IEMED, Mediterranean Yearbook 2015, p.280.

[57] http://www.fao.org/3/y5594e/y5594e05.htm

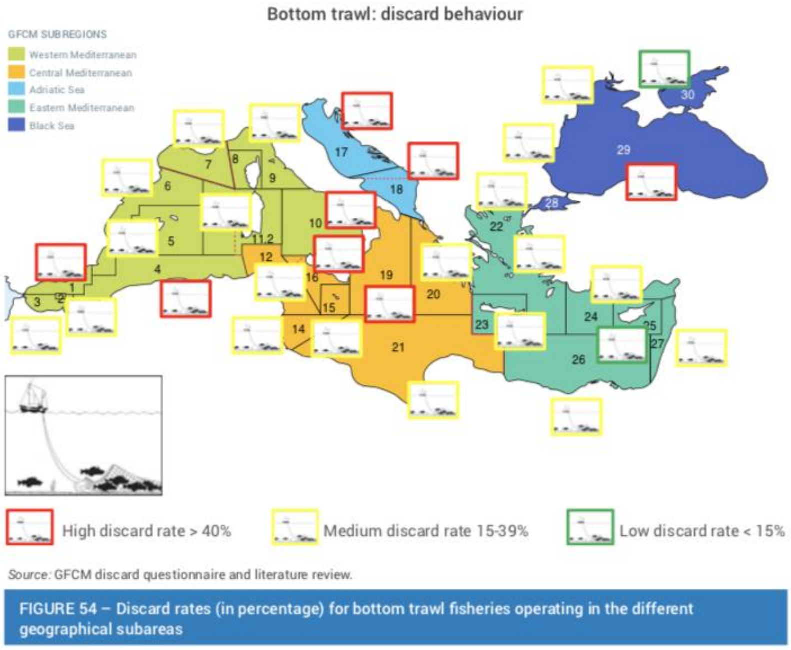

Figure 68 Bottom trawl: discard behaviour (Source: FAO, 2018)[58]

Bottom fishing: Bottom trawling is the least selective fishing practice and responsible for a high share of total catches. Standard demersal bottom trawling is an extended practice in the Mediterranean, especially along the Italian coastline of the Adriatic Sea, and the Tunisian coast (UNEP/MAP 2012:12).[59] Demersal bottom trawling leads to the destruction of benthic communities.

Responses could include a ban of non-selective techniques or restriction of trawling to designated areas.

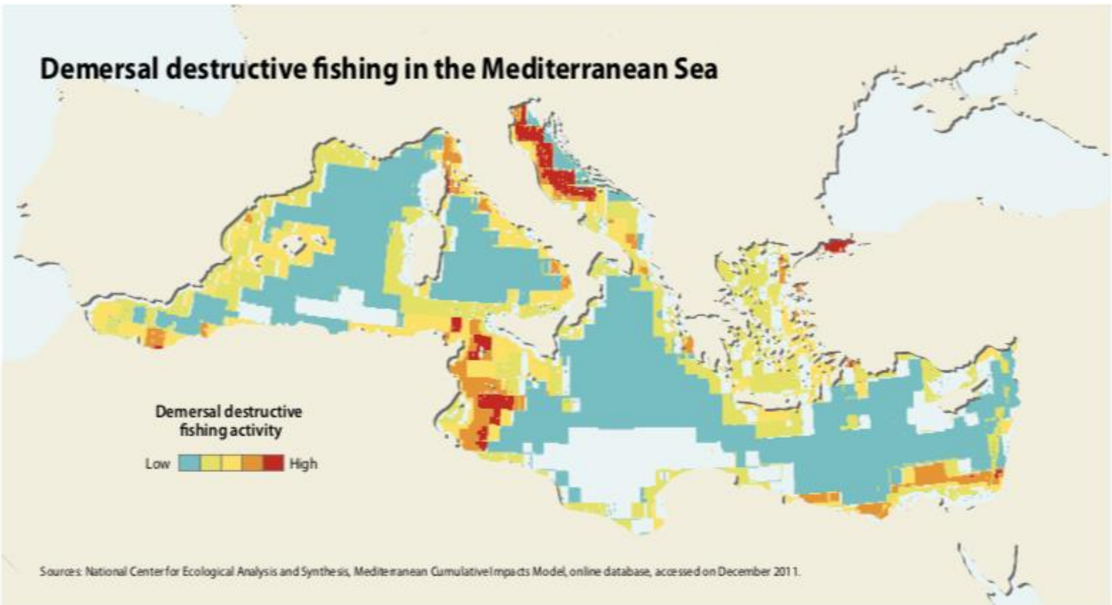

Figure 69 Demersal destructive fishing in the Mediterranean Sea (Source: UNEP/MAP, 2012)[60]

[58] FAO. 2018. The State of Mediterranean and Black Sea Fisheries. General Fisheries Commission for the Mediterranean. Rome. 172 pp, p.56.

[59] UNEP/MAP (2012) State of the Mediterranean Marine and Coastal Envir-onment, UNEP/MAP – Barcelona Convention, Athens, p. 12.

[60] UNEP/MAP (2012) State of the Mediterranean Marine and Coastal Envir-onment, UNEP/MAP – Barcelona Convention, Athens, p. 61.

The main pressures of **aquaculture** are the use of **wild fish for feed** and the **transfer of non-indigenous species (NIS), as indicated in** Figure 71 (DPSIR diagram), which summarizes these interactions of pressures with the marine environment.

Wild fish for feed: Fish used for feeding aquaculture stocks are at risk of being overexploited and, hence, aquaculture has the potential to further reduce fish stocks and cause disruptions in the food chain. Thus, limiting aquaculture of predatory species and sourcing fish from countries with management quotas and certified facilities (IUCN, 2017:5).[61]

Transfer of non-indigenous species (NIS) is mainly due to the escape of fish, mostly from biological causes (51.5%), or due to structural failures (39.4%).[62] NIS can lead to the decrease of local species due to exploitation competition, interference competition, predation, impact, mating competition, genetic interaction, and disease transfer. These negative impacts can be mitigated with facility improvements and the ban of production of non-indigenous species.

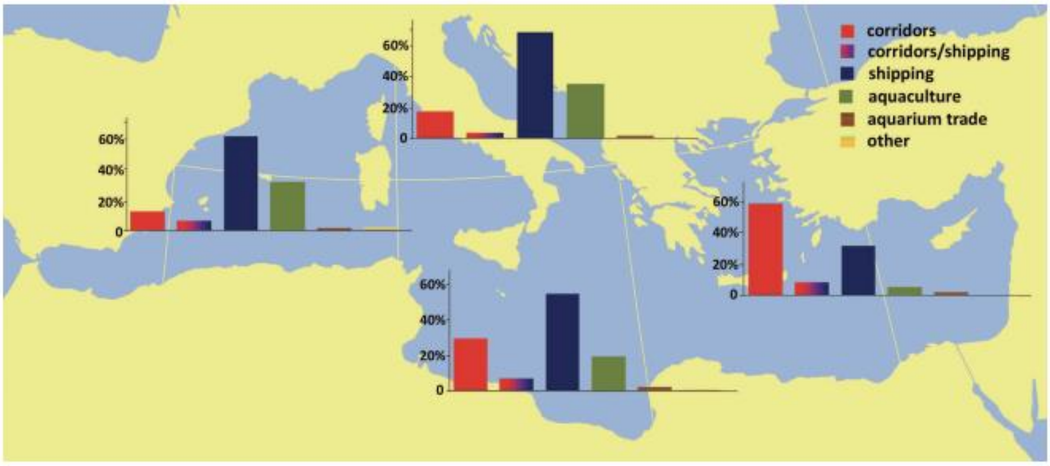

Figure 70 Percentages of marine NIS known or likely to be introduced by each of the main pathways by MSFD subregion. Percentages add to more than 100% as some species are linked to more than one pathway (Source: Zenetos, A. et al., 2012)[63]

Box 21 Contribution of the major taxa in the NIS marine biota of the Mediterranean Sea (Source: UNEP-MAP, 2018)[64]

	Eastern Med	Central Med	Adriatic	Western Med
Number of established NIS	468	183	135	215
Richest taxons in NIS biota	Mollusca, Crustacea	Microphyta, Polychaeta	Microphyta, Mollusca	Microphyta, Crustacea
Trend of rate of new introductions	increasing	decreasing	decreasing	decreasing

[61] Le Gouvello, Raphaëla et François Simard (eds.) (2017). Durabilité des aliments pour le poisson en aquaculture: Réflexions et recommandations sur les aspects technologiques, économiques, sociaux et environnementaux. Gland, Suisse : UICN, et Paris, France : Comité français de l'UICN. 296 pp

[62] Pablo Sanchez-Jerez (2013) Fish Escapes from Cage Aquaculture in the Mediterranean. WORLD AQUACULTURE, p. 30.

[63] Zenetos, A. et al., (2012) *Alien species in the Mediterranean Sea by 2012. A contribution to the application of European Union's Marine Strategy Framework Directive (MSFD). Part 2. Introduction trends and pathways*, Medit. Mar. Sci., 13/2, 2012, 328-352, p. 342.

[64] UNEP & MAP (2018) *Mediterranean 2017 Quality Status Report*, UNEP/MAP, p. 277.

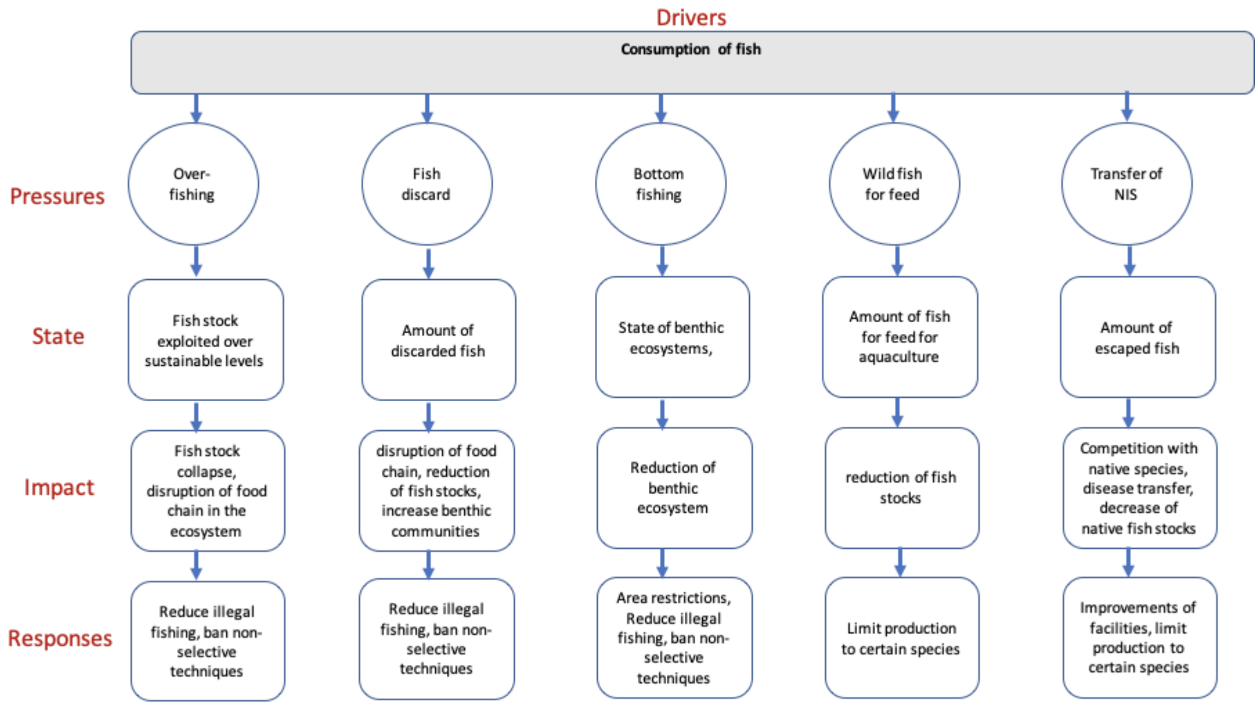

Figure 71 Assessment of pressures exerted by fisheries on the marine environment

4.3 Energy

The pollution caused by energy generation, distribution, and consumption constitutes a significant challenge to the completion of the Barcelona Convention’s objectives. This is because the energy mix of the Mediterranean 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 pollution threats in the Mediterranean environment.

4.3.1 Overview of the sector

Energy consumption

Mediterranean countries account for 7% of the world’s primary energy demand in 2015, which represents 955.29 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 72 Mediterranean primary energy demand by sub-region, 2015 (Source: OME, 2018)

According to the 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 about 40% by 2040 (reference scenario). On the other hand, if countries meet all their commitments in their NDCs (proactive scenario), energy demand will increase by 17% (OME, 2018) (see Figure 73).

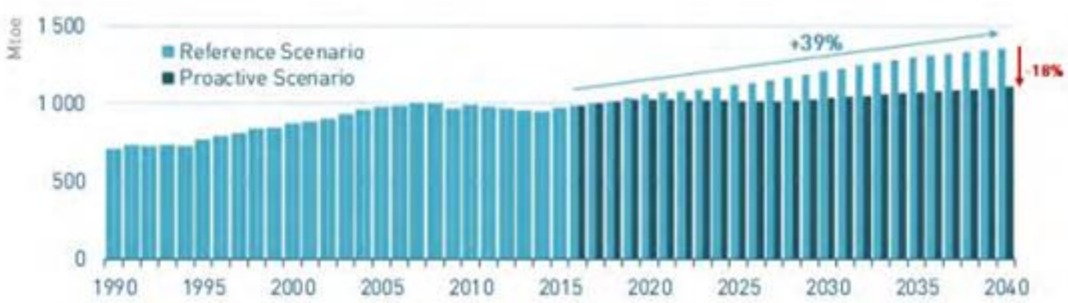

Figure 73 Mediterranean primary energy demand by scenario, 1990-2040 (Source: OME, 2018)

However, the increase in energy demand is expected to be driven by South and East Mediterranean countries, which would double demand in a reference scenario. On the other hand, the North will 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 of the 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, p. 45).

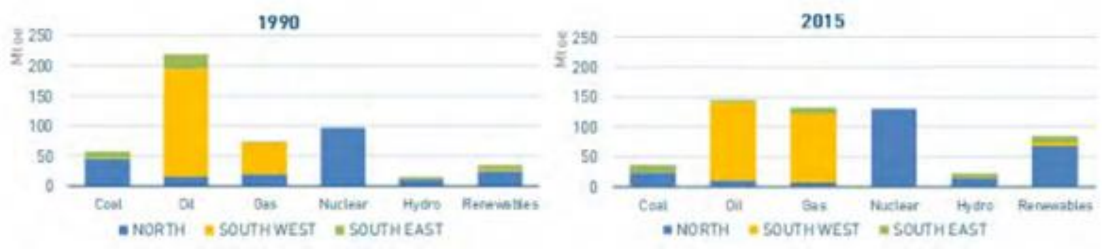

Figure 74 Mediterranean primary energy production 1990 and 2015 (Source: OME, 2018)

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 production** was estimated at 87 million toe in 2011, of which 9 million toe were from crude oil and 68 million toe from natural gas. Mediterranean oil reserves represent 4.6% of global oil reserves, which are almost entirely located off the coast of Algeria, Libya, and Egypt (Piante, 2015:36). However, there are many production areas off the coast of Greece and Turkey and recent discoveries of major gas reserves in the Levantine basin.

From 1990 to 2015, the northern countries decreased their share in total electricity generation in the Mediterranean from 84% to 65%. The South West and South East, have both about doubled their share to 17% and 19% respectively. In both the Reference scenario and the Proactive scenario, by 2040 the North region will produce about 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 South Mediterranean mainly relies on natural gas, except for Turkey, Morocco and Israel significantly relying on coal for their electricity production (Idem).

Box 22 Fossil fuels continue to be subsidized in Mediterranean countries (Source: OECD and 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. Out of 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 studied countries show a net increase of fossil fuel subsidies over the same period.

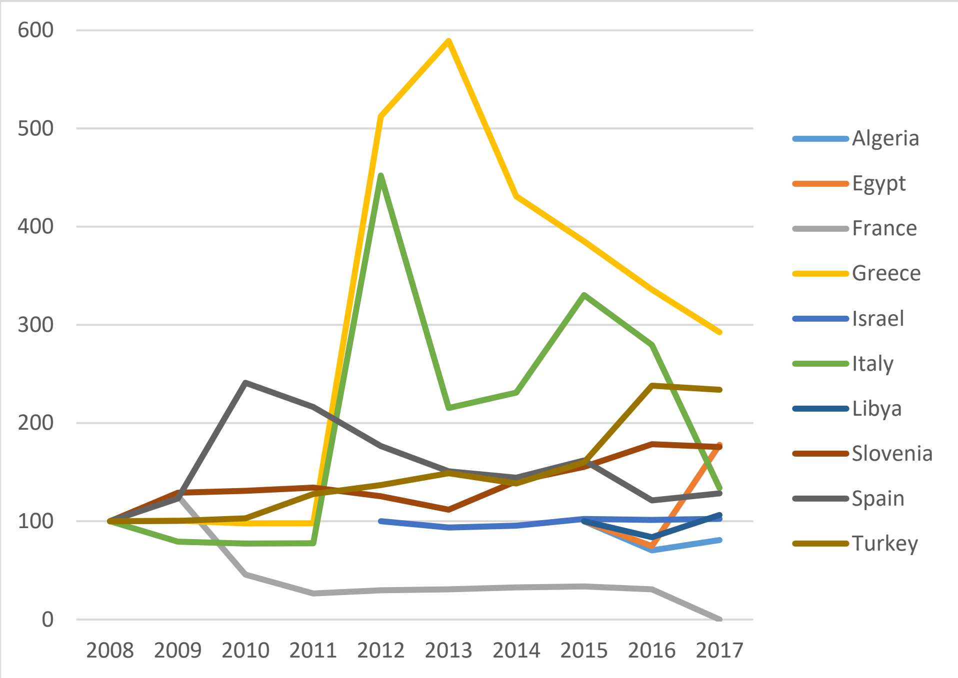

Figure 75 Indexed evolution of government fossil fuel support in Mediterranean countries, 2008=100 (Source: based on OECD and IEA, 2019) Notes: (i) Data available from 2015-2017 only with 2015=100 for Algeria, Egypt, Libya; (ii) Government support for fossil fuels in Israel = 0 from 2008 to 2011.

In Israel, between 2008 and 2012, fossil fuel subsidies were non-existant. They soared in 2012 concomitantly with the discovery of the Tamar Natural Gaz field in the Levantine Basin and have been around 480 million Shekels, equivalent to around 120 million Euros per year since then. Fossil fuel support granted since 2012 is exclusively related to natural gas, including grants for conversion of factories to natural gas and the gas agreement between Israel Electricity Company 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 expenditures. The most significant measure in terms of budget spent was a subsidy for petroleum-based small and off-grid power generators on remote islands of Greece. Another measure in place is a tax refund provided for fuels used in boats for tourism in Greece.

In Italy, the support to 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. However, since 2012 a nominal increase in diesel tax credits for lorries 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 on 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 meters extracted.

In Turkey, the 2012 New Investment Incentive Regime provides, for example, higher levels of support to coal and oil investments than to renewable-energy projects. The Strategic Plan 2015 – 2019 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 increase the utilization 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 les tan 1% of national GDP in all other studied countries.

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 with 14% to the energy supply by 2040. In the Proactive case, renewable supply would rise by 3.4% per year accounting for 24% of the provided energy. These trends in non-hydro renewables are sustained in both North and South and East Mediterranean countries (see Figure 76) (Idem).

Figure 76 Mediterranean power generation by type in 1990-2040 (Source: 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 **GHG 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 transportation of fossil fuels. See Figure 78 (DPSIR diagram) for an illustrative summary of the interaction of pressures with the marine and coastal environment.

GHG emissions: The main GHG emission from the energy sector is CO_2. Mediterranean countries are responsible for about 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% from North Mediterranean countries, and 55% from South Mediterranean countries (OME, 2018). In the assessed scenarios towards 2040, the share of CO_2 emissions from the North are expected to decrease between 9% and 13% and to increase in the South, also between 9% and 13% (Idem).

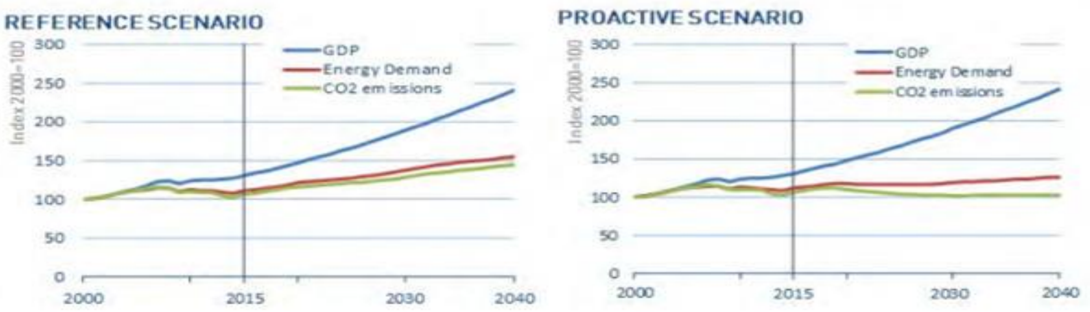

Figure 77 CO_2 emissions in the Mediterranean region for each scenario (Source: OME, 2018)

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 via climate change and related impacts.

Mediterranean countries can respond by increasing the ambition of their NDCs, to be in 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 GHG emissions are the adoption of an ambitious tax on GHG emissions and the phasing out of fossil fuel subsidies.

Underwater noise: The most relevant impacts of underwater noise are the behavioural changes, such as feeding and mating, that lead to population decrease; as well as physical damage, such as rupture of tissues and organs that can lead to death.[65] The main responses should focus on designating restricted areas and developing more silent technology.

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. However, 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 2015:22). Notably, 44% of the Med area are 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.[66] The spillage of other chemical substances exacerbates the impacts of pollution, such as bioaccumulation and biomagnification of marine organisms. The main regional instrument addressing offshore spillage is the Offshore Protocol of the Barcelona Convention (entry into force 2013). The main responses should focus on improving the technology, designating restricted areas, and ensuring effective onboard pollution control facilities.

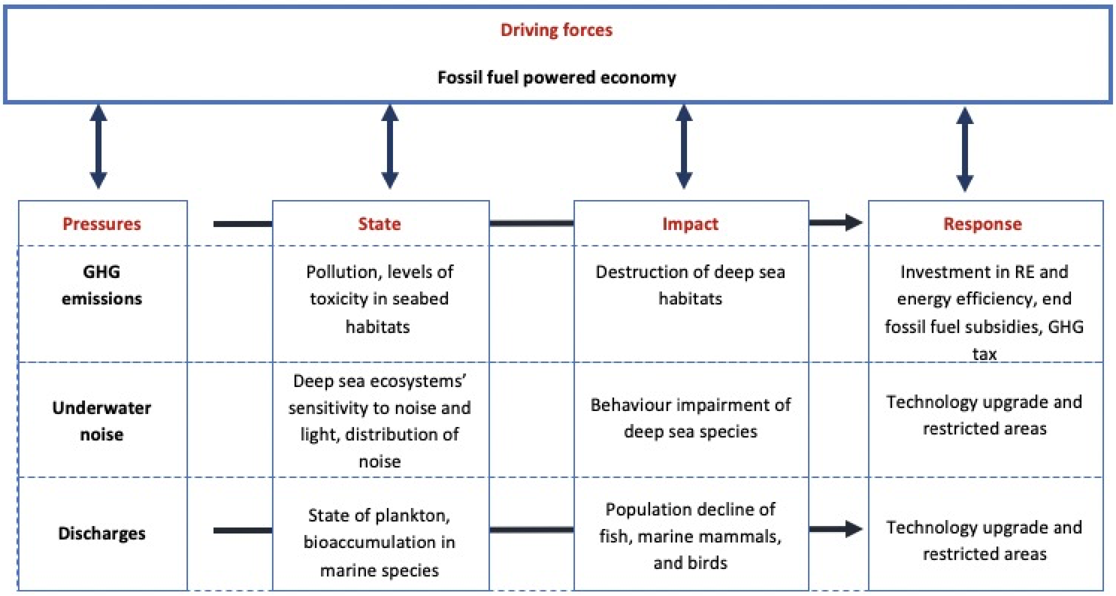

Figure 78 Assessment of pressures exerted by the energy sector on the marine environment (Source: eco-union, 2019)

4.3.3 Dependency on natural resources availability and 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 is equivalent to a 44% energy import dependence ratio. North Mediterranean countries import 90% of their fossil fuels, while South Mediterranean countries only import about 20%.

[65] Hawkins A.D. and Popper A.N. (2016). Developing Sound Exposure Criteria for Fishes. The Effects of Noise on Aquatic Life II. New York. Springer: 431-439.

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

Figure 79 Fossil fuel net trade volumes and import dependence (Source: OME, 2018)

Under the Reference Scenario—where countries only achieve their unconditional NDCs—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 can be reduced by more than half, reducing the fossil fuel import dependence rate to about 23% (OME, 2018).

4.3.4 Are we moving towards a green/blue economy?

Until the early 2000's, 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 in the North shore countries (84 Mtoe), while the remaining 23Mtoe mostly in Turkey (15Mtoe) (idem).

Therefore, the energy transition towards a green and blue economy is mostly lagging in South Mediterranean countries. However, it is in the South where there is the highest potential of renewable energy, especially in solar power.

In 2040, the Reference scenario would result in a renewable energy share of 34% of total energy production and the Proactive scenario in a 52%, the North 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 80 Renewable electricity production shares by scenario, 2015 and 2040 (Source: OME)

In any case, both scenarios fail to decarbonise the Mediterranean energy consumption and fail 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 decentralisation and the digitalisation of the energy systems are crucial to boost the potential of renewable energy systems. Besides, countries should rely on a diversity of renewable energy sources that best adapt to their national environment.

Ultimately, reaching a sustainable economy greatly depends on the amount of investment in the energy transition. In order to reach the Proactive scenario, which still falls short 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 (Idem).

4.4 Tourism

Tourism has been gradually recognized as a key economic sector within the Barcelona Convention system with the 1980 Protocol for the Protection against Pollution from Land-Based Sources and Activities identifying tourism as an economic activity to regard when setting priorities for action plans, and the 2015 SCP action plan setting a goal-oriented framework promoting sustainable tourism in marine and coastal protected areas in Southern Mediterranean countries, namely Tunisia, Morocco, Egypt, Lebanon, Palestine, Jordan, Israel and Algeria.

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 (11% of total regional jobs) and economic wealth (11% of regional GDP (WTTC, 2015)). However, 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, jobs precarity, are the raising issues that threaten the long-term sustainability of the tourism sector - and in general of the coastal communities' wellbeing- 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.

Thanks to 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 more than 337 million international tourists' arrivals (ITAs) representing about 27% of total world tourists for 2016 (UNWTO, 2017). ITAs have grown from 58 million in 1970 to more than 350 million in 2017, with a forecast of 500 million by 2030 (UNWTO, 2001 & 2017). Approximately half of these arrivals -170 million - are in Mediterranean coastal areas, aggravating concentration of human-made pressures in coastal zones, particularly during the summer season.

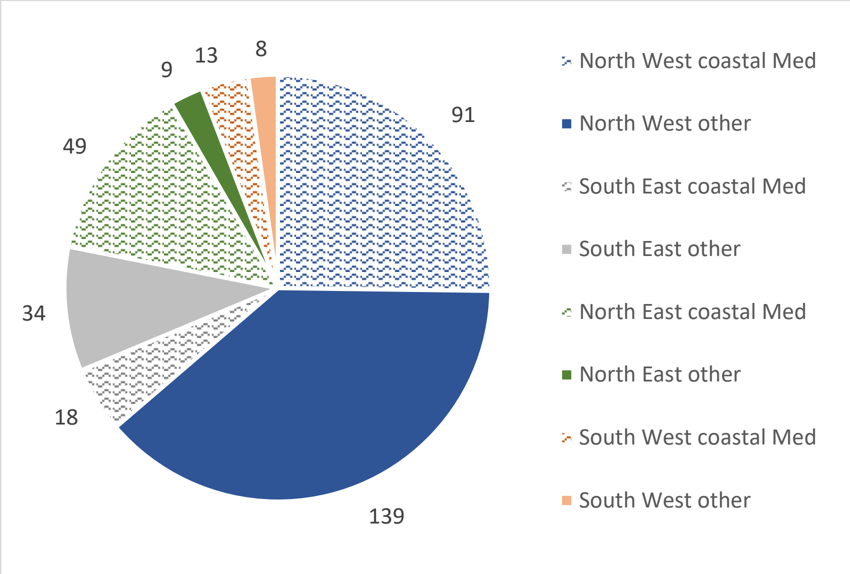

Figure 81 Share of coastal Mediterranean international tourist arrivals (ITAs) in total national ITAs in Mediterranean sub-regions, in millions of ITAs, 2017 (Source: Eco-Union estimates based on Eurostat, WTO and national sources, 2019)

The top five destinations in the 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) – represent 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).

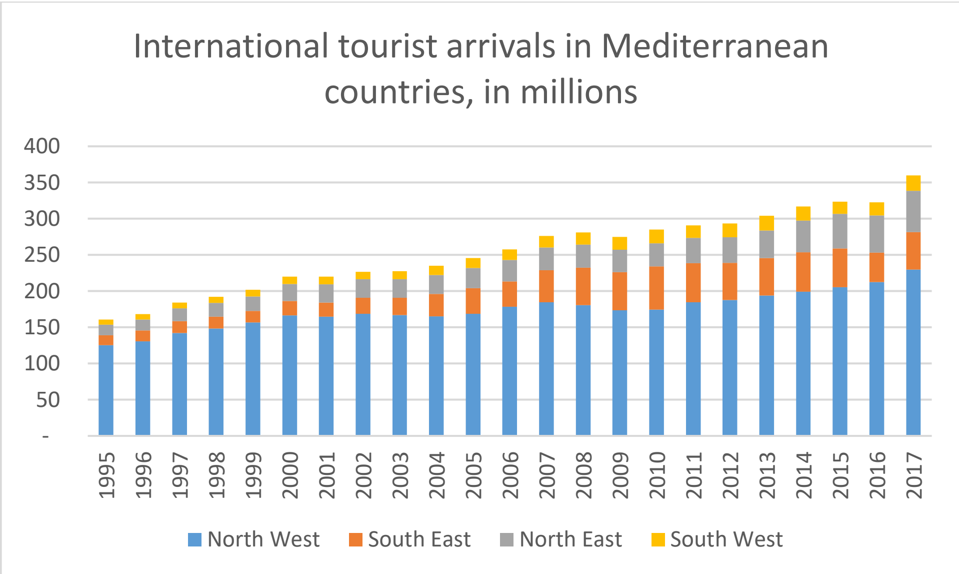

Figure 82 Mediterranean International tourist arrivals trend, in millions, 1995-2017 (Source: based on UNWTO Data, 2019)

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 83, the tourism sector contributes to 11.3% of total GDP, 11.5% of employment, 11.5% of exports and 6.4% of capital investments in the region.

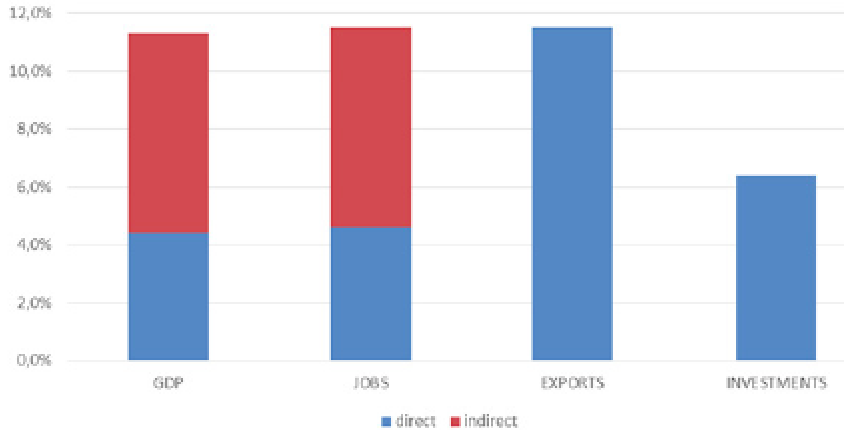

Figure 83 Economic impact of Mediterranean tourism (Source: Plan Bleu, 2016, based on WTTC Data, 2015)

However, 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 Spring, 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 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 back only just recently in 2018[67]. This change in trends might have benefited North shore countries that see their arrivals rise in this period. For instance, in France while the growth rate of international tourist arrivals was of -1.2% between 2009 and 2010, this rate jumped to 38.5% the next year. Similarly, in Italy, this rate was of 3.9% between 2009 and 2010 and of 24.9% between 2010 and 2011.

4.4.2 Pressures on the environment[68]

Tourism is a major consumer of natural resources: water – an extremely scarce resource in many coastal areas; food – sometimes causing pressure on local production, leading to overfishing; electricity and cooling/heating facilities – making tourism a massive consumer of energy. Moreover, coastal tourism generates serious environmental impacts by causing marine and fresh water 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 ecosystem services value of 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). Moreover, the tourism supply and demand tend to concentrate 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 (sea side 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

[67] According to announcements of the UNWTO, but pending official reports.

[68] *For available data concerning distribution, impacts, and responses on MED marine litter see: UNEP-MAP & MIO-ECSDE (2015) Marine Litter Assessment in the Mediterranean. UNEP_MAP & MIO-ECSDE.*

the local communities is highly questionable: large international operators, providing both the demand (groups of international tourists) and the offer (resorts, cruises, etc.), are able to extract most of the economic value generated (so called economic leakage). Despite a raising awareness about 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 84.

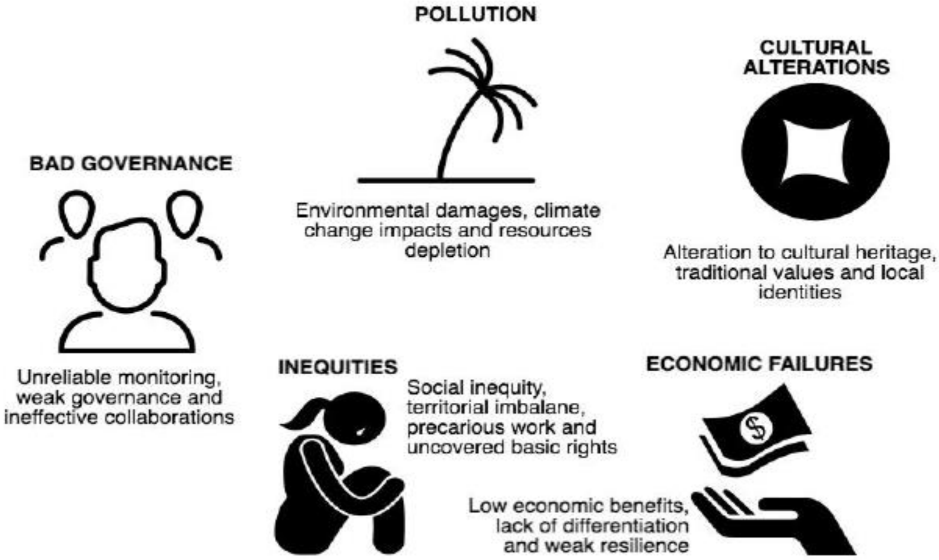

Figure 84 Main issues of Mediterranean tourism (Source: Plan Bleu, 2016)

The main pressures of the tourism sector on the marine environment are **marine litter**, **coastal land-take**, **air emissions**, **water consumption and sewage generation**, and **proximity to natural sensitive areas**. Figure 86 illustrates the interaction of pressures with the marine and coastal environment.

Marine litter: The marked seasonality of marine litter at beaches indicate that tourism is a significant source of marine litter[69] (--> 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 (UNEP-MAP & MIO-ECSDE, 2015). Regional governments can introduce dissuasive taxes, such as the Balearic tourist ecotax. The Balearic tourist ecotax applies to all tourist accommodation facilities and invests the revenue protecting, preserving and restoring the Balearic environment.[70]

Box 23 Marine litter in coastal destinations

The results of the 2016 Blue Island Project, an assessment of marine litter in Mallorca, Sicily, Malta, Rab, Crete, Rhodes and Mykonos, as well as Cyprus showed a pronounced seasonality of marine litter. The study showed that July is the month with most litter on the beaches, with an average of 450,000 litter items per km2 per day at touristic beaches, and 200,000 litter items per km2 per day at remote beaches. The majority of litter found on the beaches is formed by plastics (36.8%) and cigarette butts (30.6%). Microplastics represent 9.3% of total waste, the meso-plastics (from 0.5 to 2.5 cm) are 19.8% of the total, and macroplastics, 7.7%. Beaches with the greatest amount of marine litter: the first position is occupied by the Marsaslock beach in Malta, followed by the beaches of Torà in Mallorca, Golden Bay in Malta, Es Caragol in Mallorca, Gneja in Malta and Sunrise Beach in Cyprus.[71]

Coastal development: The development of tourism-related infrastructure along the Mediterranean coast significantly contributes to its artificialisation (--> Chapter 5) and is a major source of habitat fragmentation or loss. Authorities should respond in implementing integrated coastal management plans that take due consideration of tourism as a major pressure.

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[69] UNEP & MAP (2017) *Mediterranean Quality Status Report*, UNEP/MAP, p. 98

[70] https://www.caib.es/sites/impostturisme/es/impost/

[71] https://www.uab.cat/web/newsroom/news-detail/marine-litter-on-mediterranean-beaches-triples-in-summer-1345668003610.html?noticiaid=1345767714685

Box 24 Tourism severely threatening 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[72].

Air emissions: The tourism sector is highly dependent on carbon-intensive industries, such as transport and lodging. Therefore, air emissions from the tourism sector, including sulphur oxides, nitrogen oxides, and GHG emissions contribute to ocean acidification, while GHG 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 has increased from 3.9 to 4.5 $GtCO_2$, four times more than previously estimated, accounting for about 8% of global greenhouse gas emissions.[73] Hence, as the Mediterranean is the leading destination in the world it 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 tons of total emissions in August (Figure 85).[74]

Authorities can respond by promoting clean transport, sustainable tourism, improve efficiency standards in the sector, as well as implement a carbon cap and a robust carbon tax.

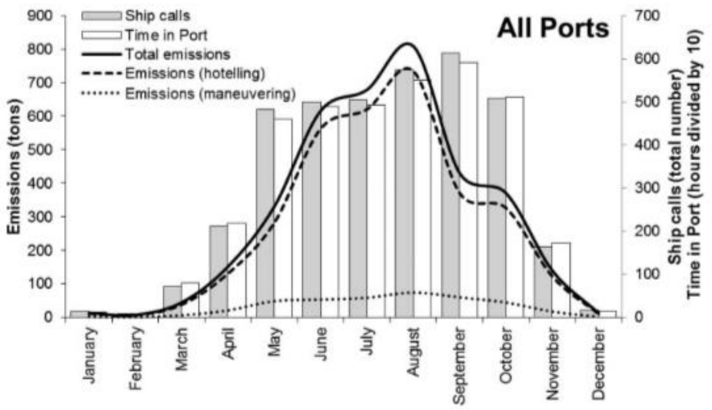

Figure 6. Seasonal variation of cruise ships' emissions (solid and dashed lines), ship calls, and time in port (bars) for all studied ports. Both ship calls (number of ships) and time in port (hours divided by 10) are read in secondary axis *y*.

Figure 85 Seasonal variation of cruise ships emissions in Greek ports (Source: Papaefthimiou, 2016)

Water consumption: Tourism as well as agriculture and industry pose a significant stress to the freshwater resources of the Mediterranean basin.[75] 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.[76] In consequence, the tourism sector's intensive demand of water contributes to the building of dams and reservoirs that reduces the amount of riverine flows to the sea. While, the impacts of reduced riverine flow 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 of estuaries and lower river system, resulting in negative consequences on estuarine dependent species and those marine species dependent on reduced salinity conditions for part of their life history.[77]

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[72] https://www.monachus-guardian.org/library/wwftou01.pdf

[73] Lenzen M., et al. (2018) The carbon footprint of global tourism. 8 Nature 522-528, p. 522.

[74] S. Papaefthimiou, A. Maragkogianni & K. Andriosopoulos (2016) Evaluation of cruise ships emissions in the Mediterranean basin: The case of Greek ports, International Journal of Sustainable Transportation, 10:10, 985-994.

[75] UNEP & MAP (2017) *Mediterranean Quality Status Report*, UNEP/MAP, p.352.

[76] medpotourismreportfinal_ofnc (1).pdf p.10.

[77] http://www.fao.org/3/V4890E/V4890E05.htm

Authorities can respond by promoting sustainable tourism, restricting water-intensive practices, and implement plans to conserve water.

Proximity to natural sensitive areas: Coastal manmade infrastructures cause irreversible damage to landscapes, habitats and biodiversity, and shoreline configuration by disrupting the sediment transport[78], 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.[79] Authorities can respond by implementing coastal management plans setting minimum standards, requiring certification systems concerning water use, and develop guidelines.

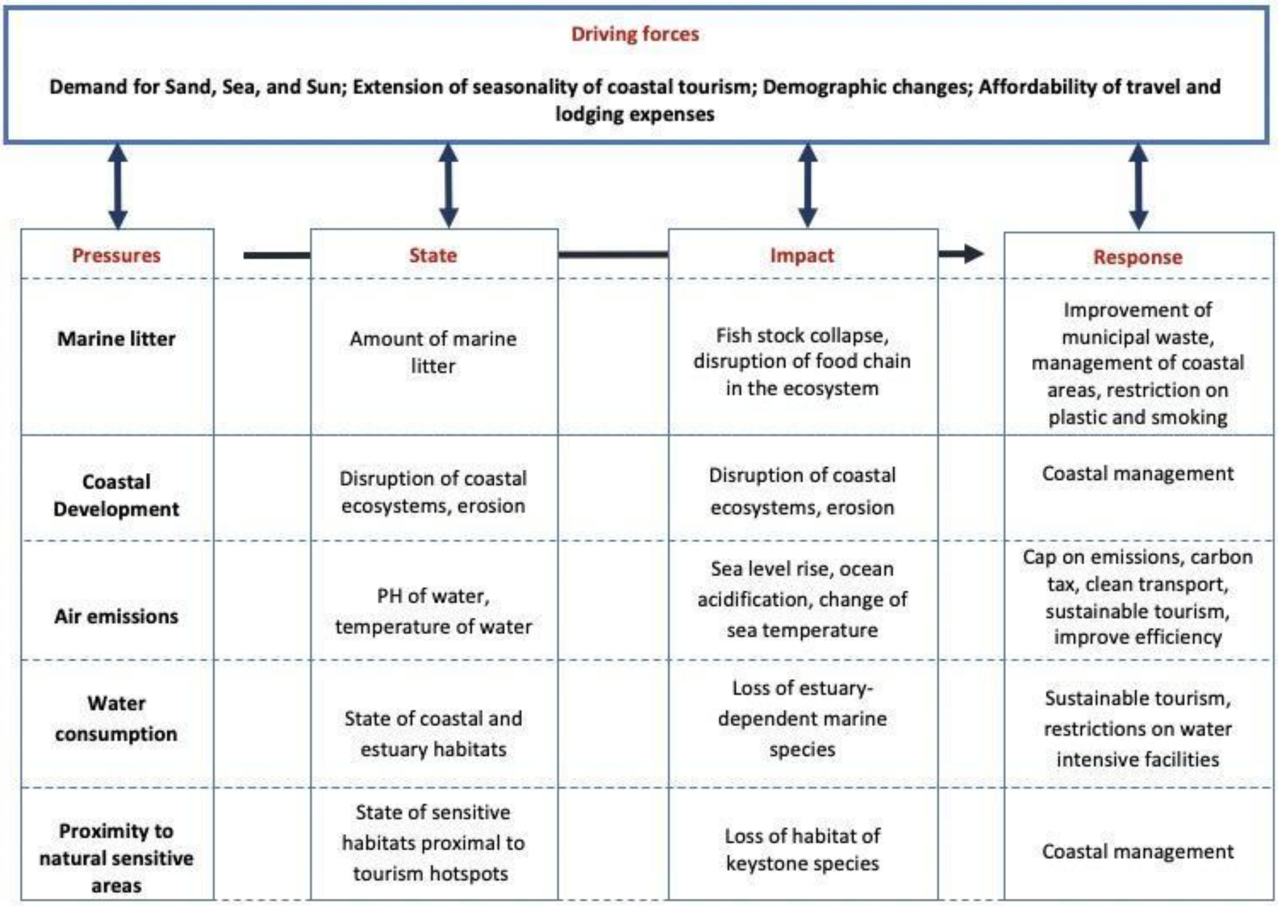


Figure 86 Assessment of pressures exerted by tourism on the marine environment (Source: eco-union, 2019)

4.4.3 Are we moving towards a green/blue economy?

The call for a 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 with a cost, in particular for the local communities that feel they are losing control of their neighborhoods and suffering irreversible cultural or environmental damage. Recently, voters of touristic cities and regions (such as Barcelona, Paris, Roma, etc.) have elected politicians who propose to regulate tourism activities more stringently and enhance transparency and governance processes to increase local benefits and reduce negative environmental and social externalities.

Taking benefit of international commitments

Mediterranean countries have recently approved global sustainability objectives such as the Sustainable

[78] UNEP & MAP (2017) Mediterranean Quality Status Report, UNEP/MAP

[79] (UNEP 2012 p. 84).

Development Goals (SDGs), the Paris Climate Agreement (UNFCCC COP21), the Convention on Biological Biodiversity (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 for the Mediterranean (SCP AP), and the Protocol on Integrated Coastal Zone Management in the Mediterranean (ICZM Protocol). Those institutional commitments are strongly contributing to tackle 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 should be embedded in a possible Mediterranean Strategy for Sustainable Tourism (MSST) to be approved by regional and national stakeholders such as countries, private sector, civil society and NGOs, and scientists.

Defining a shared vision and building a common strategy

Until now, each Mediterranean country has developed separately its own tourism strategy (national strategic framework) and set of policies to regulate and encourage the development of tourism activities. However, most of the challenges defined earlier – environmental degradation, social inequalities, lack of economic competitiveness, cultural alteration, poor governance – are going beyond national borders and therefore require a regional strategy shared by all neighbourhood countries. To do so, a common vision has to be shaped by all national and regional stakeholders to "promote a sustainable Mediterranean tourism in which visitors and hosts enjoy balanced, respectful and fruitful relationships valuing the unique Mediterranean environmental, human and cultural heritage, while ensuring inclusive socio-economic development within the carrying capacity of healthy natural ecosystems, and promoting complementarity between business sectors in tourist destinations" (Plan Bleu 2018).

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), UNWTO and UNESCO (thematic expertise), OECD (policy knowledge), European Union (financing mechanisms), and Union for the Mediterranean (political back-up). A comprehensive, transparent and reliable monitoring system with relevant indicators has also to be built to support the implementation and follow-up of the Strategy that should be fully integrated within the Mediterranean Strategy for Sustainable Development (MSSD 2016-2025). As the budget to implement the Strategy can 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, implying the need to comply to 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)[80]. Total transport energy use has increased considerably in the last decade within SEMCs comparing to NMCs. However, NMCs are consuming 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 a quasi-absolute dependence on combustible fuels for transport energy. In NMCs, a mix of combustible fossil fuels, electricity and gas sources is used for transport.

[80] http://medener-indicateurs.net/uk/download/094

Modal Share in Land Transport

Private vehicles are still the predominant way of transport at national level with a modal share exceeding 75% in NMCs. Western NMCs have the most diversified collective transport systems. Buses and coaches still are predominant as collective transport in most countries.

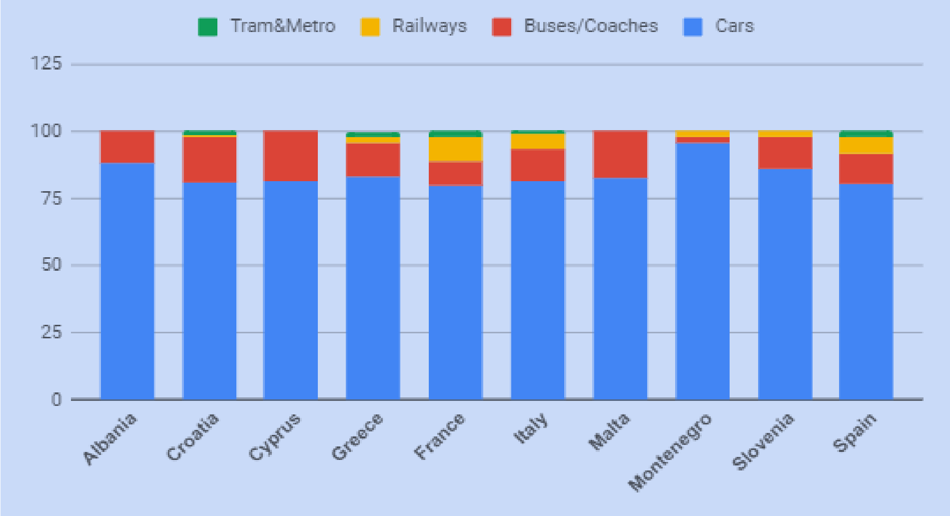


Figure 87 Land Transport Modal Share by NMCs in 2016 (Source: Directorate- General for Mobility and Transport, European Commission / Eurostat)

In Northern Mediterranean cities, public transport and soft modes (walking, biking) are the predominant transport modes over motorized alternatives (EEA, 2013)[81]. While data availability on transport modes in SMCs is challenging, modal split data is provided for motorised 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 to reduce 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 transportation and private cars is unknown.

[81] https://www.eea.europa.eu/publications/term-2013

Box 25 Barcelona Mobility Strategy

Barcelona modal share accounts for 74% public transport and soft mobility. In the last five years motorised transport travels have decreased, and bike mobility has increased.

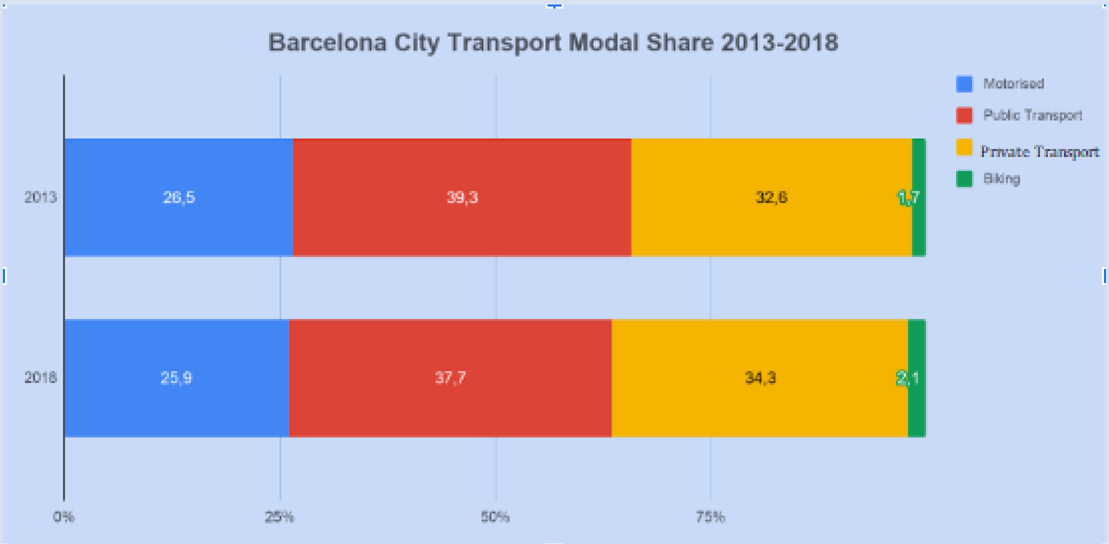


Figure 88 Barcelona City Transport Modal Share 2013-2018 (Source: PMU Barcelona 2011-2018)

The new Urban Mobility Plan 2019-2030 aspires to reduce significantly motorised private vehicles, increase the public space and low emission zones, reducing private car space and increasing the number of pedestrian streets and bike lanes. In 2019, the metropolitan area will introduce an integrated public transport card, facilitating accessibility and flexible pricing. This delimits a certain number of basic traffic roads and would place inside of each network a wider zone of pedestrian priority where only bikes, pedestrians, residents' vehicles and urban services and emergency are allowed. This implies to set Design for Sustainable Urban Mobility priority areas and access controls in a way to limit private vehicles passing. The delimitation of the pedestrian priority zone corresponds to the routes of the public transport networks.

Train passenger & 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 has evolved in eastern NMCs and SEMCs. This transport mode is however key for the decarbonisation of transport and for reducing disparities among regions and within the countries. In terms of railway freight, goods transportation has decreased in the north West-Med after the economic crisis and pre-crisis levels have not been recovered. In SMCs, train freight volumes went down in 2015.

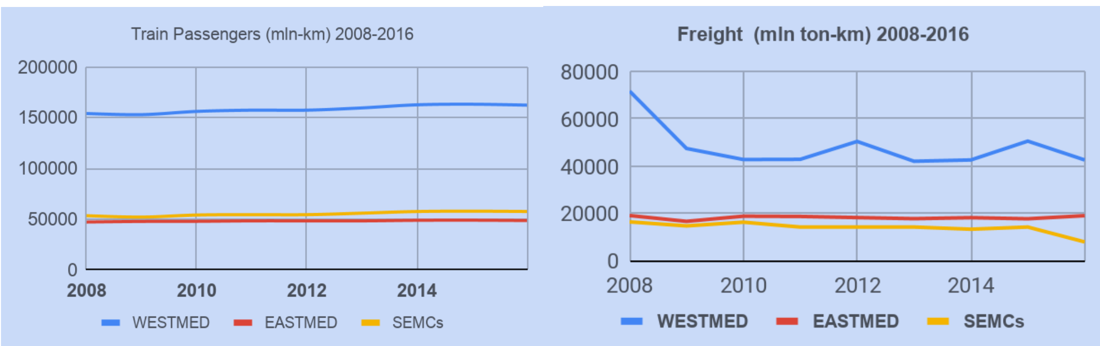


Figure 89 Train passengers in min-km 2008-2016 and freight in min ton-km 2008-2016 (Source: World Bank Open Data)

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.

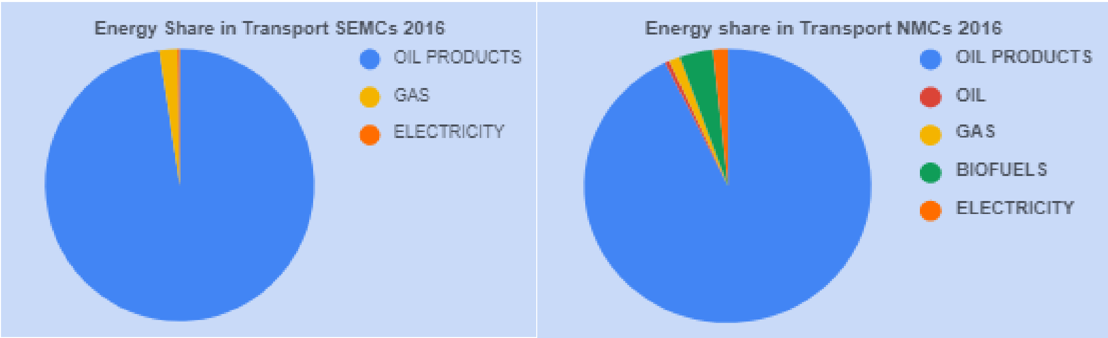


Figure 90 Energy use and transport in 2016 (Source: IEA)

Box. 26 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. Yet, the share of electric transportation in NMCs is bigger and growing faster than in SEMCs (IEA, 2016). In NMCs, public transportations such as undergrounds and trams are increasingly turning towards electrical sources of energy in order to reduce carbon and greenhouse gas emissions in urban areas (idem). However, this shift towards electricity needs to be done with awareness because shifting towards electrical sources of energy in the transport sector allows only partial decoupling. It may reduce emissions of transportation means but it generates indirect emissions due to the low share of national electricity generation based on renewable energy (ADEME et al, 2013). Even though electricity generation depends increasingly on renewable resources (hydro, wind and solar), the share of these resources in electricity generation remains lower than one third - Spain being the most reliant on renewables with a share of almost 30% (ADEME et al, 2013). In 2018, **EnerNETMob**[82], an InterregMED-funded project, has been launched in parallel of the “Sustainable Electromobility Plans” with the purpose of enabling a Mediterranean-wide network that connects cities of the coastal and maritime areas with land transportations. Through the implementation of several pilot networks of Electric Vehicles Supply Equipment (EVSE) co-powered by renewable energy, EnerNETMob aims to test interurban and interregional mobility plans and land-sea inter-modality using electric transport systems. It also seeks to coordinate future investments in electric transport in the Euro-Mediterranean region.

Box. 27 Social inclusiveness of public transportation in Mediterranean Coastal areas

Access to transport is often subject to implicit obstacles that impede certain groups to get full inclusion, specifically women and young people and particularly in rural areas. In many areas, especially in South Mediterranean countries, the lack of affordable, safe and reliable transportation causes impediments in female labour market inclusion, 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 markets and, therefore, the isolation of some social groups (European Commission, 2008). Yet, adequate infrastructure and, in particular, access to transport and the ability to travel, are identified as essential to access employment and to develop social relations in remote rural areas. More particularly, in rural regions, the dispersion of a high number of small villages make the traditional public transport services’ provision difficult and very expensive (idem). In order to facilitate commuting to cities for rural inhabitants, Italy and France have created a typology of territories to make sure villages are not marginalized and can access public transportation. Moreover, 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 relation between transport, employment and housing and are accentuated in rural areas partly because of the marginality of many regions and the costs associated with spatial exclusion, such as access to education and training facilities (idem).

[82] Retrieved from:
https://urban-transports.interreg-med.eu/news-events/news/detail/actualites/interregional-electromobility-network-for-the-mediterranean-coastal-areas-by-enernetmob-project/

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[83] (cf. Chapter 7 Health and Environment).

4.5.1.3 Are we moving towards a green economy?

In order to achieve a green terrestrial 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.

Integrated urban planning with measures to reduce traffic and avoid busy roads in the surroundings of schools and playgrounds, integrating low emission zones, increasing green areas, bike lines and pedestrianization in city centers and most congested areas, as well as public investment in (electrical) public transportation that is accessible to all and promotion of active mobility (cycling and walking) can be significant levers of action at the level of urban areas. 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 terrestrial transport system (IEA).

4.5.2 Aerial transport

4.5.2.1 Overview of the sector

Mediterranean Air Passenger Traffic: Disparities on connectivity

Commercial aviation in the Mediterranean region has experienced an almost 50% increase in air passengers between 2005 and 2015, crossing the 300 million passengers' threshold. Airport infrastructure is much bigger in NMCs, generating close to 90% of air passenger traffic. For instance, the air passenger traffic within NMCs and SEMCs countries, notably Morocco, will keep growing during next years (Eurocontrol, 2017).

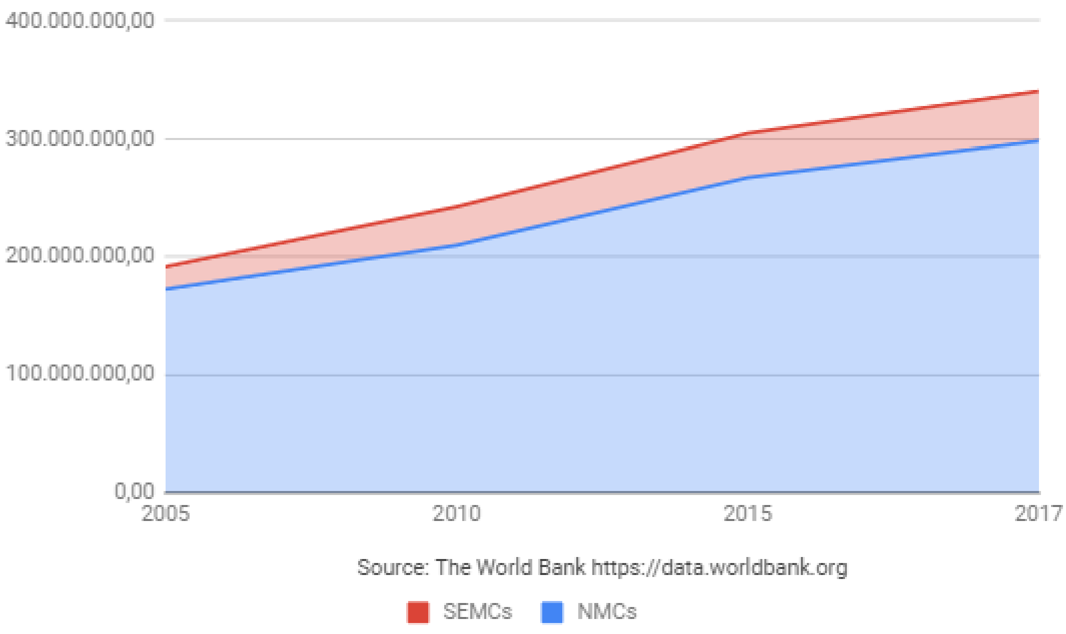


Figure 91 Air Traffic Passengers in Mediterranean Countries 2005-2017

[83] https://www.researchgate.net/publication/318833183_Health_impacts_related_to_urban_and_transport_planning_A_burden_of_disease_assessment

Figure 92 shows the striking difference between NMCs and SEMCs in terms of air passenger traffic and connectivity by key coastal airports of the Mediterranean Region. NMCs rely on an extensive network of international airports, comparing to SEMCs. Measuring the connectivity index (2012), the NMCs are further connected than SEMCs. The western Mediterranean region is the most connected, followed by the Adriatic-Ionian region. Algeria and Tunisia have the best-connected airports among SEMCs.

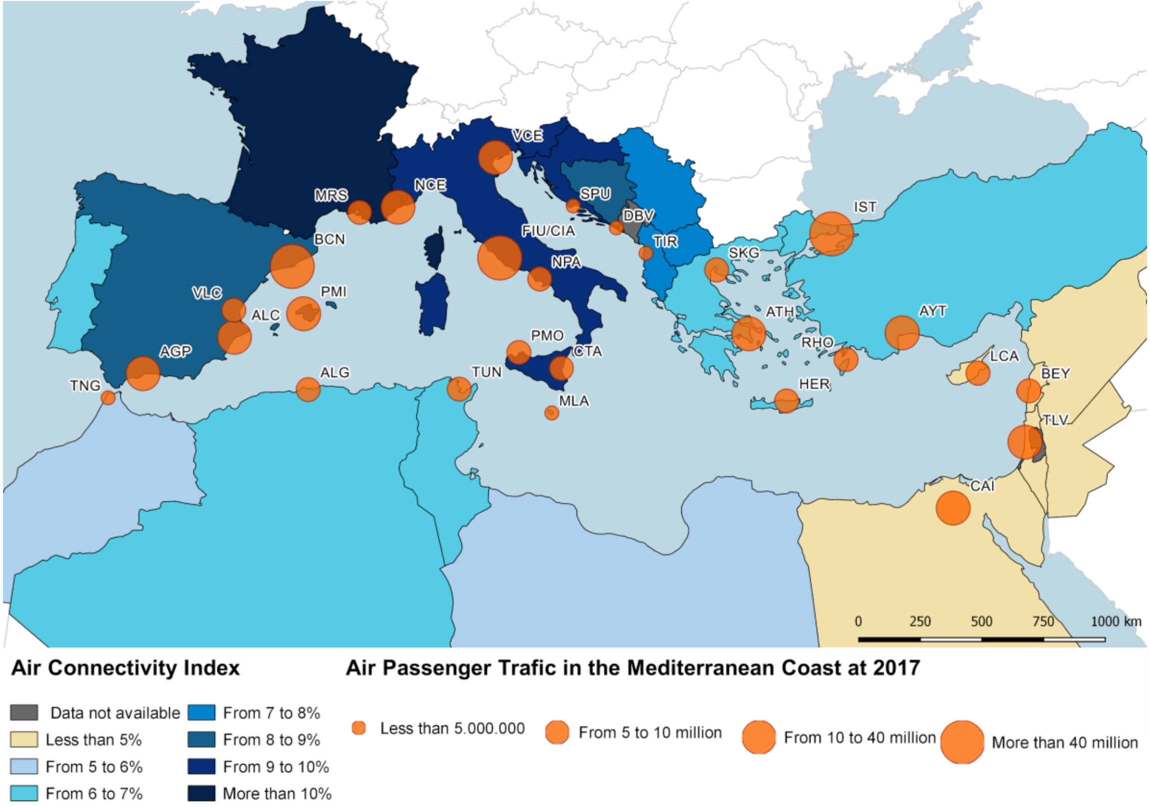


Figure 92 Air Passenger Traffic in the Mediterranean Coast, 2017 and Air Connectivity National Index, 2012 (Eco-Union based on Airport websites and Air Connectivity Index 2012 and based on IEMED, 2012).

4.5.2.2 Environmental impacts

Aviation is responsible for an estimated 4.9% of anthropogenic global warming (EC ENVI Committee, 2013). In this context, if international aviation GHG are not regulated properly, they are expected to increase by 17% (idem). While aviation is not the major source of air pollution, Mediterranean cities that have a port and / or airport nearby register higher levels of GHG emissions (U. Dayan et al, 2017).

Box 28 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 important focuses of emissions of pollutants such as NO2, SO2 or volatile hydrocarbons, emissions that are produce, in general, in metropolitan areas, although sometimes in non-urban areas (A.M. Ceballos et al, 2018).

Figure 93 PM10 and NO_2 emissions in Spain (*Source: Transport & Environment, based on EEA 2015 data)*[84]

When looking to the Mediterranean coastline of Spain, the concentration of NO2 and PM10 (airborne particles) generation corresponds to the cities where there are the biggest and busiest airports of the Mediterranean coast in Spain (Barcelona, Alicante, etc.).

4.5.2.3 Are we moving towards a green economy?

Electro fuels and biofuels are proposed among the technological solutions to decarbonize aviation, but sizeable electrification will probably not be possible in coming decades, being too heavy and costly at this stage. To fuel 50% of European aviation in 2050 with electro fuels it would need 8 million ha of land and 33 million ha of farmland, along with a renewable energy generation equivalent to 25% of total electricity supply of the EU. Its use for aviation must be considered under a conservative assessment of sustainable levels of electrification.

Box 29 Euro-Mediterranean Common Aviation Area

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 the connectivity between Europe and south and eastern Mediterranean countries. The NGO Transport and Environment (T&E)[85] with other actors such as the International Coalition for Sustainable Aviation (ICSA), are working to achieve ambitious targets to reduce 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). However, 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 the 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 the aviation sector emissions 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.

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 moved by maritime transportation). Global seaborne trade volume 1 and demand for shipping services have been

[84] https://www.transportenvironment.org/news/air-pollution-rise-spain

[85] https://www.transportenvironment.org/what-we-do/aviation

in constant - although moderate - growth after the 2008-2009 economic crisis. In 2015, for the first time, the world seaborne trade volumes exceeded 10 billion tons (UNCTAD, 2016). In 2017 the world fleet continued to grow (+3.15% in terms of deadweight tonnage (dwt) or + 2.47% in terms of 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 passages, namely the Strait of Gibraltar, opening into the Pacific Ocean and the Americas, the Suez Canal, a main shipping gateway which connects via the Red Sea - to Southeast Asia, and the Bosporus Strait, leading to the Black Sea and Eastern Europe/Central Asia.

Figure 94 Main Maritime Shipping Routes (Source: Jean-Paul Rodrigue, 2017)

With its strategic location, the Mediterranean hosts an important transit lane and transhipment activities[86] for 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).

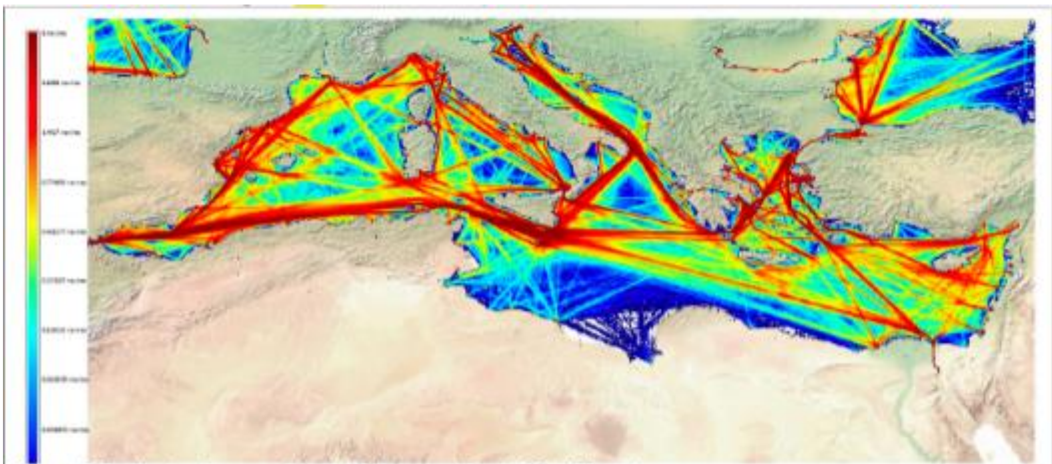


Figure 12 Traffic density map with all AIS data used for the ECAMED study

Figure 95 Traffic density in the Mediterranean Sea Area (Source: INERIS, 2019)

In terms of connections with the rest of the world, Europe (European port calls) is by far the Mediterranean main shipping connection, receiving about 40-50% of total extra (ports outside the

[86] Transhipment is the transfer of goods (containers) from one carrier to another or from one mode to another.

Mediterranean) Mediterranean traffic (Arvis, Vesin, Carruthers, Ducruet, & Peter, 2019) as shown in the Figure below.

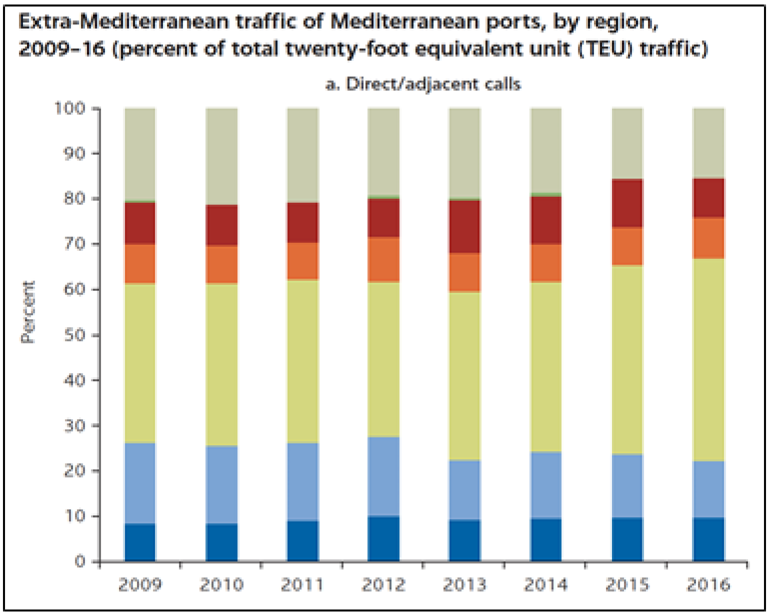
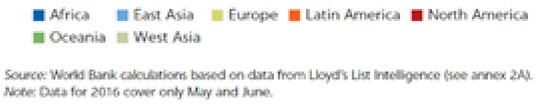


Figure 96 Traffic density in the Mediterranean Sea Area (Source: Arvis et al., 2019)



As for intra-Mediterranean traffic, its proportion in total Mediterranean traffic rose from 49 percent in 2009 to about 58 percent in 2016. This increase was attributable to either transshipment growth or coastal or short-sea growth (Arvis et al., 2019).

Box 30 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, 303.8**	**13.33%**
Oil tankers capacity	**92,771.3**	**17.34%**
Bulk carriers	**103 ,764,5**	**13%**
General cargo ships	**7, 688.3**	**10.27%**
Container ships	**25, 923.4**	**10.55%**

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 (b/d) of crude oil and petroleum in 2015, equivalent of about 9% of the world's seaborne oil trade, and (ii) the Turkish Bosporus and Dardanelles straits with 2.4 million b/d of crude oil and petroleum products in 2015 (U.S. Energy Information Administration (EIA), 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 raise in cruise ship movements over the last two decades: the number of single cruise passengers in 2017 was 4,1% higher than the number of passengers that cruised the previous year and more than double compared to 2006, when 12 million passengers cruised (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 (idem)), 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 collect and dispose of related waste.

Ports accommodating more than 120,000 cruise passengers a year are considered major ports. 36 ports in the Mediterranean fall under this category, 25 of which being 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 passenger traffic in 2017 include 15 Western Mediterranean ports, 11 Eastern Mediterranean ports and 6 ports located in the Adriatic (MedCruise Association, 2018).

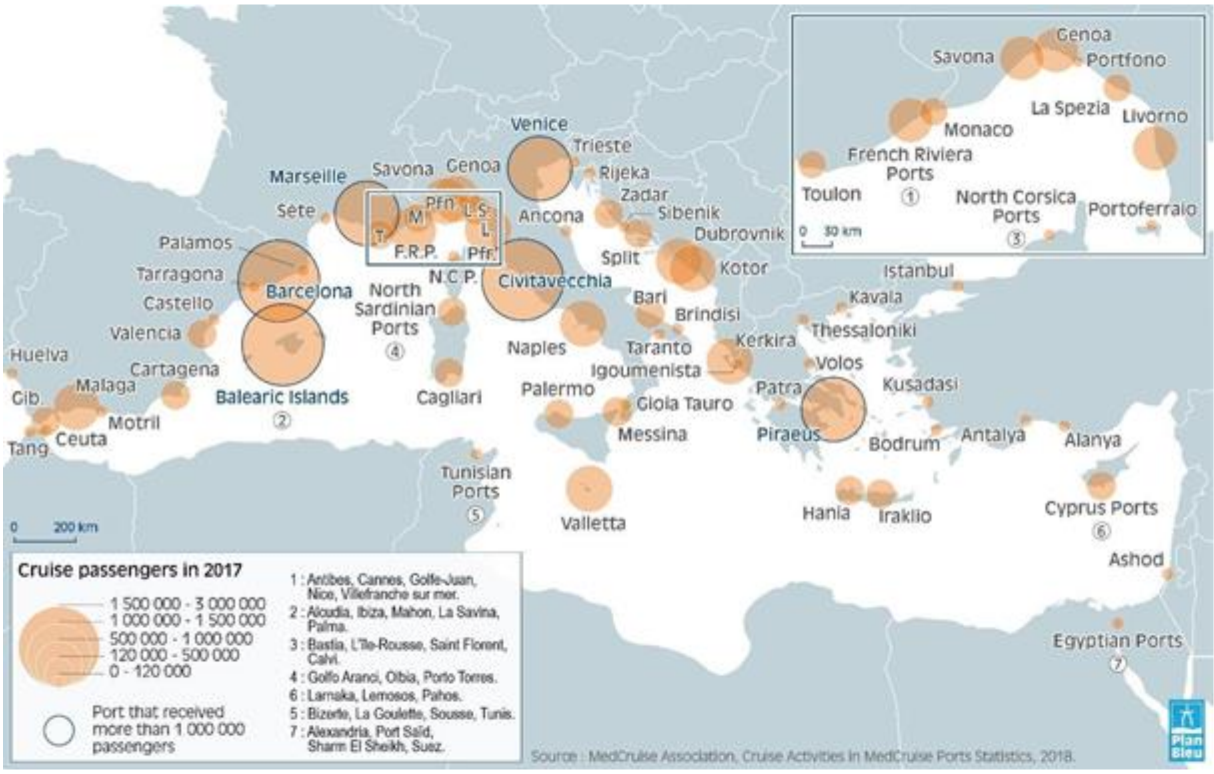


Figure 97 Cruise passengers per cruise call in the Mediterranean, 2017 (Source: MedCruise, 2018)

For 3 years in a row, Mediterranean cruise ports hosted, on average, more than 2,000 cruise passengers per cruise call (Figure 98). 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).

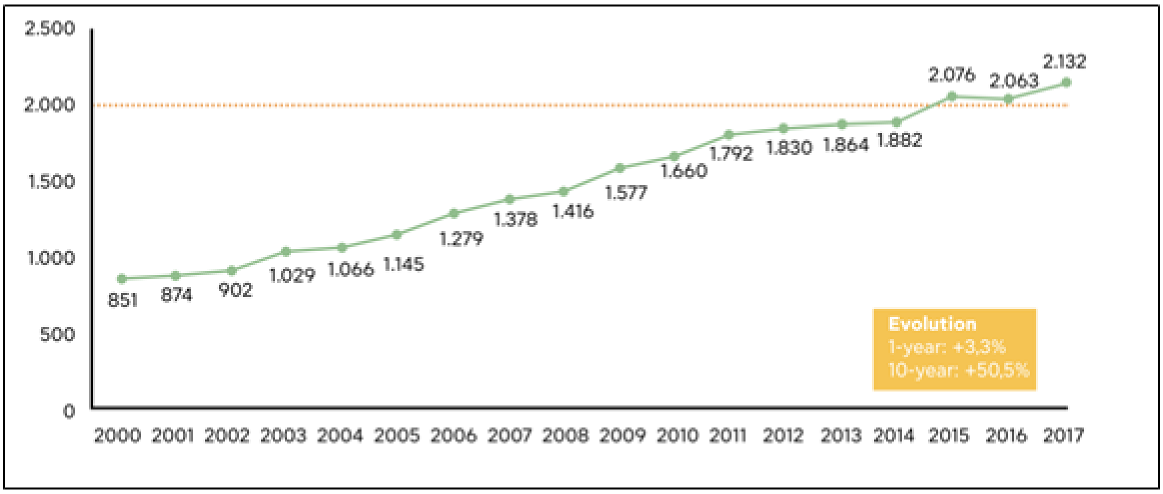


Figure 98 Average number of cruise passengers per cruise call in the Mediterranean, 2000-2017 (Source: MedCruise Association, 2018)

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 oily discharges have historically been the focus and appear to be under control due to a series of technical and regulatory measures implemented over the last 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 102 (DPSIR diagram) for an illustrative summary of the interaction of pressures with the marine and coastal environment.

Accidental and illicit discharges: Incident rates, and notably incidents involving oil, have decreased globally including the Mediterranean, despite a steady increase in oil and other cargo volumes moved by ship. This can be attributed to the adoption and implementation of international maritime conventions addressing 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 tons of oil have been released into the Mediterranean Sea as a result of incidents. The number of incidents involving oil spills dropped from 56% of the total number of incidents for the period 1977 – 1993, to 40% for the period 1994 – 2013. 61% of these incidents resulted in a spillage of less than 1 tonne (REMPEC, 2014). In the Mediterranean, the quantities of HNS accidentally spilled have considerably decreased during the period 1994 – 2013. Since 2003, the release of HNS has become insignificant compared to the period 1994 – 2002. According to the findings of the Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea (REMPEC), showing as Figure 99 (the majority of incidents occurred in the Eastern Mediterranean area (REMPEC, 2014).

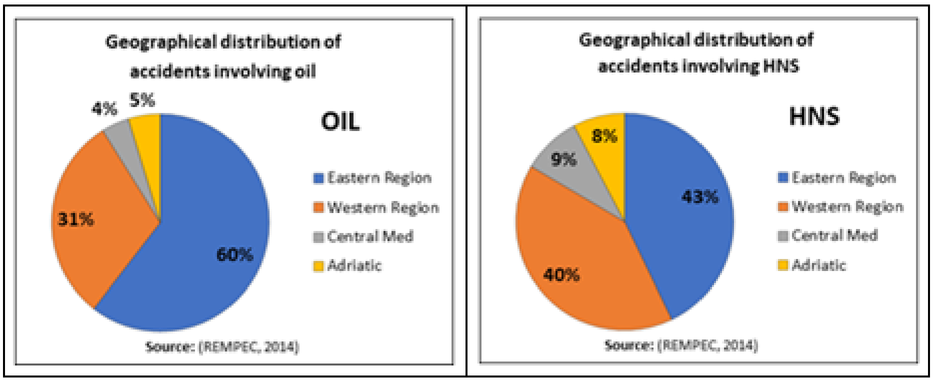


Figure 99 Geographical distribution of accidents (Source: REMPEC, 2014)

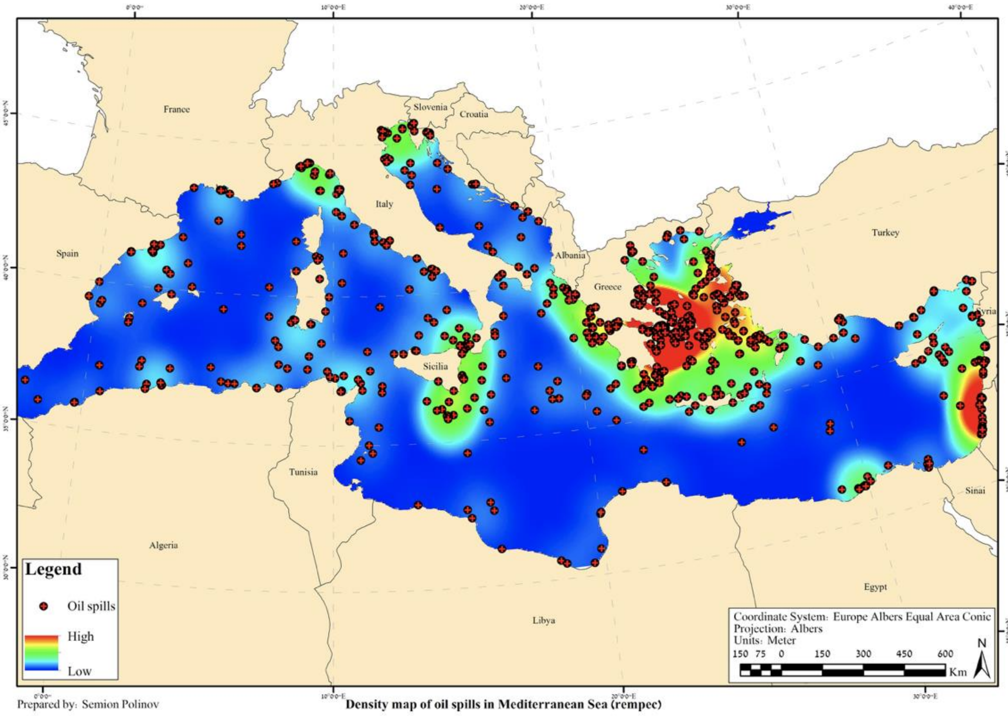


Figure 100 Map oil spills in the Mediterranean Sea, 1977-2017 (Source: Polinov, S from REMPEC data)[87]

Oil spills and other hazardous substances lead to the reduction of plankton, physical damage of fish stocks, marine mammals, and birds resulting in general population decline.[88]

For an effective response to accidental discharges, countries should agree in adopting recommendations set forth by the International Council on Clean Transportation (ICCT), UNEP/MAP and EEA concerning the design of new engines and vessels as well as the use of cleaner fuels and onboard pollution control facilities.[89] Furthermore, sustained efforts to control illicit oil ship pollution discharges 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 towards a better enforcement will contribute to minimising the occurrence of illicit ship pollution discharges.

Marine litter: Although most of marine litter in the Mediterranean originates from land-based sources, commercial fishing has been recognised as a sea-based source of litter, particularly fishing gear (UNEP/MAP, 2015). The litter from fisheries, such as nets, deploy fish stock by continuously capturing fish, and can also result in the transfer of NIS. Responses should focus in emplacing mandatory measures concerning onboard management of litter.

Ballast water released at sea and hull fouling: facilitate the transportation and proliferation of non-indigenous species (NIS). Shipping is the primary source of the over 1000 established NIS in the Mediterranean, the eastern Mediterranean being the most impacted due to the principal entry point of ships through the Suez Canal.[90] NIS negatively impact the environment through predation and competition upon native species. The primary responses to tackle NIS from ballast water is the 2017

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[87] Polinov, Semion (2018) Historical changes in human activities in the Mediterranean Sea, University of Haifa, p.14. <https://www.docdroid.net/3YilKUX/semion-polinov-historical-changes-in-human-activities-in-the-mediterranean-sea-hamburg-20-22-marcons-wp1-training-school.pdf> accessed 17 February 2019.

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

[89] Ameer Abdulla, PhD, Olof Linden, PhD (editors) (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.

[90] UNEP & MAP (2018) *Mediterranean 2017 Quality Status Report*, UNEP/MAP, p. 277

IMO's 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 IMO's voluntary GloFouling partnership 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 (GHG). Ship emissions contain toxic gases and particulates like sulphur oxides (SOx) and nitrogen oxides (NOx). These, when released into the atmosphere, have adverse effects on human health and cause acidification of soil and aquatic environment, impairing the life of fauna and flora. GHG emissions lead to ocean acidification, sea level rise, and temperature rise. GHG from ships, particularly carbon dioxides (CO_2) contribute to climate change. According to the 2014 third GHG study published by IMO, shipping accounted in 2012 for 2.2% of global CO_2 emissions (International Maritime Organization (IMO), 2015). A recent study published by the International Council on Clean Transportation (ICCT) shows that shipping contribution to global CO_2 emissions has slightly increased (2,6% in 2015) (Olmer, et al.; Rutherford, 2017). Predictions indicate that by 2050, those emissions could grow by between 50% and 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 are expected to curve air emissions, fostering low-sulphur and alternative fuels and energy. Further responses should adopt ambitious emission reductions with the upscale of RE-powered transport 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, one of the world's busiest waterways, is deeply affected by underwater noise. Given the significance of shipping traffic taking place in the Mediterranean Sea area, several attempts to predict or assess noise levels from vessels in the region have been carried out. A recent study published by ACCOBAMS[91] has identified and mapped several areas of high anthropogenic pressure in the Mediterranean region (noise hotspots)[92] including noise from shipping and port activities (A. Maglio, G. Pavan, M. Castellote, 2016). The initial data from the ACCOBAMS survey projects illustrates that underwater noise from shipping is considerably more abundant in the Western Mediterranean, though the coast of Greece is also a significant hotspot.[93]

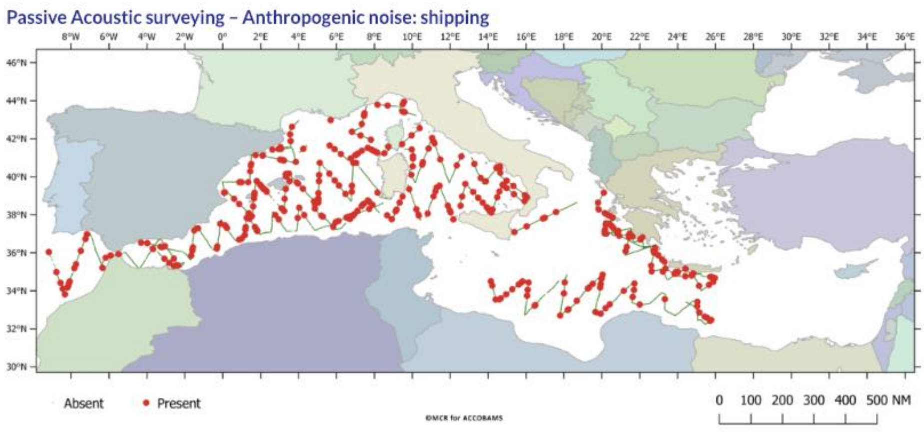


Figure 101 Passive acoustic surveying – anthropogenic noise: shipping (Source: ACCOBAMS, 2018)

[91] Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic Area (ACCOBAMS).

[92] Activities considered are: commercial and recreational marine traffic, harbour activities, commercial and scientific seismic surveys, oil and gas drilling activities, wind farms projects, military exercises.

[93] http://www.accobams.org/main-activites/accobams-survey-initiative-2/asi-preliminary-results/

The most relevant impacts of underwater noise are the behavioural changes, such as feeding and mating, that lead to population decrease; as well as physical damage, such as rupture of tissues and organs that can lead to death.[94]

Box 31 Potential impacts of underwater noise on marine animals (Source: Hawkins A.D. and Popper A.N. (2016)[95]

Impact	Effects on animal
Mortality	Death from damage from sustained noise
Injury to tissues	Injury of gas-filled organs, such as the swim bladder; internal haemorrhaging...
Damage to the auditory system	Rupture of hearing organs
Masking	Masking of sounds essential for species survival
Behavioural	interruption of feeding, schooling, spawning, migration...

Despite the fact that many agreements acknowledge the issue of underwater noise, such as the Barcelona Convention, the GFCM, and the ACCOBAMS Agreement, no relevant response has led to effective adoption of minimum standards of quieting technologies nor speed limits to reduce underwater noise.

Collisions with marine mammals: About 220,000 vessels of over 100 tonnes cross the Mediterranean Sea every year, often navigating in autopilot day and night. Such vessels pose a significant risk of collision to marine mammals, specifically cetaceans spending long periods of time at the surface.[96] A collision between a ship and a marine mammal can be caused directly by a ship crossing routes with a mammal in motion, but it can also be caused by underwater noise from shipping activities, acting as sound masking interfering with mammals' communication and echolocation (E.R. Gerstein; J.E. Blue; S.E. Forysthe, 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 available quantitative data shows that ship strikes killed 16% of carcasses found between 1971 and 2000 (Panigada et al. 2006).[97] Though, studies also suggest that most strikes are unreported, and some indicate that in Greece ship strikes are responsible for 60% of whale deaths.[98] 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, relocation of ferry routes, and reducing ship speed in high cetacean density 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, marine and coastal ecology, leading to the degradation of coastal ecosystems due to bottom contamination. Authorities should minimise the impacts of the land-use change derived from port-infrastructure by turning existing ports into greenports, and building new port infrastructure based on environmental impact assessments.

Anchoring has a significant impact on keystone species present at the sea-floor, such as *Posidonia oceanica*, and thus can lead to the destruction of seabed habitats. As a response, some local authorities,

[94] Hawkins A.D. and Popper A.N. (2016). Developing Sound Exposure Criteria for Fishes. The Effects of Noise on Aquatic Life II. New York. Springer: 431-439.

[95] Hawkins A.D. and Popper A.N. (2016). Developing Sound Exposure Criteria for Fishes. The Effects of Noise on Aquatic Life II. New York. Springer: 431-439.

[96] Panigada, S., Pesante, G., Zanardelli, M., Capoulade, F., Gannier, A. and Weinrich, M.T., 2006. Mediterranean fin whales at risk from fatal ship strikes. Marine Pollution Bulletin, 52(10), pp.1287-1298, p.1292.

[97] Panigada, S., Pesante, G., Zanardelli, M., Capoulade, F., Gannier, A. and Weinrich, M.T., 2006. Mediterranean fin whales at risk from fatal ship strikes. Marine Pollution Bulletin, 52(10), pp.1287-1298, p.1292.

[98] https://www.theguardian.com/environment/2018/may/27/shipping-routes-move-save-whales-greek-seas-dying-agony

such as Port Cros, France, have emplaced anchoring restriction areas, especially in zones designated as environmentally sensitive.[99]

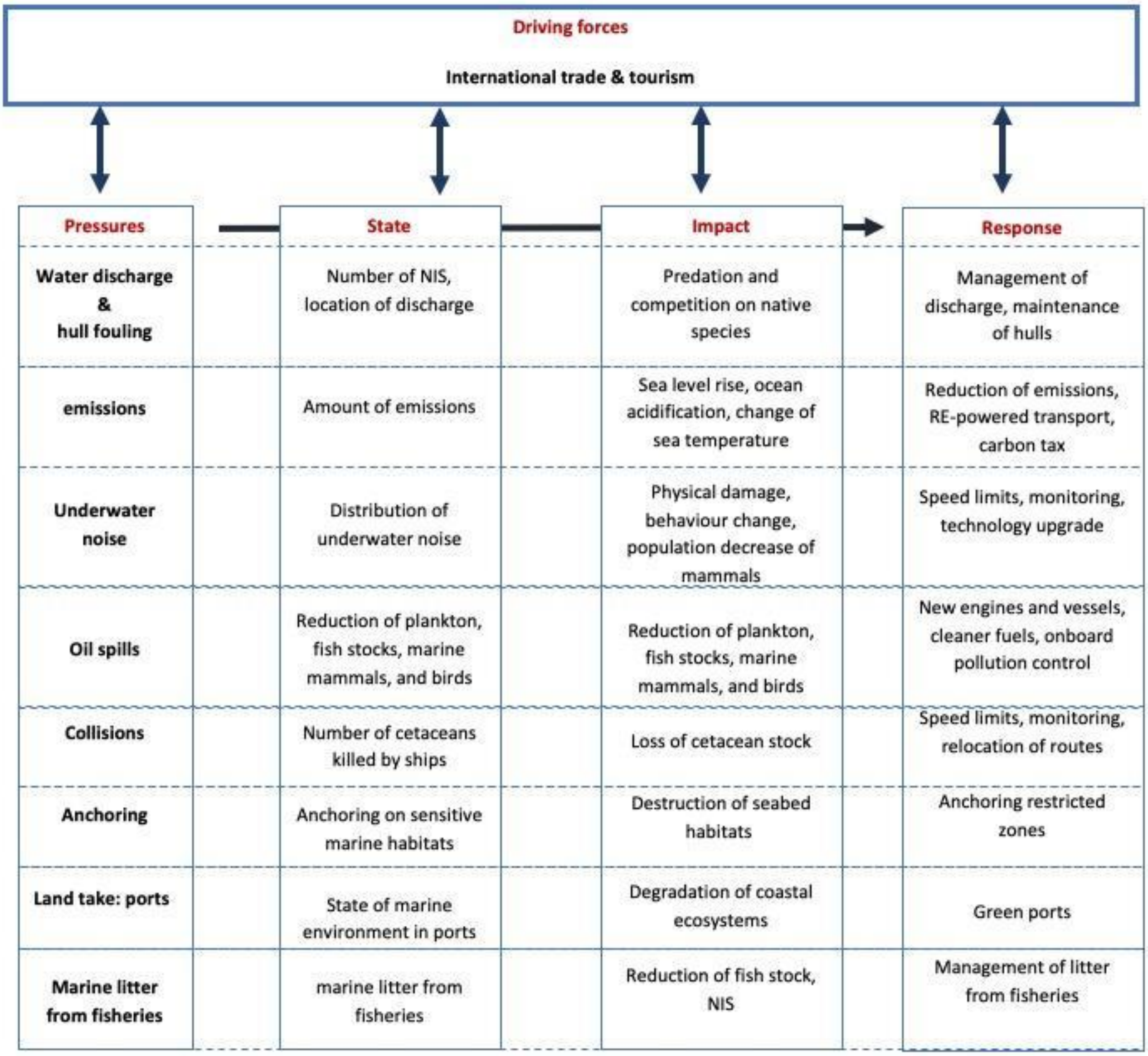


Figure 102 Assessment of pressures exerted by maritime transport on the marine environment (Source: eco-union, 2019)

4.5.3.3 Are we moving towards a green/blue economy?

Shipping and the UN Sustainable Development Goals (SDG). Shipping, compared to road, rail and aerial modes of transportation, is a low-cost, energy efficient and safe mode of transportation. 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 linkages between its work and the SDGs. The shipping industry has also embraced sustainable development by participating in the UN Global Compact initiative, an UN-led corporate sustainability movement in support of achieving the SDGs by 2030, and mapping opportunities of 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 further conservation and sustainable use of marine biodiversity in areas beyond national jurisdiction (BBNJ) through the development of a new legally-binding instrument

[99] Abdulla (n 85) p. 24.

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 MARPOL Annex V special status and oily wastes, in accordance with MARPOL Annex I, into the Mediterranean Sea area. Second, by promoting the availability of port reception facilities so that ships can dispose on shore of their wastes for further collection, treatment, if needed, and final disposal. Third, following the adoption in 2013 of the Regional Plan for the Marine Litter Management of the Mediterranean, by promoting, within the framework of the EU-funded “Marine Litter-MED” Project, the application of charges at reasonable costs or, as applicable, a No-Special-Fee system for the use of port reception facilities by ships calling Mediterranean ports - whether they use port reception facilities or not. 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, 2000) applicable to EU ports. As shown in the Figure below, some EU ports in Mediterranean Sea 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 (NSF) 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.

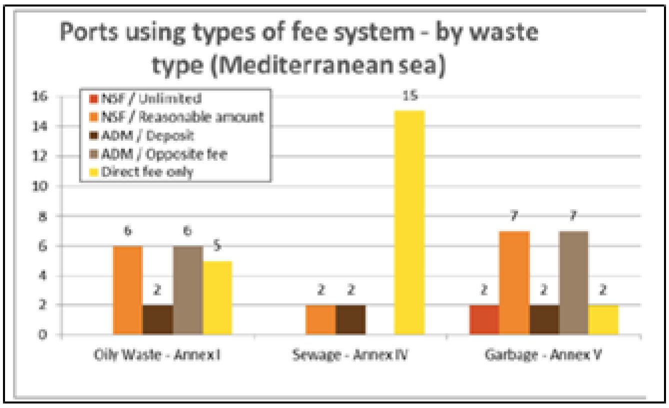


Figure 103 Types of fee systems used in EU ports located in the Mediterranean region (Source: UNEP/MAP, 2018)

Operational cooperation to address ship pollution illicit discharges in the Mediterranean. Cooperation amongst Mediterranean countries is key to address, in a coherent and effective way, ship pollution illicit discharges in the region. In recent years, joint work 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 relating to MARPOL within the framework of the Barcelona Convention (MENELAS) 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.

Alternative fuels and energy. There are emerging promising alternative fuel and energy options for potential GHG 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 allowed 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.

Table 21 Alternative fuels and potential energy and corresponding CO_2 emission reductions (Source: OECD/ITF, 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%

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 do not consider the Mediterranean as a whole. In most cases, Mediterranean coastal States are distributed among 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 ecosystem in the region.

4.5.3.4 Dependency on natural resources and quality of ecosystems

The transport sector is the second largest component of the Mediterranean Ecological Footprint after the food sector, with a share of 22% of the total (Mancini M. and Galli A., 2017). Transportation's footprint in the region is mostly due to personal transportation (both private vehicles and public transport) in major Mediterranean cities. More the city has higher income levels, the higher its ecological footprint is high 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. Approximately 14% of the ecological footprints of cities with lower per capita footprint such as Cairo and Tunis are due to transportation while 25% of the footprint in cities with largest values, such as Athens and Barcelona is due to this sector. The transport sector is also strongly dependent on public services and policies as well as personal behaviours. Having a well-functioning public transport network allows a country to lower its resource requirements of the sector allowing households to depend less on private cars (idem).

Therefore, two conflicting dynamics are taking place in Mediterranean cities (idem). Cities concentrating investment are able to maximise resource and energy efficiency contributing to lower dependency on natural resources availability and a smaller per capita Footprint. Yet, cities are also the territories allowing an increase of wealth per capita and an upgrade of lifestyles which increase the demand for resources, dependence on quality of ecosystems and pressures on natural resources. In order to understand the dependency of Mediterranean cities towards natural resources and the quality of ecosystems it is essential to understand the trade-offs between these two dynamics (idem).

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 inducing a growing total energy use (Brun M. et al., 2016). Bing an energy intensive sector, transport is until now mostly dependent on fossil fuels and requires the massive use of natural resources at every stage of production and delivery to satisfy human requirements as well as for all three types of transportation, terrestrial, aerial and maritime: infrastructure building, the car and other means of transportation industries, oil or petrol or gas to enable the functioning of transport means, etc. (idem). According to the estimations of the International Energy Agency (2014), by 2040, global energy demand would increase by 37% and be equally divided into four elements: oil gas, charcoal and low carbon emission energy sources (Brun M. et al., 2016). Moreover, transportation representing the second largest driver of the Mediterranean region's Ecological Footprint and constantly growing in size and value, its dependence on natural resources is likely to increase if national and regional actors do not prevent an unsustainable allocation of resources. For instance, general maritime traffic is expected to grow with the future implementation of 'motorways of the sea', which is a part of the Trans-European Transport Network, implying a considerable increase of the volume of traffic in the Euro-Mediterranean region (idem).

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" (Barcelona Convention amendments, 1995). This implies that activities of marine biotechnology industries and 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 when it comes to scientific and technological cooperation (Article 11) in the Mediterranean.

4.6.1 Industries of marine biotechnologies

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 et al, 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 addressing major global challenges (idem).

There is little statistical data on the global development of marine biotech industries, and even less regarding the Mediterranean region specifically (idem). It has been estimated by the European Union that the sector may be producing a GVA of EUR 1 billion in European waters, although there are no statistical databases that back these estimations (idem).

On the other hand, a report tried to define the value of bioprospecting for Blue Economy, and estimated that the size of the European Blue Biotech sector in 2012 was approximately of EUR 302 – 754 million in terms of revenues (Ecorys and Consortium Partners, 2014). If a market growth of 6-8% per annum is maintained, revenues from this sector in Europe should reach €1 billion by 2020, which would result in the creation of 10,000 jobs (Idem). However, there is no data on the economic value of the Blue Biotechnology market (GDP contribution) nor on public funding of R&D (UfM et al, 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 have been registered during the 1991-2009 period.

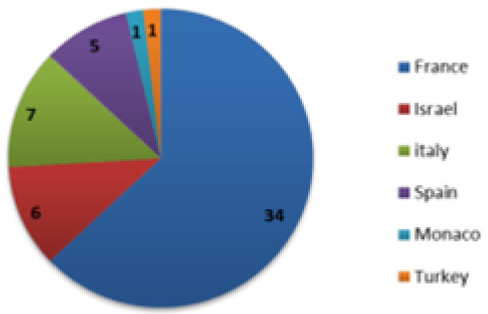


Figure 104 Number of bioprospecting patent claims on marine organisms in Mediterranean countries (Source: eco-union and Plan Bleu, 2017)

Over 50% of the European patents are related to health, followed by cosmetics, genetics and food, while patent claims in energy and aquaculture are fewer (eco-union & Plan Bleu, 2017). Due to the small number of claimed patents, 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 Biotech sector in Europe could range from 11,355 to 39,750 (Ecorys and Consortium Partners, 2014). These numbers are expected to grow in the next decade as the Mediterranean region has been identified as a region of high endemic potentialities, especially with the Mediterranean being rich in species with the highest potential for application (sponges, extreme microorganisms) (idem).

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 et al, 2017). In the longer-term, the potential impacts are rather unclear due to the immaturity of this sector. If bioprospecting undergoes an important development, there could be risks of biological contamination and over-exploitation of organisms in the Mediterranean Sea (idem).

4.6.1.3 Are we moving towards a green/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 m or more, which are considered of great value for Blue Biotechnology (idem). Yet, the cost of prospecting in such deep environments is extremely high (idem). To foster bioprospecting in the Mediterranean area, several channels can be explored (idem):

- Increase the coordination between academic and industry partners in common projects;
- Facilitate publicly funded 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 extractions 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 depends for more than 90% on imported metals (idem). However, despite deep-sea mining representing an opportunity, many potential environmental issues remain unknown questioning the sustainability of such practice.

Until now, there are no projects that have been granted a mining license in the Mediterranean. Apart from the exploration project submitted and granted in 2007 in Tyrrhenian sea in Italy, there is no deep-sea activity in the Mediterranean (UfM, 2017). This slow development of deep-sea exploitation can be partly explained by the low technological development in the region, on the one hand and the lack of the regulatory system, on the other (idem).

Moreover, the Mediterranean region seems to have a rather low resources potential for deep-sea mining attracting less investment projects, particularly when compared to other locations such as the Pacific Ocean (idem). Researchers seem to still be divided about the profitability of turning to deep-sea mining in the Mediterranean and launching exploration projects. Even when 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).

4.6.2.2 Pressures on the environment

There is little understanding of 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 the knowledge about the ecosystems' faculty to recover after mining operations and its 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, 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" (UfM, 2017). It could also impact local communities by disturbing fishing or tourism.

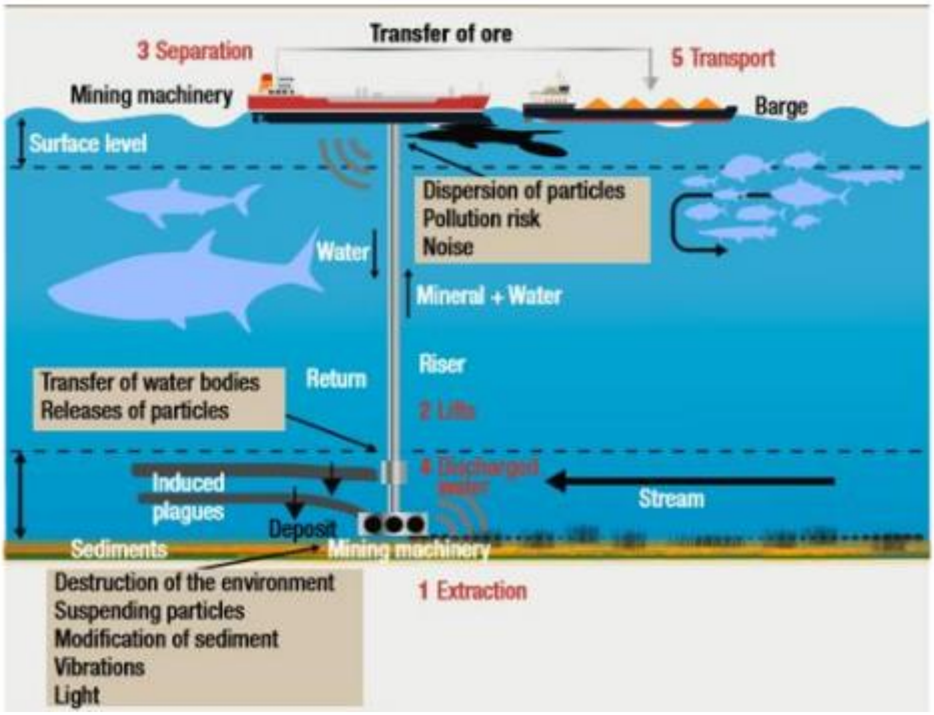


Figure 105 Environmental impact of deep-sea mining (Source: Amundi, 2017)

These potential harmful environmental consequences would mostly derive 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 the fragile deep-sea ecosystems, which are essential to biogeochemical cycles (Amundi, 2017).

Underwater noise and light: Deep sea species have evolved in silence and complete darkness, and thus are sensitive to noise and light. Therefore, the noise and light from deep sea mining may result in behavioural changes of seabed species, such as the impairment of sensing food-fall (the fall of organic matter that is an essential food source of deep-sea species) (Amundi, 2017).

Water discharge: Deepsea mining can affect the environmental state present at different depths by releasing water extracted from the seabed. The pollution can thus affect species and degrade the habitats in all depths of the area of mining.

Regulations of the emerging deep-sea mining activities should respond by tackling all pressures at once, such as 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.

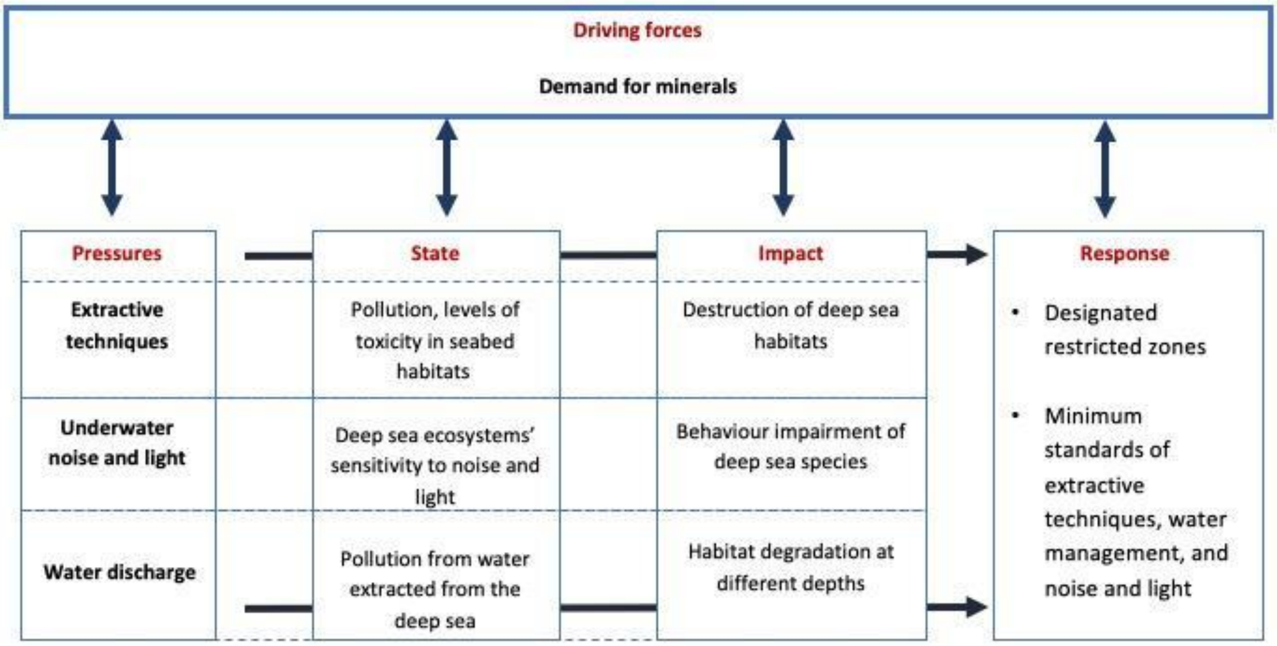


Figure 106 Assessment of pressures exerted by deep-sea mining on the marine environment (Source: eco-union, 2019)

4.6.2.3 Are we moving towards a green/blue economy?

From 2013 to 2016, the European Union partly funded the MIDAS[100] (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 implied by deep-sea mining, in the Mediterranean, among other regions, and focusing on the direct impacts of mining caused on the ecosystems of the ocean floor, as well as the impacts of sediment plumes and toxic chemical products released by mining activities (UfM, 2017).

Thanks to this project, more information has been collected on the potential capacity of recovery of ecosystems including species. This allowed researchers to elaborate a set of recommendations and good practices essential to guarantee the relative sustainability of the deep-sea mining industry (idem). One of the main recommendations was about the creation of conservation zones where mining activities would be prohibited. Recommendations are being translated into regulations within each member state of the European Union for areas located in their Exclusive Economic Zone (idem). Moreover, these

[100] MIDAS project: http://www.eu-midas.net/

recommendations are being integrated within the regulations of the International Seabed Authority (for international waters located at more than 200 miles from a State's baseline) (idem).

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 107 shows pollution hot spot areas (in red) and areas of major environmental concern (in yellow) (UNEP,2012).

Figure 107 Pollution hot spots and areas of environmental concern on the Mediterranean coast (Source 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 (non-point-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 Lions, the Gulf of Gabès, the Adriatic, Northern Aegean and the SE Mediterranean (Nile–Levantine). The coastal area of the south-eastern part of the Mediterranean is under eutrophic conditions, mainly caused by the sewage effluents of the cities of Cairo and Alexandria. The Northern 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 show that in areas where assessment is currently possible, key nutrient concentrations in the water column are in ranges 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 of the stations in the gulf of Lions were in a less than moderate state. Slovenia, Croatia and Montenegro were assessed in the Adriatic with all the stations in good environmental status. Cyprus, Israel and the Mersin area in Turkey were assessed in the Aegean-Levantine sub-region showing that stations in Cyprus are in good status and in Israel and Mersin area, Turkey, in moderate status (UNEP MAP, 2017).

Based on remote sensing, chlorophyll-a concentrations in the Mediterranean Sea have been modelled by the European Commission's Copernicus Marine Service. The figure below 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 throughout the last twenty years.

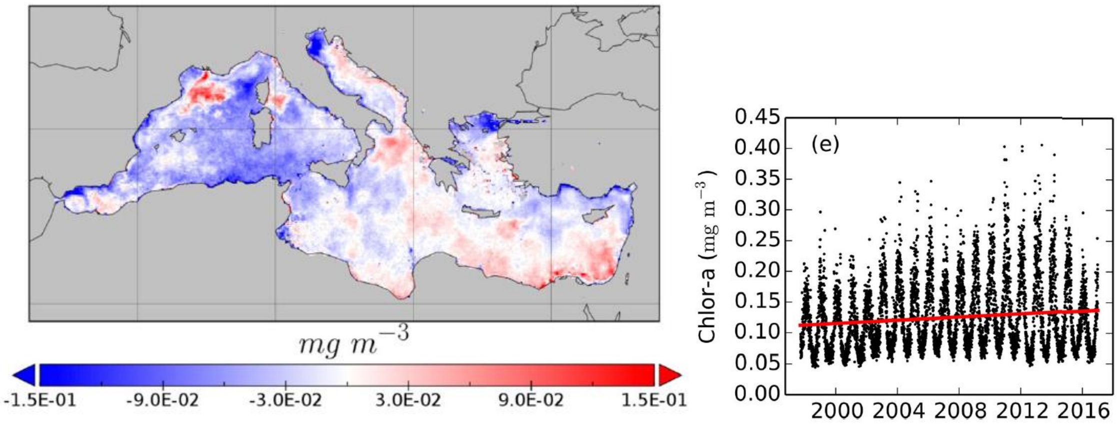


Figure 108 Chlorophyll anomalies for 2016 relative to the 1997–2014 reference period (left) and Regional time series of chlorophyll-a in the Mediterranean region, 1997–2016 (right) (Source: Schuckmann et al., 2018)

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 determined and harmonised throughout the Mediterranean region as well as coastal water type reference conditions and boundaries for chlorophyll-a concentration in the water column for the southern Mediterranean region (UNEP MAP, 2017).

Box 32 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, 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 concern begins when they are 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 MAP Integrated Monitoring and Assessment Programme (IMAP) combines the information on nutrient levels, direct effects (chlorophyll-a concentration and water transparency) and indirect effects (oxygen concentration). Coastal water types reference conditions and boundaries between good and moderate status were agreed and adopted in the IMAP for chlorophyll-*a* in the Mediterranean. These are based on the influence of freshwater inputs as the main nutrient drivers.

4.7.2 Contaminants status

The trends and levels of the 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.

In terms of the assessment of key harmful contaminants measured in the relevant matrix, for biota (mussel and fish) acceptable conditions exist for heavy metals (mercury, cadmium and lead) in terms of good status, for coastal surface marine waters, 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 show an impacted situation for the coastal benthic ecosystem, especially for total mercury, which should be further investigated and assessed against assessment criteria, taking into consideration sub-regional specificities.

Petroleum Hydrocarbons and persistent organic pollutants (POP) data 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 a 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 roughly acceptable environmental status assessed from bivalves and fish against Background Assessment Concentrations (BAC) and Environmental Assessment Criteria (EAC). For lead 10% of the stations show levels above the set EC maximum concentrations in foodstuffs to protect public health for mussel samples. Heavy metal concerns are found in the coastal sediment compartment for lead and total mercury indicating an impact of 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 the potential for adverse biological effects on organisms. 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, 2017).

4.7.3 Industrial Pollution

The MED POL National Baseline Budget (NBB) is the reporting tool established by the Mediterranean Action Plan to detect the evolution, including any possible reduction trend, in the direct and indirect releases of pollutants into the marine environment. The main activities contributing to emissions of pollutants are wastewater treatment plants, metal production and processing, energy production, pulp and paper processing and production, 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; building of, painting or removal of paint from ships).

Figure 109 shows the total aqueous effluent values per sector for the Mediterranean reported by NBB 2003, 2008, 2013 and the European Release and Transfers Register (E-PRTR) 2013. In 2003 the major effluent values reported are from the chemical industry (74% of total releases in the industry) and the food and beverage industry (11%). In 2008, the major reported sectors discharging pollutants to effluent 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%).

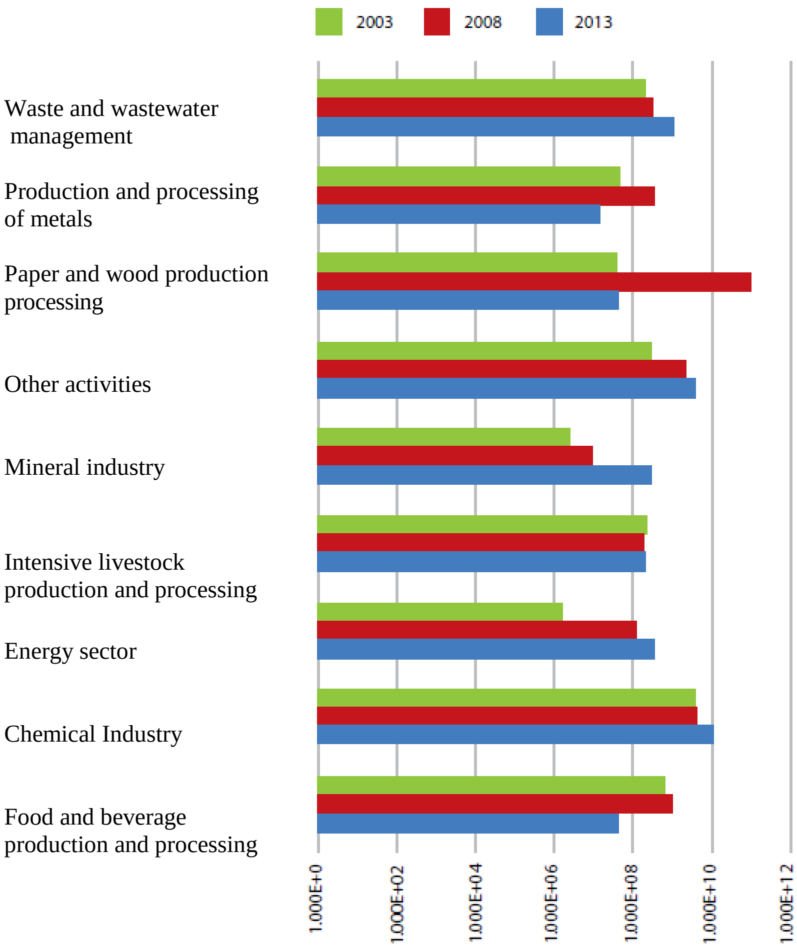


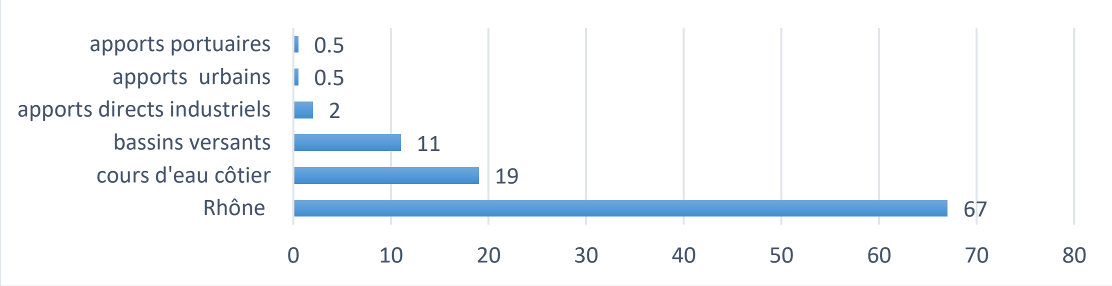
Figure 109 Total aqueous effluent values per sector (NBB 2003, 2008 and 2013 and E-PRTR 2013)

From Figure 109 there is an indication that from 2003-20013 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 x shows values for Intensive livestock products and processing remaining the same from 2003-2013.

There are constraints and limitations of 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 delimitate the geographic scope to build-up the NBB industrial inventory. While it is generally acknowledged that a large percentage of pollution received by coastal waters is stemming from land-based sources located in Mediterranean water sheds and flowing as riverine inputs into the coastal zone, NBB data analysis is currently not systematically conducted at the watershed level, but per administrative zone. This introduces a significant bias to the analysis especially where the geographical limits of watersheds do not coincide with administrative. In these cases, pollution stemming from sources located upstream behind administrative limits are not taken into account. Along with the lack of data validation, this hinders to some extent the identification of reliable trends, and thus the extraction of solid conclusions and recommendations for action.

Box 33 The importance of riverine inputs of industrial contaminants to the Western Mediterranean Sea

Using the River Rhone as an example, in comparison to port contributions, urban contributions and direct industrial contributions, riverine inputs (watersheds, coastal watrcourses, the river Rhone contribute 97% of the main heavy metals with concentrations greater than a flow without effect (Boissery, 2018).



Box 34 A best practice case study of a "switcher", resource efficiency and sustainable waste management in Palestine (Source: UNEP-MAP SCP RAC Website)

Three Palestinian environmental engineers invented an innovative concept of treating waste by 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.

An eco-friendly efficient integrated wastewater treatment unit was designed by three Palestinian women, that 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 efficiency is 99%. Moreover, 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 waste water 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.

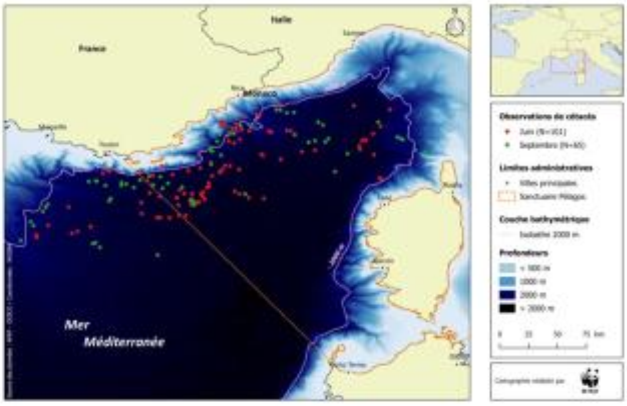
4.7.4 Emerging Pollutants

The term "'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 herbicides, bisphenol A (used in plastic wrappings), plasticizers such as phthalates, nanoparticles (measuring less than 100 nm, 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), non-halogenated substances (carboxylic 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 not been sufficiently carried out for a number of substances and does not currently keep the pace at which new substances are being created. To date, the European Chemicals Agency has registered more than 22 000 substances[101] under the REACH regulation, whereas, worldwide, more than 142 million exist[102].

[101] European Chemicals Agency, 1 February 2019, https://echa.europa.eu/fr/registration-statistics-infograph#

[102] Base Chemical Abstract Service, American Chemical Society

Box 35 The presence of phthalates and dibromo-biphenyl in the "Pelagos" Sanctuary, 2015. (Boissery, 2018)



Composés	Abréviation
Mono-Butyl phthalate	MBP
Mono-Benzyl phthalate	MBZP
Mono(2-ethylhexyl) phthalate	MEHP
Di methyl Phtalate	**DMP**
Di Ethyl Phtalate	**DEP**
Diisobutyl phtalate	**DiBP**
Dibutyl phthalate	**DBP**
Bis(2-methoxyethyl) phthalate	**DMEP**
4-4' dibromobiphényle	4,4'DiBr
Di- n-Hexylphthalate	**DNHP**
Benzylbutyl phthalate	**BBP**
Bis(2-ethylhexyl) phthalate	**DEHP**
Diisooctylisophthalate	DIOIP
Di-n-octyl phthalate	**DNOP**
Diisononyl phthalate	DINP
Diisodecyl phthalate	DIDP
Di-n-decyl phthalate	**DNDP**

	DEP	DEHP	DBP	DIBP	DNHP + BBP	DMP	DMEP	DNOP	DNDP	Total
Ordre d'abondance	1	2	3	4	5	6	7	8	9	
Moyenne	14656	1060	629	409	337	267	184	5	0	17547
Ecart type	14747	1390	825	497	413	359	480	15	0	15227

Although depollution measures, such as wastewater treatment, are improving in their capacity to effectively treat or eliminate certain substances, it is likely that neither 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.

4.7.5 Pollution from noise

As underwater noise is considered a major threat for cetaceans, in the period 2015-2016 ACCOBAMS undertook a study aiming 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).

Box 36 The ACCOBAMS study on underwater noise hot spots

The positions of 1446 harbors, 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. Results revealed several noise hotspots overlapping important cetacean habitat such as the Pelagos Sanctuary, the Strait of Sicily, and the upper portion of the Hellenic Trench. Moreover, these results provide strong evidence of multiple stressors acting on the marine environment and of the need for urgent management and conservation actions.

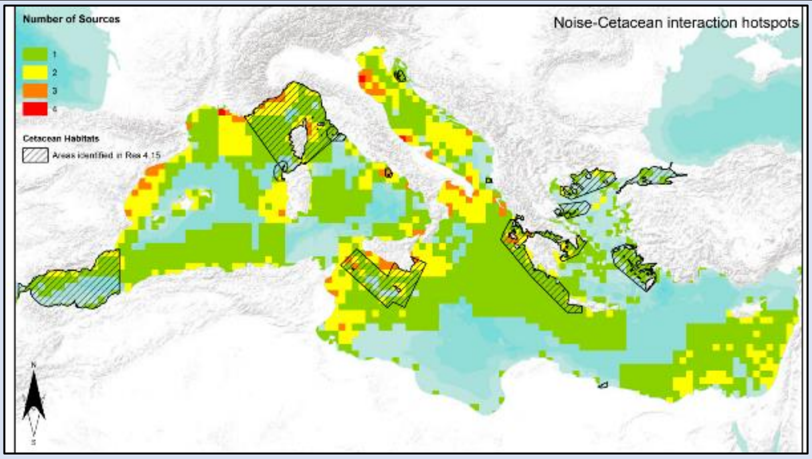


Figure 110 Overview of the noise hot spots in the ACCOBAMS area (Source: ACCOBAMS)

4.8 Waste

Types and amounts of waste generated and linked management practices vary widely in Mediterranean countries. The total amount of municipal solid waste produced in Mediterranean countries is around 183 million tons, i.e. an average of 370 kg per capita per year (about 1 kg/cap/day).

In NMCs, the range of value is from 1.1 to 1.7 kg/cap/day and raised to more than 3 kg/cap/day in Monaco. In SEMCs, the amount generated is from 0.5 kg/cap/day in Morocco to 1.1 in Algeria (the value for Israel is similar to EU countries). In the NMCs (and Israel), the percentage of Food & Organic waste is between 30% and 52% while this rate in the SEMCs is still higher (from 52% in Lebanon to 70% in Libya).

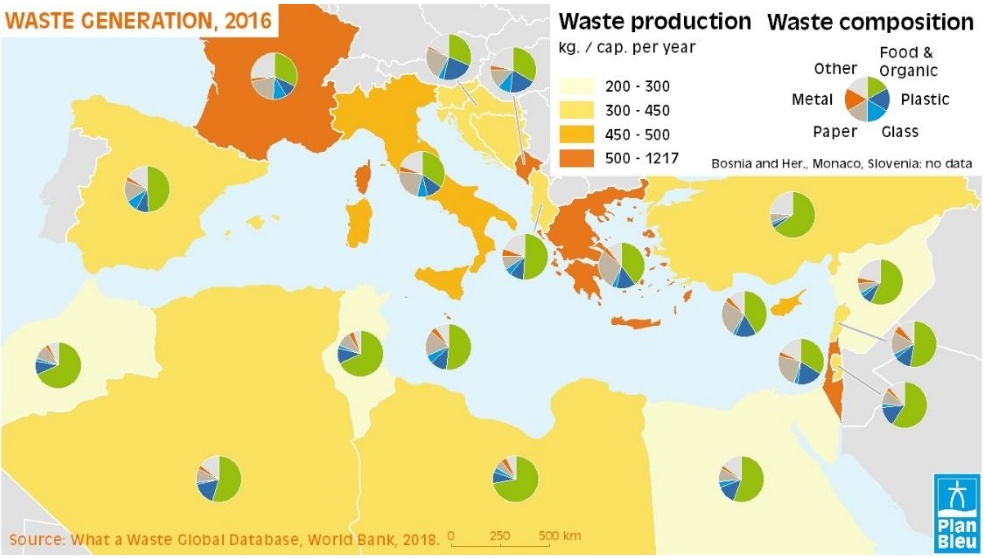


Figure 111 Waste generation and composition in Mediterranean countries, 2016 (Source: World Bank, What a Waste Global Databank, 2018)

Recycling rates are also widely varying. In the NMCs, the recycling rate is above 13% and raises to 46% in Slovenia. Bosnia-Herzegovina is an exception on the northern shore with a rate close to 0. In SEMCs, Egypt has the highest recycling rate (12.5%) after Israel (25%) and the recycling rate is especially low in Syria, Palestine and Turkey.

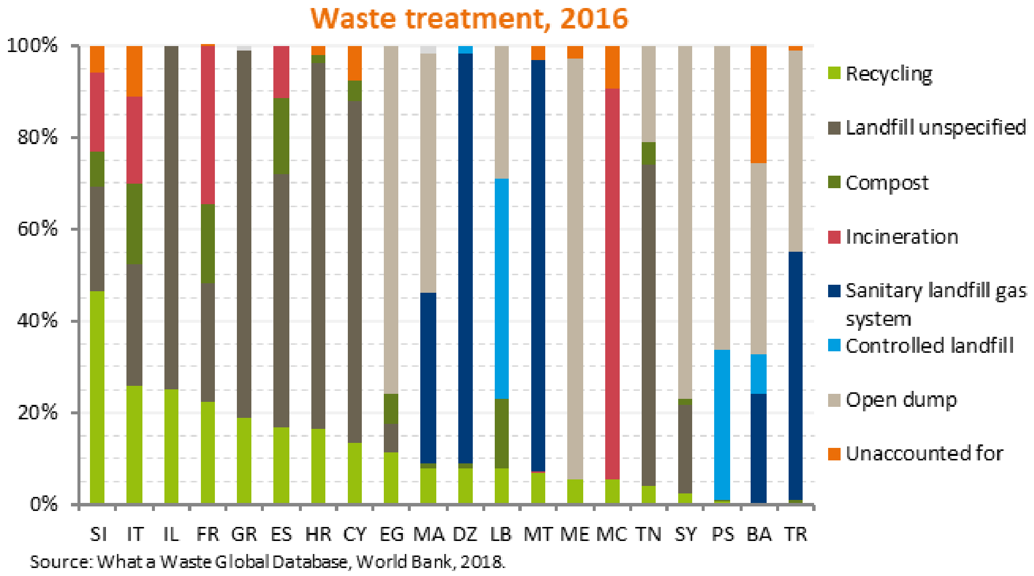


Figure 112 Waste treatment in Mediterranean countries, 2016 (Source: World Bank, What a Waste Global Databank, 2018)

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 growing global consumerism is confronted to deficiencies in waste management, particularly in low-income communities, resulting in alarming amounts of waste leaking the oceans every day. For plastic only, the global production of resins and fibers has increased from 2 Million tons in 1950 to 380 Million tons in 2015, an annual growth rate of 8.4% is observed (Geyer et al., 2018), while the production of resin in Europe has reached 64 million tons in 2017 (Plastic Europe, 2018).

Global commitments have resulted from the United Nations Environment Assemblies since 2016, from the convention on Biological Diversity, in the recent G7 and G20 declarations, and within the Target 14.1 of the Sustainable Development Goals (UN Environment, 2018), while More than 200 tons of plastic are entering the Mediterranean Sea every day (UNEP/MAP, 2015).Consequently, the Regional Plan on Marine Litter Management in the Mediterranean Regional Plan was adopted in 2013 by the Barcelona Convention COP18 as the first legally binding instrument to reduce marine litter, an issue of high concern for the Barcelona Convention since its first years. In addition, the European policies such as the EU Plastic Strategy and various directives such as the Marine Strategy Framework Directive (MSFD, 2008), the Directive on Port Reception Facilities (PRF, 2000), revision in progress) and the Directive on Single-use Plastics (2018) provide a driving force to act on marine litter and 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 NAPs (Markovic & Hema, 2016).

4.9.2 Situation and evolution of marine litter in the Mediterranean

Studies on marine litter in the Mediterranean basin were started in the 90's, but more attention was given to the issue after 2010, where more data became available on the abundance and distribution, when the first attempts to assess trends were made, micro plastics entered into the agenda and mapping of impacts became a priority. There is however, no comprehensive assessment on the economic impacts of marine litter in the Mediterranean Sea, apart from 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 #210 million inhabitants. It is the first tourist destination in the world, with more than 320 million visitors every year, and receives waste from coastal zones, as well as from many large rivers flowing from largely urbanized cities such as the Nile River contributing with more than 200 tons of plastic into the sea per year (Lebreton et al. 2017). In addition, more than 20% of the 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 up to 95-100% of total floating marine litter and more than 50% of seabed marine litter. The analysis of 33 beaches conducted in 2016 (Hanke, 2016), indicated that only 5 types of debris, mostly single-use plastics (cutlery/trays/straws, cigarette butts, caps/lids, plastic bottles and shopping bags) represent more than 60% of the total recorded marine litter on beaches. No change was observed in the percentage of the same five marine litter categories between 2013 and 2018 on the beaches of 8 Mediterranean countries (Ocean Conservancy, 2018). Typically, most of the litter on beaches is originating from beach/ recreational activities, with glass bottles and metal beverage cans disappeared from the top ten lists in the non-touristic areas over the last years because of behavior changes.

On the sea floor of the North Western basin, plastics and fishing-related items have (some of which also being made of plastic) both remained at 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 gears (ALDFG), that 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 nano plastics 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/km2 (UNEP/MAP, 2015) and maxima reach more than 64 million floating particles/km2 (Van Der Hal et al., 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 211,500 tons/ year or 580 tons/ day (Table 22), depending on the coastal population that may vary depending on the country, representing 2.3% of the total inputs in the world ocean.

Table 22 Estimated total Waste generation, plastic mismanagement and plastic littered in Mediterranean countries (adapted from UNEP/MAP, 2015)

Country	Waste generation (kTons/person/Year)*	Mismanaged plastic waste [Tons/person/year]*	Plastic waste littered [tons/Year]**
Albania	0.77	0 .28	1,273
Algeria	1.2	0.44	17,332
Bosnia /Herzegovina	1.2	0.44	613
Croatia	2.1	0.77	2,636
Cyprus	2.07	0.76	1,518
Egypt	1.37	0.5	18,972
France	1.92	0.7	11,134
Gibraltar	2.1	0.77	61
Greece	2	0.73	14,229
Israel	2.12	0.77	14,417
Italy	2.23	0.81	32,761
Lebanon	1.18	0.44	2,665
Libya	1.2	0.44	4,240
Malta	1.78	0.65	628
Monaco	2.1	0.77	62
Montenegro	1.2	0.44	273
Morocco	1.46	0.53	2,547
Palestine	0.79	0.29	1,396
Slovenia	1.21	0.44	355
Spain	2.13	0.78	30,085

Syria	1.37	0.5	4,691
Tunisia	1.2	0.44	7,616
Turkey	1.77	0.65	41,922
TOTAL / MEAN	1.58	0.58	211,425

* World Bank (in *Jambeck et al, 2015*), ** inputs from Egypt, France, Morocco, Spain and Turkey were estimated for the Mediterranean coast only (adapted from *Jambeck et al, 2015*).

At the level of Mediterranean watersheds, another study (Weiss et al., 2019) has modelled plastic flows into the Mediterranean Sea, as shown in the Figure below.

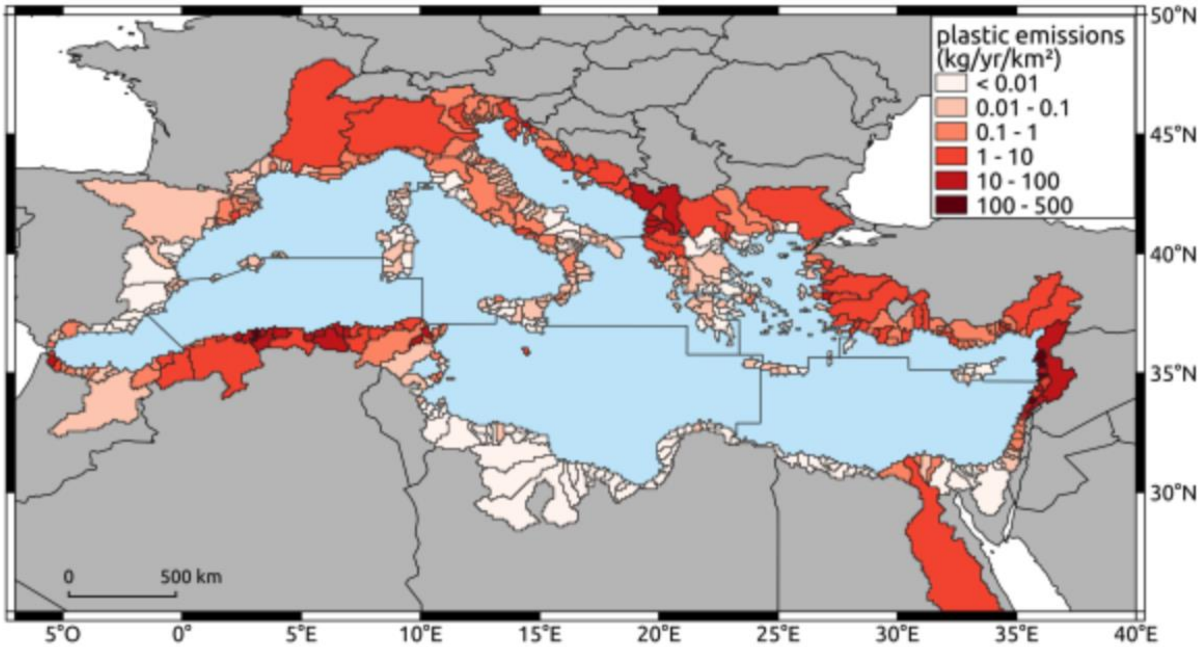


Figure 113 Estimation of annual specific plastic flows (kg/M3) rejected by watersheds into the Mediterranean Sea. Flows calculated based on Lebreton et al., 2017 (Source: Weiss et al., 2019)

In some areas, up to 58% of the collected municipal solid waste is still disposed in open dump sites. Out of the millions of tons of plastic waste produced each 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 pathway for waste leaking into the sea, a key challenge is that in the Mediterranean region only 21% of wastewater (25% in Southern Countries) undergo only basic treatment, and less than 8%, (1% in southern countries) is undergoing tertiary treatment (UN Environment/MAP, 2017a). Key economic sectors in the Mediterranean, such as fisheries, tourism and shipping, also generate large amounts of litter (table 2).

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 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 expenditures linked to beach clean-ups are generally known. In European countries beach cleaning may reach € 3 800 per ton per year (CleanSea project, 2016), depending on clean-up methods. For floating litter, the same study indicated that removal equal to a unit cost of € 2 200 per ton per year per km^2. For the fishing sector, an annual economic loss of € 61.7 million has been estimated in European waters (WWF, 2018) for a total cost for all sectors of 263 million euros (Arcadis, 2014). Extrapolating loss at the Mediterranean level will require more data and studies, but the costs may 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, reduce (ghost fishing) or contaminate catches, and more broadly affects marine ecosystems. Marine litter alsocreates economic pressures on 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. Damage costs to marine ecosystems and the services, for example the introduction of alien invasive species, must also be considered despite a limited understanding of the detrimental impacts on the marine ecosystem structure 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 and then human (Gesamp, 2016).

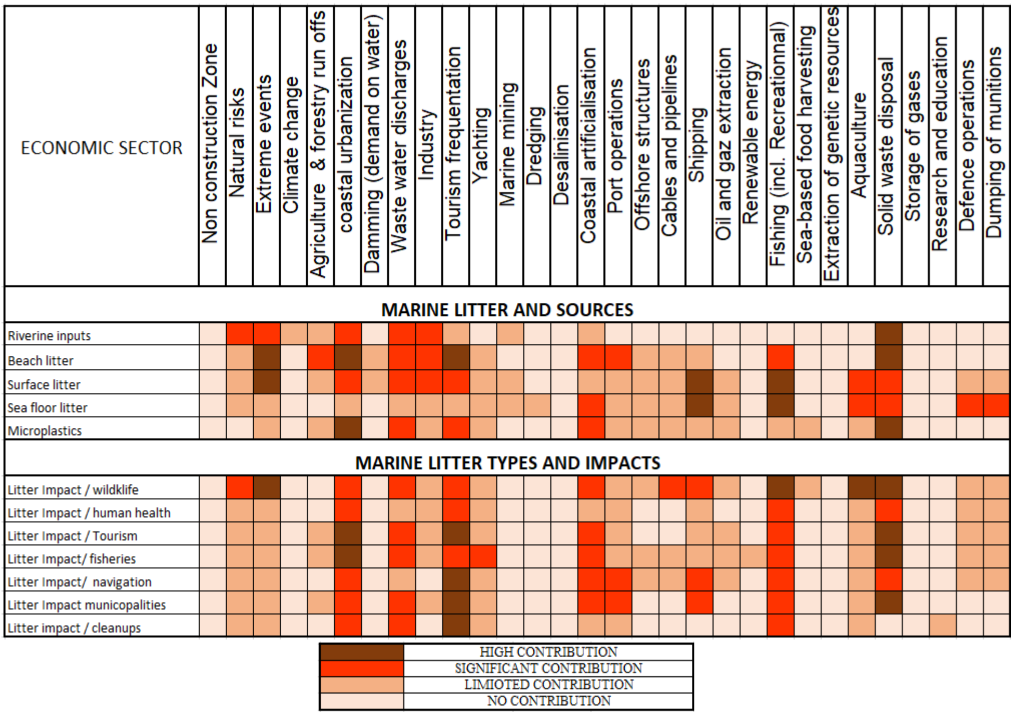


Figure 114: Marine litter in relation to the Economic sectors in the Mediterranean Sea. Sources, amounts and impacts (After UNEP/MAP 2015 & UN Environment/MAP 2018)

4.9.5 *A regional and circular economy approach as a response to marine litter in the Mediterranean region*

Acknowledging the importance of prevention and 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 (UN Environment/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 the Mediterranean countries have made progress towards upgrading the regulatory framework for reducing of single-use plastic bags and many of them have adopted, or are progressing in adopting EPR as 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 system. In addition, five Mediterranean countries have joined the #CleanSeas campaign. Policy action by sub-national authorities, industry-based solution (https://www.marinelittersolutions.com) and large scale green economy initiatives (https://switchmedconnect.com/en/) support the transition towards a more sustainable economy, promoting the transfer of Environmentally Sound Technology to the industry, policy changes and incentives to enable the Circular Economy, providing innovative and long-term solutions. The action of civil society (i.e. www.breakfreefromplastic.org, mio-ecsde.org) has been of great importance in this issue, not only in terms of awareness, but also on advocacy and promotion of concrete solutions to marine litter.

Notwithstanding, with only one binding quantitative target to reduce marine litter of 20% on beach 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, the insufficient waste treatment infrastructures and policies, as well as separate collection, strong regional disparities between urban and rural areas and poor storm water management are still gaps that need to be addressed. Despite the measures for the establishment of Wastewater treatment (WWT) systems in most agglomerations, there are still many coastal cities without WWT plants, especially in the southern and eastern Mediterranean. Moreover, 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 even clearer that the waste management schemes at national level need to become more effective and efficient.

Single-use plastic bags have been generally addressed through bans and economic disincentives, as shown in this map. However, they are still persistent as well as other iconic items such as cigarette butts.

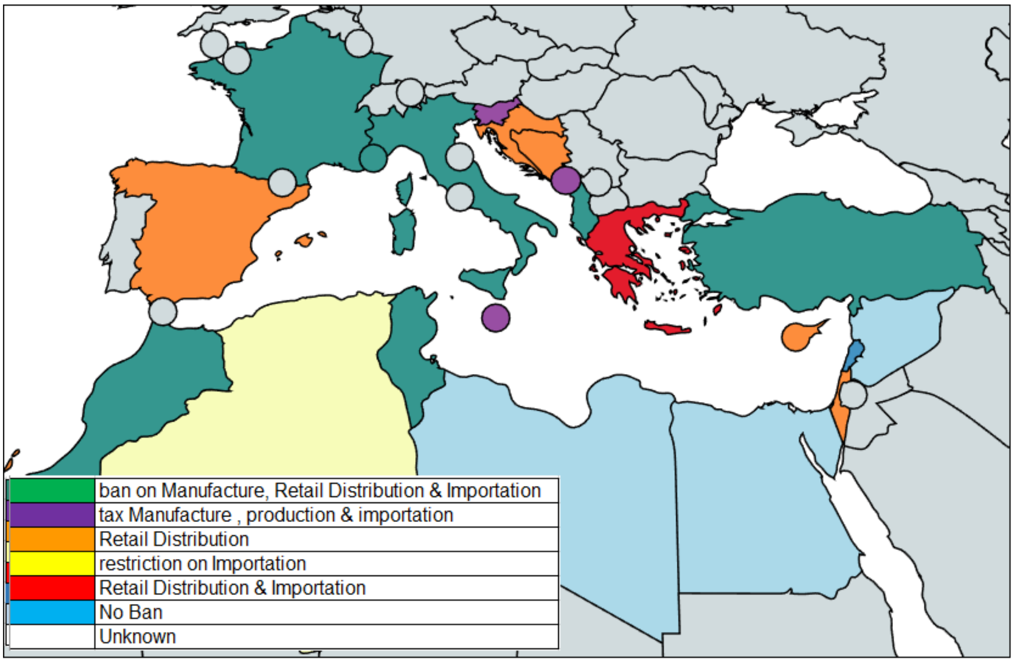


Figure 115 Total and Partial Bans and Taxes on the Manufacture, Free Distribution, and Importation of Plastic Bags (Source: UN Environment, 2018)

Ship-generated waste and cargo residues can be managed through port reception facilities. However, 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.

Objectives and actions towards the reduction of plastic consumption, supporting eco-design/innovation, resource efficiency and a better management of waste and water, long-term efficient and viable recycling targets for municipal waste and packaging/plastic waste, a 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 are the most critical levers to reduce litter (Ten Brink et al., 2018).

Socio- economic assessments made on/of various measures at the Mediterranean level (Plan Bleu, 2017) have demonstrated the cost-effectiveness of a Mediterranean plastic bag tax, estimated levied at the retail level, a cost of €670 million for a 95% reduction of incremental plastic bag waste during the first year of implementation. "Fishing for litter[103]" initiatives, at large scale, also lead to an estimated cost-effectiveness of around €900/ton of fished litter, with reduced indirect costs to the fishing sector itself. Other measures such as the use of port reception facilities at reasonable cost, or the no special-fee system where this is applicable are recommended, because of their positive impacts on employment and tackling chronic pollution from ships.

Finally, In the Mediterranean Sea, adopting ambitious reduction targets on the production and consumption stages of 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.

4.9.6 Conclusions

Solving the problem of marine litter is a complex task because of the diversity of actors involved, sources, materials, socioeconomic aspects and regulatory frameworks. Changes towards a more circular economy were observed in the recent years, but important gaps remain. Prior to the hinder effective implementation of needed measures at the national level, political, environmental and operational targets must be set to drive the necessary actions. Moreover, the Mediterranean region may have to face new challenges, such as the increase of plastics production, the use of new materials (bio- plastics, copolymers, etc.) that may not have been produced to be environmentally relevant and may mislead consumers. The need for better understand the links between marine litter fluxes and 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 activities described above are based on a dominant pattern of systemic unsustainable resource consumption and linearity (non-circular business models) and generate a number of environmental degradations and pollution, including carbon emissions. Economic activities remain coupled with environmental degradation, which means that for each unit by which an economic activity grows, there will be additional environmental degradation, which can be referred to as negative externalities. Throughout the last decade, the described activities have grown, and so has the environmental degradation generated by them.

Transitioning to sustainable economic activities requires urgent and profound changes in production and consumption patterns based on more environmentally responsible lifestyles. Targeted policy mixes, including market-based instruments that favor environmentally-friendly activities and disadvantage polluting ones (including by making producers accountable for the entire life-cycle of their products) are needed to factor climate change concerns, biodiversity protection and circular economy principles into prevailing business models, thus enabling the transition towards a blue/green economy. On the demand side, decisions can be improved by increased involvement of social and behavioral sciences in decision-making that help in fostering needed radical changes in consumer behavior. Such changes need to be brought about via an inclusive approach that pays attention to inequalities and involves civil society in decision and action, in particular women who 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 itself. 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 trends today and tomorrow. This is consistent with the UN 2030 development agenda and its SDGs, as well as the Mediterranean Strategy for Sustainable Development.

[103] Fishing for litter: Action where participating fishing vessels are collecting marine litter that is caught in their nets during their normal fishing activities.

Moving towards energy efficiency and reliance on low carbon energy mixes is key. The energy sector is too often presenting considerable fossil fuel subsidies (including tax exemptions of polluting activities such as for fuels of aviation and maritime transport), going well beyond those needed for social purpose. Its environmental impacts are to be mastered in energy facilities (at primary production, at electricity production plants, at refining facilities).

Moving towards sustainable tourism requires the cooperation of the multiple actors of the sector and their commitments to value and preserve Mediterranean cultural and environmental heritage while ensuring the wellbeing of local populations.

Moving towards a sustainable transport sector requires attention to infrastructure (e.g. investment and maintenance in road, rail, port and airport facilities, their environmental impacts), vehicles (e.g., pollution control of new and in use vehicles and use of best-available-techniques, transition to renewables-based 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), and traffic management (e.g. urban traffic police, urban public transport optimization, control of straights and canals, legal and illegal movements of maritime transport of freight and humans).

Industry and mining need to improve : i) their resource use in the context of a circular economy with reduction, reuse and recycling of waste, ii) their attention to chemicals production and use, in their impacts on humans and the environment and the presence of chemicals in the environment and products (e.g. traditional pollutants, endocrine disruptors, substances), and (iii) their use of best-available-techniques.

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 above described economic activities. However, 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 externalities can neither be avoided nor reduced, to compensate them. Integrating this mitigation hierarchy into the prevailing business models will be key to achieving sustainability in the Mediterranean region.

5 Draft Chapter 5: The coastal zone dynamics and related impacts

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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, though their growth, sometimes exponential, and their intensification generate many impacts that alter the invaluable Mediterranean natural and social capitals.

For the purpose of this chapter, three issues considered as crucial are more particularly covered:

1- Population rural-urbanl migration and socio-economic disparities in a preoccupying climate context;
2- Coastal urbanization and environmental changes degrading natural capital and cultural heritage & increasing risks for population;
3- Booming and multiplication of maritime activities challenging Good Environmental Status.

After highlighting each of them, the urgency of putting more coherence in the implementation of policy and management frameworks is emphasized. At the core of it lays the ICZM Protocol, more particularly through its common regional framework and its strong links with Maritime Spatial Planning and the Ecosystem Approach (EcAp).

5.1 Introduction: coastal areas under high cumulated pressure

Coastal areas are among the most valued parts of the Mediterranean countries. They are highly coveted for both living and economic activities and thus subject to high pressures. Acting as an additional pressure, climate change will have a great impact on the coastal zone, in both its land and marine parts. As described in Chapter 2, it will increase extreme weather events, coastal flooding followed by accelerated coastal erosion, sea water contamination and groundwater salinization. Densely built and with a high concentration of economic activities and infrastructure (including ports), the coastal fringe is particularly exposed to sea level rise and extreme coastal events, while shallow 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 the landside, elevated temperatures and decrease of precipitation will result in more frequent recurrence of droughts and increasing risk 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 terms. In that context and to address cumulated pressures in the coastal zone, a unique document has been established: the Integrated Coastal Zone Management (ICZM) Protocol (Box 37).

Box 37 The Integrated Coastal Zone Management (ICZM) Protocol

As a response to increasing pressures and climate change threats, and at the initiative of 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 years consultation process with representatives of all relevant stakeholders. The Regional Forum, a number of experts working group meetings, a consultative workshop, COP 14 of the Barcelona Convention that established another working group composed of government designated experts, and COP 15, resulted finally in signing a Protocol on Integrated Coastal Zone Management (ICZM) in the Mediterranean 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 a coordinated implementation of national integrated coastal and marine management policies. By 2019, 10 countries and the EU ratified the Protocol.

This chapter first examines the challenges to be taken up in the Mediterranean coastal zones, starting from the watershed, through the land-sea interface to the open sea. The main drivers at stake for the three above mentioned issues are reviewed, followed by priorities for action, which are then combined as integrated recommendations under the main policy and management frames 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 at reducing pressures on coastal areas while maintaining a socially equitable, environmentally sustainable and economically viable development.

5.2 Population internal migration and socio-economic disparities

The Mediterranean region and its dynamics of coastal development appear to be mainly one of urbanization and "coastalization". Although percentages of built-up infrastructures and population density vary considerably along the Mediterranean, the overall continued and unabated trend towards coastal urbanisation and the linked concentration of wealth production in the coastal zone to the detriment of the hinterland is perceived particularly strong in the Mediterranean. The following section deals with issue inducing urban sprawl, disparities across territories and landscape fragmentation.

5.2.1 Territorial unbalance & fragmentation

The loss of rural economy dynamic is proportional to cities and coastal areas increased attractiveness. Such situation contributes to generating strong dualities / inequalities between a neglected hinterland and a coastal area subject to rapid urbanization now affecting the whole Mediterranean coastal zone. This change continues to deeply affect the watersheds and land-sea interface management, although many policies tried hard to reduce such 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. In Northern Mediterranean countries, the trend towards a historic decline in rural life is a long-standing reality. The processes of revitalization of rural areas encouraged by the second pillar of the European Union Common Agricultural Policy[104], the promotion of natural and cultural heritage in the countryside, the resistance of family farming and the maintenance of agriculture on territorial bases could not reverse this downward trend in the rural population. For example, over the period 1961-2016, rural population has halved in Spain, passing from

[104] 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.

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 remains high in 2017, with rates ranging from approximately 33% in Montenegro to 41% in Albania, and even 46% in Slovenia. These rates of the rural population, close to those recorded in countries such as Syria (46.5%), Morocco (38%), Tunisia (31%) or Cyprus (33%), reveal the persistence of a vitality of rural territories in certain regions of Europe. These rurality rates are comparable to those of France, Spain, Italy or Greece in the 1970s (Eurostat, 2017).

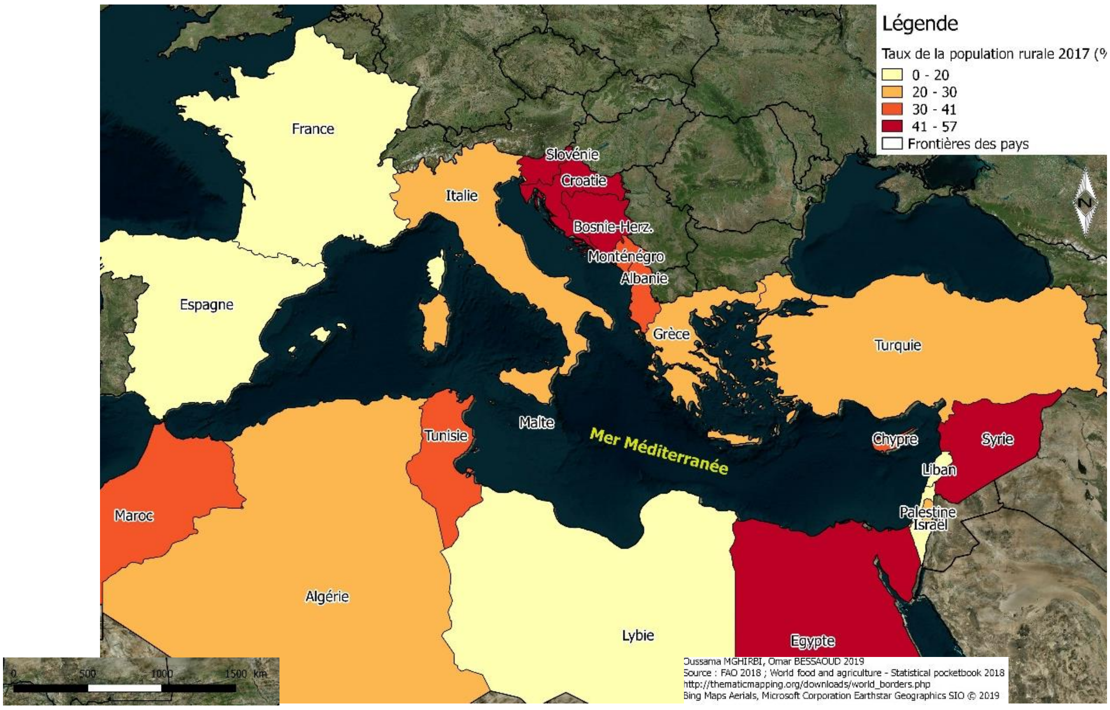

Figure 116 Rural population rate in 2017 (Source: FAO, 2018)

With nearly half a century difference compared to Northern Mediterranean countries, the countries of the South and East have initiated in recent decades a historic process of 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 countries now have an urbanization rate of over 50% (FAO, 2018).

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%). The process of 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%) or Turkey (-0.5%)[105]. Egypt remains by far the country where the rural and peasant world is experiencing a remarkable demographic growth. With an annual rural population growth rate of 2%, Egypt went to 35 million rural people in 1995, to about 56 million in 2017 (FAO, 2018, World Bank, 2017)[106]. Syria, which had barely 3 million rural people in 1960, counted more than 7.2 million in 1995 and 9.7 million in 2016.

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[105] The population of Mediterranean Arab countries in rural areas in 2017 is barely 40.3 million while Egypt alone has 55.8 million inhabitants in rural areas.

[106] Turkey, which in 1980 counted more than 25 million rural people, more than 56% of the population, counts in 2016 only 20.1 million (25.3% of the total population).

5.2.1.2 Housing and basic services in coastal urban areas

"Ensuring access for all to adequate, safe and affordable housing and basic services and upgrade slums", by 2030, is part of the Agenda for Sustainable Development (Target 11.1 of the Sustainable Development Goal (SDG) 11 that clearly expresses the need to "make cities and human settlements inclusive, safe, resilient and sustainable"). This represents a real challenge in the Mediterranean coastal region, where housing is influenced by specific social, economic and environmental characteristics like rapid rural to urban migration, mass tourism, land ownership status and changing climatic conditions.

Rapid and ever increasing growth of cities in the coastal zone is linked to the formation and extension 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 population living in slum area (characterised by areas with limited access to improved water, sanitation, durable housing and sufficient living area, measured at the national level) is available for only 8 out of 22 Mediterranean countries (Figure 117), indicating the difficulty of monitoring the achievement of SDG Target 11.1.

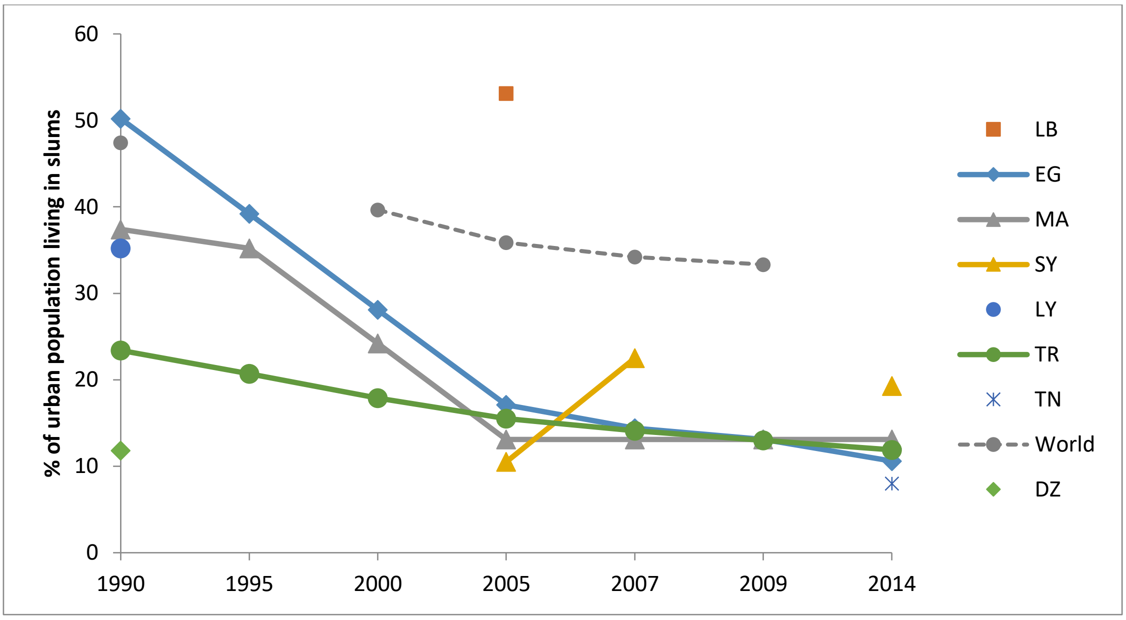

Figure 117 Proportion of urban population living in slum areas in Egypt (EG), Lebanon (LB), Morocco (MA), Syrian Arab Republic (SY), Tunisia (TN), Turkey (TR) Algeria (DZ) and Libya (LY), compared to global trend (Sources: World Development Indicators, accessed on January 2019; United Nations Human Settlements Programme (UN-Habitat), Global Urban Indicators Database 2014)

According to UN Habitat data, the proportion of urban inhabitants living in slums tends to decrease in most documented South and Eastern Mediterranean countries significantly faster than world average. Nevertheless, latest available data show that a large proportion of the urban population in some of the Southern and Eastern Mediterranean countries lives in informal settlements, namely in Lebanon (53%), Libya (35%), Syria (19%), Algeria (12%), Morocco (13%), Turkey (12%), Egypt (11%) and Tunisia (8%). People living in informal settlements are prone to disease exposure, due to lack of drinking water and sanitation services, are more susceptible to coastal risks and have a limited financial capacity to recover from disaster.

Beside the issue of informal settlements, the housing market in costal Mediterranean cities, at least in the Northern countries, suffers from an unbalance 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-house owning culture" (Gentili & Hoekstra 2018). The proportion of the cost of housing in relation to the total household disposable income indicates overcharge[107] in Greece, Spain and Italy for example (EC Europa). 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 migrations. 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 related to daily activities (work, shopping and leisure) inscribed 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 actors illustrated various urban mobility weaknesses, more particularly in Mediterranean riparian countries. 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 managerial challenge in Mediterranean cities, independently 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 continue increase of mobility and the lack of capacity to face common challenges such as: traffic congestions, alarming air pollution indicators, lack of public urban transport systems and increase in the dependency on individual vehicles, seasonal demands' negative impacts, inefficient parking and monitoring systems, etc.

During the 2008 economic crisis, CO_2 emission and use of private cars decreased in most of the north Mediterranean cities. This effect is attributed to a combined impact of the sustainable mobility polices in the previous decade and the decrease of the urban mobility during the recession. With economies recovering, statistics tend to go back to previous levels and mobility scenarios, potentially mitigated in those cities, mainly in the northern Mediterranean shore, that have adopted 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, leading to the implementation of sustainable mobility actions. Most of the southern cities, on the other hand, are in the first phases of Urban Mobility Planning, and mobility measures remain insufficient or inefficient, due to the large-scale solutions required in a context of rapid urbanisation, the lack of skills and economic resources in local governments for implementing such large-scale projects or initiating public-private partnerships.

The WBCSD provides an online tool (http://www.wbcsdsmp.org) that allow cities to analyse their sustainable urban mobility performance, identify solutions, map their solutions and provide information document to support stakeholder communication in the city.

In Mediterranean cities, a more consistent Mediterranean regional strategy is required for enabling the implementation of urban mobility planning and actions. While the current Interreg MED countries (EU territorial cooperation programme limited to European Mediterranean and IPA countries) includes an axis 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 previous experiences and enhancing cooperation on sustainable urban mobility becomes necessary across the Mediterranean shores in order to bridge the gap.

[107] 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. Source: EU-SILC survey, Eurostat.

Box 38 From mobility to smart mobility in Koper (Slovenia): a user-oriented approach in a multi-operator context

With the support of Interreg MED Program, 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 to this information via web and mobile applications but also on LED displays on bus stops, multimodal knots and streets.

The Municipality of Koper is able to provide information for all transport modes (traffic congestion, urban & suburban Public Transport tracking, parking fill rate, etc.), thanks to the installation of (i) bus trackers, (ii) sensors for counting traffic (vehicles, pedestrians and cyclists), (iii) parking lot occupancy counters, (iv) data centralisation by the Transport Information Centre, and dissemination through an integrated application and information panels. Thanks to 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 39 Sfax developed the first SUMP of Tunisia: the Sfax Tramway as sustainable large-scale project in south med cities

Sfax could be consider as a southern city with a great experience on Urban Mobility planning by developing a traffic plan (PDU) in 2002 and updating it together with a National Appropriate Mitigation Action (NAMA) in 2017. The actions' implementation rates are very low, but important large-scale projects are in process.

The Sfax tramway network was defined by the preliminary study carried out in 2014, entitled "feasibility of a system of Public transport in own site ecologically viable in the agglomeration of Sfax". The network selected for 2030 is composed of 70 Km in five lines: two tramlines of 33.5 Km with a size of the fleet: 20 trains and three lines of BRT of 36.5 Km.

The Traveller Information System (TIS) monitors rowing in real time. It consolidates the means of information intended for tramway users and managers. The calculations of the multi-modal horizon for the study shows the tendency for improving the multi-modal scenario from 6% of use of public transport in 2018 up to 25% in 2030.

After reviewing the state and consequences of population migrations and their related socio-economic disparities, the following sections give some elements of response and how they could be implemented.

5.2.2 Networks of cities

The present section focuses on networking initiatives in the Mediterranean, either formal or informal, which promote cooperation among Mediterranean cities with a focus on sustainable urban development, effective delivery of urban services, and effective urban governance and management systems. Such initiatives are crucial for building a culture of cooperation and strengthening the cities' capacities to cope with similar problems, by exchanging, sharing and transferring technical know-how, expertise and experiences. However, such networks face the challenge of discontinuity in their work due to their dependency on project funding.

Although no precise quantitative data exist regarding networking among Mediterranean Cities, this section illustrates the relations among coastal cities from all shores of the Mediterranean through their participation in networking initiatives. The modus operandi and organisational 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 associations of cities with stable functioning, to informal networks of cities or networking platforms with ad hoc membership. Furthermore, it includes networks with exclusive membership from Mediterranean cities; international networks with a regional MED focus; or international networks where there is also participation of Mediterranean cities, although there is no concrete geographical focus on MED area.

A review of the major active networks in the Mediterranean, shows that the creation of these is relatively recent, some of them stemming as a result of the Euro-Mediterranean Partnership or Barcelona process:

- **MedCities** is a Mediterranean network, created in Barcelona in 1991 and promotes the elaboration 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 Ionic Cities.** the Forum 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 created in 2001 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 are:

- **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 towards 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).

And finally, initiatives to facilitate networking and bilateral cooperation, with a geographical focus including among others **Programme CoMun, and CATMED**.

Besides networks focusing on the region, Mediterranean cities are active in some of the international or 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, such networks should continue exchanging, sharing and transferring technical expertise and experiences among stakeholders from all shores of the Mediterranean. An inspiring example for an integrated approach to urban development in the Mediterranean could be the ERDF URBACT (an European exchange and learning programme promoting sustainable urban development) that, from 2000 to 2015, has 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. This recommendation provides guidelines to integrate policies and practices of conservation of the built environment into the wider goals of urban development in respect of 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 - in particular to the Sustainable Development Goal 11 on Making cities and human settlements inclusive, safe, resilient and sustainable, and directly to Target 11.4 for the strengthening of efforts to protect and preserve the world's cultural and natural heritage.

The starting point for the development of Sustainable Urban Development strategies is the conservation of cultural heritage. Without an effective action for conservation, the legacy of the past can rapidly be lost, as it is happening in many urban contexts characterised by intensive and rapid development processes, with the loss of connection between communities and the built environment in which they live. Promoting the regeneration 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 revitalisation and sustainable tourism are powerful economic sectors that can generate green employment, stimulate local development and foster creativity.

The urban morphology of medinas and the typology of its dwellings make social, generational, and functional diversity possible. Being 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. A key element of urban citizenship in the Arab world, the urban heritage of the medinas can be a real strength in favour of social cohesion against the backdrop of economic, social and cultural restructuring. Walkable 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, the 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.

Box 40 The 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, very interesting traditional houses, palaces, hammams, mosques and various souks are still conserved, testifying of all cultural influences that have spread throughout the country including Punic, Numidian, Roman, Berber or Ottoman culture.

The conservation of this site, inscribed in 1992 on the World Heritage list, is impacted by challenging factors, such as densification and change of population, complex land tenure, lifestyle disruption, lack of maintenance of habitat leading to increased insalubrity, etc. resulting in a serious degradation of the urban fabric, of public space and infrastructures. In order to implement the UNESCO 2011 Recommendation on 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 socio-economic structures, an international meeting was organised 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 to foster and support the development of projects galvanising the economic and social development in order to create growing clusters that lead to the mix of uses and social diversity, with an important component granted to 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 focusing on the enhanced use of local resources and local knowledge particular to the place.

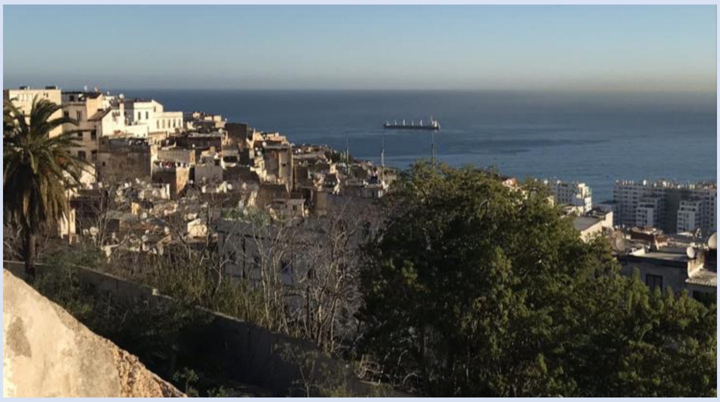

Figure 118 Kasbah of Algiers (© UNESCO / Youmna Tabet)

5.2.4 *Planning alternatives to metropolisation*

The main urban areas benefit from most of the world's demographic and economic growth. In the Mediterranean, it is often the port cities. In recent decades, the city has grown and is organized at the larger territorial scale, the one 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 seasonality that is difficult to manage in terms of urban metabolism. In that way, this structure does not meet environmental requirements against the backdrop of climate change, nor the needs of social coherence. An alternative to this model would be to organize the metropolitan area in an interconnection between the big city, intermediate cities, villages and countryside according to economic and cultural complementarities and social solidarities. This spatial figure of urban and economic archipelagos is conceived as a set of links, roads, interdependencies existing or to be created between urban concentrations, nodes, intersections that structure the metropolitan whole and gives it life and function. In this form of metropolisation nothing is empty, the countryside is not a void, it is the nourishing space of the metropolis and the mountain which constituted an urban limit can become a metropolitan park, a biodiversity reserve.

Inventing these new metropolitan registers thus becomes a major challenge in the fight against littoralisation, and implies tangible and intangible investments and certainly renewed territorial narratives.

5.2.5 Regional planning and territorial cohesion

The international discussion of recent years has highlighted the centrality of the territory in the process of sustainable development (UN, 2015)[108]. At the European and national levels, territorial development policies are now considered indispensable to achieve smart, sustainable and inclusive growth[109]. 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 Region. It adds to the concept of economic and social cohesion by translating 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, 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[110] 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'[111], there are basic difficulties to define them only according to a spatial logic based on twofold criteria of inclusion or exclusion[xliv]. Doubtless, some regions of the Mediterranean still face economic, social, and environmental problems due to a multiplicity of factors that can be variously sectoral, structural and transactional (AA.VV. Mediterranean Yearbook 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 explore the socio-cultural and political underlying dynamics only partially. It emerges, for example, the centrality of cultural landscape connotation designed by the Mediterranean lifestyle, understood as an interaction

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[108] United Nations General Assembly: Transforming our world: the 2030 Agenda for Sustainable Development (2015).

[109] See: European Commission: Europe 2020: A strategy for smart, sustainable and inclusive growth. COM (2010) 2020 final. Niestroy, I.: Sustainable Development Governance Structures in the European Union, in Institutionalising Sustainable Development, 67–88, OECD Publishing, Paris (2007)

[110] In this paragraph the term « region » is used to designate sub-national rather than supranational geographic entities.

[111] “*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*” (Gilles van Hamme, Claude Grasland. Divisions of the world according to flows and networks. 2011. ffhalshs-00654535)

between nature and humanity, in the UNESCO recognition of the Mediterranean Diet as Intangible Cultural Heritage of Humanity[112]. The Mediterranean area has in part regained, in the last decade, the cultural role of cities as a bridge between Europe, Africa and the Middle East. In addition, the internationally recognized Mediterranean niche in tourism, culture and management of great events are the elements through which the socioeconomic power of cities consolidates (IEMed 2017). In this prospective of the 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 hence reducing the gap between the lagging regions through the achievement of a sustainable development. The promotion of a common territorial framework in the Mediterranean is called at reconciling the different approaches between the two shores, with priority intervention related to strategic sectors, such as the enhancement of environmental, cultural heritage and tourism, energy efficiency, education, quality employment, mobility network, research and innovation, urban and rural sustainable development[113].

Another concern about the ‘coastalisation’ of urbanization should be the multiplication of deep-water ports. Port developments marked by the development of containerisation and the race for gigantism of vessels require the creation of new ports of transhipment in deep water, whose impacts on the quality of the coastline are numerous. For the Mediterranean territories, the capture of these flows of goods becomes a major stake which supposes colossal investments. The efficiency of these new ports is dependent on their integration into a logistic-industrial system, hence the production close to economic activity zones. Without a Mediterranean strategy, competition will be exacerbated, and ecological considerations will again be difficult. Another approach could be based on a logic of alliances between national and international ports, in direct dialogue with private port transporters. Should we consider, for each country, work worth several billion euros to open access to boats of 18 to 20 thousand containers and thousands of trucks, or substitute 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.

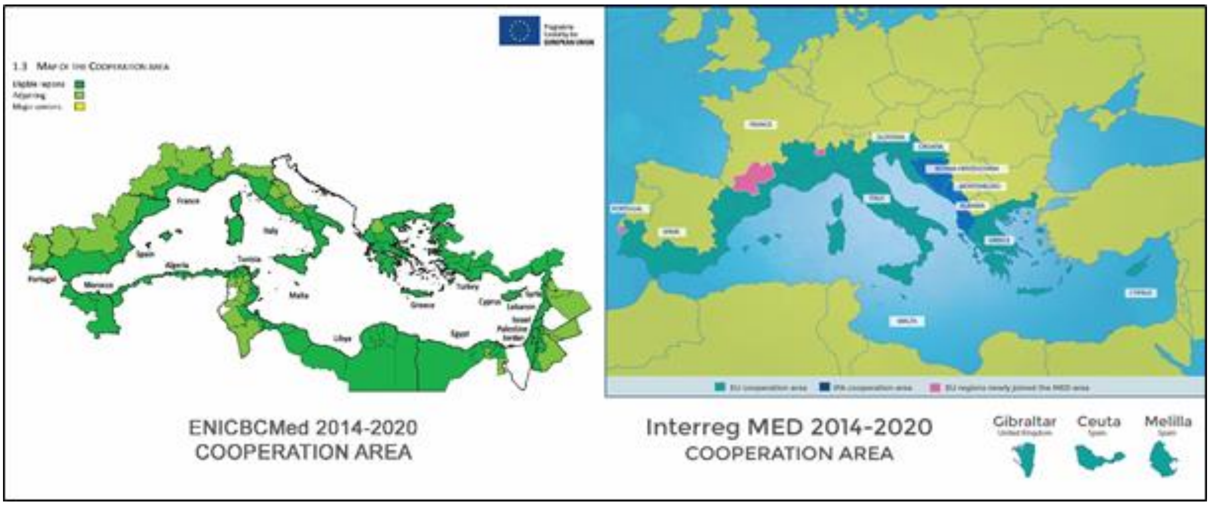

Figure 119 Maps of the Cooperation Areas (EC 2015). Left: eligible regions of the 14 countries participate in the ENI CBC Med 2014-2020 Programme. Right: 57 regions divided among 10 EU Member States and 3 countries from the Instrument for Pre-Accession Assistance (IPA) participate in MED Cooperation Programme 2014-2020

5.2.6 Promoting traditional knowledge, skills and crafts.

In the Mediterranean region, people have always had to face the scarcity of resources, unpredictability of the environment and climate variability. These conditions have allowed to acquire appropriate

[112] The Mediterranean Diet was inscribed in 2010 on the Representative List of the Intangible Cultural Heritage of Humanity, involving Italy, Spain, Greece, Morocco, and from 2013 also Cyprus, Croatia, Portugal.

[113] Territorial Agenda of EU 2020

knowledge at the local level to deal with adversity, manage ecosystems, carry out technical, artistic architectonic works, and realize urban complex universally recognized for their beauty and harmony. Traditional techniques, skill and crafts exist on 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 with superficial suggestion of the absolute superiority of modern technology, the conservation and transmission of this knowledge is lost and needs re-discovering.

Traditional Knowledge cannot be reduced to a list of mere isolated technical solutions able to solve a specific problem. Using traditional knowledge today means to re-interpret 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.

Some traditional techniques are re-discovered, more particularly in sustainable agriculture, water and soil management. They are often particularly adapted to an economy efficient in resources. Others persist to date. Local knowledge is an economic factor in different production sectors. Situations in which tradition persists, and its role in society and economy is consolidated and stabilised, exist in the most technologically advanced countries and sectors. The values of tradition, manufacturing practices and the craftsmen’s skills are the basis on which is founded the great added value of productions of enormous economic importance for many modern countries (Box 41).

Box 41 Re-discovering traditional knowledge to solve current issues: a few examples

- Agriculture

Prehistoric traditional techniques, used to build the Mediterranean agricultural landscape, are today re-proposed in agriculture as best practices to replenish soils, save water and combat hydrogeological instability and desertification.

- The technique of the drainage ditches spread in 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 humid 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 are suffering terrible inundations in winter and extreme drought in summer.
- In southern Italy practices such as the grassing and sowing on “hard soil” are 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 soils. This technique enables to protect soils and reduce costs. It is most advantageous during droughts as ears of wheat grow remain shorter and need less water and chemical fertilizers.
- The practice of setting cistern-jars full of water or calcareous masses close to the plants to provide irrigation is today re-proposed. These traditional innovative techniques are used for reforestation, allowing each single shrub to be supplied with the quantity of water it needs for its initial growth.
- The drainage tunnels are underground tunnels spread over arid areas for 3,000 years to supply the oases with water and are still working today. They allow to absorb the right quantity of water for the replenishment of the environment itself. This solution could be re-proposed in the coastal area 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 the dry limestone walls are used by all ancient societies. Authentic aerial wells, atmospheric condensers producing water from vapour, are used in the coastal areas capturing the evaporation from the sea. Today water turbines are engineered. They produce water from atmospheric moisture according to the principles of ancient techniques.

- Production and landscape

Typical food production such as oil, cheese and wine safeguards both the aesthetic and environmental quality of the landscape. The growing dissemination of organically controlled agricultural productions and meats shows even more interest in traditional techniques of husbandry and breeding.

- Urban settlement

Several innovative techniques coming from tradition can be used in the cities to drastically reduce water and energy consumption. Roof-gardens are re-introduced covering with vegetables the terraces of modern buildings and houses. Those gardens keep optimal climatic conditions inside the houses, harvest water and become an area for entertainment and contemplation. The micro-solutions for city quarters 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. Greater plants for heating the whole house have been also realized.

- Architecture

In restoration and urban regeneration, traditional skills and crafts are essential to ensure the aesthetic and functional qualities of the architectures. A very large series of products, materials and know-how are necessary to the heritage architecture. The aesthetic components that we appreciate in ancient towns, the beauty of the natural materials, the comfort of the buildings and spaces, the organic relationship with the landscape are due to the intrinsic qualities of traditional techniques and to the search for the symbiosis and the harmony embedded in the local practices. In this field, experiences of firms re-proposing market materials and processes derived from tradition, such as lime, natural clay and pozzolana, both for rehabilitation and new constructions are now largely spread.

5.3 Coastal urbanization and environmental changes

In 2019, the percentage of built-up areas have reached an astounding rate. The coastal strip, more and more populated and built up, concentrates most of the major cities, many transport routes (roads, ports, airports), as well as industrial and energy infrastructures. Such concentration keeps growing every year and generates more pollution and disturbance leading to environmental degradation and increased risks for coastal population and infrastructures. Besides these pressures in coastal areas, natural hazards such as storms and flooding add to the overall challenge. While their frequency, occurrence and intensity increase, they constitute a real threat and contribute to the fragilization of the resilience of ecosystems, human population and its coastal infrastructures. In this context of increasing environmental changes, including climate change, a strong landscape and ecosystems protection set of policies is needed.

5.3.1 Land use and artificialisation

5.3.1.1 Landscape diversity

Landscapes are the realisation of natural processes combined with human actions. The concept of landscape integrates 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 the fascinating and rich combination of human and natural landscapes.

Human settlements have been influenced by Mediterranean natural characteristics for millennia. 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 benefiting from sheltered marine environments even if natural ports were not immediately present. Frequently calm waters in closed bays or navigable estuaries facilitated first settlers to base cities in the Mediterranean. Situating the major milestones of Mediterranean Ancient civilization under the dominant role of sea trade and coastal activity can be placed in many sites where conditions were favourable. The number of ancient cities that “used” the accessible Mediterranean Sea at locations that are not immediately adequate for port activities is overwhelming.

From the 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 inputs is dominated by locally generated sea waves typically short crested and steep with short periods. This promotes wave energy dissipation on narrow surf zones which, combined with an almost tide-less sea level variation, represent highly active littoral drift alongshore moving considerable quantities of sediments around input points such as river-mouths.

Terrigenous inputs of sediments are key to the existence of beaches and dune systems. The latitude along which the Mediterranean sits implies that - during the last cold phases of our Planet - no glaciations were observable, and thus 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 riverine input for sediment feeding, lacking 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 deprival of sediment input rapidly translates in erosive trends. Large sedimentary deposits are not available neither on the (narrow and steep) continental shelf, nor in dune systems. This combined with generally steep hinterlands and shelf makes the coastal sedimentary system very vulnerable to modifications both natural (i.e. high energy, low frequency events) and human induced.

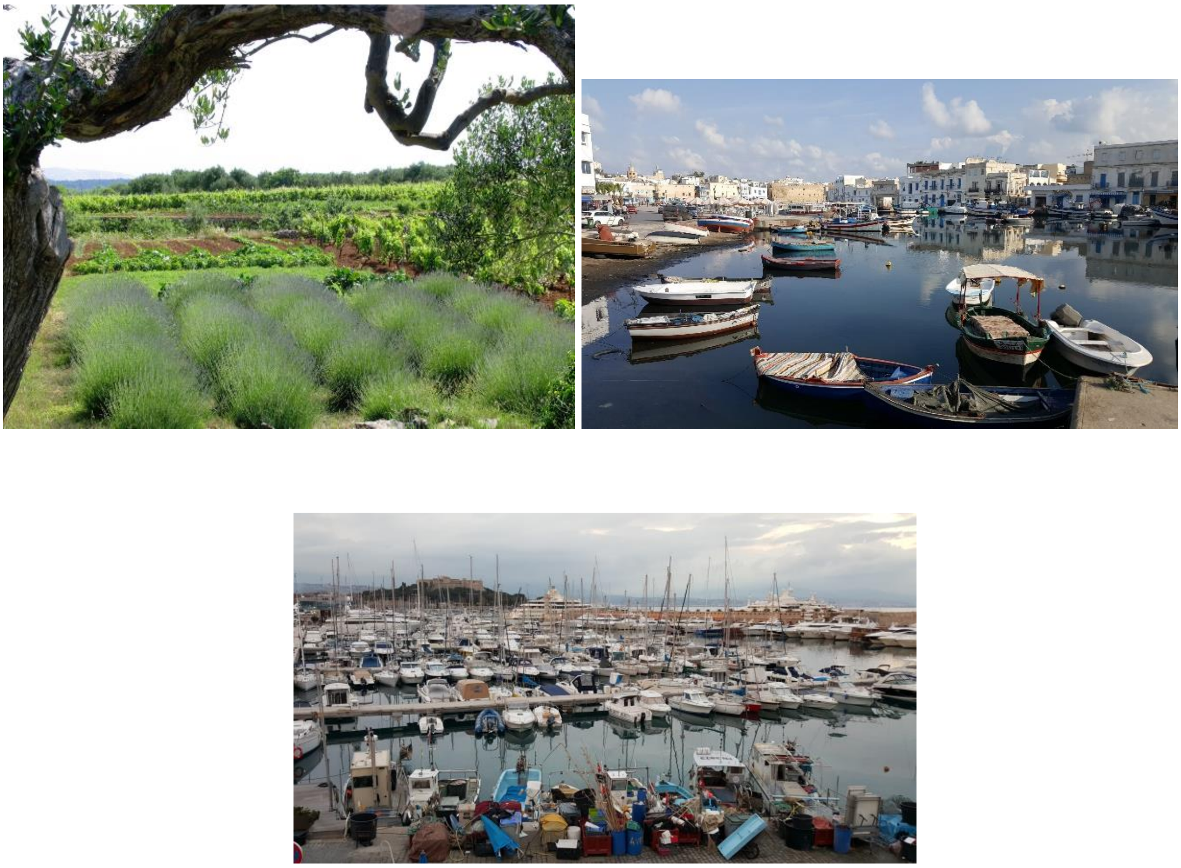

Figure 120 Mediterranean agricultural landscape, traditional port in Tunisia and modern port in Antibes

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 of specific actions for the strategies of protection and development of the islands" (Louis Brigand et al., UNEP - BP / RAC, 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 valorise exceptional territories. Mediterranean islands are excellent experimental laboratories. Conservation operations experimented on the islands can then be extended on all the shores of the Mediterranean.

The Mediterranean Sea has nearly 15,000 islands and islets, among which two islands have the status of State (Malta and Cyprus); several "large" island entities (Balearic Islands, Sicily, and Sardinia) have a status of autonomy whilst Corsica has a special status distinct from other metropolitan regions of territorial authorities. Finally, a large majority of small islands, inhabited or uninhabited, have very variable administrative situations while remaining attached to a continental authority.

In total, the islands coastline represents around 19,000 km, or more than 41% of the Mediterranean coastline (Pantelina Emmanouilidou, 2015), but the islands only represent 4% (in terms of land area) of the whole Mediterranean Sea basin (Kolodny EY, Edisud, 1974). In thirty years (1987-2018), the total permanent population of these islands increased by 1 million; from 10 million (of which ¾ in the western Mediterranean) to 11 million.

Representing more than 85% of the Mediterranean island territories, the small islands inferior to 1000 ha make up, thanks to the diversity and multiplicity of their characteristics (geographical, ecological, socio-economic, political, etc.), particular and remarkable entities of the Mediterranean heritage. From an ecological viewpoint, if the small islands remain "poor" territories in terms of number of species or populations compared to the coastal fringe, they provide a refuge for flora and fauna often threatened on the continent, as for example with the 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 thus at the origin of endemism phenomena. These small islands are thus considered as important and valuable assets in terms of biodiversity within the Mediterranean biodiversity hotspot.

Regarding human history, small islands have also played a key role in the evolution of human settlements across the Mediterranean and this since prehistory: 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 phenomena have influenced the landscape and resource availability of small islands. Since the 1960s, most of the small Mediterranean islands are witnessing a reversal of migration and mobility trends (Bernardi-Tahir N., 2016): marked by the return of former island emigrants or the arrival of new immigrants. Residents looking for a 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" (Louis Brigand et al., UNEP - BP / RAC, 1991).

Given the attractiveness of these territories, it is essential that all island stakeholders, public and private, be involved in the process of co-building projects for sustainable territories: how best to regulate the uses and limit the impacts of human activities? How to regulate and frame visitor flows? What energy to choose? How to better manage water resources? How to reduce and treat wastes? The setting up of 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 good 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 status of protection, such as the Habibas Islands Nature Reserve in Algeria or the Palm islands in Lebanon, the Zembra-Zembretta National Park in Tunisia (also Man and Biosphere Reserve of UNESCO) or Port-Cros in France, 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 local level, many international initiatives have focused on the need to conserve small islands. The Mediterranean Sustainable Small Islands Initiative (SMILO) is part of an international cooperation process of providing 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, aims to strengthen the conservation of wetlands in Mediterranean islands, through the improvement of knowledge on these territories and the setup of local advocacy at the international level. The programme SMILO (Small Island Organization) works with many Mediterranean islands to develop operational solutions to improve water, energy, waste, biodiversity and landscape management through pilot actions, and promoting exchanges and labelling of good practices. Finally, Article 12 of the ICZM Mediterranean Protocol establishes an obligation of 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 uses and know-how" and "to take into account the specificities of the island environment as well as the need to ensure interaction between islands in national strategies, coastal plans and programs and management tools, particularly in the areas of transport, tourism, fisheries, waste and water" (ICZM Protocol, PAP RAC, 2008). It thus constitutes a pioneering tool in the reflections towards the emergence of a legal framework specific to the Mediterranean islands, which would allow in the long term to 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[xlv]. The share of the coastal population 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 337 million international tourist arrivals (ITAs) per year, representing about 27 % of world tourism in 2016[xlvi], largely concentrated in coastal zones and summer months.

In 2017, UNEP-GRID prepared for PAP/RAC an analysis of the built-up area in coastal zones of Mediterranean countries between 1975 and 2015[114]. For the first time, the coastal urbanization along northern and south-eastern shores of the Mediterranean has been assessed by applying a unique methodology. A set of data processed from the Landsat collection, more precisely the Global Human Settlement Layer (GHSL), was provided by the European Commission, the Joint Research Centre. Data on built-up areas were calculated for three coastal belts of 150 m, 1 km and of 10 km width. 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 values trends (Figure 121). For all countries the highest percentage of the built-up areas is within the first kilometre, except for the State of Palestine and Malta (small countries by surface and by population) where the highest percentage is within the 10-kilometre zone.

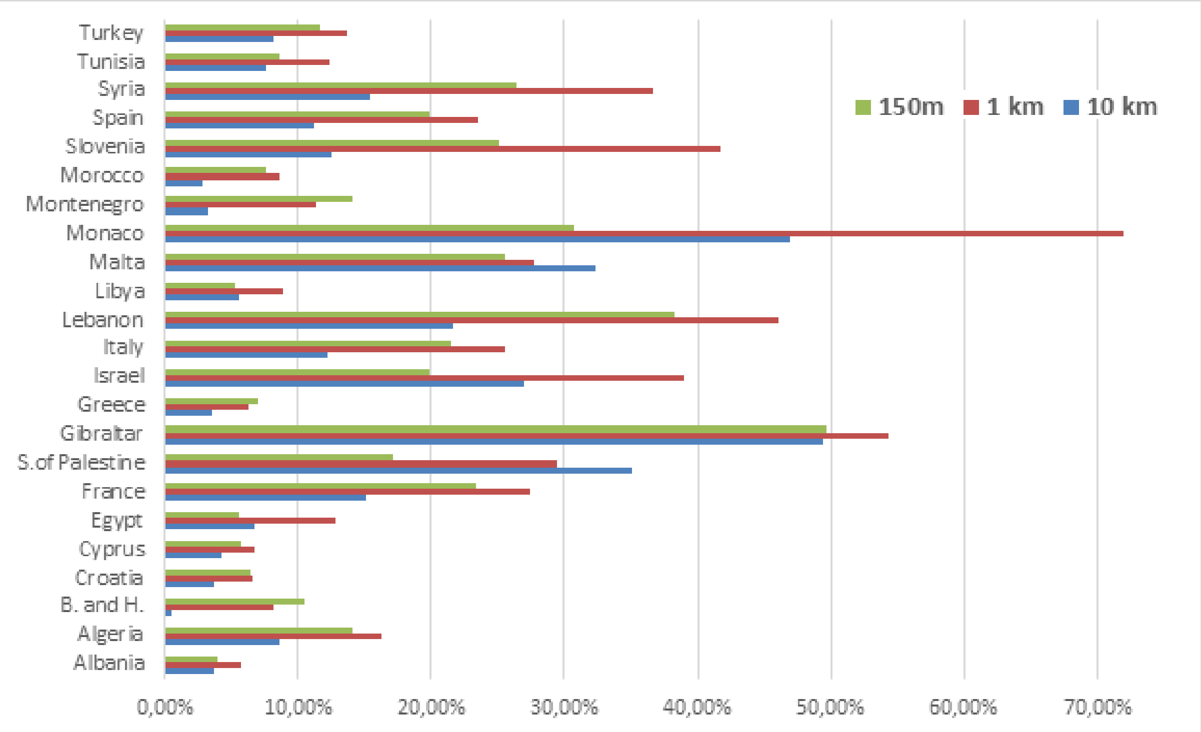

Figure 121 Percentage of build-up area per coastal zones as of 2015 (Source: UNEP-GRID, 2017)

[114] UNEP GRID Geneva (2017) *Evolution of the built-up area in coastal zones of Mediterranean countries between 1975 and 2015*. PAP/RAC.

Population density varies considerably along the Mediterranean coasts. Figure 122 presents the data collected by Plan Bleu for the period 2008-2017.[115] Besides Monaco and State of Palestine, Malta, Lebanon, Syria, Israel, and Algeria have the highest density of inhabitants per km^2 in Mediterranean coastal regions.

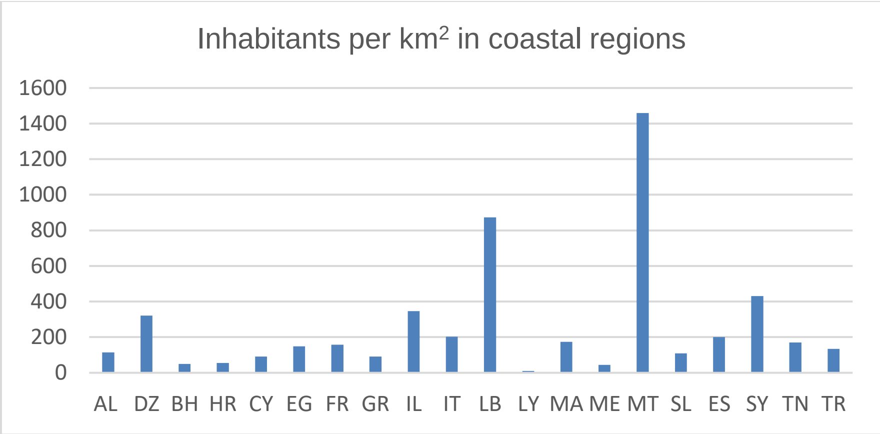

Figure 122 Inhabitants per square kilometer in coastal regions [source to be included]

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 coast 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, still they make 85 % of the total population. Croatia's coast accounts for 13% of the Mediterranean, 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 islands coast, but most of it belongs to two biggest Mediterranean islands (Sardinia and Sicily), bigger than some Mediterranean states, such as Cyprus or Malta. Other countries with an important share of the Mediterranean coast are Turkey (11%), Spain (6%), Libya (4%), France (4%), Tunisia (3%), Algeria (3%) and Egypt (2%). Some of these countries also have rather important share of islands coast, but mostly far less than Greece and Croatia.

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 from the percentage of a built-up area within 10 km compared with the 150 m coastal belt. Bosnia and Herzegovina and Greece are the only countries in the Mediterranean where the percentage of built-up area in 150 m is higher than in the 1st kilometre. This is particularly important for Greece, since it holds alone 33% of all Mediterranean coasts.

The historical trends of built-up area within the first kilometre from the coastline is presented in Figure 123. Besides Monaco and Gibraltar that are rather specific, countries with the highest percentage of built-up areas within the first kilometre from the coastline are Lebanon, Slovenia, Israel, Syria and Malta. It is interesting to note the differences between the population density in coastal regions and the percentages of the built-up areas.

[115] Monaco and State of Palestine are excluded since their density is 15 and 5 times higher than Malta, so they disrupt the graph.

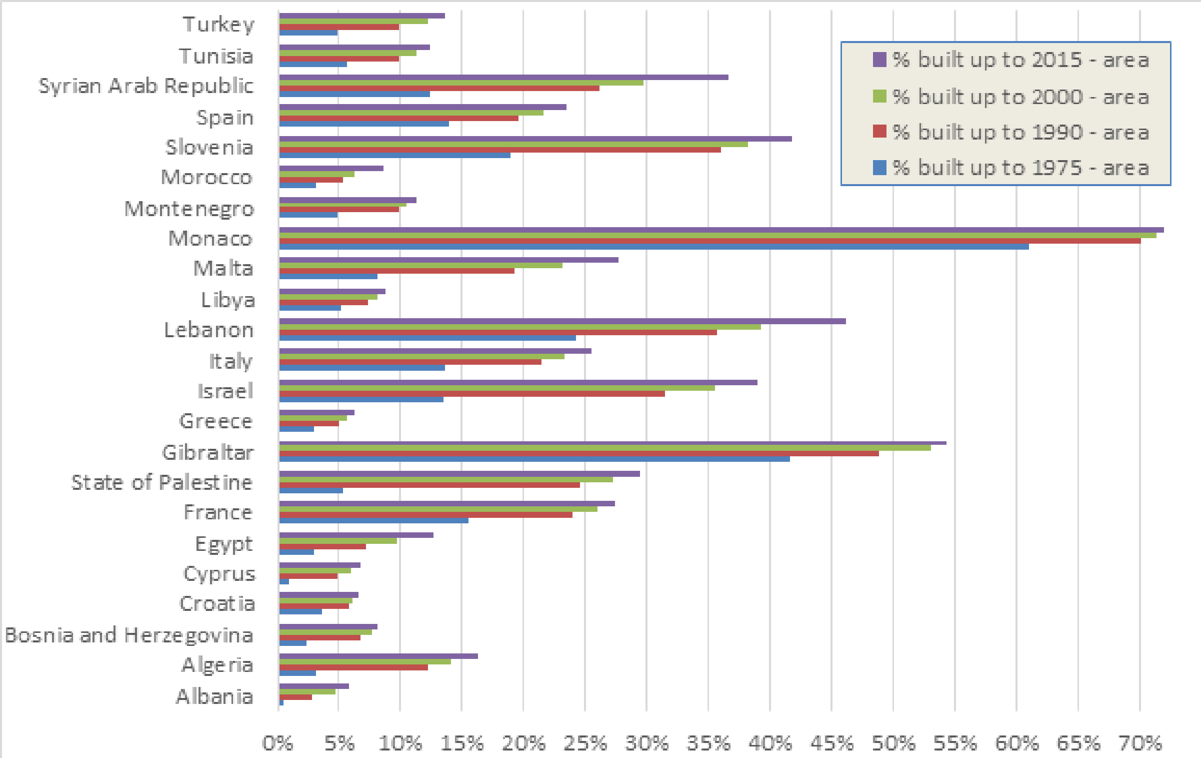

Figure 123 Percentage of built-up per coastal belt of 1 km from the coastline (Source: UNEP-GRID, 2017)

On the coast, the "tourism/coastline" and "energy/hydrocarbons" nexus drive the economic development. As an example, the growth of tourism, which is very often only oriented towards the development of seaside mass tourism, has generated many development plans and programs which, combined with the development of transport infrastructures, have greatly contributed to coastline artificialisation. For a long time, industrial investment (refining, petrochemicals, iron and steel industry, etc.) was considered a priority by public authorities, resulting in very high concentration spots often corresponding to extensive industrial-port areas on the North shore, but also more and more on the southern shore of the Mediterranean.

5.3.2 Land-sea interactions

Land-sea interactions and related processes constitute the central issue of the 3rd Mid-Term Strategy 2016-2021 of UNEP-MAP, and correspond to the first objective of the Mediterranean sustainable development strategy (MSSD) and to 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[116]. However, 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. 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 provide for three levels/dimensions (surface, water column, and sea bed), the time factor being important for both ICZM and MSP.

[116] SIMWESTMED.2018. Recommendations and Guidelines to support common understanding on a regional scale on MSP, including synergic implementation of regionally relevant policy instruments 1.3.1.2./1.3.1.4.

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 the natural processes and impacts of the 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 the mangrove habitats are examples of interfaces 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 124).

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 off-shore desalination, CO_2 capture and storage)
- Energy industry (offshore /oil and gas] energy, offshore renewable energy [wind, waves, surge/)
- Infrastructures (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 boat
- Recreation and Sports
- Biotechnology
- Marine Protected Areas (MPA), Biological Protection Zones (BPZ) (and in general 'area-based management tools, including marine protected areas')
- 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

at "land" interacting with "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 plant, including desalination plant, CO2 capture and storage)
- Energy industry (onshore energy /oil and gas/, onshore renewable energy /wind, sun, geothermal/)
- Infrastructures (river ports, including dredging activities, engineering work, including dam, bridges, remediation activities, railways and roads) Port activity
- Transports (river transport, road and rail transportation)
- Tourism, Sports and Recreation activities (i.e. bathing stations, touristic facilities)
- Biotechnology
- Natural Protected Areas (Nature reserves, National Parks, Regional Parks, etc., on-shore or with off-shore boundaries)
- Defence and security

GENERAL HUMAN ACTIVITIES

- Urban plants (including pollution of water bodies that collect waste water)
- Waste
- Services network (i.e. sewage systems)

NATURAL

- Soil erosion (leaching, wind action)
- Natural subsidence
- Hydrogeological instability (including landslides)
- Transport od river sediments
- Flooding
- Volcanic and tectonic activities

Figure 124 Land-Sea Interactions according to the conceptualization, Source: CAMP Italy Project (2017)

Similarly, human activities might have interaction across the coastal border including both directions: land toward sea and sea toward land. Most of the activities taking 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), extend their domain also at sea (Box 42).

Box 42 Trends of activities having a strong connection with coastal infrastructures

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 ports activity and development, the number of which is currently over 600 commercial ports and terminals, almost half of them are located in Greece and Italy. Development include passenger transport that will continue to grow at an annual rate of 10%, driven by trends in tourism development, more 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 27 million passengers went through Mediterranean ports in 2013. Coastal tourism is expected to maintain an upward trend over the next 15 years. International tourist arrivals in the Mediterranean is expected to significantly increase to reach 500 million arrivals at the Mediterranean region level.

Fisheries and aquaculture. In the Mediterranean and Black Seas, capture fisheries production declined from1.4 million tonnes to about 1.2 million tonnes (FAO, 2014) from 1993 to 2013 (FAO, 2015), as most fishing stocks are overexploited (Colloca et al., 2013) and declining (Vasilakopulos et al., 2014). According to the GFCM (2016), about 80% of scientifically assessed stocks in the Mediterranean and Black Sea are not sustainably harvested. It is to 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%. The aquaculture production forecasts in the EU's Mediterranean countries are expecting the production to more than double between 2010 and 2030, from 280,000 tonnes to 600,000 tonnes (WWF, 2015).

5.3.2.2 The booming of maritime activities

In addition to the "coastalization" phenomena, the "maritimisation" of human activities is now under fast development, requiring the extension of integrated coastal zone management towards offshore waters (so-called 'maritime spatial planning' or MSP), whilst the land-sea interface area remain indispensable for maritime activities development, more particularly ports and related infrastructures. The development of what is now called the 'Blue Economy' become possible thanks to the availability of technological development at sea (beyond 3 and 12 nautical miles). At the same time, it is worth recalling that such new economic 'El Dorado' means added pressures on an already heavily impacted coastal zone. It is therefore essential to articulate the integrated management approaches related to water resources, the coastal area, and the open sea.

The Mediterranean Sea is a semi-closed, fast-changing, and highly anthropized sea that reflects the global evolution of the state of the ocean. Adding to the climate induced-changes the Mediterranean Sea is currently facing an acceleration of existing (tourism, shipping, aquaculture, offshore oil and gas) and new maritime activities (renewable energy, seabed mining, biotechnology) development (WWF, 2015). Their development and resulting pressures can generate significant conflicts between sectors and represent an additional threat to the health of already-stressed Mediterranean ecosystems.

In fact, significant increase in maritime activities have already determined relevant consequences on land and future trends of the sectors are expected to cause additional impacts. For example, hydrocarbon exploration projects and associated drilling activity have become more and more 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 number of routes and traffic intensity, also due 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. Actually, marine renewable energy, including offshore wind, wave, tide-current and thermal gradient energies, is in the early stages of development in the Mediterranean Sea (WWF, 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 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 a 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, the ecosystems and the economic activities and infrastructure in the coastal zones of the Mediterranean are expected to be amplified under climate change. As further detailed in Chapter 2, the IPCC AR5 Report notes that the Mediterranean Region is “highly vulnerable to climate change” and that it “will suffer multiple stresses and systemic failures due to climate changes”. As a matter of fact, changes in the Mediterranean climate and their consequences are already being observed.

Box 43 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 went through a series of change that altered their features in a dramatic way though there is a lack of appreciation of their synergy effects. These observed modifications come as follows (Boero, 2015)[117] :

- Tropicalization: non-indigenous species of warm-water affinity become increasingly established.
- Meridionalization: the species that usually thrive in the southern part of the basin expand northwards, adding to tropical ones in changing northern biota.
- Impairment of cold-water engines: the Eastern Mediterranean Transient current showed that, in a period of global warming, the cold engines might fail renewing deep Mediterranean waters, with vast consequences on the Mediterranean Sea ecosystems.
- Changes in the phenology of the species: reproductive patterns are modified by different thermal conditions; 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 in deeper waters, their surface populations having already suffered severe mass mortalities. The risk of extinction cannot be ignored but species might adapt as well to the new conditions.
- Less fish, more jellyfish and jellyfish eaters: the fish-jellyfish transition is observed in many seas of the world as in the Mediterranean.
- Habitat destruction: the cumulative effects of both direct (e.g. building maritime infrastructures) and indirect (e.g. pollution) impacts of human activities greatly contribute to habitat destruction.

The principal climate-related risk for the Mediterranean coastal zones is sea level rise and associated hazards. Recent studies by the JRC project a sea level rise of 0.53m by 2100 for Eastern and Central Mediterranean under the medium-low emission scenario RCP 4.5, and 075.m under the high-emission scenario RCP 8.5. As described in Chapter 2, such scenarios are currently being reviewed in light of scenarios and observed phenomena on the melting of polar ice caps.

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. Coastal aquifers, already overexploited, would become increasingly threatened by salt-water 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 those risks, maintaining or restoring wetlands, dunes or salt marshes represent efficient nature-based solutions.

In December 2018, IPCC published “Global Warming of 1.5˚C” report (IPCC, 2018). This report revealed huge risks for the coastal zones, next to warm-water corals, and the Arctic systems. 1.5 ˚C is

[117] Ferdinando Boero. 2015. The future of the Mediterranean Sea ecosystem: towards a different tomorrow. Rend. Fis. Acc. Lincei 26 :3-12

the most ambitious goal of the Paris agreement, originally included at the request of small island nations. Due to the high urbanization of the Mediterranean coasts, it might be understood as a desirable, if not critical goal for the entire Mediterranean region, making coastal population to become the major advocate of mitigation and adaptation.

Box 44 DIVA method implementation and local coastal plan in Šibenik-Knin County (Croatia)

In 2015, DIVA[118] assessment of costs of sea-level rise was done for the Republic of Croatia (PAP/RAC, 2015). Usually this kind of assessments is based on the population projections. In this case, assessment also took into consideration the census data on housing, as well as the future construction as foreseen by the spatial plans. Results showed significantly higher costs from those obtained when solely population projections were taken into account. Finally, a separate study was done for the coastal County Šibenik-Knin (PAP/RAC, 2015). The objective was to compare costs resulting from the DIVA assessment with the expected impacts of climate change to the following sectors: tourism, agriculture, fisheries and aquaculture, water management, manufacturing, maritime transports, ports, energy, health, forest fires and cultural heritage. Assessment showed that the greatest potential impacts will be reflected in the damage to coastal assets. This means that primary residents, owners of the secondary houses and tourism facilities located in the low-lying coastal zone will be particularly affected. Although economic indicators of the County Šibenik-Knin are not very strong, these results represent an important finding. Both studies confirm the assumption that Mediterranean's dedication to coastal tourism makes it additionally vulnerable.

5.3.3.2 Coastal erosion

A significant part of the Mediterranean beaches experience severe erosion, threatening coastal settlement, communication lines, 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 cover few areas only, but this process needs to be better understood and monitored with shared methodologies to allow comparative studies among riparian countries. This will allow to acquire a high-level knowledge of processes acting in this unique environment, where not all the theories, models and solutions valid elsewhere are applicable.

Most of the coasts accreted thanks to deforestation and pasture expansion after sea level stabilized approximately 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 and Thirgood, 1982).

All phases of human development are accompanied by coastal degradation, always correlated by chronicles to intense deforestation; whereas demographic decline (Fall of the Roman Empire, Black Death) triggered agriculture abandonment and beach erosion (Pranzini, 2018).

Land use changes, including abandonment of the 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 the sediment material from reaching the shores. Additional factors on the north and predominant on the south are dam construction, river bed quarrying and land reclamations.

Interruption of longshore transport by commercial and recreational harbours unbalances the coastal sediment budget, making updrift sectors to enormously accrete, but inducing an extended downdrift erosion. Naval gigantism asks for deeper water port, with structures extending far offshore and impacting a longer coastal sector; pleasure crafts follow a similar trend and marinas conform to answer this profitable market request. Also, traditional shore protection structures, when effective, determine an uneven sediment distribution and often favour their 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 transform it in the main agent in coastal reshaping. When erosion started to hit the Mediterranean beaches, the largest part of the coast was uninhabited, both for sanitary and military reasons, and many of the few settlements were on rocky

[118] Dynamic Interactive Vulnerability Assessment

coasts. Further coastal colonization (urban, industrial, tourism) reduced coastal resilience; in addition, shore protection structures were implemented, making the system even more unable 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 one. Seawalls, revetments, or refilling are used to stabilize the shoreline with poor results in maintaining a beach. Sequences of groins 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 even more than 200 elements for several tens of kilometres in European countries. Both induce rip currents formation with strong risk for bathers: casualties are here more frequent than in 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 consequent to a recent tourism development, interact with sediment longshore transport triggering erosion even in coastal cells where global sediment budget is positive. To reduce groins and detached breakwater landscape impact and favour water circulation, as well as to mild their effect, in 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 efficiency and stability has not been fully demonstrated. The same is for beach dewatering, based on devices draining the swash zone favouring 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), later with continental shelf sediments. This activity boosted in the 1990s and was accompanied by an increase in vessels capacity and possibility of deep dredging, down to 130 m; this makes very cost-effective large projects, but mobilization and demobilization costs are unbearable for small nourishment. Sediment bypassing to reduce harbour impact on longshore transport is a sort of land-to-land nourishment now possible with high performance systems and therefore the most promising option for the future.

Many beaches, and their related economies, have been saved though beach nourishment with large scale (e.g. Spain) and small scale (e.g. Malta) projects, and this approach has become synonymous of 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 *Posidonia oceanica* and the many protected areas suggest a very careful use of this methodology.

Following the above assessment of continued extension of built-up areas and consecutive 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 those ever-increasing pressures.

5.3.4 Land-use regulations & planning

5.3.4.1 Setback zoning and spatial recomposition

One of the current most important challenge on the coast is the various risks due to climate change impacts. The Figure 125 shows a regional risk assessment map for the Mediterranean developed using the CRI-Med method.

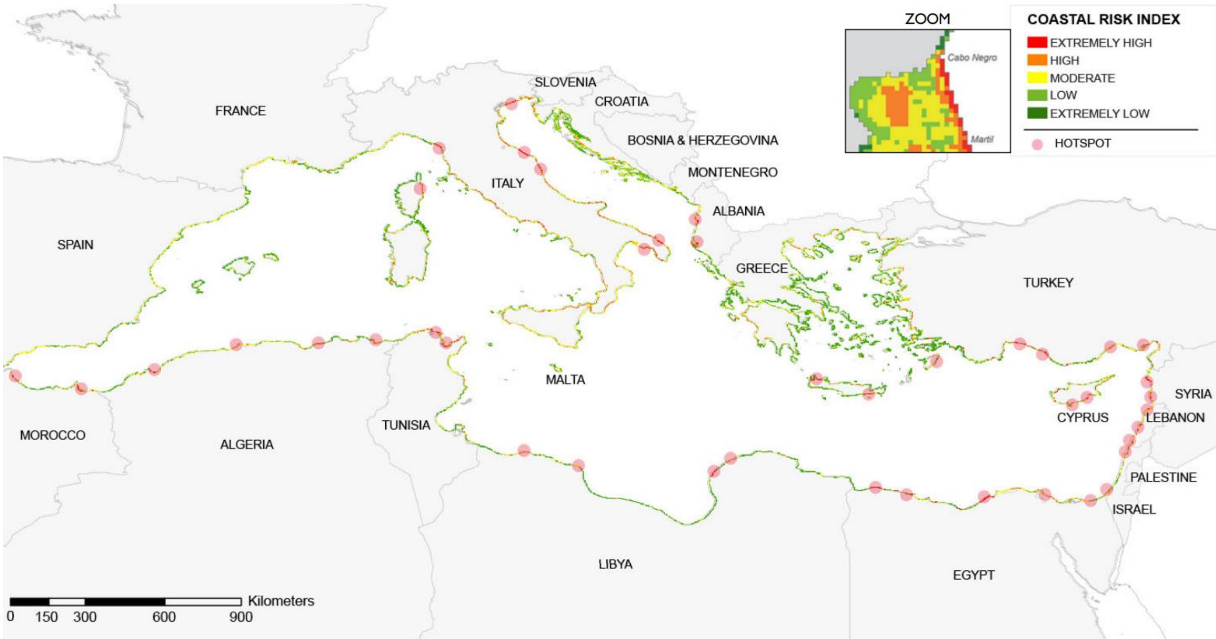

Figure 125 Regional risk assessment map for the Mediterranean based on the CRI-Med method

Actions have to be taken to protect population and infrastructures. It is possible through coastal planning and land-use regulations, a central pillar of any ICZM policy. In this respect, Article 8-2 of the ICZM Protocol, laying down the establishment of a 100-metre setback zone in the Mediterranean coastal areas (Box 45), is proving to be a tool that meets many different policy objectives such as biodiversity protection, maintenance of ecosystem services, preservation of cultural and natural assets and traditional landscapes and adaptation to climate change (IDDRI, 2008). These buffer zones provide a disaster risk reduction tool, low-cost alternative and effective method of minimising 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 policies. However, 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 local stakeholders.

Box 45 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, urbanisation or development are provided for by national legal instruments;

(c) shall notify the organization of their national legal instruments providing for the above adaptations.

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 opens up some opportunities for the preservation of 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. The transfer of ownership to the benefit of the State may intervene in case of incorporation of submerged land to 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 (Lambert, 2013): the MariL119 method (Méthode d'Anticipation du Recul Intégré sur les Littoraux), to spread over time measures of buildings abandonment and to create a new legal concept: the coastal public domain, which would be added to the existing maritime public domain. This method "is based on the anticipation of the shores of tomorrow, through the delimitation of submerged areas by 2100, and having not yet integrated the maritime public domain at present. The zones thereby identified constitute a "coastal public domain" (CPD) or "coastal common heritage" (CCH) on which new rules of law could be envisaged."120

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. This method therefore appears as an opportunity for ICZM. To date, the theory has been taken up within the framework of Camadapt[121], an adaptation project in French Camargue. This new public domain could then benefit from a differentiated management according to the zones: 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 of laws, this method could apply essentially to most recent acquisitions.

5.3.4.2 Nature-based solutions and green infrastructures

The concept of nature-based solutions (NBS) have been put forward by practitioners (in particular the International Union for Nature Conservation, 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 infrastructures). The science and practice are clear that protection or restoration of natural habitats can be a cost-effective complement to build infrastructure approaches for protecting communities and infrastructure from coastal hazards. However, the disconnection between the state of the science and practice has left a gap in guidance for implementing habitat-based solutions for coastal protection (Moser, Williams, and Boesch, 2012).

Box 46 Strategic retreat in the absence of catastrophe, 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. Thus, an experiment to replenish the beach and reduce erosion, by adding sand extracted offshore, was realized in 2005 and allowed to increase (provisionally) the width of the beach and to create a submarine 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 visits.

The site in question is the "Lido du grand et petit Travers". It is a site of great environmental value, property of the Conservatoire du littoral (except for the beach), with strong landscape interest (70 % of community habitats), a part of the area is under protection measures (northern part included in the classified site "pond of Gold", Natura 2000 and special

[119] LAMBERT, Marie-Laure, *Risques littoraux : évolution du droit et prospective,* Jourénée Eccorev, 21 juin 2013

[120] DOZE Elodie, *L'appréhension juridique du risque inhérent aux espaces naturels littoraux*, Thèse de doctorat en Droit public 2016

[121] ALLOUCHE Aurélien, NICOLAS Laurence, *Adaptation aux changements globaux dans la réserve de biosphère Camargue Grand Delta (CAMADAPT),* MEDDE (Ed.), 2014, p. 103-104.

protection area (Birds Directive)). This site is very busy throughout the year and faces difficulties welcoming the population (parking, intense traffic in the summer and trampling 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 program. 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 actors: associations, traders, users etc.

The total cost of this development amounts to 5 M €, supported mainly by the State, the Region, and the ERDF (63 %) but also by the Hérault Department (17 %), the Conservatoire du littoral (10 %), the Pays de l'Or Agglomeration and the communes 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 Pond of Gold, the suppression of the departmental road RD59 (a first in France!), the creation of large car parks behind the dune and access to the beach via decks, as well as the creation of a bike path and interpretive trails.

The success of this project, which could be replicable in the Mediterranean, was made possible thanks to:
- the availability of a basis of scientific studies over time;
- convictions shared at all levels, the establishment of a very wide consultation and a "project" team;
- the alliance between a co-developed adaptation strategy, clearly identified societal challenges, as well as financial and political support;
- the establishment of a continuous technical follow-up of the actions carried out under the initiative.

In a first analysis undertaken by IUCN-Med consulting several databases such Naturvation, OPPLA, EKLIPSE, ICLEI which provides examples of the multiple benefits delivered by Nature-based Solutions in cities, has made a compilation of 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. From the Trees Master Plan in Barcelona or the initiative Grow green in Valencia to Urban Agriculture in the Greater Cairo Region, Green roofs in Athens, and VISA VERT in Marseille or the BIO.FOR.POLIS. project to increasing biodiversity and ecosystem and social services of Forests in the Naples-Caserta metropolitan area, or a project funded by Project Identification Phase of the Urban Projects Finance Initiative (UPFI) on sustainable urban development in Sfax Taparura (Tunisia). In most cases or this preliminary study, NbS act as open innovation drivers for cities, engaging multiple actors and generating benefits that bridge social and economic interests in the related cities.

Green infrastructures are also inspired by nature-based solutions. Green infrastructure, as opposed to the grey-built infrastructure, is the living infrastructure in cities towards "ecology-based management of water, food, air and energy in towns. One of the best examples is the development of green roofs.

Box 47 Green roof in Athens

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 for oiko, pronounced eeko, meaning building-ecological, 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 of 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 m2, equaling 52% of the roof space and 8% of the total floor space. Despite this, energy savings totaling 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 still further. The study also stated that while measurements were being made by thermal cameras, a plethora of birds and beneficial insects were observed on the roof, ranging from robin redbreasts, yellow hammers, yellow tits, 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, tiger swallowtail and monarch butterflies, also dragonflies and ladybugs. 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 acceptable load. The wet weight of the build-up is under 50 kg / m2. 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 to be able to survive the harsh conditions of this particular roof.

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 uses, ownership and destination of land. It defines the principles and rules of property rights on the land and natural resources it contains, as well as the legal frameworks for access and use, the validation, and the 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 the only 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 infrastructures) or in the framework of risk prevention measures (flood expansion zones, submersion zones...) and can also adapt to the acquisition of ordinary unbuilt properties (e.g. agricultural zone, wasteland, ordinary nature ...) useful to achieve these objectives.

In order to implement control policies for the coastal area through land protection, there are various instruments, measures and legal tools, of which the most specific are detailed below. The various land policy tools described below must be applied in coordination with land-use planning.

Table 23 Legal tools for the protection of coastal areas

Land acquisition	Within the framework of the protocol relating to the integrated management of Mediterranean coastal zones, it is desirable to facilitate amicable acquisition procedures, by pre-emption, by donation of land, and by expropriation in case of necessity, in favour of public or private bodies responsible for the sustainable conservation of the coastal area. Moreover, in the case where the coastal zone is already public property, it remains important to give a status to the sensitive coastal areas: by allocation of land for the benefit of organizations dedicated to conservation or by documents on land-use management.
Land concession	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 a 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 a 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 dispose of 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, we talk about 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 artificialisation or construction.
Land Stewardship	Tool that is halfway between land concession and dismemberment. It is a strategy that associates, with the help of civil society, landowners and users to 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[122]. There are three levels of stewardship agreement: Management Support, Management Transfer, and Transfer of Ownership.

[122] Xarxa de Custodià del Territori (XCT)

In addition, some instruments have a purely financial purpose, they are set up to generate financial resources for public budgets, in which case the objective is that all or part of the funds raised is 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 populations and economic actors by introducing incentive or dissuasive instruments. "Deterrent taxes" aim to greatly reduce the pressure related to this activity, without prohibiting this activity; conversely, "incentive taxes" aim to support the actors in a process of change of practices that would be more favourable for the sustainable management of coastal areas.

- Mediterranean examples of redistribution practices toward financing 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[123].
- The allocation of the royalty fee on the sea fishing license or the tourist tax for stays in tourism accommodation establishments to the local government budget[124].

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 varied approaches and methods in line with the ICZM Protocol, a 'Common Regional Framework' for ICZM is under development. At the heart of this "integrated approach", taking cumulative impacts into account is the main operational requirement related to the Ecosystem Approach (EcAp) implementation 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 local scale, a more operational cooperation in coastal management has been developing since the 1990s and moving faster since 2005 thanks, among others, to ICZM implementation tools (including the Coastal Area Management Programmes, -CAMP- in many countries) 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 through the co-construction of projects in between the Contracting Parties of the Barcelona Convention, hence encouraging partnership at different governance levels to exchange experiences and practices.

5.4.1 Effective implementation of the ICZM Protocol

Since 1990's ICZM proved to be the most appropriate operational tool in achieving sustainable development in the coastal zones, complementing other methodologies and approaches. Ecosystems extend across the interface of land and sea, but policies relating to the protection of marine biodiversity are often delivered separately to those for the land. The proper application of the ecosystem-based approach enables crossing this policy divide of land and sea. The ecosystem approach, along with the SDGs provide 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 the adaptation to the impacts of climate change. With such a plethora of sectoral priorities and policies, combined with the multiplicity of delivery agencies and governance, 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

[123] Exemple français de la taxe départementale des espaces naturels sensibles

[124] Ces deux derniers exemples de taxes sont pratiqués au Maroc.

a key objective, with the emphasis on building synergies and avoiding overlapping, conflicts or waste of resources.

Box 48 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).

Integrated Coastal Zone Management (ICZM) and Marine Spatial Planning (MSP) offer valuable responses in a coherent and sustainable manner 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, on the expenses of the environment.

ICZM and MSP both apply the precautionary principle - so they are not only concerned with minimising conflicts between on-going activities but are designed to avoid such conflicts by anticipating future developments. Being adaptive, flexible and dynamic from the outset in the planning process enables dealing 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 in meeting new goals or to support local solutions within an overall 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 integrated approach to adaptation and mitigation, the health of oceans is to be dealt with the ecosystem approach and marine spatial planning.

5.4.2 Articulating 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 achievement - including local pilot actions, thematic strategies and cooperation - the ICZM Protocol put the Mediterranean at the global forefront in the sustainable management of the coast. 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, do not stay still - the demands and pressures on our environment, particularly on the coast continue apace. The need for evolving and adaptive responses to meet those 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, however the new challenges, such as climate change, advent of MSP and other approaches has led to the need for what one commentator called 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 (CPs) 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 towards achieving SDGs.

The past decades have witnessed the rapid developments in our ability to access and exploit our maritime spaces, and the value of MSP as a policy tool to manage these developments is recognised 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” is now in development to steer this.

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 objective. The Common Regional Framework will allow for harmonization of the regional action plans and instruments, as well as national and transboundary strategies and plans.

Put simply, the objective here is coherence, and the achievement of this coherence requires alignment/integration of the different approaches, methodologies and tools applied respectively on land and at sea, notably ICZM, MSP, ecosystem approach and climate action. The interlinkages between the first three approaches are shown below, demonstrating how ICZM can function as the central pillar – bringing MSP and the ecosystem approach together at the coast:

ICZM will therefore continue to deliver this coherence through tools and instruments that already have 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 the existing and developing new methods and tools to operationalise the Ecosystem Approach concepts, as well as SDGs, within ICZM and MSP; and
- Developing additional coastal indicators to complement the existing, predominantly marine-oriented Ecosystem Approach indicators to better reflect the interaction between terrestrial and marine ecosystems, habitats and species, and to reduce pressures of economic activities that exceed the carrying capacity.

Box 49 Way 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;
- Deployment of cross-cutting action in the programmes’ preparatory phases, benefiting for existing initiatives with the same purpose;
- Starting discussion on common strategic planning at sub-basin scale in the sectors of port and maritime transport.

Although MSP is not expressly mentioned in the ICZM Protocol, the geographical scope and the definition of the coastal zone given in its Art. 3 includes both the land and sea; it follows therefore that planning should be equally applied consistently even if it is delivered by different authorities, or even different states.

Box 50 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 environment, considering the competition in seas for maritime transportation, 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 defense issues; and to analyze 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 process”* (Regional Framework for ICZM).

Appropriate policy, institutional and legal framework are needed to successfully implement ICZM and MSP. However, all other governance functions such as enforcement mechanisms; scientific expertise and technological tools and methods, information/education, consultation and participation process, monitoring and evaluation, all are needed to create an enabling environment for successful implementation.

Partnerships are essential for forging collaboration, starting from different responsible agencies to regional collaboration needed to address complicated global and 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. Cross-sectoral coordination, in particular existing platforms and coordination mechanisms for coastal zones, MSP, disaster risk reduction and adaptation to climate change, could constitute a good starting point in Mediterranean countries.

The effective implementation of the Protocol will require a wide societal engagement involving civil society and individual citizens in the coastal zone, as well as different governmental institutions. To achieve this, a good communication strategy, utilizing innovative communication methods needs to be developed to raise public awareness, strengthen multisectoral 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, such an effective communication mechanism will strengthen local stakeholders' acceptance and 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 development efforts at national level will be very useful in catalysing financing not only from the private sectors, 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 etc. 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 concerned coastal and marine area.

Yet, 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 through the strengthening and networking of local fora, projects/initiatives, institutions, and platforms with permanent exchanges and adjustments between the varied sides involved in the transboundary area.

To go into that 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[125]. But before getting the countries and regions down to work and together improve their maritime activities planning and management, the first step seems to make them recognized 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

[125] Bensted-Smith, R. and H. Kirkman. 2009. Comparison of approaches to management of large-scale marine areas. Technical report prepared for Conservation International. Washington D.C. https://www.researchgate.net/profile/Hugh_Kirkman/publication/228813958_Comparison_of_Approaches_to_Management_of_Large_Marine_Areas/links/0c96051a176bcc7716000000/Comparison-of-Approaches-to-Management-of-Large-Marine-Areas.pdf

thematic (more particularly in coordinating their respective IMAP/MSFD action plans) and geographic (MPAs 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 it is promoted by SPA/RAC, the need to integrate marine protected areas (MPAs) and other effective 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 the ecological point of view, fragmentation impairs the ability of species to adapt to the rapidly shifting habitat patterns and environmental processes that result from climate change, further weakening that resilience, and increasing the likelihood of trophic web shifting.

From the social point of view, fragmentation of initiatives and organisations impairs the ability of local stakeholders and decision-makers to exchange between them and to upscale their vision so that it better reflects the scales at which ecosystems are evolving and the extent of human activities cumulated impacts on these ecosystems.

Like ICZM, MSP should be a multi-scale learning and incremental approach that, in the case of the SIMWESTMED area at least, could be supported by the establishment of a regional scale programme that would be considered as a WESTMED sub-macroregion.

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. The planning process is the topic of several guidelines published by PAP/RAC and described in detail on its online ICZM Platform[126]. 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 plans, adaptation and shoreline management plans. Finally, maritime spatial plans, in particular their "land-sea interactions" analysis represents an integral part of ICZM.

UNEP/MAP launched its Coastal Area Management Programme (CAMP) in the mid-1980s (Box 51) and by 2019 almost all Mediterranean countries had a CAMP. Several countries have also adopted national ICZM strategies and plans. Figure 126 shows locations of such projects, strategies and plans.

Figure 126 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.

Box 51 Coastal Area Management Programme (CAMP)

CAMP is oriented at the implementation of practical coastal management projects in selected Mediterranean coastal areas, applying Integrated Coastal Zone Management (ICZM) as a major tool. The objectives of CAMP are:

- to facilitate at the local level the implementation of the ICZM Protocol in a particular country;
- to develop strategies and procedures for a sustainable development in project areas;
- to identify and apply the relevant methodologies and tools;
- to contribute to the capacity building at local, national and regional levels; and

[126] iczmplatform.org

> - to secure a wider use in the region of the results achieved.
>
> Major outputs of the CAMP project 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 Portfolio. Results are presented at high level in the host-country government.
>
> CAMP Projects which did not pretend to find immediate solutions to coastal zone governance in many southern Mediterranean countries have had the merit, overall, of lifting the inconsistencies in the public instruments and the technical insufficiencies in the management of these fragile areas but of high economic, social and cultural value. CAMPs have been a real tool for the promotion of ICZM in these countries, especially among policy makers but also with non-institutional actors and the scientific community. In all the countries where a CAMP project has been implemented, a dynamic has 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 sub-regional dimension that considers cross-border aspects with a multidimensional approach, where socio-economic aspects and hybrid issues will be complemented.

A national strategy should serve to agree among conflicting use on the joint vision, goals and measurable targets, as well as on the ways to reach them. Its preparation process represents an opportunity to harmonize 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 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 given 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 global change. Examples of the Coastal Plan according to the ICZM Protocol are the Coastal Plan for the Šibenik-Knin County (Croatia), the Reghaia Coastal Plan (Algeria) and the transboundary Integrated Resources Management Plan for Buna-Bojana (Albania-Montenegro), with benefited from PAP/RAC support. While the first one was focused on adaptation to climate change, the last is an example of integrated plan with the water resources management and was prepared in partnership with the Mediterranean Regional Water Partnership of the inter-governmental organisation Global Water Partnership (GWP) and the UNESCO-International Hydrological Programme (IHP).

Just as 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 defining what these priorities mean in time and space. MSP cannot be delivered in isolation: to effectively implement MSP many complex interactions across land and sea should be taken into account. These Land Sea Interactions (LSIs) actually lie in the very heart of the ICZM; this is that very place where all interactions occur, where terrestrial and marine part of the coastal zone meet and where results of the natural processes and impacts of the human activities create the highest number of conflicts and issues to be resolved and harmonized. Therefore, it is of essential importance that these interactions must be planned and managed in an integrated way. Despite this however, spatial planning of land and sea is often divided by both legislation and practice.

Although the ICZM Protocol does not expressly include the concept nor the LSI definition, 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 socio-economic 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 crossing the coastline delimitation, interactions among land and sea-based socio-economic 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 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 MSF Directive. This strategy was prepared for the Croatian part of the Adriatic Sea, from the outer limits of the jurisdiction of the Republic of Croatia to the landward outer limit of the competent coastal units.

Among the ICZM-related planning instruments shoreline management plans are focused on finding solutions primarily to coastal erosion and marine flooding. For this kind of plans a sedimentary cell approach must be followed and local problems shouldn't be addressed without a full-scale analysis.

Regardless of the name and plan main focus, the fact is that planning in coastal zone should respond to major identified threats. Due to size of climate change impacts that coastal zones around Mediterranean are experiencing already, adaptation should represent a central axis of any coastal planning. Integrated approach in planning ensures systemic analysis of issues area is facing, identifying their root causes and designing comprehensive, integrated policy solutions.

Despite existing legislations and institutional capacities through various tools and instruments (programmes/plans/strategies; coastal agencies...) a stronger political support is still needed to ensure a full implementation and compliance. At the land-sea interface, the response to ensure a more balanced coastal development and management goes with a better assessment of ecosystems complex interactions, though economic pressure towards short-term profitability still represent a serious obstacle. In fact, there are still many constructions that largely encroach the coast including marine areas, as well as many illegal and ill-practices like in fishing or dumping at sea that also represent a serious obstacle. Full awareness of multiple stakeholders is needed to move to 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 been put in place, either incompletely (lack of implementing legislation and national standards) where they can't find adequate framework 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 the Mediterranean Action Plan of 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 the preparation at the administrative level as well as the institutional arrangements existing in these countries. In addition to that, the public policy evaluation processes for the marine and coastal areas have largely shown the still important need for the southern countries regarding the capacity reinforcement at all levels. Particularly in the administration and at the scientific community level.

Table 24 below shows an overview of the status of the ICZM Protocol, national coastal laws, national ICZM strategies and national coastal agencies.

Table 24 Status of ICZM Protocol, national coastal laws, national ICZM strategies and national coastal agencies in Mediterranean countries (Source: PAP-RAC and Plan Bleu, 2019[127])

	Status of the ICZM Protocol	National coastal law[128]	National ICZM strategy	National coastal Agency
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. The Algeria's "Commissariat du Littoral National (CNL)".
Bosnia & Herzegovina	No	Different issues covered under different laws	No	No specific agency
Cyprus	No	No coastal law been approved	No	?
Croatia	**Entered into force** 28.02.2013	No single coastal law, but different issues covered within different laws. Spatial development law recognizes protected coastal zone. Law on ratification of the ICZM Protocol is a constituent part of the national legal system.	Croatia responded to EU Marine Strategy Framework Directive and ICZM Protocol with one Strategy. Programme of measures was adopted by the Government, but the "Strategy for the Management of 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	EEAA ?
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 been approved	In 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	National ICZM Strategy	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)	In preparation	No	At the regional level. The Coastal Conservatory of Sardinia, a new agency of the Sardinia Region, can acquire coastal

[127] 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

[128] the question on ICZM legislation and coastal legislation should be divided to enable the identification of ICZM-specific legislation from general coastal laws (Brian Shipman and Sylvain Petit, PAP/RAC. Final global results of the ICZM stock-taking. Submission date : 12/02/2014).

				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)	In preparation	Applied within the GEF project	No
Libya	No	No single law, but different aspects covered within different laws.	No	No
Malta	Signature (21.01.2008)	No coastal law been approved	National ICZM Strategy	?
Monaco	Signature (21.01.2008)	No coastal law been approved	No	?
Montenegro	**Entered into force (**08.02.2012)	Different coastal issues covered by different law. Law on ratification of the ICZM Protocol is a constituent part of the national legal system.	National ICZM Strategy adopted by the Parliament in 2015.	No specific agency.
Morocco	**Entered into force** 21.10.2012	Coastal law has been approved	National Strategy for the littoral under preparation by the Ministry of Territorial Planning.	No specific agency. But has several land acquisition mechanisms such as the expropriation for public utility, the decommissioning of the public domain, and the acquisition mechanism for the construction by the State. However, the use of these mechanisms of acquisition is constrained by fiscal issues, and lengthy administrative and judicial proceedings.
Slovenia	**Entered into force** 24.03.2011	In preparation	In preparation	?
Spain	**Entered into force** 24.03.2011	A coastal law has been approved	The Ministry of the Environment and Rural and Marine Affairs (Ministerio de Medio Ambiente Medio Rural y Marino) co-ordinated in 2007 the development of the Estrategia para la Sostenibilidad de la Costa.	Yes. The Shore Act (1988) gives national administration competence for acquisition and easements.
Syria	**Entered into force** 24.03.2011	No coastal law been approved	No	No
Tunisia	Signature (21.01.2008)	There is no one 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.	No specific agency.
European Union	**Entered into force** 24.03.2011			

5.4.4 In need of an ICZM common regional framework

The Common regional Framework (CRF) on ICZM is a strategic instrument intended to facilitate the implementation of the ICZM Protocol, providing guidance mainly for the regional (Mediterranean) and sub-regional (four Mediterranean sub-regions, 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 with the relevant international instruments.

The proposed methodological guidance (Barcelona Convention COP 21, December 2019), is based on three major phases (Figure 127):

- **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 part 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. Biodiversity, 2. Fisheries, 3. Coast and Hydrography, 4. Pollution and Litter.
- **Phase C** –Identification of operational recommendations to implement the CRF on ICZM with the aim of contributing to the achievement of EcAp Eos and GES, coherently with other instruments of the Barcelona Convention System.

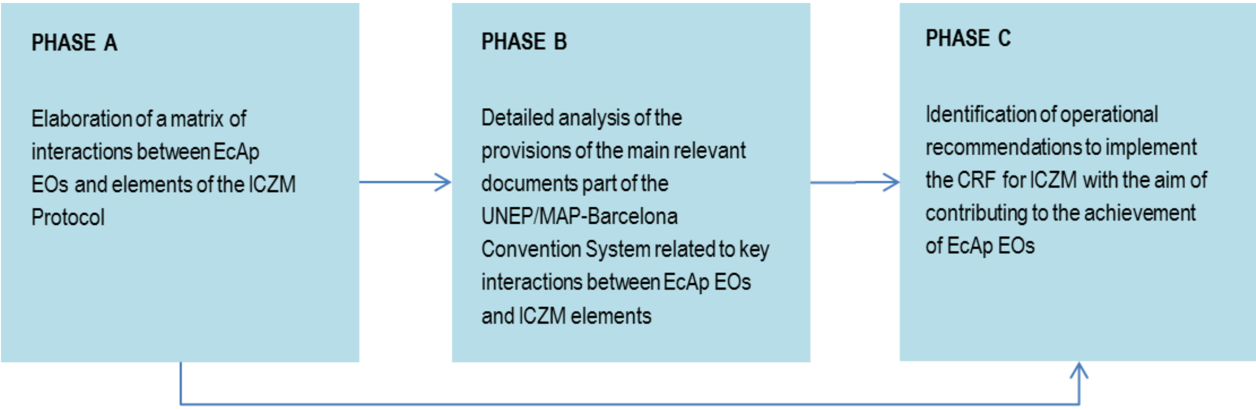

Figure 127 Phases of the methodological guidance

The proposed methodology aims to finally identify (in Phase C) a set of operational recommendations, if needed and as appropriate, which shall be calibrated on the specific considered geographic and temporal context, as well as on the cumulative impact integration rules, and regularly updated.

Considering that the CRF on 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 the 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 effort for the multi-scale networking of ICZM-like initiatives including MPAs and OECMs.

5.4.5 Managing beyond the divide between conservation and development

Besides Chapter 17, the Agenda 21 also contains two separate chapters on 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. Therefore, the challenge is to ensure that biodiversity conservation, ICZM and freshwater issues become more integrated and mutually supportive. In addition to national policies, that should be the task of Regional Seas Programmes such as the Mediterranean Action Plan, which is the first to have an ICZM Protocol, a legally binding documents 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[129]). ICZM places an emphasis on the people, and ICZM practitioners usually function as impartial, neutral brokers for communities and various users, whereas conservation practitioners are typically advocating 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 (MEA, 2005)[130] much facilitated this task in proposing a scheme articulating biodiversity with the 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) as well as applying 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, protected or not, understood as complex and dynamic interconnected systems that encompass many interactions between people and ecosystems, and must be managed as an articulated whole.

Very much in the spirit of the Aichi Target N°11[131], 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 along a nested governance approach, at local, national, regional and international scales.

Table 25 Integrating the strength of ICOM and biodiversity conservation (Adapted from Best, 2003)

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,	Global biodiversity assessments and threats-based approach

[129] Best, B. 2003. « Conservation and integrated coastal management: looking beyond marine protected areas », pp. 325-342. In: Crafting coastal governance in a changing world. Ed. S.B. Olsen, Coastal Management Report 2241. Coastal Resources Management Program, US Agency for International Development, University of Rhode Island Coastal Resources Center, Rhode Island, USA.

[130] https://www.millenniumassessment.org/documents/document.356.aspx.pdf

[131] 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

	strengthen local communities and authorities	
Site-based approaches and strengths	Emphasis on governance process helps establish legal, decision-making and enabling environments across local, sub-national and national scales; establishing strong national ICM policies, framework 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 ICSM 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

In the spirit of the WWF and IUCN ‘Guide for quick evaluation of management in Mediterranean MPAs’[132], 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 hence creating the enabling conditions for the networking of management initiatives following a nested governance approach.

[132] Gomei M., Di Carlo G. 2012. Making marine protected areas work – Lessons learned in the Mediterranean. WWF Mediterranean

Tempesta M., Otero M. 2013. Guide for quick evaluation of management in Mediterranean MPAs. WWF Italy, IUCN

6 Draft Chapter 6: Food and water security

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Food security and water security in the Mediterranean are intrinsically linked and are facing similar challenges. Food security is threatened mainly by a high dependency of Mediterranean countries on food products imports, making them vulnerable to external pressures such as the volatility of food prices. From a nutritional perspective, the occurrence of overweight and obesity has increased due to abandonment of the traditional Mediterranean diet. Water security is fragilised 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 footprint than global average, an aggravating scarcity of renewable water resources, increased number and capacity of dams exerting a pressure on freshwater ecosystems, and increasing risk of conflicts between water users and countries. Access to water and sanitation remain a major challenge in the region. Territorial fractures separating coastal urban and remote rural areas deepen, making isolated populations such as smallholder farmers particularly at risk of food and water insecurity. With climate change, precipitation is expected to decrease and temperature to increase in the region, which will affect water supply (and thereby energy and food supply), but also soil moisture and crop growth directly, thereby further increasing irrigation water needs.

There are clear but difficultly measurable interactions between the water, energy and agriculture sectors, as one needs and affects the other and vice-versa, which call 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 agroecosystems is key to ensure sustainable development, and require dealing with ongoing loss of arable land, land intensification, and soil erosion and salinisation. Integrated Water Resources Management and Water Demand Management provide guidelines for achieving better water efficiency and reduce 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 comparable characteristics: i) billions of people do not have secure access to them; ii) global demand is rapidly growing; iii) all are 'global goods' involving 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) involve the security of food and water; in particular SDG1, no poverty; 2, zero hunger; and 6 clean water and sanitation, highlighting the fact that food and water security are an essential component of sustainable and inclusive development.

Food security[133] is achieved 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: “End hunger, achieve food security and improved nutrition and promote sustainable agriculture”.

Food security status and challenges vary across Mediterranean countries. At the regional level, **food availability** is dependent on imports, with a regional agricultural trade deficit of 36.6 billion USD in 2017 (WTO, World Trade Statistical Review, 2017). Only France and Spain produce an agricultural surplus. Mediterranean countries account for one-third of world cereal imports, for only 7% of the world population. Egypt and Algeria are among the world largest cereal importers. Import dependency ratio for cereals in the Mediterranean (import / consumption ratio) is very high (86% in Lebanon, 72% in Algeria, 60% in Tunisia, 42% in Egypt) (FAO, 2018). Importing countries are thus very sensitive to the volatility of international prices, and were strongly hit by the food crisis of 2007-2008.

Beyond food availability, **access to food** depends on multiple factors including purchasing power and state of infrastructure. In many Mediterranean areas, territorial fractures 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 may occur.

From a **nutritional** point of view, worsening of overweight and obesity is alarming in all Mediterranean countries (e.g. with 30% obese adults in Eastern Mediterranean countries); and a high prevalence of anemia affects women of childbearing age.

Factors that may disrupt food security in the region include: dependency on imports, political instability and conflicts, global warming and erosion of natural resources (soils, biodiversity). Rising water insecurity is a key factor, water and food being intimately 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 socio-economic 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, 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 (<500 m^3 per capita per year) and five additional ones are under the water scarcity threshold of 1000 m^3 per capita per year (FAO, AQUASTAT, 2014). Most 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 most important source of freshwater (Aureli *et al.* 2008). Satisfying the simultaneous needs for high quality drinking water and a high water demand for irrigation is a particularly complex problem. Water scarcity induces tensions and possible conflicts between users of groundwater and land owners, and between countries. Tensions are exacerbated by the increasing water demand for irrigated agriculture in a context of demographic growth. In numerous Mediterranean areas, groundwater quality is also under threat from pollution, sea water intrusion and overexploitation.

Pre-existing water scarcity in the Mediterranean region being aggravated by population growth, urbanization, growing food and energy demands, pollution, and climate change, ensuring water security will require inclusive approaches and coordinated responses across sectors. The **Water-Energy-Food Nexus** has emerged as a useful concept to describe and address the complex and interrelated nature of those three resources (Figure 128), on which we depend to achieve a range of social, economic and environmental goals (FAO, 2014b).

[133] Data on global food security come 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.

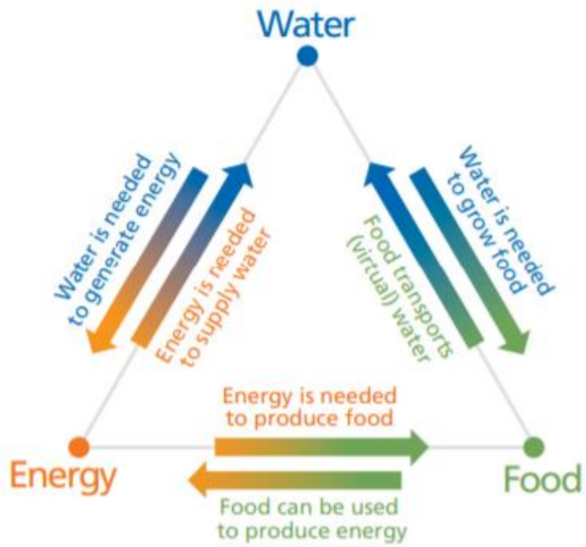

Figure 128 The Water- Energy-Food Nexus (Source: UN-Water, 2013 - adapted from: Water - A Global Innovation Outlook Report, IBM, 2009)

As 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 concentrated solar power). Energy is required to process and distribute water, treat wastewater, pump groundwater, and desalinate seawater. Water is the keystone for the entire agro-food supply chain, while agricultural intensification impacts water quality. Energy is also an essential input throughout the agro-food 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 mobilized in upcoming 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 MENA region is projected to be 13 times higher in 2040 than 2014. Currently, desalination for municipal use is already gaining importance in islands and coastal cities with limited water resources. In absolute terms, the largest production of freshwater through desalination in the Mediterranean region takes place in Algeria (615 million m^3/yr), Egypt (200 million m^3/yr), Israel (140 million m^3/yr) and, Italy and Spain (both 100 million m^3/yr) (FAO, 2016). In relative terms, Malta is the desalination leader, with more than half of its drinking water supply coming from 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 saltwater 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 for energy generation wastewater treatment by-products, such as biogas and sludge thus reducing emissions from the water sector and overall energy demand. However, about 80 percent of the Middle East North Africa region's wastewater is still being discharged in the environment without being reused (World Bank 2017).

Agriculture accounts for 2/3 of the increase in water withdrawals in the Mediterranean basin. Increasing water scarcity in the southern and eastern Mediterranean are 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 demands from urban areas and the industrial sector. Increasing water scarcity and the resulting declines 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 total 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 domestically produced electricity respectively), while in Bosnia & Herzegovina hydropower represents about a third of the production. In both Montenegro and Bosnia & Herzegovina, the rest of the domestic electricity generation comes exclusively from coal (IEA statistics). All countries in the EU or EU accession process have adopted renewable energy targets by 2020 (e.g. 38% for Albania, 40% for Bosnia and Herzegovina and 33% for Montenegro; all three countries being 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 emission. 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 on 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[134].

Without proper planning, river dams - including those intended to produce hydropower - can have significant impacts on the longitudinal river continuum for biota and sediments, potentially leading to a loss of ecological integrity, and serious river degradation processes downstream of dams (channel incision) down to the coastal zone, leading to coastal erosion, deterioration of deltaic and marine ecosystems. Such impacts do not only affect the environment; coastal tourism may suffer as well. Moreover, countries that rely heavily on hydropower may face reduced generation and higher prices in a case of protracted drought.

All the interconnections above described 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 to a stronger integration across sectors. Such gains should encourage governments, private sector and civil society to take on coordination efforts.

6.2 Water resources/water security

6.2.1 Precipitation and soil moisture

The Mediterranean climate is generally characterized by mild and wet winters, and dry and hot summers. However, precipitations strongly differ across sub-regions, especially in winter. Long-term average precipitations[135] range from 33 mm per year in Egypt to 1325 mm per year in Slovenia, i.e. 40 times more (Table 26 and Figure 129), with a clear North/South divide. Notable in-country variability is associated in particular with the orography of the continental regions with larger precipitation in mountainous areas than plains[136].

Table 26 Long-term average annual precipitation by country, 1961-2015 (Source: World Bank, 2016[137])

Country	Precipitation (mm)	Country	Precipitation (mm)

[134] 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.

[135] During the period 1961–2015.

[136] The maximum precipitations are recorded over the Alps and Dinaric Alps with over 1500 mm per year. While the minimum precipitations are found over Southern Mediterranean with important precipitations on the Atlas Mountains in Algeria and Morocco.

[137] Calculated as the average annual precipitation between 1961 and 2015 from data extracted from the World Bank Climate Change Knowledge Portal.

North	
Albania	981
Bosnia-Herzegovina	1072
Croatia	1066
Cyprus	468
France	841
Greece	649
Italy	927
Malta	428
Montenegro	1135
Portugal	839
Slovenia	1326
Spain	610

South	
Algeria	83
Egypt	33
Libya	44
Morocco	315
Tunisia	271
East	
Israel	258
Lebanon	565
Palestine	413
Syria	289
Turkey	568

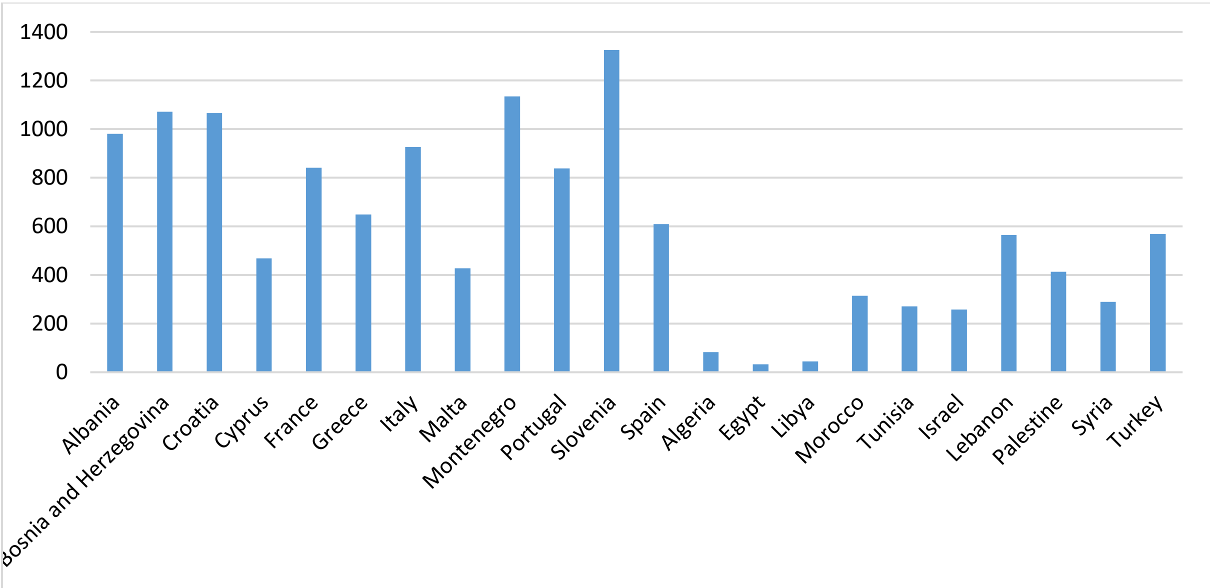

Figure 129 Long-term average annual precipitation by country (1961-2015). Source: World Bank, 2016

Precipitation over the Mediterranean region is critical to the availability of water resources. It provides the water 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 surface and the atmosphere, which impacts the rainfall–runoff processes. Thus, soil moisture is vital for the ecosystem and agricultural outputs (food security). In southern and eastern Mediterranean, soil moisture is very low due to low precipitation and high temperatures, limiting the possibility of rainfed crop production. As in these parts of the Mediterranean region, precipitation is considerably less than potential evaporation, any future decrease in precipitation will often cause a decrease in soil moisture.

The Mediterranean region has been recognized to be one of most vulnerable regions to climatic changes, 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 and Ludwig, 2013), however 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, increasing number of reservoirs and increasing irrigated area.

6.2.2.1 Total Renewable Water Resources

Total Renewable Water Resources (TRWR[138]) are unevenly distributed across Mediterranean sub-regions: 67% are located in the North, 10% in the South, and 23% in the East, of which more than 20.5% in Turkey (AQUASTAT; FAO, 2016). Those heterogeneities are further emphasized by uneven population growth, as population stagnates in the water rich North and continues growing in the water poor South (Figure 130). With less than 500 m^3 per capita per year, Algeria, Israel, Libya, Malta, the State of Palestine and Tunisia face absolute water scarcity. With more than 500 m^3 but less than 1,000 m^3 per capita per year, Cyprus, Egypt, Lebanon, Morocco and the Syrian Arab Republic are water scarce (AQUASTAT; FAO, 2014). On the contrary, most of the NMCs population is water-secure, with some countries considered as living in the comfort of water abundance, such as the Balkans.

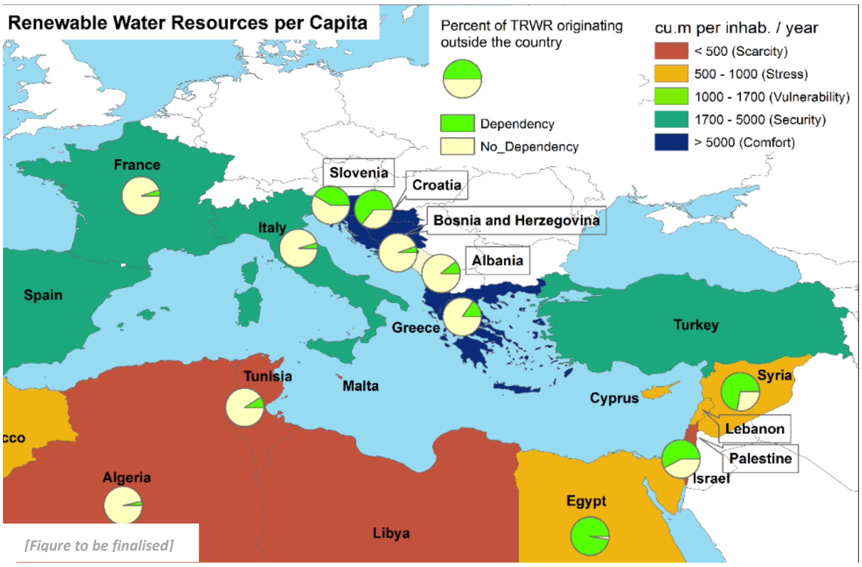

Figure 130 Total renewable water resources per capita in the Mediterranean (Source: AQUASTAT FAO, 2016)

Figure 131 represents the total renewable water resources (i.e. the sum of internal and external resources), which can hide the dependency of some countries on external water resources, i.e. water originating from outside of their borders. For instance, Egypt depends for 97% of its freshwater resources on external water, the Syrian Arab Republic for 72 % and Israel for 56% (Figure 130). Total renewable water resources in the Mediterranean Region amount to 1,030 km^3 (FAO, 2016).

[138] The 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: FAO, AQUASTAT, Glossary.

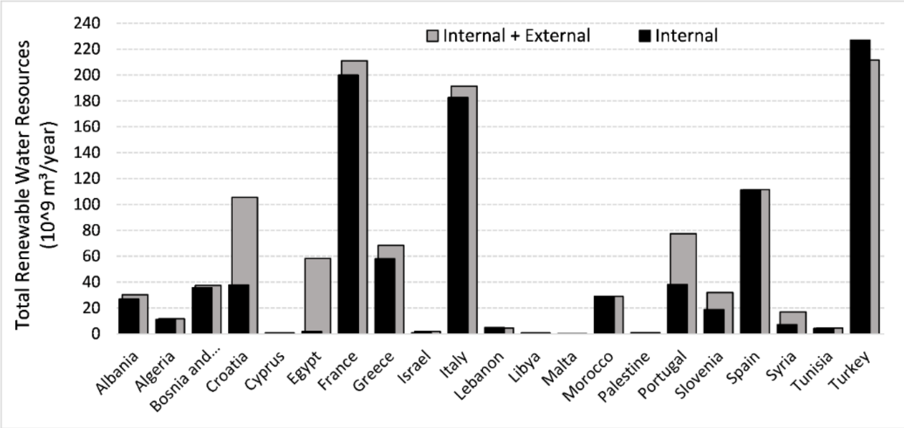

Figure 131 Internal and external renewable water resources in the Mediterranean (Source: AQUASTAT FAO, 2016)

The water resources of Mediterranean countries have deteriorated. Internal freshwater resources (IRWR) per capita have decreased by 29% between 1997 and 2014. The most affected countries are Lebanon (- 45%) and the State of Palestine (-37%). Between 1997 and 2014, the IRWR per capita have on the contrary increased on average by 5% in the Balkan countries while they decreased by 4% on average in the European Union.

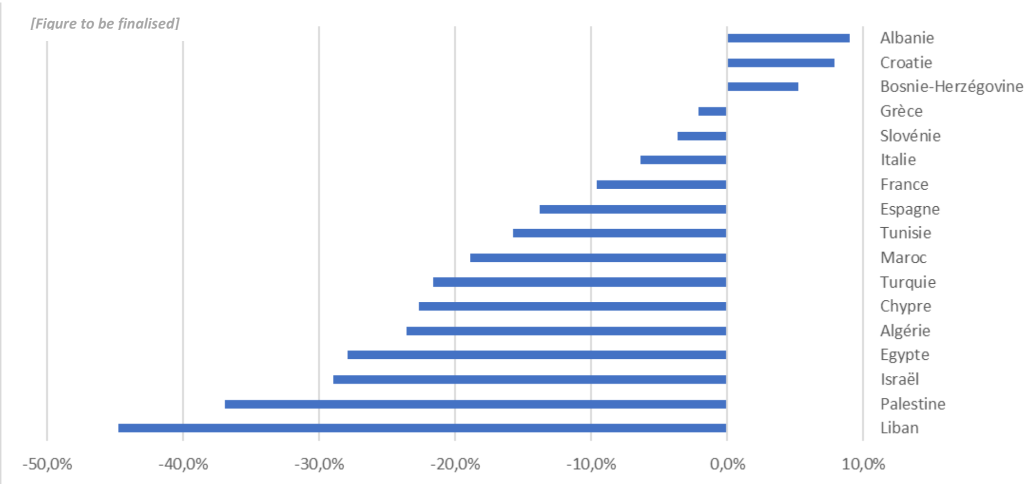

Figure 132 Evolution of internal renewable water resources per capita between 1997 and 2014, variations in % (Source: WDI World Bank)

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 aquifers depletion (Dalin, Wada, Kastner, & Puma, 2017) threatening the sustainability of food production, inducing significant environmental degradation, such as land subsidence and seawater intrusion (Caló, et al., 2017; Custodio, 2018), and contributing to the major transboundary challenges affecting the Mediterranean region (UNEP-MAP, UNESCO-IH, 2015).

72% of groundwater resources are located in the northern shore, 23% in the Middle East and only 5% in the southern shore. Surface water is located for 75% in the North, 17% in the East and 8% in the South (Figure 133). In the southern sub-region, surface water represents 85% of water resources, and up to 96 % in Egypt (Figure 133 and Figure 134).

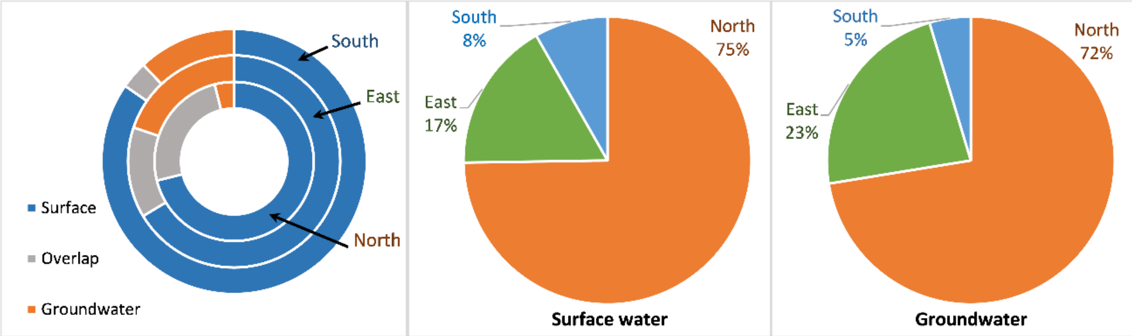

Figure 133 Surface and Groundwater Renewable Water Resources by sub-region (Source: AQUASTAT FAO, 2016[139])

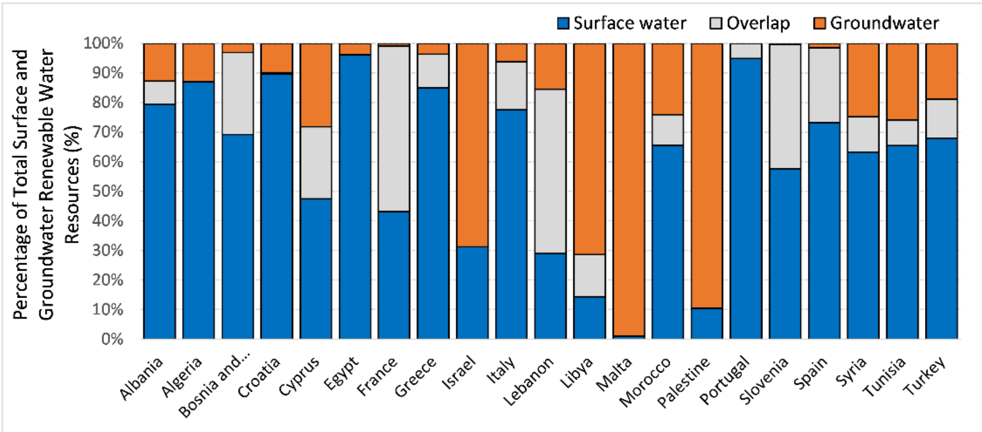

Figure 134 Surface and Groundwater Renewable Water Resources by country (Source: AQUASTAT FAO, 2016)

Algeria, Morocco and Tunisia rely on both surface and groundwater for their freshwater withdrawals. Malta relies entirely on groundwater. Groundwater supplies above or around 70 % of freshwater withdrawals for Cyprus, Croatia, Libya and Tunisia. Most islands in the sub-region 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 mainland to deal with structural shortages (Greek islands, Croatian islands) or during droughts (MED-EUWI WG, 2007). In the eastern sub-region, the State of Palestine and Israel rely mostly on groundwater, 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 part 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 *et al.* (2012) as the Mediterranean country with the highest groundwater depletion. Over-exploitation 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 a high additional demand in peak seasons in coastal areas that in most of the cases are coincident with the dry season and might thus put considerable strain on available water resources 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 135). The North-Western Sahara aquifer system has a renewal rate of only 40% of the withdrawals (Goncalves *et al*, 2013), indicating

[139] The ‘overlap’ represents the part of the renewable freshwater resources common to both surface and groundwater.

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 135 shows the critical aquifers in the region with very low recharge. Sustainable use of these aquifers is essential to protect this valuable resource.

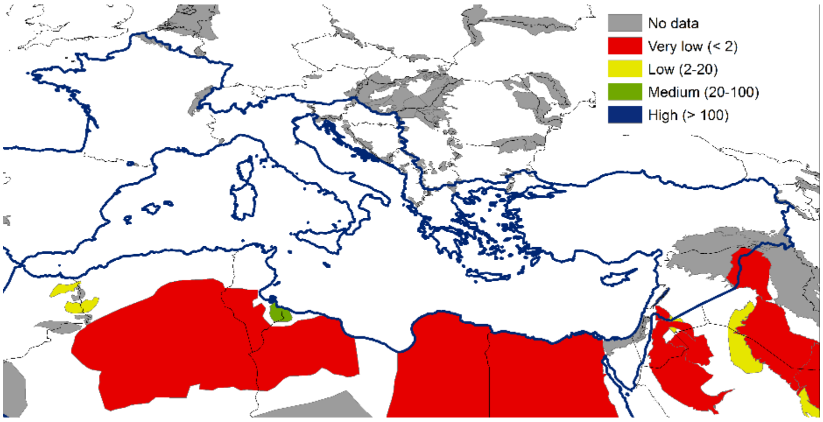

Figure 135 Transboundary aquifers (Source: layer extracted from GRAC-UNESCO-IHP, 2015) and mean annual groundwater recharge (mm/year) (Source: layer extracted from UNESCO-IGRAC, 2016)

6.2.2.3 Climate change influence on freshwater availability

Water availability in the Mediterranean Basin is expected to further reduce in the upcoming decades as a consequence of (i) precipitation decrease, (ii) temperature increase, and (iii) population growth especially in the countries already short in water supply. Its quality is also expected to decrease due to pollution and salt intrusion on the coast. Both phenomena may increase conflicts over freshwater use. Overall, there is high confidence of strong increases in dryness and decreases in water availability in the Mediterranean and southern Europe from 1.5°C to 2°C of global warming.

According to García-Ruiz *et al.* (2011), the annual precipitation is projected to decrease in 2040–2070, compared to 1960–1990, by around 15% in South Mediterranean countries and the Middle East; while this decrease is expected to be around 10% in South Italy, Greece and South Turkey. It is projected that SEMC as well as southern Spain will experience a decrease in winter precipitation, which is most important in the Mediterranean region.

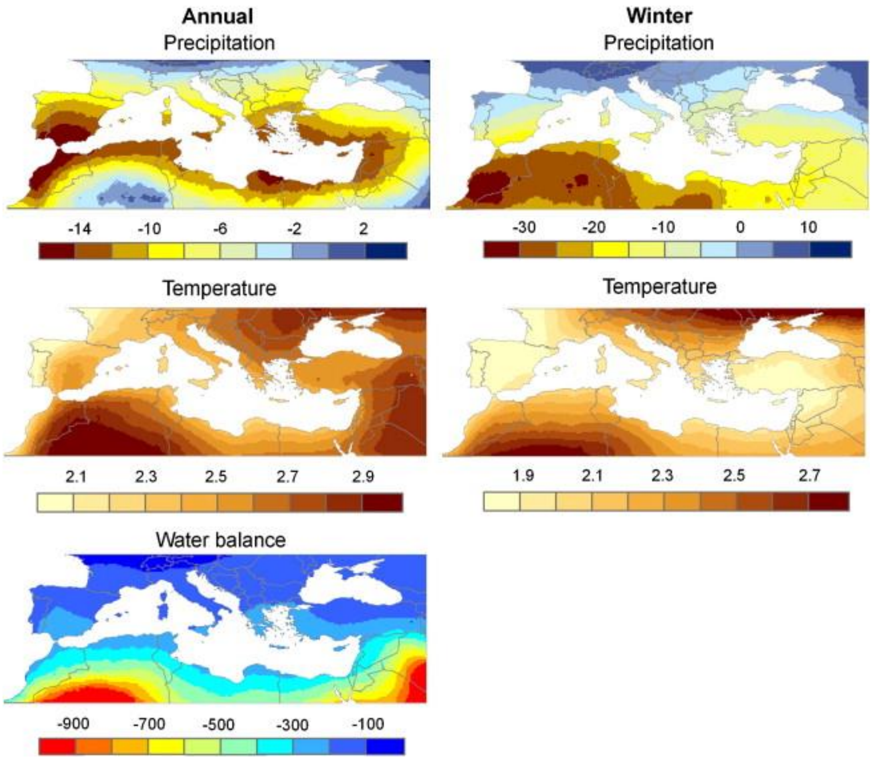

Figure 136 Mean annual and winter climate changes, precipitation (P, %), temperature (T, °C) and water balance (P−T, mm) projected for the Mediterranean region between 2040 and 2070 in comparison to 1960–1990 by nine general circulation models (Source: García-Ruiz et al.,2011)

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 largest decreases in the world (Cisneros *et al* 2014; Gudmundsson and Seneviratne, 2016; Gudmundsson *et al*., 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 a large uncertainty. Koutroulis *et al* (2016) has calculated that on a 18% reduction of water availability of TRWR in Crete under a +2°C scenario, 6% only are due to the precipitation reduction and 12% to the evapotranspiration increase. In Greece and Turkey, water availability may fall below 1000 m^3 per capita and per year for the first time in 2030 (Ludwig *et al*, 2010). In Southeastern Spain and on the southern shores, water availability may drop to below 500 m^3 per capita per year[140]. People inhabiting river basins particularly the Middle East and Near East 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). Impact on wheat and barley production is expected to be maximum in the Syrian Arab Republic and neighbouring countries. The importance of covering environmental flow requirements for assuring the healthy functioning of aquatic ecosystems will call for maintaining certain amounts of water in the systems, further limiting availability for human uses (Hermoso and Clavero, 2011).

Under climate change scenarios, river flow is generally reduced, particularly in the South and East of the region where water is in critically short supply (Forzieri *et al*, 2014). Because precipitation decrease, 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 very likely to change, with earlier declines of high flows from snow melt in spring, intensification of low flows in summer and greater and more irregular discharges in winter (Garcia-Ruiz *et al*, 2011).

[140] Assuming a constant population, Gerten *et al*. (2013) reveal that an additional 8% of the world population will be exposed to new or aggravated water scarcity at 2°C warming. This value is almost halved - with 50 % larger reliability - when warming is constrained to 1.5°C.

Water levels in lakes and reservoirs will likely decline. For example, the largest Mediterranean lake, the 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. Recharge of groundwater will be diminished, affecting most of the region. Irrigation water requirements in the Mediterranean region are projected to increase 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 uses and demands (breakdown by sector/categories of users, efficiency of water use)*

6.2.3.1 Water demand

The socio-economic development of the Mediterranean region is highly dependent on water availability. Substantial pressure on finite water resources is induced by rapidly growing population and urbanization requiring an increase in agricultural, energy and industrial outputs.

Demand in Mediterranean watersheds. While data at watershed (i.e. catchment) level is crucial in the Mediterranean, no recent data is available at this geographical scale for the entire region. The total water demand[141] in Mediterranean watersheds was last estimated to 119.5 billion m^3/year (according to Margat & Treyer, 2004 and Milano *et al.*, 2012). Irrigated agriculture was the most water demanding sector with 66 billion m^3/year (55%), mainly for the production of cereals, vegetables and citrus. The other main sectors were the energy and domestic sector, which water demands amount for 21.8 billion m^3/year (19%) and 19.5 billion m^3/year (16%), respectively. Water demands for industries not connected to the municipal water network amounted to 12.2 billion m^3/year (10%). Significant differences in the proportion of water demands existed between catchments. Water demand for irrigation purposes represent more than half of the total water demand over all catchments, except in France and Italy where water demands for energy and industrial purposes prevail, and in Slovenia and Croatia where domestic water demands prevail (Figure 137).

[141] 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.).

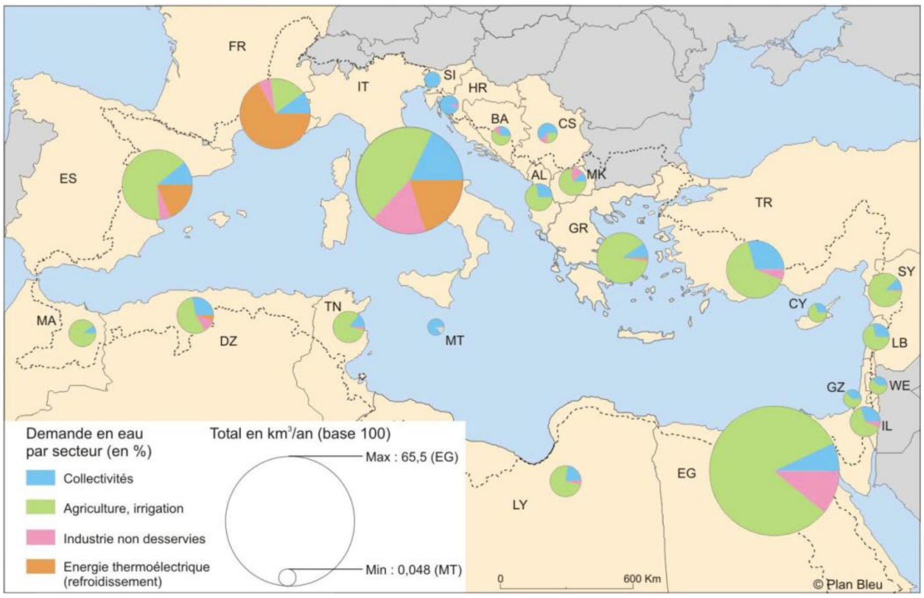

Figure 137 Demand for water from the Mediterranean basin by country over the period 1995-2000 **[to be updated with data from Margat & Treyer, 2004, Milano et al. 2012, and AQUASTAT 2013]**

Water demand can also vary significantly throughout the year. During summer, irrigation water demand increases due to hot and dry climatic conditions and maximum phenological stage (Collet *et al.*, 2013). Water demands from the domestic sector also increase as a result of tourism activities. For example, in riparian areas, domestic water demands can double in summer in la Costa Brava (Spain) or Côte d'Azur (France) compared to winter water demand (Plan Bleu, 2011).

Withdrawal[142] in Mediterranean countries. In Mediterranean countries, total water withdrawal from all sectors is 290 billion m^3 per year (Blinda, 2018), but their distribution is uneven between the three mains sectors: irrigated agriculture, industry and services (Figure 138).

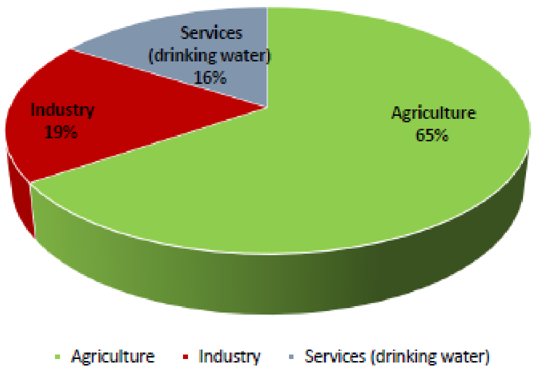

Figure 138 Distribution of total water withdrawals between the three main sectors of water use in the Mediterranean region (Blinda, 2018)

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 (green water[143]), which is not developed enough and could be further valued in the semi-arid and arid zones. Improved efficiency of rainfall

[142] Water withdrawal describes the total amount of water withdrawn from a surface water or groundwater source. Measurements of this withdrawn water help evaluate demands from domestic, industrial and agricultural users. Water consumption is the portion of the withdrawn water permanently lost from its source.

[143] Green water is the soil moisture from precipitation, used by plants via evapotranspiration

agriculture by conserving water and soil would increase the rainwater storage capacity of the soil and thus limit the need to irrigate, while limiting the erosion and silting downstream.

By 2050, under a business-as-usual water-use scenario, water withdrawals are projected to double or even triple in catchments of the southern and eastern rims 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 in the new irrigated land (mainly maize and alfalfa) have higher water needs than traditional Mediterranean crops (cereals, olives, grapes). In the northern rim, agricultural water demands for irrigation are projected to increase mainly in the Ebro catchment (Spain) and in Greece due to warmer and drier conditions affecting crops' water needs (Milano *et al.*, 2012). Domestic water demands in the northern rim should remain constant or decrease as population is projected to stabilize in the medium term.

6.3 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).

Renewable freshwater resources of the Mediterranean region amount to 1,123 billion m^3 per year (FAO, 2015). 84 % of average long-term flows are generated by precipitation inside the countries, and 16 % of water entering the countries, considering flows reserved for upstream and downstream by agreements or treaties. On the other hand, total freshwater withdrawals, defined by the volume of freshwater extracted in rivers, lakes, or aquifers for the needs of agriculture, industry and municipalities, is evaluated at 290 billion m^3 per year (FAO, 2015). Hence exploitation is estimated at 37 % (Blinda, 2018), which remains well below the 70 % threshold indicating severe water stress and potential water shortage. However, the level of water stress differs across countries with four groups (Blinda, 2018):

- Algeria, Egypt, Israel, Libya, Malta, the Syrian Arab Republic and Tunisia exploit more than 70% of their available renewable water resources and their level of water stress tends towards serious water shortage;
- A 2nd group of countries made up of Morocco and State of Palestine with exploitation close to 70% indicating that they are approaching a water shortage;
- A 3rd group of countries with a risk of water shortage in the future, including Cyprus, Lebanon and Spain with exploitation approaching 50%;
- Albania, Bosnia & Herzegovina, Croatia, France, Greece, Italy, Slovenia and Turkey exploit less than 25% of their available renewable water resources.

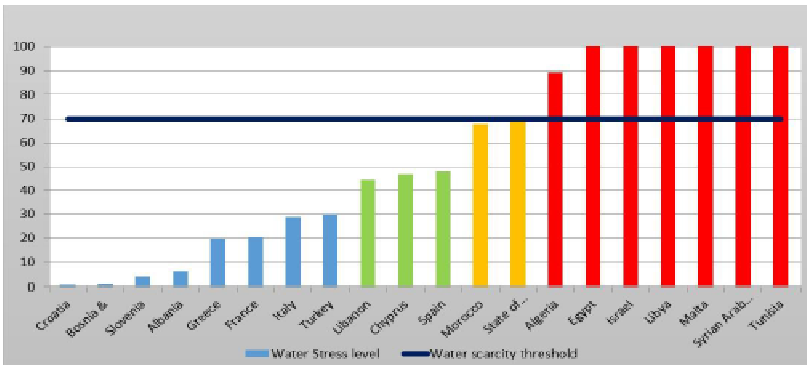

Figure 139 Water stress level in the Mediterranean with four groups of countries illustrated by different colors, (Blinda, 2018)

A regional-scale investigation was conducted for the Mediterranean basin (Milano *et al.*, 2013a). It highlighted that 112 million people are experiencing 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 should 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 trim down to 228 million. The occurrence of severe water stress situations could be moderated in Albania, Greece and Turkey but efficiency improvements alone would not be able to reduce water tensions in Spain and in the South of the Mediterranean basin.

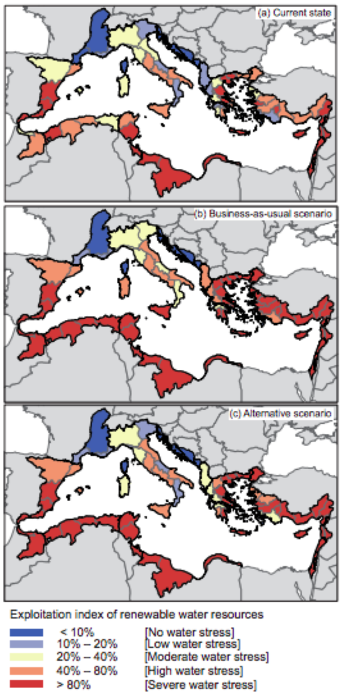

Figure 140 Evolution of hydric stress in the Mediterranean. Current water stress over the Mediterranean basin (a) and changes by the 2050 horizon according to a business-as-usual scenario (b) and an alternative scenario (c). (Source: Milano et al. 2012a; Milano et al. 2012b)

Differences may also occur within countries according to multiple factors such as the level of development, population density, the availability of conventional and non-conventional water resources, general climatic conditions, spatial and seasonal variability.

6.3.1.1 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 added value by quantity of water withdrawn, expressed as USD /m^3 for a given sector[144]. In the Mediterranean, it is estimated at 27 USD /m^3 (Blinda, 2018). As this is a new indicator, it is impossible to define a specific target for its value. But the indicator should, at a minimum, follow the same path as the country's economic growth.

[144] 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 sector compared to total withdrawals. Only runoff (blue water) is taken into account when calculating the indicator. Agricultural production generated by rainfed agriculture in particular should be substracted from the overall sectoral added value.

$WUE = Awe \times PA + Iwe \times PI + Swe \times PS$

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

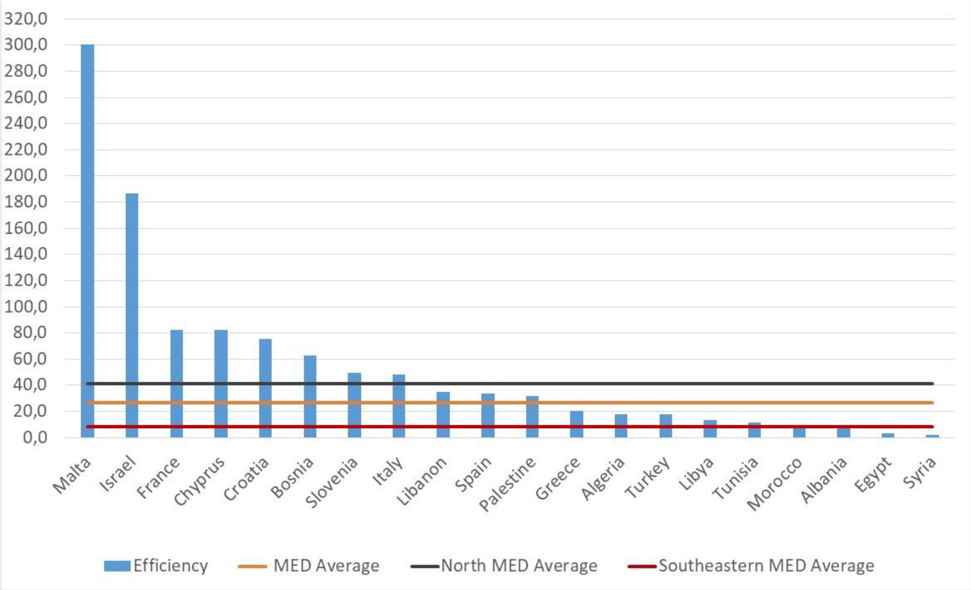

Figure 141 Water use efficiency calculated for the Mediterranean countries (Blinda, 2018)

Economic efficiency is also unevenly distributed among sectors.

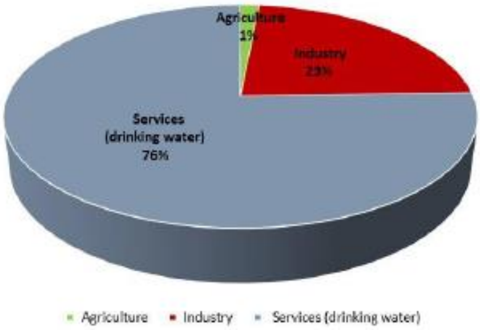

Figure 142 Distribution of economic efficiency between the three economic sectors of water use in the Mediterranean region (Blinda, 2018)

In the Mediterranean, irrigated agriculture takes 189 billion m^3, or 65% of total water demand (world average: 69%, FAO, 2016), considered as the most water-consuming sector. But its water use efficiency in this sector is only 1 % of the total. Water demands for services and industry are 16% and 19% respectively. Their water use efficiencies, on the other hand, reach 76% and 23% respectively (Blinda, 2018). Important water losses undermine water efficiency in the agricultural sector, which calls for a modernization of irrigation systems and farmer awareness raising programmes on water saving practices.

6.3.1.2 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 the functioning of coastal and marine ecosystems. Environmental flows, or environmental water requirements, describe "the quantity, timing, and quality of 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 Plan and Water Allocation Plans. FAO recently launched new guidelines for incorporating environmental flows into the SDG indicator 6.4.2. "level of water stress" to assist countries to 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 European 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. The main use of Mediterranean dams is for the majority irrigation and hydroelectricity generation. 398 dams are recorded in the Mediterranean basin (Plan Bleu calculations based on GRanD database v1.3, Lehner et al. 2011). 24 were built in the period 2009-2016, 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 Catalan and Kremasta Dams in Turkey and Greece respectively (62 km^2). The Ermenek Dam in Turkey and Vajont Dam in Italy have the highest height.

The increase in the number and capacity of dams in Mediterranean countries (Figure 143), as well as changing land covers, and increasing pollution, has notable impacts on downstream ecosystems and the services they provide. Flow regulation infrastructures affecting land-sea interactions (esp. ecological connectivity) are often related to agricultural developments, energy, and water supply, therefore requiring an integrated management.

Water demands in coastal areas of the Mediterranean region are 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 inside the Mediterranean basin, take place to 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 an impact on riverine ecosystems which is not negligible.

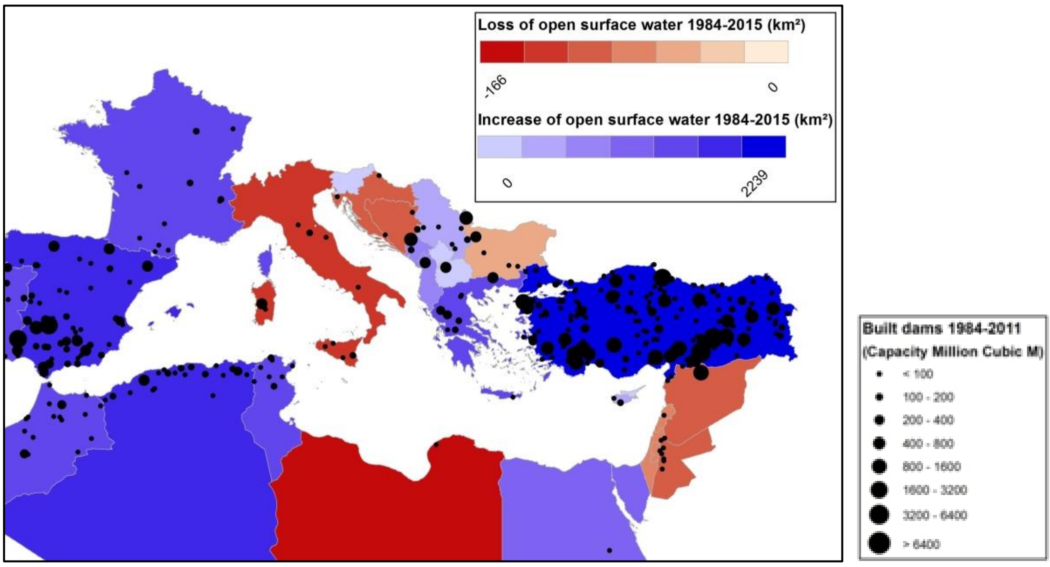

Figure 143 Loss and increase in open surface water area and number and capacity of dams (Source: Global Surface Water Explorer and Global Reservoirs and Dams database).

Over the past three decades, despite notable geographical disparities, Mediterranean countries as a whole have experienced a strong population growth accompanied by a marked increase in cultivated area (about 1.6% average annual increase between 1992 and 2015) and increase in open water areas (approximately 12.3% between 1984 and 2015). The latter seems to be correlated with the number and capacity of water infrastructures, especially dams for agriculture (Pekel *et al.*, 2016). The vast majority of these infrastructures are related to agricultural projects, and there is therefore a link between agriculture, the development of surface water infrastructures, water dynamics and natural wetlands, which for many of them, directly depend on inflow from upstream freshwater bodies. This results in profound modification and alteration of the ecological functioning and could lead, in certain cases, to their gradual drying up or even complete disappearance. It is therefore recommended to partially or entirely rethink the models of agriculture development of the Mediterranean countries, so that agriculture, a key economic sector, does not enter in conflict with the conservation of natural wetlands and the services they provide (surface water purification, groundwater recharge, flood regulation, drought mitigation, biodiversity conservation, etc.).

Box 52 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 a fair sharing among water users while ensuring its preservation and improving its quality. Spanish legislation through a variety of laws and texts 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 accomplishment

The Jucar River Basin Authority applied an E-flow assessment methodology for the first time with the publication of the Public Order legislation the 13th of August 1999. Since then, one of the basic component of E-flows, i.e. the minimum flow, has been assigned and approved in the RBMP. The first minimum flows 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 (2015 – 2021) planning cycles. However, while some of the E-flows studies have improved the E-Flows with the aim of improving the ecological conditions, a set of 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 accomplished during the 1st and 2nd hydrological planning cycles, respectively. Figure 144 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 in relation to its Mean Annual Flow (MAF) in those water bodies under regular monitoring, for the first and second planning cycles.

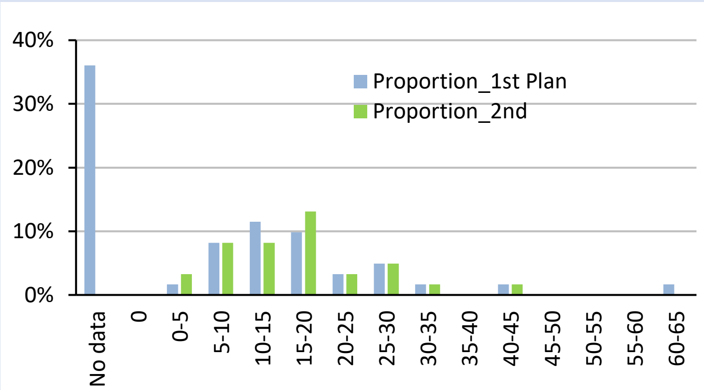

Figure 144 Proportion of minimum flow values to the natural mean annual flow (MAF). 1st and 2nd Hydrological Planning Cycles are compared.

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 of the advance in the assessment and implementation of some components of Environmental Flows in the Jucar River Basin for the last decade; however, some fundamental components such as the 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 fundamental challenges where much improvements are necessary. Furthermore, bigger efforts are still necessary by the JRBA because the percentage of water bodies without regular flow monitoring is still very high (253 out of 314).

Figure 144 shows the proportion of water bodies where the minimum flow is in the range of 10-15% has decreased by the 2nd period from 11% down to 8%, while the proportion in the range of 15-20 % has increased. However, from a historical perspective, the number of sites with minimum flows smaller than 10 % has slightly increased, which suggests that the improvement of the ecological status in some areas is has been neglected for prioritising other water uses.

Jucar river basin E-flow related indicators

Besides the minimum flow values, three more components of the E-flows must be considered in Spain under the legal frame of hydrological planning: the maximum flows in regular operation or management (Q_{max}), the limitation to the rate of change, and the high flows or small floods; in addition, the temporal variability should be considered for the four components. Figure 145 shows the percentage of the water bodies where maximum flows and ratio of change were approved; the percentage of water bodies with control of minimum flow accomplishment; and the percentage of water bodies where minimum flow was accomplished.

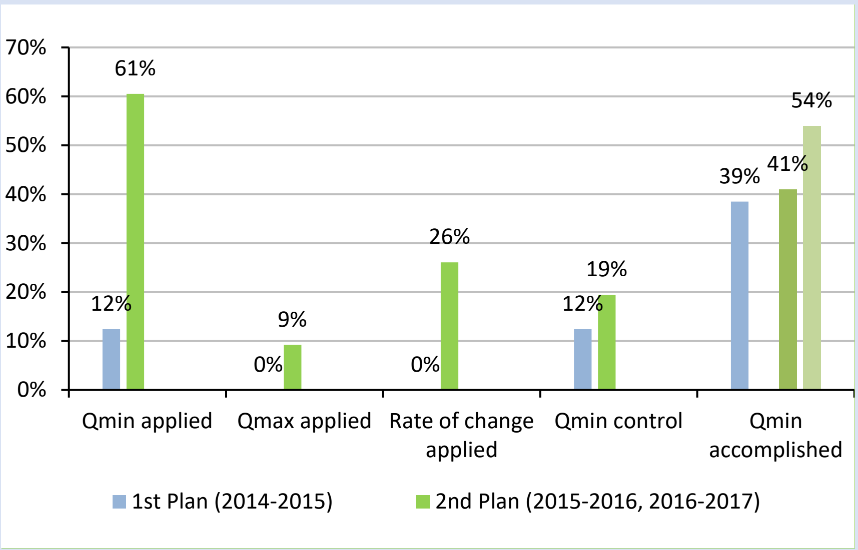

Figure 145 Comparison on five indicators about legal forcing and accomplishment of environmental flows in the Jucar River Basin, for the 1st vs. 2nd cycle of hydrological planning. Percentage (perc.) of water bodies where minimum flow is approved, and similar perc. for maximum flow (Qmax) and rate of change. And, perc. of water bodies with control of E-flows accomplishment (gauging), and of water bodies where minimum flow was actually accomplished.

Minimum flow is legally approved in an incremental number of water bodies (up to 61%). Other two components, i.e. the maximum flow and rate of change began to be controlled in the 2st 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 accomplish the minimum flow.

Box 53 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 number of incoming/outgoing tourists, tourism revenues, consumption patterns, income and welfare.

In Roson and Sartori (2014), the economic impact of variations in tourism flows for some Mediterranean countries, possibly induced by the 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 tourism related to beaches. As it is well known that the per capita water consumption of an average tourist is far higher than that of a local, one should conclude that an increased tourism activity would bring about higher pressure on scarce water resources.

However, 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 covers about two thirds of total water consumption in the Mediterranean, meaning that even a modest decline in agriculture could more than compensate the increased tourists' demand. Not all water savings obtained in agriculture could be redirected to supply water for tourists, though. 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 termed instead “blue water”.

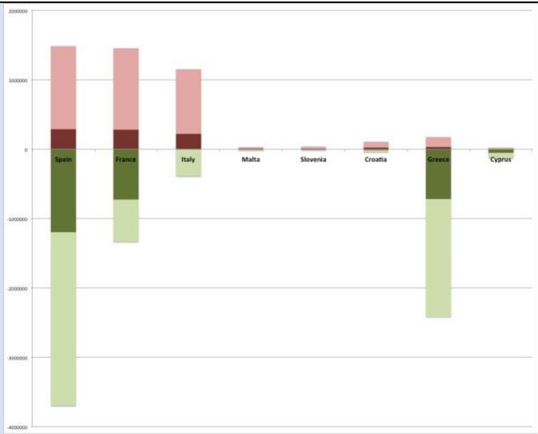

Figure 146 Variations in direct and indirect water consumption (L/yr) *[Figure to be revised]*

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 % probability 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 ones. This is not a coincidence: relatively arid countries are characterized by more irrigation in agriculture, so any decline in agricultural production would free surface water, which then becomes available for the tourism industry.

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, policies in tourism development should be geared at making tourism flows more continuous over the year, reducing seasonal peaks (thereby reinforcing the effect induced by the climate change itself). They should also avoid further development in over-exploited areas. One way to provide efficient access is to allow water trading where this is possible in engineering terms.

6.3.1.3 Water footprint in the Mediterranean

In the Mediterranean region, trade in raw materials and manufactured products induces virtual water transfers that impact water resources management at different scales. A water footprint[145] has three components: green, blue and grey. The blue water footprint refers to consumption of blue water resources[146]. The green water footprint is the volume of green water[147] 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.

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 (Plan Bleu, 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 are thus impacting virtual water flows and water uses.

As far as Northern countries are concerned, Spain, France and Italy are net virtual blue water exporters in the Mediterranean with respectively 9,050 hm^3/yr, 7,400 hm^3/yr and 7,100 hm^3/yr. Spain is the largest

[145] 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)

[146] Fresh surface and groundwater, i.e., the water in freshwater lakes, rivers and aquifers

[147] 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.

net exporter of virtual water in the Mediterranean, linked to trade in bovine meat, even if a large amount of virtual water is imported through grain for animal feed (Mekonnen and Hoekstra, 2011; Blinda 2018).

However, when considering global virtual water, including blue, green and grey waters, Italy and Spain are generally net importers; with 51 km^3/yr and 14 km^3/yr for 1997-2001, they occupy the 2nd and 9th position in the world.

In the eastern rim, Turkey is the first exporter of virtual blue water (and in the whole Mediterranean) with 11,370 hm^3/yr followed by the Syrian Arab Republic with 3,300 hm^3/yr.

In the southern rim, Egypt and Morocco are the countries that most export virtual blue water, respectively 6,800 and 2,400 hm^3/yr (Mekonnen and Hoekstra, 2011; Blinda 2018).

Moreover, the inter-Mediterranean trade seems low compared to trade with the rest of the world. The Mediterranean region is the world's largest importer of cereals (Plan Bleu, 2007; cf. section 6.3.3.1). Guaranteeing these imports is thus a major challenge for food security. The demand for virtual water related to agricultural products in the Mediterranean for the period 1996 - 2005 is estimated at 168 km^3/year (Mekonnen and Hoekstra, 2011; Blinda 2018).

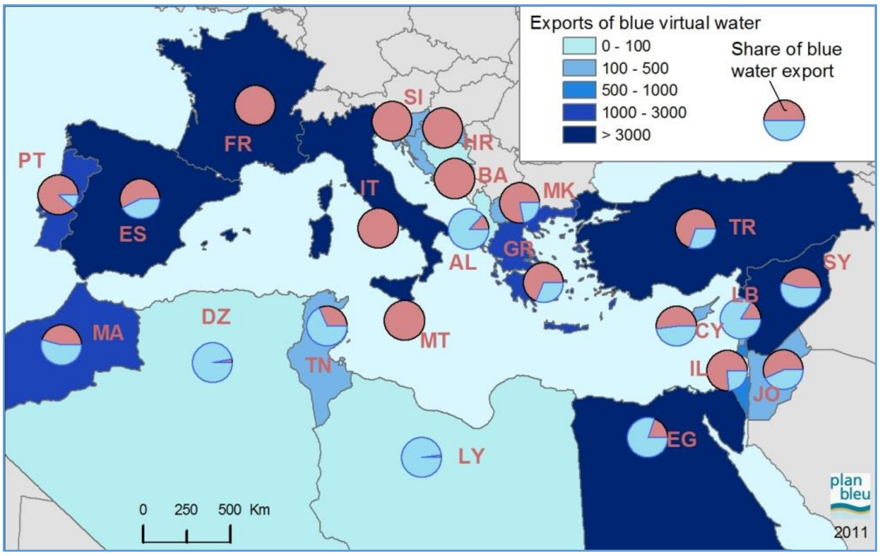

Figure 147 Share of virtual blue water exported from the Mediterranean countries, period 1996-2005 (in percentage of the total blue water consumed in the country), Source: Mekonnen, M.M. and Hoekstra, A.Y. (2011)

Mediterranean people use lots of water for drinking, cooking and washing, but even more for producing things such as food, paper, cotton clothes, *etc*. In the Mediterranean region, when the water footprint and available water resources are compared per country, two situations emerge:

- One group composed of the NMCs with the water footprint lesser than available water resources[148];
- A second group especially the SEMCs with the water footprint exceeding the available water resources[149].

In order to make comparisons between countries in the region, it is useful to calculate the average footprint of water per capita per country (m^3/capita/yr).

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 industrial goods consumption also account 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, in addition to poor agricultural practices often water-consumers.

[148] Turkey, France, Italy, Spain, Croatia, Albania, Bosnia and Herzegovina, Slovenia

[149] Egypt, Morocco, Syrian Arab Republic, Algeria, Lebanon, Tunisia, Israel, Cyprus, Lybia, Montenegro

In the Mediterranean, the water footprint per capita for developing countries has a similar variation as in industrialized countries. For developing countries, values are found in a range of 1050-2200 m^3/yr per capita. At the high end there are Tunisia (2217 m^3/capita/yr), Lebanon (2112 m^3/capita/yr) and Syrian Arab Republic (2107 m^3/capita/yr) (Mekonnen and Hoekstra, 2011; Blinda 2018). With the disclaimer that the extreme values can also partially relate to weak basic data on consumption and water productivity in those countries, the differences can be traced back to differences in consumptions patterns on the one hand and differences in the water footprints of the products consumed on the other hand. The ranking in Figure 148 shows that in the range of relatively large water footprints per capita there are both industrialized and developing countries. The latter are in that range generally not because of their relative large consumption – although relative large meat consumption can play a role – but because of their low water productivities, i.e. large water footprints per ton of product consumed.

The ranking of countries shows also that industrialized countries have water footprints per capita in the range of 1780-2500 m^3/yr.

The average water footprint of the Mediterranean countries (2,082 m^3/capita/year) is higher than the world average (1,385 m^3/capita/yr) (Mekonnen and Hoekstra, 2011; Blinda 2018).

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.

Figure 148 Water footprint of Mediterranean countries (1996-2005), Mekonnen, M.M. and Hoekstra, A.Y. (2011), Blinda 2018

The virtual-water export of a country is the volume of virtual water associated with the export of goods or services from the country. It is the total volume of water required to produce the products 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. It is 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).

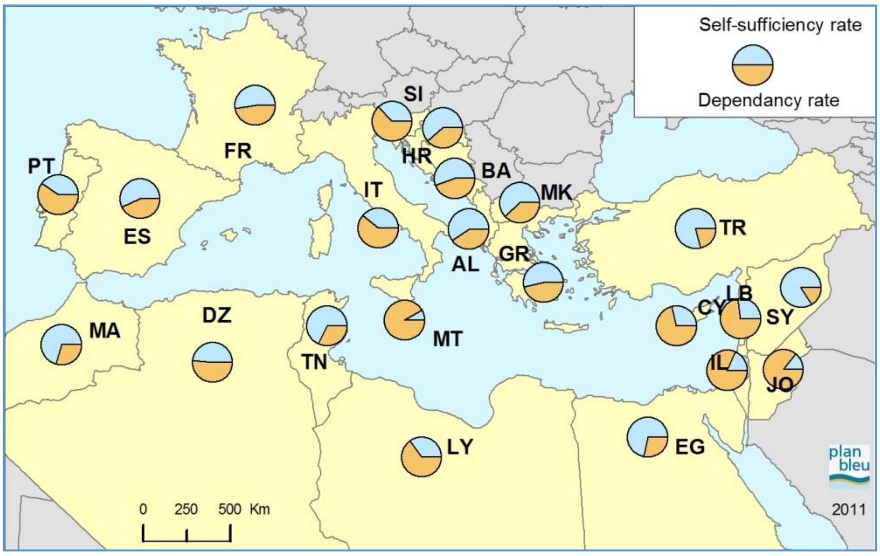

Figure 149 Self-sufficiency and dependency rate150 in relation to the water footprint (1996-2005) (Source: Plan Bleu 2011; Mekonnen, M.M. and Hoekstra, A.Y. 2011; Blinda 2018) ***[Figure to be updated]***

The 'water self-sufficiency' of a nation is defined as the ratio of the internal water footprint to the total water footprint of a country or region. It denotes the national capability of supplying the water needed for the production of the domestic demand for goods and services. The 'dependency rate' of a country is defined as the ratio of the external water footprint of the country or region to its total water footprint.

All external water footprints of Mediterranean countries together constitute 43% of the total global water footprint (Plan Bleu, 2011). The share of external water footprint, however, varies from country to country. Some North Mediterranean countries, such as Malta, Cyprus, Slovenia and Italy have external water footprints contributing 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.

Countries with a large external water footprint apparently depend upon freshwater resources in other countries. Water-scarce countries that have a large external water dependency are for example: Malta (dependency 92%), Israel (82%), Lebanon (73%) and Cyprus (71%). However, not all countries having a large external water footprint are water scarce. In this category are many Northern European countries like Slovenia. They depend upon freshwater resources elsewhere, but the high dependence is not by necessity (e.g. 15 931 m3/capita/yr for Slovenia), since these countries have ample room for expanding agricultural production and thus reduce their external water dependency (Mekonnen and Hoekstra, 2011; Blinda 2018).

A number of Mediterranean countries reduce the use of their national water resources (blue water) through the import of agricultural and industrial products. These countries decreased their blue water demand such as Spain 13.5 km^3/yr (40%), Libya 6.5 km^3/yr (152%), Morocco 6.0 km^3/yr (60%) and Italy 5.3 km^3/yr (60%). In terms of blue water saved, Spain, and a number of countries in the Middle East come on top of the world list (Mekonnen and Hoekstra, 2011; Blinda 2018).

The term 'saving' is used in a physical sense, not an economic one. Besides, the 'water saving' does not necessarily imply that the water saved is allocated to other beneficial uses (De Fraiture *et al.* 2004). In water scarce countries, however, 'water saving' is likely to have positive environmental, social and economic implications.

[150] The 'virtual-water import dependency' of a country or region is defined as the ratio of the external water footprint of the country or region to its total water footprint.

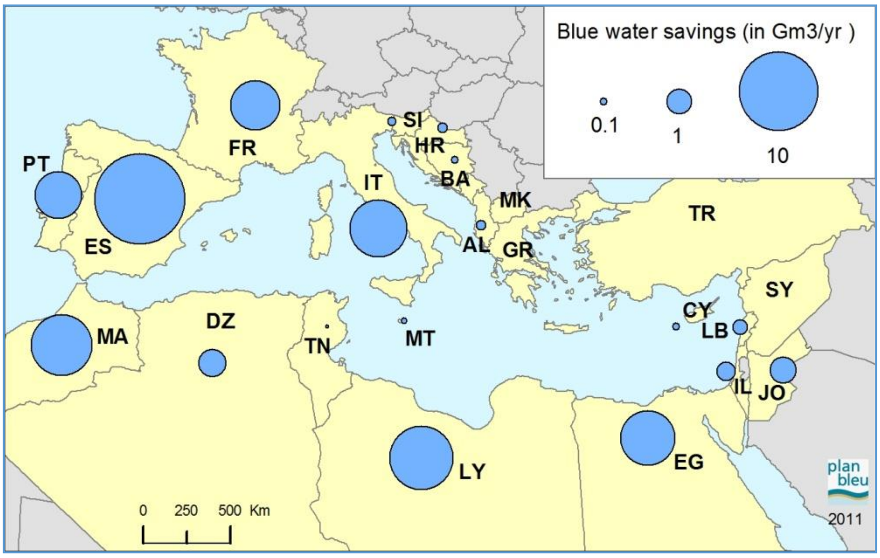

Figure 150 Blue water savings in each Mediterranean country (1996-2005), Mekonnen, M.M. and Hoekstra, A.Y. (2011)

The global water saving related to trade in agricultural and industrial products in the period 1996-2005 in the Mediterranean was 43 km^3/yr (99% from agricultural products, 1% from industrial products). This volume is equivalent to 5% of the global water footprint which is 809 km^3/yr ((Mekonnen and Hoekstra, 2011; Blinda 2018)). So the Mediterranean contributes to about 44% of blue water savings in the world.

Imports of virtual water related to international trade of agricultural products or other water users can help to cope with water crises and shortages.

6.3.2 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. However, 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 sub-regions as 44% of wastewater is produced in the North, 33% in the South and 23% in the East (Figure 151). Yet about 80 % of wastewater in the MENA region is released into the environment without being reused (World Bank, 2017), whereas positive experiences in the region demonstrate that wastewater can be safely recycled for irrigation or aquifer recharge. 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 Syrian Arab Republic directly use 2.7 and 2.3 million m^3 of agricultural drainage water, respectively. Particular attention to water quality degradation of drainage water should be paid. Israel is reuse leader in 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 reuses 0.2% of its wastewater (IPEMED, 2019).

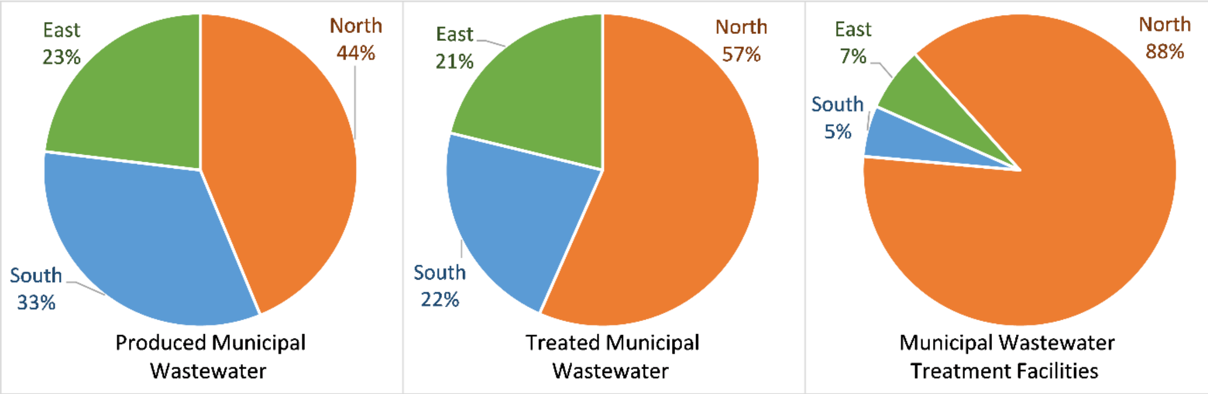

Figure 151 Distribution of municipal wastewater produced and treated, in reference to the total wastewater in the Mediterranean (Source: AQUASTAT FAO, 2016)

First developed in situations of island isolation (Balearic Islands, Cyclades, Cyprus, Dalmatia, Malta, ...) and in coastal zones 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 152). 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 constructed 11 desalination plants since 2003, and is proposal to build two new desalination plants with capacity of 300,000 m^3 per day each. This is part of the plan to have 13 facilities and total capacity of 2.31 million m^3 per day. The two new plants will bring desalinated water to 25 % of the national drinking water supplies, 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.

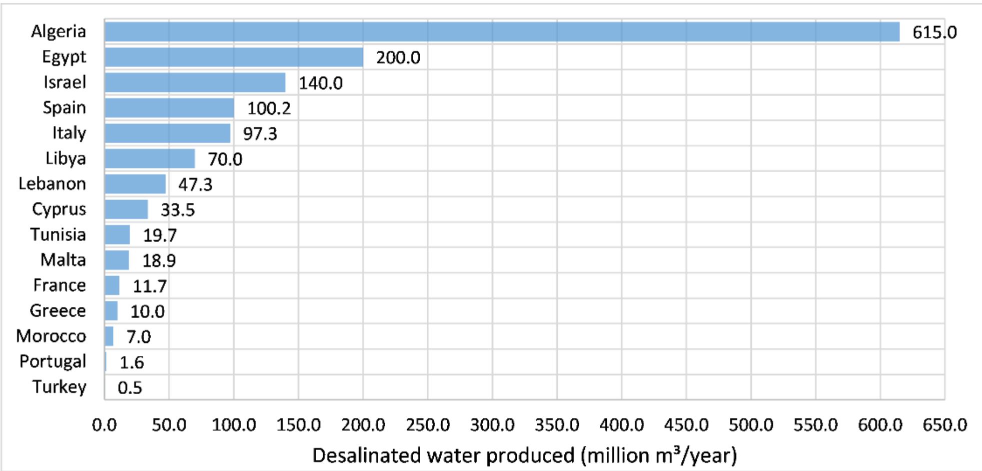

Figure 152 Production of desalinated water in the Mediterranean (Source: AQUASTAT FAO, 2016)

In the Mediterranean, desalination production in 2008 was 10 Mm^3 per year and could multiply several times over the next decade. However, large-scale desalination remains a costly option that consumes large amounts of energy and emits greenhouse gases. The cost of water produced by desalination of seawater is around 0.4 to 0.6 € 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. Desalination has, moreover, negative impacts on the environment, related to the development of coastal infrastructure but also to the discharge of brines. However, options with low CO_2 emissions are possible. The most energy-efficient desalination systems must be upgraded: 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 issues of financing and competitiveness.

A limiting factor for desalination plants can be water 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. Moreover, the proximity of seawater inlets to infrastructures, such as oil terminals and ports, can also potentially lead to closures, when oil is released into the Mediterranean (Tal, 2018).

6.3.3 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 to achieve the objectives of sustainable development by 2030. These aim 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 (UN, 2015). 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 this water point. Targets 6.2 on sanitation and hygiene and 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 level "improved", which was used in the MDG indicators. The previously used “improved” level corresponds to the now-called "at least basic" level, including the “basic” and “safely managed” water levels.

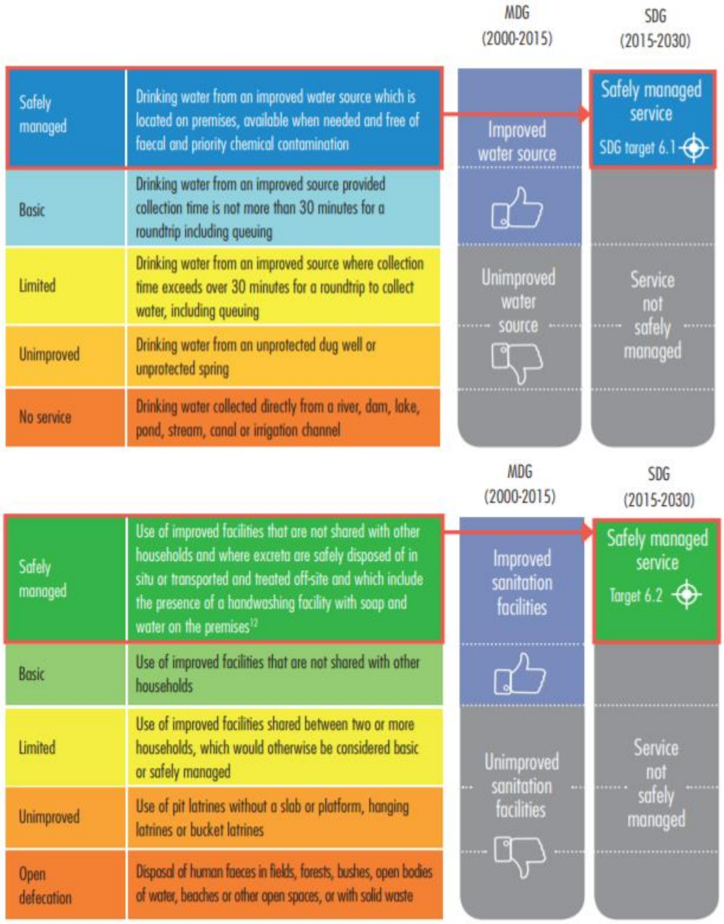

Figure 153 Source: Ps-EAU 2018 The Sustainable Development Goals for Water and Sanitation Services; Interpreting the Targets and Indicators. *[Figure to be adapted]*

In 2015, around 18 million Mediterranean people do not yet have access to an improved drinking water supply (JMP 2017), i.e. 3.6% of the total population of the Mediterranean region, 89 % of which come from the South-East. Countries in this region recorded an average rate of access to improved water of 96 % (Blinda, 2018), which is higher than the world average of 91 % (WB). 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 access to water in a sustainable way directly impacts the living conditions of women who can spend hours fetching water, and increases girls' schooling.

In 2015, it is noted that around 23 million people, with disparities between countries, do not yet have sustainable access to adequate sanitation (WHO / UNICEF, 2017), or 5% of the total population of the Mediterranean region, 80% of which come from the South-East.

As for access to water, the countries of this South-Eastern Mediterranean region have also made very encouraging progress, with an average sanitation access rate of 91% (Blinda, 2018), which is higher than the world average of 68% (World Bank). Considering 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 are not yet served. An enormous effort still remains to be made in the sanitation sector in particular.

Good hygiene habits, such as hands washing with soap and water after using the toilet and before food preparation and consumption, are equally important in limiting the spread of communicable diseases.

The 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 governmental budget. Between 2000 and 2015 the amount of public aid for development related to water and sanitation allocated to North Africa (Algeria, Egypt, Libya, Morocco and Tunisia) rose from 455 million USD to USD 777 million (UN: statistic division, 2015), representing a growth rate of 71% unequally distributed among the 5 countries. Disparities are significant between countries registering a minimum of USD 430,000 for Libya and a maximum of USD 404 million for Morocco.

This increase in ODA devoted to water and sanitation can be explained by 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, Blinda, 2018).

6.3.4 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 at the Mediterranean basin scale on the status and trends of water quality parameters. Moreover, the number of existing contaminants, as well as their spatial and temporal variations, amplify the difficulty of the monitoring exercise.

The main environmental water quality 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 in terms of surface water pollution and habitat degradation along the Mediterranean coastline, 49% of water bodies on average are failing to achieve the Good Ecological status, the highest proportion being found in Sicily, Italy, and lowest in Corsica, France (EEA, Ecological Status of Surface Water Bodies, 2018).

It seems that the main flow and pollution impact to the Mediterranean Sea is due to the contributions from NMCs and Turkey; contributing 87% of the stream flow, 95.4% of the TN load and 93.6% of the TP load (Nikolaidis *et al*. 2014; Strobl *et al*., 2009). Nitrate concentrations and loads increased steadily from the 1970s in the Rhone, Po and Ebro rivers, and remain approx. constant since the 90s (Montreuil and Ludwig, 2013). Nitrogen and Phosphorus are essential for maintaining biological productivity at sea and are strongly associated to 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 (Bouraoui and Malago 2017).

Increasing water temperatures and decreasing dissolved oxygen levels were caused by air temperature increase in the Ebro (Spain) and Adige (Italy) river basins (Diamantini et al. 2018). Agricultural practices and population density had some influence on chloride, BOD and phosphate contents in the Sava (Slovenia) and Ebro river basins.

6.3.5 Stability/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 *et al.*, 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, socio-economic and political factors. In its absence, short- to long-term processes leading to political instability, livelihood depletion, ecosystem degradation and population displacement may arise. What is more, 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 *et al.*, 2017).

Water, Instability and Population Displacement

One of the ultimate manifestations of this vicious cycle is population displacement. Recent phenomena in the Mediterranean region, such as the Syrian refugee crisis and the ongoing flux of migrants crossing the Mediterranean to reach its northern shores, highlight the complex interlinkages 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 capacity of populations to ensure their livelihoods (notably through agriculture) is strongly impacted, which can lead to migratory crises and conflict situations due to competition for resources, as well as increased pressure on host communities. Nonetheless, it is widely agreed that it is not possible to simply "blame the drought", namely environmental factors such as climate change, for instability linked to water resources in the region. Water scarcity or water-related factors rarely figure in migrants' and refugees' decisions to flee their homes (Jobbins *et al.*, 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, however, 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
- Failure to preserve surface, ground and transboundary water resources (Sadoff *et al.*, 2017)

These policy failures can threaten social cohesion while increasing tensions between governments/policy makers and citizens, and can either be partly caused or exacerbated by long-term environmental factors, such as the numerous effects of climate change. In the Syrian Arab Republic, the wave of rural to urban migration and the following broader crisis and conflict resulted from broad governance failures, and not from the severe drought which struck the Syrian Arab Republic starting from 2005 (de Châtel, 2014). Indeed, the drought did not lead to widespread migratory phenomena from rural to urban zones in other neighboring countries that were also affected, such as Iraq, Turkey, Lebanon and Jordan (Weinthal, Zawahri and 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 its effects of migration (Jobbins *et al.* , 2018). Nonetheless, while water resources and 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 and Swain, 2016).

Emerging from the "vicious cycle" of water insecurity 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 and Swain, 2016). Profound social instability is one of the main factors that prevent integrated water strategies to take 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 primordial resource and deprived of their capacity to access clean drinking water, proper sanitation, and to produce food to ensure their subsistence and revenues. Indeed, food crises can be directly related to water shortages or water supply inefficiencies. Indeed, food is effectively water that humans “eat”: when water is insufficient due to environmental or human factors, food production is directly impacted further down the chain. Unable to feed themselves or to obtain sufficient incomes from their agricultural produce, 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’ often 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 and World Bank, 2018). This long-term, regional and collaborative approach is instrumental in building regional resilience to human or environmental shocks such as conflict, forced displacement and extreme weather events and ongoing environmental degradation.

The Syrian up-rising, which began in March 2011 is the outcome of complex but interrelated factors (Gleick and Heberger, 2014; Kelley *et al*, 2015). While the main target of the multi-sided armed conflict has been a political regime change, the uprising was also triggered by a set of social, economic, religious and political factors leading to a disintegration of the country with a growing rural-urban divide, rising unemployment, and growing poverty (De Chatel, 2014). The climate hypothesis has been contested and although causality cannot to be found in such a simple direct relationship, it cannot be denied that drought played a significant role in triggering the crisis, as this drought was the longest and the most intense in the last 900 years (Cook *et al*, 2015).

6.4 Agroecosystems, soils and food security

6.4.1 Agroecosystems

Agroecosystems are generally defined by a dominant agricultural activity influencing the living and non-living components interacting in an ecosystem. Mediterranean agroecosystems include irrigated agriculture, rainfed agriculture, pasture and aquaculture, which can be found in two different zones, providing differing agroecosystem services:

- « fertile » areas, where large irrigation schemes and rainfall agroecosystems occur. They are said favorable, because they receive more than 400 mm annual rainfall and are limited spatially by resource availability (water and land). Oasis, peri-urban and lagunar systems are also integrated in this zone.

- « handicap/marginal » areas characterised by mountains and semi-arid, non-irrigated fields, where agriculture is often marginal and interferes with pastoral economy, the latter becoming dominant in steppes. Agricultural economy in these areas can be called « agro-sylvo-pastoral ».

In the fertile areas, the most significant type of ecosystem services rendered is provisioning of food, fuel (timber) and fiber (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 values 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 favorable 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 the sprawl of rural areas leads on the contrary to reduce the infiltration of water and increase GHG emissions (growth of transport consumption...);
  - fire prevention by grazing activities, which decrease woody vegetation density;
  - water regulation through specific agrarian and forestry practices;
  - pollination through the maintenance of higher floral diversity communities; recycling of urban effluents; habitat creation and safeguarding of agricultural biodiversity.

In the « handicap/marginal » zones, the main ecosystem services are:

- provisioning of water for the benefit of the downstream users (essential roles of "water towers" 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 infiltration of water, which can contribute to a positive hydrology and the storage and reorganization of carbon, but also safeguarding of biodiversity;
- cultural services rendered by the 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.

6.4.2 Soils

Soil is one of the main contributors to agroecosystem function and food security, being as precious as water throughout the Mediterranean. In Mediterranean history, the disappearance of some civilizations can be associated with a decline in food production due to the large development of 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 a 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 154), 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.

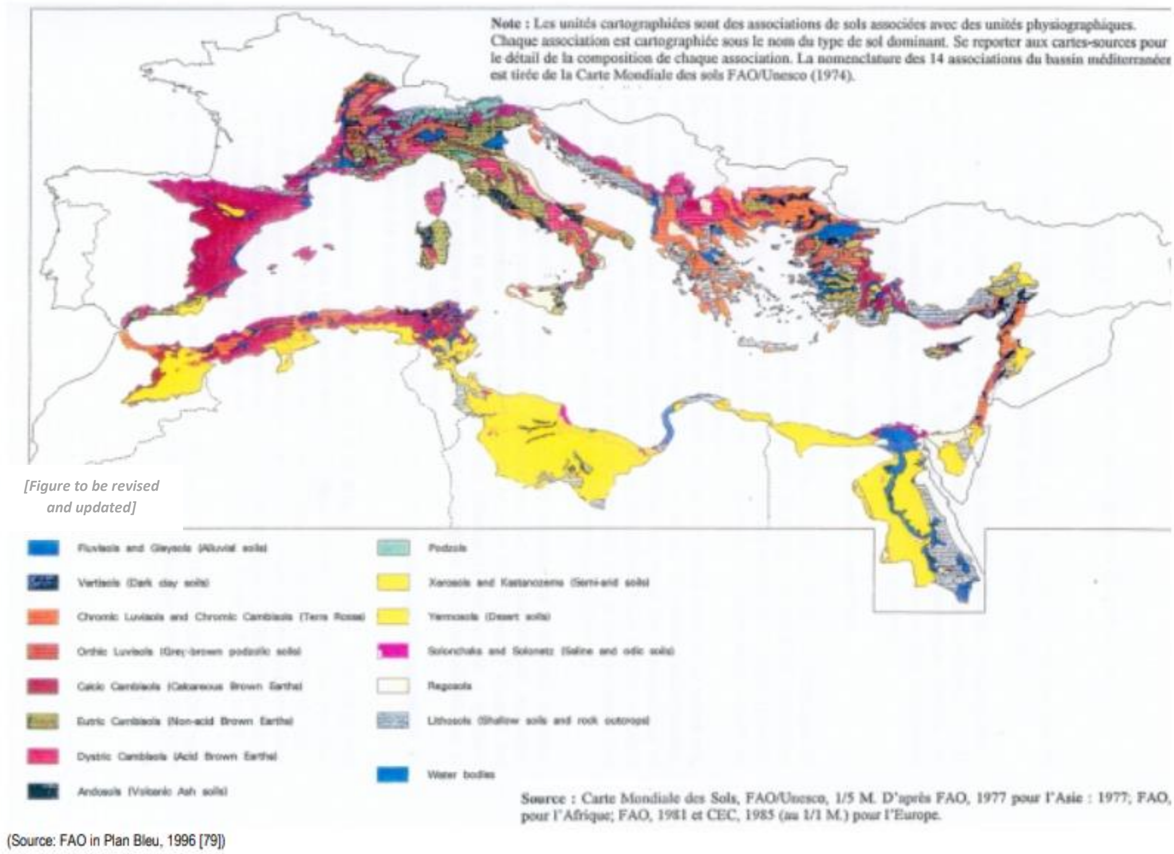

Figure 154 Main soil types in the Mediterranean region (Source: FAO) *[Figure to be updated]*

Soils are shaped due to 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, surface stability, they host biodiversity, have an aesthetic and spiritual value, and an archive of geological and archaeological heritage (FAO and ITPS, 2015). These services are supported by a myriad of organisms, many of which invisible to the naked eye but 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. At the level of the Mediterranean basin, scientific literature currently lacks a comprehensive synthesis of the state and trends of Mediterranean soil.

The area of arable land decreased by an average of 13% over the period 1995-2015. This decline is particularly marked in the State of Palestine (-42%), Lebanon (-27%) and Turkey (-16%) and Israel (-14%). The total number of hectares of arable land decreased by an average of 10% in the Balkan countries between 1995 and 2016. At the country level, 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 area of arable land per capita (Figure 156) fell by an average of 41% over the same period, more than double that 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%), Lebanon (-62%) and Jordan (-55%).

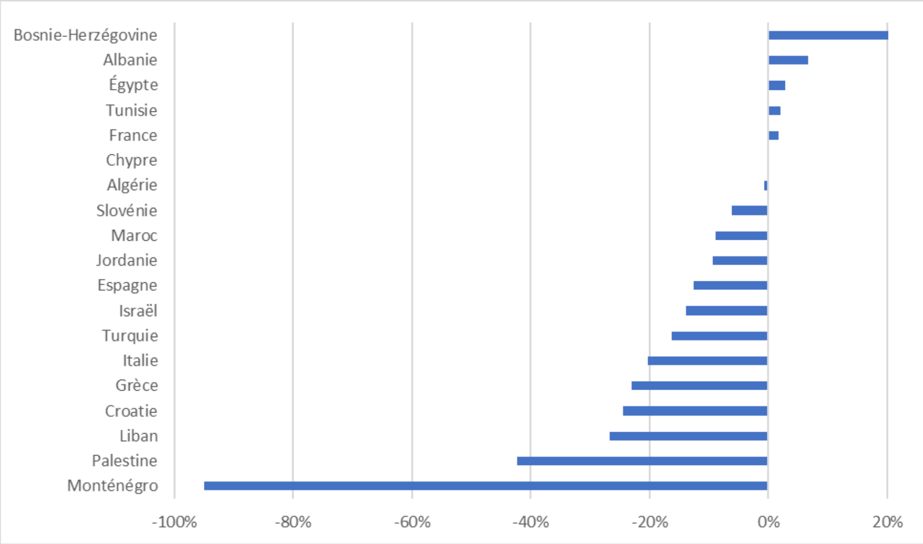

Figure 155 Evolution of arable land surface between 1995 and 2015, difference in % (Source: World Bank WDI) Note: In Montenegro data collection for agricultural land statistics follow a new methodology since 2013, which explains the unrepresentative change in arable land surface. *[Figure to be translated]*

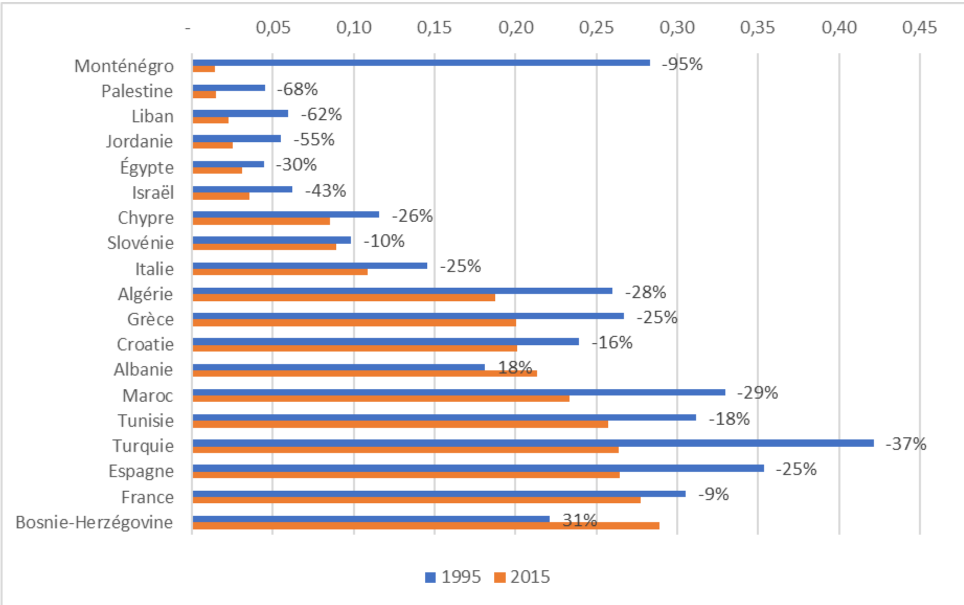

Figure 156 Number of hectares of arable land per capita in 1995 and 2015 and evolution between these dates (Source: World Bank WDI) *[Figure to be translated]*

Arable land is also unequally distributed across the Mediterranean, with over 46% of arable land in the North and only 31% in the South (FAO-Stat, 2018); 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: an often sparse vegetation cover, a high annual climatic variability alternating wet and (very) dry years and frequent high intensity rainfall and wind events, rocks often of easily erodible, a rugged relief where 45% of the area having 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 a continuous practice of agriculture and livestock since the Neolithic (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:

population growth (particularly in the southern rim of Mediterranean basin) and access to subsidies (countries subjected to 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); littoralisation and urban sprawl; and construction of transport infrastructure. The processes of soil degradation include, among others: 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”, aiming to monitor progress towards the goal “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 parallel with intensification, many inland areas of the European Mediterranean countries witness an increasing rural land abandonment and associated depopulation and economic marginalization. Land abandonment brings about an aging and **depopulation of rural areas** and migration to urban areas. When rainfall conditions are favourable, a woody encroachment of former agricultural lands follows land abandonment. This secondary succession process results in higher biomass which can provide habitats for various species (while not been favourable to grassland specific species), but also result in an increasing fire risk.

Soil erosion is a natural process, but it becomes an issue when the rate of erosion is higher than the rate of soil formation. Natural erosion in balanced ecosystem has a tolerable level of annual surface horizon loss (5 tons/ha). This loss can be accelerated by human activities to rates higher than 50 tons/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 the soil, and changes of other soil properties (e.g. coarsening soil texture). Erosion also affects the capacity of the soil to stock and regulate carbon, making it eventually a net contributor to greenhouse gas emissions. Studies in semiarid part of Spain revealed 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 non-point pollution and eutrophication of downstream water bodies caused by the exportation of eroded sediments and the nutrients and pesticide attached to them, higher risk of flash flood transporting high loads of sediments, and reservoirs siltation. The reduction of reservoirs’ capacity is a serious issue in North African and Eastern Mediterranean countries where water availability for irrigation and drinking mainly rely on surface water storage (Ayadi *et al*., 2010).

Box 54 State of soil erosion

Quantifying the extension and intensity of soil erosion has proved a difficult task subject to a high uncertainty. Erosion is scale-dependent with highly temporal variability that requests performing standardized, long-term and nested across scales monitoring systems to gather representative, reliable and comparable data.

Reported erosion rates show a wide 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 Olivier *et al*. 2010, estimated rill and interrill erosion rate of 1.3 t/ha/yr for the Mediterranean area of Europe. This accounts for 21.5 % of the total Pan-European soil losses. Measured erosion is strongly influenced by land use (Table 27). A similar study conducted by Maetens *et al.*, 2013 confirms the key role of land use as determinant of erosion rates in the Mediterranean. The annual mean rate for bare plots and plots where crops have been cultivated range from 1 to 20 t/ha/yr while plots with permanent cover have erosion rates lower than 1 t/ha/yr.

The erosion rates are lower for bare and cultivated areas than observed in wetter part of Europe. On contrary, areas covered by (semi-)natural vegetation showed higher, yet low < 1 t/ha/yr, rates than in the rest of Europe. These counterintuitive low values of soil erosion obtained in Mediterranean region are explained by the large fraction of rock fragments on the topsoil and the importance of other erosion mechanism such as gully erosion, landslides and riverbank erosion that are not well represented at plot scales.

Table 27 Estimated average erosion rates by land use in the Mediterranean region

Land Use	Erosion Rate (t/ha/yr) measured at plot scale	
	Olivier *et al*.2010	Maetens *et al*. 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 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

Modelling soil erosion rates provides, however, a slightly different picture in which the Mediterranean Europe is identified as a global hot spot (i.e. areas where soil loss rate are beyond 20 t/ha/yr) at global level (Borreli *et al*., 2017). At European level, Panagos *et al*, 2015 estimate soil erosion rate by using a revised version of the Universal Soil Loss Equation (RUSLE2015). The results showed that the Mediterranean climatic zone has a high erosion rate (4.6 t/ha/yr). In this study, estimated soil loss of eight Mediterranean EU Member States (CY, ES, FR, GR, HR, IT, MT and PT) amounts to 67% of the total soil loss in the European Union (28 countries) (Table 28). These higher values are mainly explained by having the highest rain erosivity and the presence of permanent crops, which include most of the vineyard, almonds and olive trees growing in Mediterranean region, and sparsely vegetated land areas, both land uses suffering from high erosion rates, 9.5 and 40.2 t/ha/yr, respectively.

Table 28 Average soil loss rate per EU-Mediterranean country (all land, arable lands) and share of EU soil loss. Source: (extracted from original Panagos et al.,2015)

Country		Estimated soil loss rate (t/ha/yr)		% of the total soil loss in EU
		Overall Mean	Mean in arable land	
CY	Cyprus	2.89	1.85	0.25
ES	Spain	3.94	4.27	19.61
FR	France	2.25	1.99	11.85
GR	Greece	4.13	2.77	5.31
HR	Croatia	3.16	1.67	1.74
IT	Italy	8.46	8.38	24.13
MT	Malta	6.02	15.93	0.01
PT	Portugal	2.31	2.94	2.01

Soil salinisation is one of the most spread 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 match market conditions and demand. Salinisation 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) respectively negatively affect soil fertility and productivity. High soil osmosis and head potential restrict water availability to plants which negatively affect plant growth and reduce crop production. Conditions causing low biological activity like low surface organic matter content after fires, weak microbial activity caused by salinity or pollution, and 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 special impact on soil functions and is associated with an increasing risk of **aridification**, i.e. the process of land degradation in arid, semi-arid and dry sub-humid zones. It is considered that approximately ten percent of the European territory is affected by different levels of intensity of desertification processes (Rubio and Recatala, 2006). Soil is the main actor in the processes of desertification: it constitutes a living environment with enormous biological activity that is highly sensitive to the availability of water and variation of climatic parameters. In Mediterranean terrestrial ecosystems, short-term effects of a drier climate on decomposition lead to a reduction of soil microbial biomass (Curiel-Yuste *et al*. 2011), reduced soil respiration (Emmett *et al*. 2004; Asensio *et al*. 2007; De Dato *et al*. 2010) and reduced soil enzyme activities (Sardans & Peñuelas 2005; Hueso, Hernández & García 2011). Mid-term (i.e. a few decades) effects impact on litter quality by reducing nutrient content (Wessel *et al*. 2004; Sardans *et al*. 2008) or by increasing recalcitrant compounds (molecules resisting microbial decomposition) (Munné-Bosch & Alegre 2000; Hernandez, Alegre & Munné-Bosch 2004), and altering the composition of decomposer communities by feedback processes.

Soil degradation, in turn, affects important parameters of climate regulation 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 of 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 (forced migrations, water scarcity, food insecurity, forest fires) and important socioeconomic consequences.

6.4.3 Food security

The four pillars of food security are availability, access, utilisation 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 in 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 some stability, partially from internal production, but especially from trade and reliable international markets. Price volatility for agricultural commodities can damage 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 commodities markets and price volatility. This volatility came at a time of prevailing difficulty for international markets for agricultural commodities, 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 SEMC 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 agroclimatic 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.

6.4.3.1 Food availability: imbalance between production in the northern and southern Mediterranean region and increased dependency of southern countries for basic food commodities

Trends in food production

The demand for livestock products is expected to grow in the next decades but there are significant challenges for livestock systems under changing climate and social conditions (Herrero *et al*, 2013b). In 2014, animal food and feed import represented around 32 % of total food import (Weindl *et al*, 2015). The impacts of climate change on local production potential, combined with the growing demand of animal products due to demographic growth and changing consumption habits changes will increase the food dependence of the south Mediterranean countries in the coming decades (estimated at around 50 % for 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; Fitzgerald *et al.*, 2016; Fernando *et al.*, 2016). Pests and diseases as well as mycotoxins could also represent a serious threat under unfavorable climate conditions (Bernues *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, would impose additional constraints to the agricultural land (Herrero *et al*, 2013a).

Yields for many winter and spring crops are expected to decrease due to climate change, especially in the South. By 2050 reduction by 40% for legume production in Egypt, 12% for sunflowers and 14% for tuber crops in Southern Europe have been estimated. Warming will also affect olive production by increasing the irrigation requirement (Tanasijevic *et al*, 2014), the risk of heat stress around flowering and the lack of chilling accumulation (Gabaldon-Leal *et al*, 2017), and by altering fly infestation risk (Ponti *et al*, 2014). Although the impact is not projected to be large for aggregated productions, local and regional disparities will emerge (Ponti *et al*, 2014). Changes in the phenological cycle towards shorter duration and anticipated flowering are projected for grapevines, with associated increase in the exposure to extreme events and increase in water stress (Fraga *et al*, 2016). These conditions could also affect the quality. Anticipated flowering and insufficient time with 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 yield limiting factor (Arbex de Castro Vilas Boas *et al*, 2017), although water-saving strategies to enhance the quality and nutritional aspects while keeping satisfactory yield levels could be developed (Barbagallo *et al*, 2013). In some crops, yield increases may occur, due to CO2-fertilization effects which could increase water use efficiency and biomass productivity (Deryng *et al.* 2016 ; Fraga *et al*, 2016), although the complex interactions among the various factors and current knowledge gaps imply high uncertainties (Fitzgerald *et al*, 2016 ; Link *et al*, 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 a important role in the future. Mediterranean countries import more fish products than they export, as a result of the 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 of 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 fish sector. By 2040–2059 relative to 1991-2010, more than 20 % of exploited fishes and invertebrates currently occurring in eastern Mediterranean are projected to become locally extinct under the most pessimistic scenario (RCP 8.5) (Jones & Cheung, 2015; Cheung *et al*, 2016). By 2070–2099, 45 species are expected to qualify for the IUCN Red List whereas 14 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 relative to the 1990s under RCP 8.5 (Cheung *et al*, 2016). The expected migration of species to cooler areas as the ocean warms up (Poloczanska *et al*, 2016) is eventually limited in enclosed seas and the Mediterranean Sea has been described as a ‘sans issue’ (no exit) for endemic fishes, including commercial species, facing climate change (Ben Rais Lasram *et al*, 2010).

Box 55 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 great 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 the 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, large uncertainties and high 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 their productive, environmental and social functions (Bernues *et al*., 2012; Herrero *et al*., 2013a). Currently, the Mediterranean region is characterized by mixed production system in the northern regions and in some southern ones, while grazing systems dominate the southern regions (Herrero *et al*., 2013b). The number of agricultural holdings with grazing livestock is in decline but associated with an increase of animals per farm (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 have increased by 25% from 1993 to 2013.

Overall, expected climate and socio-economic changes pose threats for food security in the Mediterranean region. These pressures will not be homogeneous across the region and sectors of production, creating further regional imbalances. Sustainability of food production represents an issue in unfavorable climate and socio-economic 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 agroclimatic 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), and represents for the latter the first 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) have the monopoly on 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[151], 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)[152].
The main actors in the world agricultural trade are, in the Mediterranean, northern countries (Spain, France, Italy and Greece), three northern 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 cereals deficit and a high cereals dependency ratio (see Figure 156 and Figure 157).

The climate regime and natural resources limit cereal production[153]

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 under 7% of global cereal supply in recent years (FAO-Stat, 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 MED-Amin network coordinated by CIHEAM was launched in 2014 in 13 countries to process information on cereal markets in the Mediterranean. The first Policy Brief (MED-Admin, 2016) summarised the cereal situation in the region as highly imbalanced as the region is facing strong constraints and is exposed to cereal markets reversals.

Figure 157 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 coming from the Mediterranean region was higher in the West than in the East for 2011-2013.

[151] 5th most traded fruit in the world after citrus fruits, bananas, mangos and pineapples.

[152] Turkey is the largest global exporter of dried apricots. It is also the world's second producer and leading exporter of raisins (FAO-STAT, 2017).

[153] This paragraph specifically mentions cereals given the importance of these crops in Southern and Eastern Mediterranean countries (SEMC).

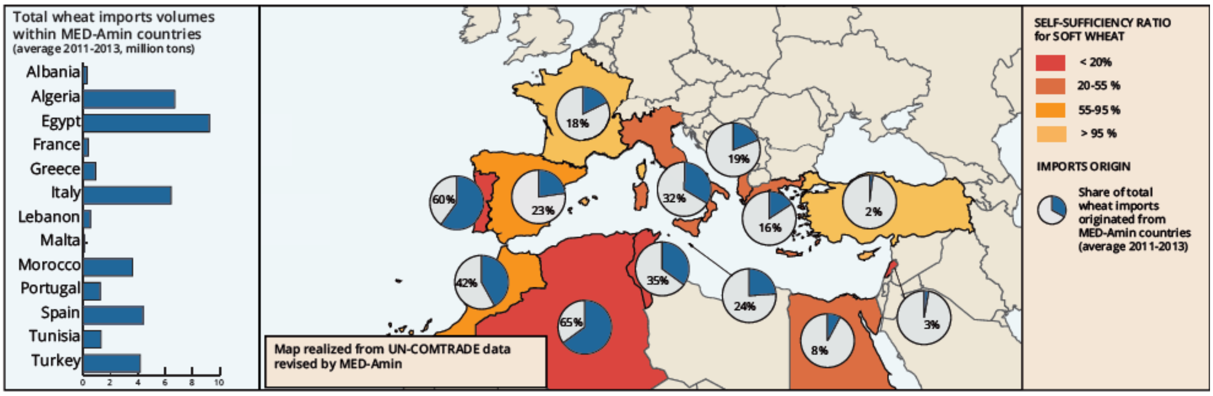

Figure 157 Total wheat imports in Med-Amin countries

The agricultural production deficit is primarily due to agroclimatic conditions and the scarcity of arable land (see above) and water resources[154]. Average rainfall is another agricultural difficulty facing Mediterranean agriculture, particularly in Southern countries (Table 29).

Table 29 Land availability, rainfall and cereal crops in the Mediterranean (Source: World Bank, 2017, * 2016, ** 2007)

	Arable land (ha) **(2016)**	Hectares per person	Average precipitation mm per year (2014)	Cereals (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 & Herz.	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	
Spain	12,338,000	0.27	636	6,265,086	24.7	17.6
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	
Palestine	64,000	0.01	402	24,497	10.6	
Slovenia	184,050	0.09	1,162	99,435	9.1	0.5
Syria**	4,662,000	0.25	252	2,244,751	25.4	9.4
Tunisia*	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	1,500,0000,000	0.19	-	718,123,234	11.0	

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 salination due to lack of drainage.

[154] 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, 2018).

In addition to these characteristics, the southern 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 below:

Table 30 Exports and imports, balance of agricultural trade (10^6 USD) (Source: FAO Statistics. World food and agriculture. Statistical pocketbook 2018)

	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 & Herz.	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
Spain	10,984	20,468	37,399	8,620	14,180	21,337	16,062
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	61	1,167	2,479	1,323,	1,774	3,861	-1,382
Palestine							
Slovenia	231	421	1,201	559	931	1,883	-682
Syria	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

There is a large food trade deficit in the commercial balance of food products in the Mediterranean of 36.6 billion USD (WTO, 2017).

The only Mediterranean countries with an excess agricultural trade balance are France (+3.4 billion USD) and Spain (+ 13.1 billion USD). Turkey registered a positive trade balance in 2016 of over 5.7 billion USD (FAO-Stat, 2017), but a negative balance (- 99 million USD) in 2017 (WTO, 2017).

In 2017, food import expenditure per capita varied by country. It was especially high in countries like Malta (1,198 USD per capita), Montenegro (820 USD per capita), Cyprus (738 USD per capita), Israel (547 USD per capita) and Lebanon (461 USD per capita). It is low in Tunisia (92 USD per capita), Croatia (78 USD per capita), Turkey (12 USD per capita) and Morocco (5 USD per capita).

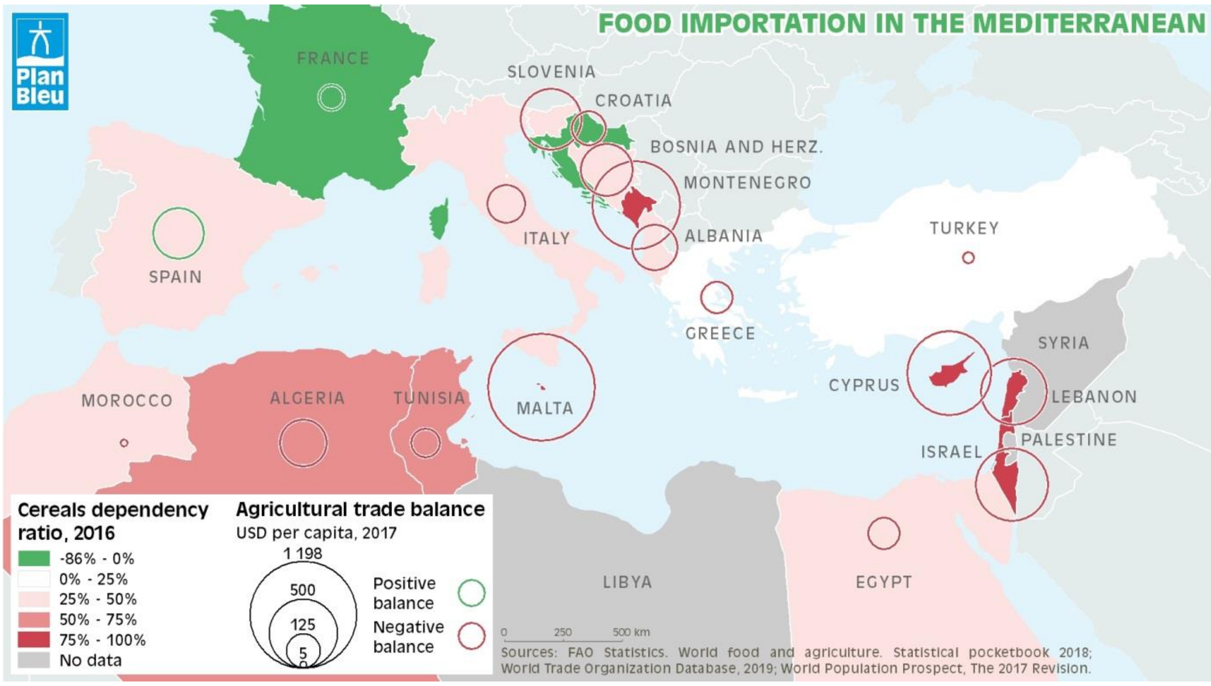

Figure 158 Agriculture balance and cereal dependency ratio for Mediterranean countries (Source: data from FAO Statistics and WTO, 2017)

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.

The Mediterranean countries received one third of global cereal imports (Abis, 2016): 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 10 billion USD on wheat (3.5 times 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 below:

Table 31 Cereal Import Dependency Ratio in the Mediterranean (Source: FAO Statistics. World food and agriculture. Statistical pocketbook 2018)

Country	Cereal import dependency ratio (%) in 2016
Albania	40.2
Algeria	72.2
Bosnia & Herz.	37.0
Croatia	-11.6
Cyprus	100
Egypt	42.1
Spain	31.8
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
Syria	N/A
Tunisia	59.7
Turkey	4.0

*Negative values mean that the country is a net exporter of cereals. N/A: data unavailable

UN forecasts for 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 Forecasts 2030/2050).

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 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.

However, 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, 2018).

6.4.3.2 Access to food: rural populations are more exposed to poverty and food insecurity

One of the main factors in 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 subsidence and standards of living. In the Mediterranean region, the situation is different between the North (EU) and the SEMC. 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 fragile 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 urbanisation in the region, there is still a large rural population. Major territorial divides are forming between rural and marginalised 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 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 requiring 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 (Mediterra, 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 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 agri-food 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 SEMC) or social safety nets, help to mitigate food price increases and improve purchasing power to a certain extent. However, 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).

6.4.3.3 Nutrition, quality and use of food: 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 exist 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 certain 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. However, 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 urbanisation, changes to food distribution, the globalisation 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 (SEMC).

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 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, MAP, IFAD, UNICEF and WHO; SOFI 2018) show **a worrying increase in the number of people who are overweight or obese between 2012 and 2016 in all Mediterranean countries** (Figure 159). 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 & 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.

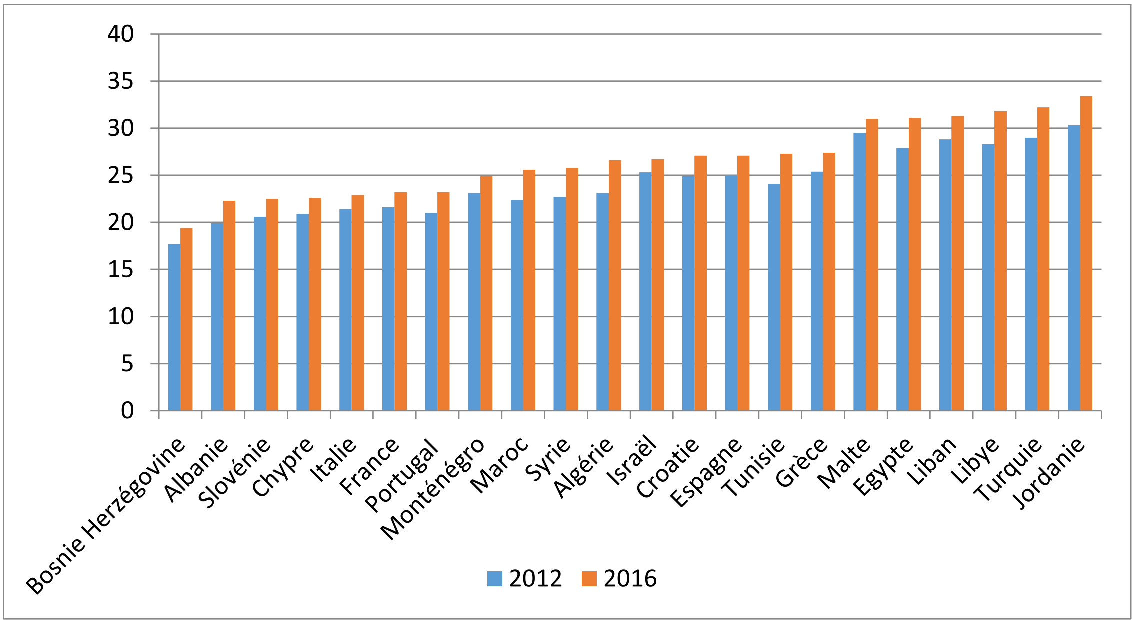

Figure 159 Prevalence of obesity in adults (18 and over) in % (Source: SOFI data, 2018)

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 160)**.** It exceeds 30% in Algeria, Lebanon, Libya, Morocco, Syrian Arab Republic, Tunisia and Turkey.

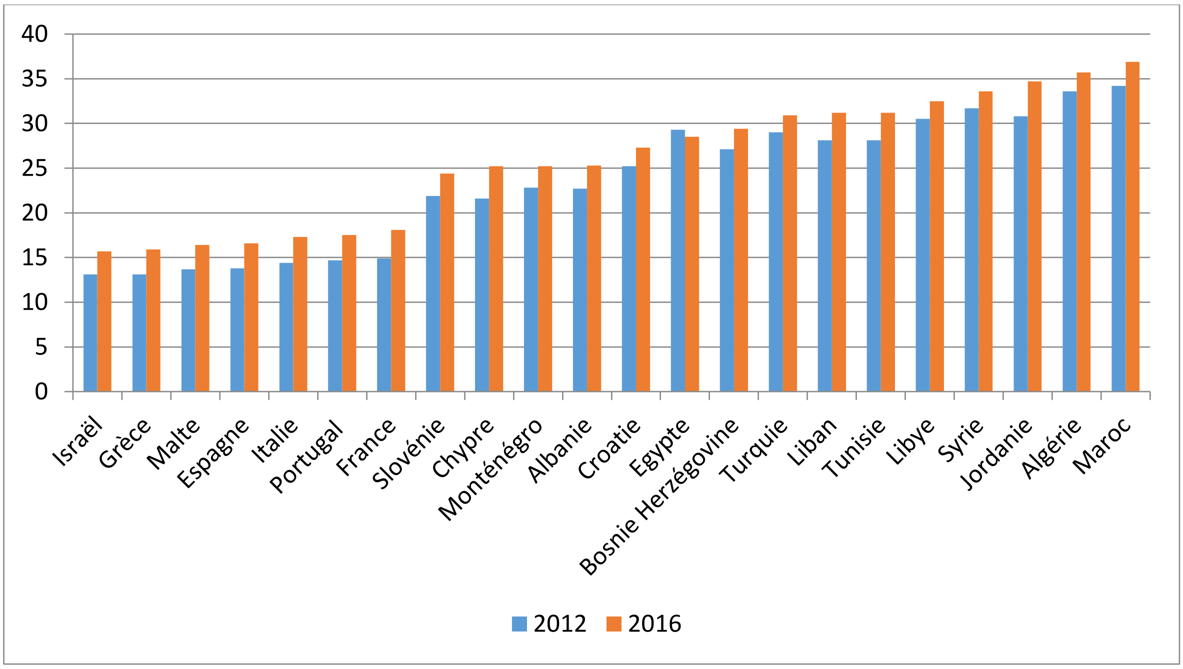

Figure 160 Prevalence of anaemia in women of childbearing age (15-49 years) (Source: SOFI data, 2018)

Although food safety has generally improved in recent decades with the rise of globalisation and major retailers, nutritional quality is somewhat lacking, with less food diversity, reduced consumption of local and seasonal products, the loss of traditional recipes and know-how for conservation. However, since the 1990s, citizens' movements have promoted short circuits 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).

6.4.3.4 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 regular 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 thanks to several world records in cereal production especially, 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. 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 capacities.

The second factor to take into account for 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 (Regional Report, 2017) 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. That is six times higher than the proportion of the undernourished population in countries not affected by conflicts (4.6% on average). For example, the prevalence of undernourishment in Libya or 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 localised 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 security. Despite international food assistance, Syrian refugees are putting a strain on host communities in neighbouring countries (Lebanon & 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 fall dramatically due to a global increase in temperatures, prolonged periods of drought and extreme climate events. According to the World Bank report (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.

6.5 Responses and priorities for action

The status and trends of water and food security in the Mediterranean region depicted above show that there is an increasing risk among Mediterranean people and countries of depletion of resources (water, soil), degradation of resources 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;
- Agroecology and sustainable agriculture;
- Rural development and support to smallholder farming.

6.5.1 Integrated Water Resources Management

As presented throughout this chapter, water security entails issues of ecosystem and human health, tackles issues of water quantity and quality, and questions water governance arrangements. However, water security is not a ready-made operational concept yet. A first step in the introduction of this concept in its entirety 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). In line with this definition, integrated frameworks were developed to address water resources and demand relationships and their evolution under climatic and anthropogenic changes, and promote dynamic water resources and demands management. These modeling tools evaluate the hydro-climatic conditions of catchments in the first place and then water demands to finally assess water stress or water allocation rates under climatic 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. Sub-regional decision support systems were then developed like the models WEAP (Yates *et al*., 2005), REALM (Perera *et al*., 2005), Aquatool (Andreu *et al*., 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 sites relationships, dam operating systems or even local institutional instruments. They hence provide better insights on local water issues and on the effectiveness of adaptation policies or techniques. They are also useful to identify the most vulnerable regions to climatic and/or anthropogenic pressures as well as sectors and seasons during which water shortage might occur.

The development of integrated approaches on water resources reflects the spatial variety of pressures and availability. It also supports, at a local level, the consideration of which sustainable development strategy to adopt according to the geographical and anthropogenic specific issues of the area.

6.5.1.1 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 interventions and organizational systems intended to increase the technical, social, economic, environmental and institutional efficiency in the different sectors of water use (intra-sectoral efficiency) but also for a better allocation of water between different uses (inter-sectoral efficiency). This concept of WDM was developed in the 1990s in response to water supply development policies in the agricultural sector in particular.

It is based on the implementation of a combination of actions and tools (legislative, institutional, technical, economic, *etc.*) such as the reduction of leaks, the use of water-saving equipment, the establishment of progressive pricing of water, environmental taxes, quotas, water rights or payments for environmental services.

Economic valuation also suggests that WDM measures are often cost-effective and allow for a better allocation of scarce financial resources, when compared to, for example, dam construction, water transfers or desalination in areas facing problems of water scarcity. 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 tools for decision support.

Box 56 Examples of progress made toward 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 is no example on a very large scale in the Mediterranean, but it exists elsewhere. In Ethiopia, for example, in twenty years, the water table previously fallen at 30 m depth has been recovered to less than 3 meters. Poverty has been halved simply by better managing all vegetation, soil and water.

6.5.2 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 realised that in a traditional fragmented approach, attempting to achieve the security in one of these sectors without addressing trade-offs with the other two sectors will endanger their sustainability and security. Overall security can be achieved by creating intelligent synergies and fair trade-offs among them, while providing opportunities for innovation and learning to minimise 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, with a view to reconciling their interests and resolving 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 dialogue, governance improvements, mobilization of financing, replicable applications, collaboration and coordination.

In order to fully capture the benefits and synergies under a Nexus approach, the development and management choices in the water-energy-food sectors require enhanced integration at the knowledge, policy, legislative and institutional levels/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 in separate groups, with limited interaction.

However, 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 and the achievement of integration at the level of planning and implementation of actions, even though some ministries or sectoral institutions often have the 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 32 Mapping of Nexus-related Ministerial Competencies in the Mediterranean (Source: GWP-Med)

<table>
<tr><th>Country</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</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>National Water Authority</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 colspan="4">Ministry of Environment, Sustainable Development, and Climate Change</td><td>All</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 Urban Planning</td><td>Ministry of Energy and Natural Resources</td><td colspan="2">Ministry of Agriculture and Forest</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>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>
</table>

Libya	Ministry of Health & Environment	Ministry of Electricity & Renewable Energy	Ministry of Water Resources	Ministry of Agriculture, Animal and Marine Wealth	-
Tunisia	Ministry of Local Affairs and Environment	Ministry of Energy, Mines and renewable Energies	Ministry of Agriculture, Hydraulic Resources and Fisheries		Agriculture & Water
Algeria	Ministry of Environment and Renewable Energies	Ministry of Energy	Ministry of Water Resources	Ministry of Agriculture, Rural Development and Fishing	Environment & Energy (only regarding renewables)
Morocco	Ministry of Energy, Mines and Sustainable Development		Ministry of Public Works, Transportation, Logistics and Water	Ministry of Agriculture, Maritime fisheries, Rural Development, Water and Forests	Environment & Energy

Box 57 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, -www.medspring.eu) – aimed to contribute to the quality of the Euro-Mediterranean research area, with a special focus on bi-regional Euro-Mediterranean Scientific & Technological (S&T) cooperation, Research & Innovation (R&I), 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 frame 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/calls addressing the Nexus:

1. Integrating the Nexus concept in all relevant policies, laws and regulations by:

- Promoting participatory policy making 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, system-wide manner is challenging because of the still limited knowledge of 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.

Box 58 Chrichira case study - The principle of energy economy and recovery of energy lost in water pumping

CHRICHIRA in the Kairouan area, an example in the Water Energy Nexus in Tunisia, with SONEDE and United Nations ESCWA (Economic and Social Commission for Western Asia)

In all drinking water systems, much energy is spent for pumping, to raise water in water towers and reservoirs on a high point. 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 transmission system. For that purpose, SONEDE had devised a preliminary plan to optimize piping layout to improve system efficiency and install 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 proposal suggested by SONEDE from both the technical and financial perspectives and assist in the preparation of technical specifications to initiate the project tender. 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 center 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 transmission network of about 226 km of pipes of different diameters, allowing the production and transmission of nearly 1000 l/s (year 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 piped network.

Figure 161 Water pressure dissipation using a load breaker

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 3 years. Based on assessment outcomes, installing hydroelectric micro turbines in water transmission systems of favorable technical conditions may present a very promising energy resource within the context of the water-energy nexus. From the study conducted for the case of Chrichira, conclusions and general recommendations are to be drawn for other projects in drinking water networks:

- There is no unique solution, one must adapt to each context and each situation.
- First look for energy savings on pumping, by hunting for 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 of technical solution, followed by a thorough optimization in dialogue with the suppliers of the equipment, (eg. fixed flow, variable flow, or combination of two turbines or PaT).
- After having chosen a turbine or pump according to the data of the studied site (height of fall and flow), do not hesitate to **make a second phase of optimization** according to the available equipment (adaptation of the flow of water in exploitation to a specific pump, to aim the optimum of operation if it is possible).
- **In the choice of equipment, take into account the human dimension and corporate culture** (for the know-how in operation and maintenance, the needs in capacity building and training). For example, "pump as turbines" are well adapted to the case of SONEDE, which already manages a large number of pumps.

6.5.3 Agroecological transition and sustainable agriculture

Considering agriculture as a producer of various services – besides food production only – would facilitate the transition towards a more sustainable agriculture.

Target 2.4 calls for the development of sustainable food production systems and implementation of resilient agricultural practices that increase the 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 on the proportion of agricultural area under productive and sustainable agriculture, considering the three dimensions of sustainability - environmental, economic and social. Between 2006 and 2017, the number of organic farms has highly increased in Croatia, Egypt, France, Slovenia, Spain, Tunisia and Turkey (Figure 162). Better soil management would result in their enrichment in organic matter, through agroecology, irrigation and land protection.

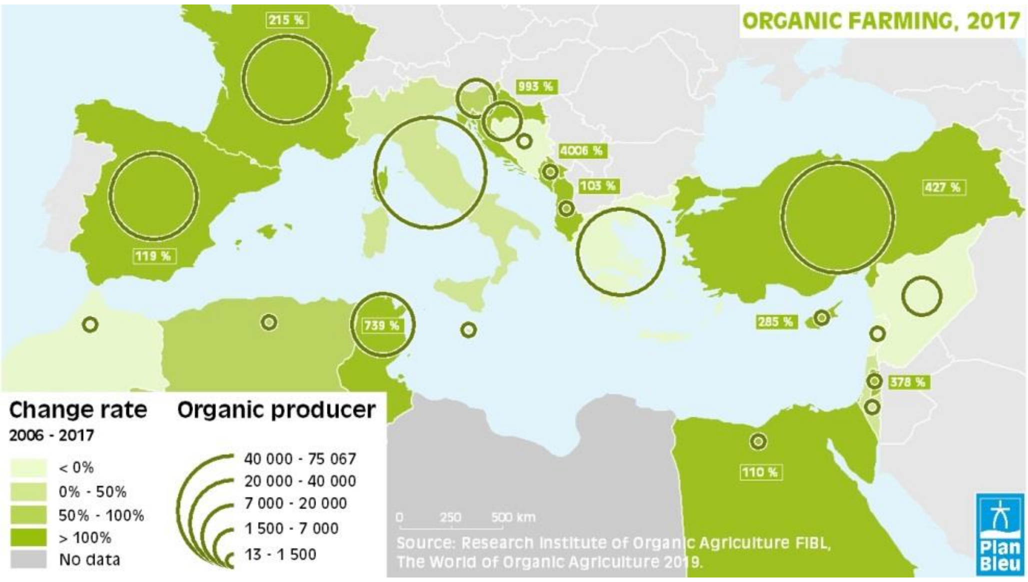

Figure 162 Change in the number of organic farms in the Mediterranean countries *[Figure to be revised]*

6.5.4 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, radicalisation and conflicts. Collective organisations (rural markets, farmer organisations, local value chains, infrastructure, distribution, new services) need to be developed with new initiatives from citizens.

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. Capitalising 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 preserving biodiversity and conserving 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 recognised, and improving agricultural practices and production can help improve the nutrition of family members, including children, the causal link is not currently systematically virtuous (Dury *et al.*, 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 organisations of women representing their double function of 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 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.**

6.5.5 Climate change adaptation

MENA countries have acceded to international conventions and created institutions dedicated to climate change management. Various measures have been planned/demonstrated in terms of water saving, such as construction of dams and hollows, adaptation of itineraries, introduction of new techniques, systems of production conversion, combating desertification and drought, basin management, diversification of activity in rural areas, management of forest areas and development of insurance against climate risk. Another proposed measure is to mobilize the civil society to contribute to environmental management. In priority 4 of its strategic orientations, 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 is also no system for monitoring or evaluating these measures.

At the regional level, research programs are functioning, but there is no sufficient exchange or 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 put at the service of 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.

Some recommendations can already be made:

- Structural reforms are needed to support family/smallholder farming,
- The gradual withdrawal of agriculture, or of certain crops, from the growing inadaptability to the bioclimatic environment should be organized,
- 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 locate non-agricultural activities in rural areas and / or to organize progress.
- Investment in human capital will provide a dignified living environment for rural populations.

Box 59 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 to act in the face of climate change.

Regarding the water sector, the challenge is fairly broadly shared and valid everywhere: 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 according to the territories and remains subject to uncertainties with which it is necessary to act.

Recommended solutions concern the efficiency in the use of available resources, the equitable share of water between users, converging towards more solidarity, the fight against waste or the development of more sober uses of water and thereby less vulnerable to hazards. The plans also call for preserving or restoring the proper functioning of aquatic, wetland or littoral 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 carried out, within the framework of Schémas Directeurs de la Gestion des Eaux (SDAGE), to recover the good status of water bodies and habitats. Climate change adds urgency or additional level of effort in their implementation. Given the generalized vulnerability of the territories for the availability of water, the question is no longer whether or not to act, but rather to identify where and on what priority issue to invest for carrying the effort. To scale up this effort, the Rhône-Méditerranée (2014) and Corsica (2018) adaptation basin 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 avoiding maladaptation.

From now on, the initiatives multiply to act locally on what makes the vulnerability of a territory or a sector of economic activity. The water managers specify the diagnosis in order to identify the different sectors, structures and natural environments that would be very vulnerable to the phenomena induced by climate change. This work may include, for example, drinking water supply schemes, irrigated agricultural sectors or remarkable natural environments. Thus, investment priorities are identified to act faster or stronger in the face of climate change.

6.5.6 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 are not always consistent. Data are lacking, at the level of coastal areas or coastal watershed that could often be the most relevant scale of analysis in the context of the Barcelona Convention.

Monitoring the impact of tourism on water resources is one of the key area of data gaps. Only cities are covered by monitoring systems on 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, flood and flood prevention, and coastal protection.

The major knowledge gaps highlighted throughout this chapter are:

- no recent data available at the hydrological basin/watershed/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 on the potential influence of climate change on crop yield including seafood production
- statistics and typologies on small-scale family farming, disaggregated by gender in particular to determine women's place in agriculture and their contribution

6.5.7 Priorities for actions (data based, according to current status and trends in regards to the policy objectives)

This review of water and food security components, including aspects of availability, demand, quality and stability of resources, lead to the definition of 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 services for all;
- upgrade non-conventional water sources 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 adapted training, job creation and innovation: to improve the attractiveness of agricultural work among young people, we can consider, in particular, (i) the strengthening of legislation relating to the protection of rights and social security (social protection against accidents at work, sick leave, settlement of disputes and payment of charges for retirement to ensure parity with labor laws prevailing in other sectors of activity), and ii) the institutional recognition of women's work in agriculture, which is sometimes not even enumerated. On the other hand, local collective actions for the creation of decent jobs, training adapted to the labor market, innovations and micro-enterprises dedicated to rural youth would make it possible to diversify the rural economy and enable them to become autonomous without resorting to exodus.

- support to 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 production and marketing (cooperatives, producer groups, etc.) with the aim of better control by producers of value chains, and ii) reinforced 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 the North and South of the Mediterranean.

7 Draft Chapter 7: Health and Environment

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Human-induced environmental degradation impacts not only ecosystems but also human health: the Mediterranean countries count more than 20 million life years lost annually due to ill-health, disability or death and more than 500,000 deaths from living or working in unhealthy environments in one year. The health burden is mainly due to air pollution but also to chemicals, workers' 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 in morbidity and mortality linked to heat waves, extreme events such as drought, storms and floods but also to increased transmission potential of vector-, water- and food-borne diseases. Integrated policies fostering the link between health and environment, including emergency preparedness, response and recovery plans, can be further elaborated, 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 concerns are an unavoidable subject of public health

It is generally recognized that the environment in which people live significantly affects their health. Most environmental policies and regulations are co-motivated by public health concerns, and human health impacts often represent a major part in economic valuation exercises 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 and industry in collaboration with the health sector and policy makers. Coordinated action will allow to give priority to the prevention of risks rather than to health-sector activities that cure the resulting illnesses.

The interactions between 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 both to the main environmental hazards and to deficiencies in access to health services. This is also recognized by the 2030 Agenda for Sustainable Development which calls for a new approach to health, environment and equity. In May 2019, the World Health Assembly endorsed the WHO 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.*"

Realizing the extent to which disease and early death can be prevented by acting on modifiable environmental conditions is a key lever for promoting healthy environments and encouraging the design and implementation of both public health and environmental strategies and interventions.

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 Global Health

Observatory). 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 Global Health Observatory). 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 a high variability between Mediterranean countries with Bosnia Herzegovina reaching 27 % and Monaco 8 %.

Figure 163 presents the different factors included and excluded in WHO's calculation of DALYs and deaths attributable to the environment.

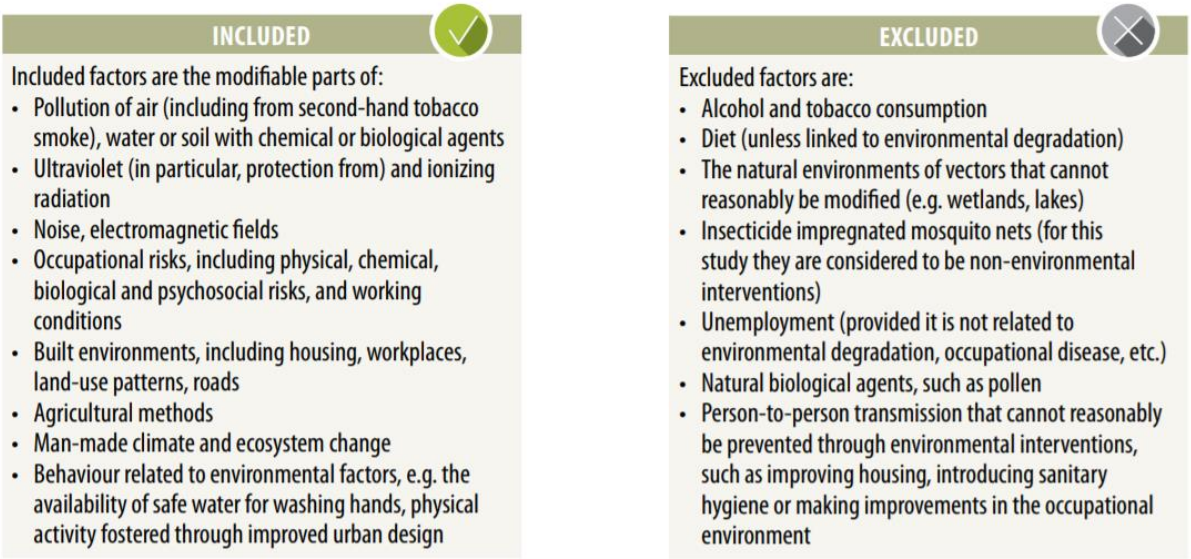

Figure 163 Summary of included and excluded factors in WHO calculation of burden of disease attributable to the environment (Source: WHO, 2016.2)

Age-standardized[155] deaths linked to preventable environmental conditions are twice as high in Southern and Eastern Mediterranean Countries (SEMCs) compared to European Mediterranean countries and three times as high in some non-EU Balkan countries and Egypt (see Figure 164).

[155] Age-standardization adjusts for differences in population age distribution.

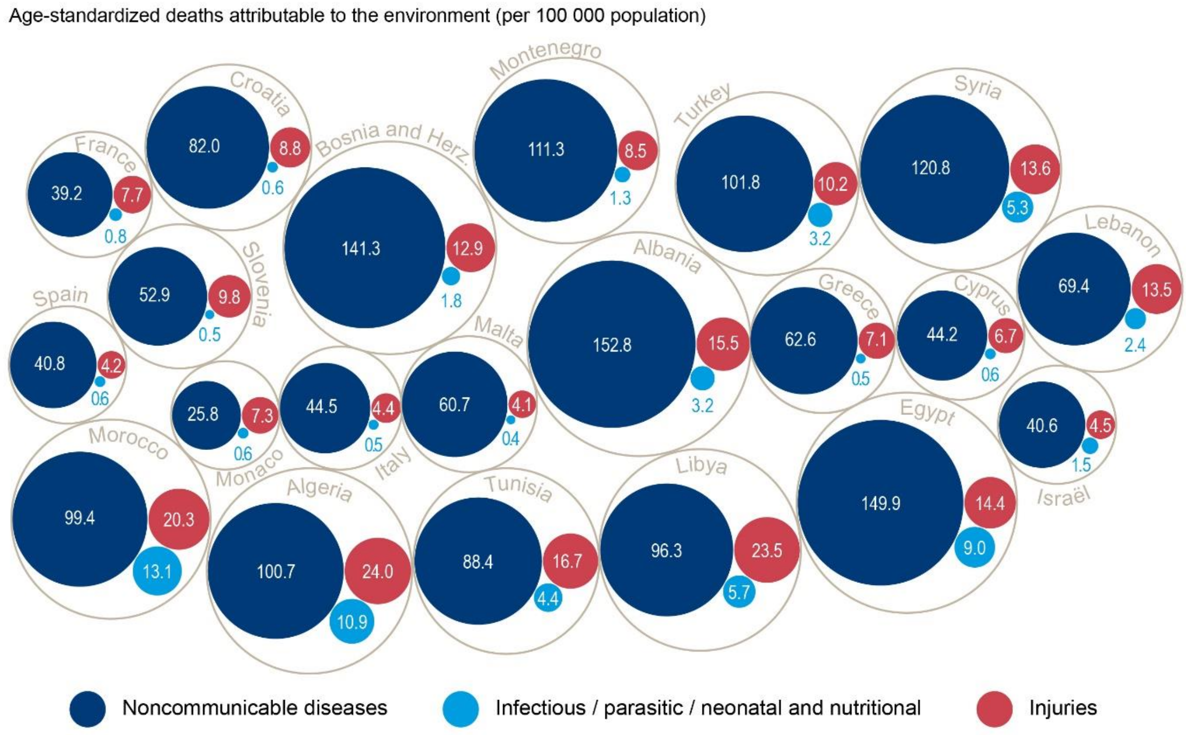

Figure 164 Age-standardized deaths attributable to the environment, per 100 000 population, in Mediterranean countries, 2012 (Source: WHO World Health Observatory)

With 84 % of all deaths attributable to modifiable environmental conditions, the large majority of these deaths is due to non-communicable diseases, in all Mediterranean countries where updated data are available, followed by injuries and infectious/ parasitic/ neonatal and nutritional diseases. Figure 3 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.

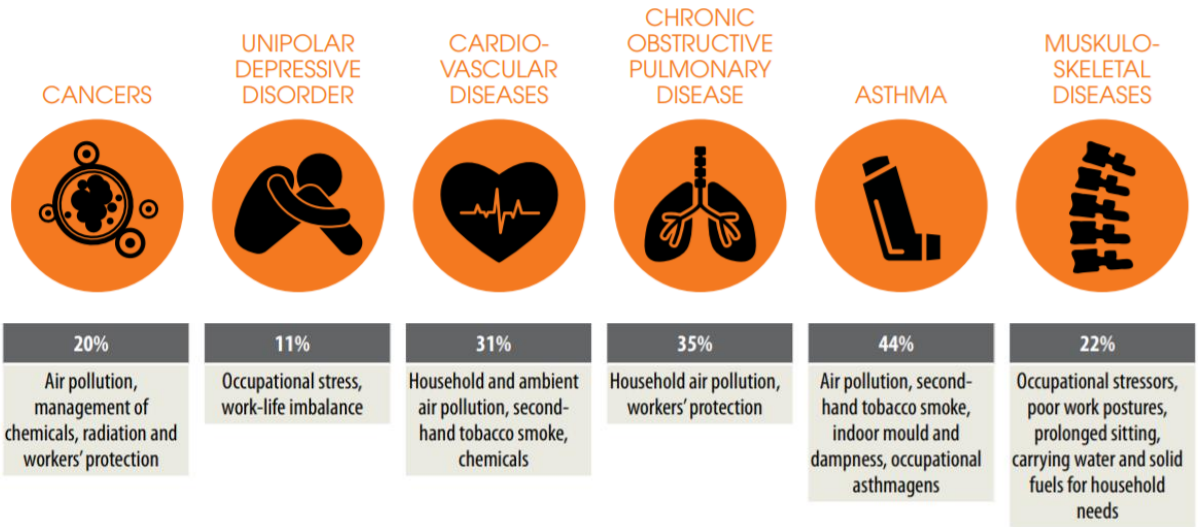

Figure 165 Non-communicable diseases with the highest preventable disease burden from environmental risks (Source: WHO, 2016.2)

Based on WHO-monitored data, analysis suggests that priority prevention opportunities for current health risks 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 neighboring inhabitants to air, water and soil pollution; chemical and drug residues in food; chemicals in consumer products including plastics), 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.

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, or heat stress, and so do natural and man-made disaster risks, as presented in the following sections.

7.2 Water and sanitation have remarkably improved but remain critical in a context of demographic growth

Inadequate sanitation, 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 (WHO, 2012). Mortality due to unsafe water, sanitation and hygiene is relatively low in Mediterranean countries, with the highest rate recorded in Syrian Arab Republic (3.7 deaths for 100,000 population[156], 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.

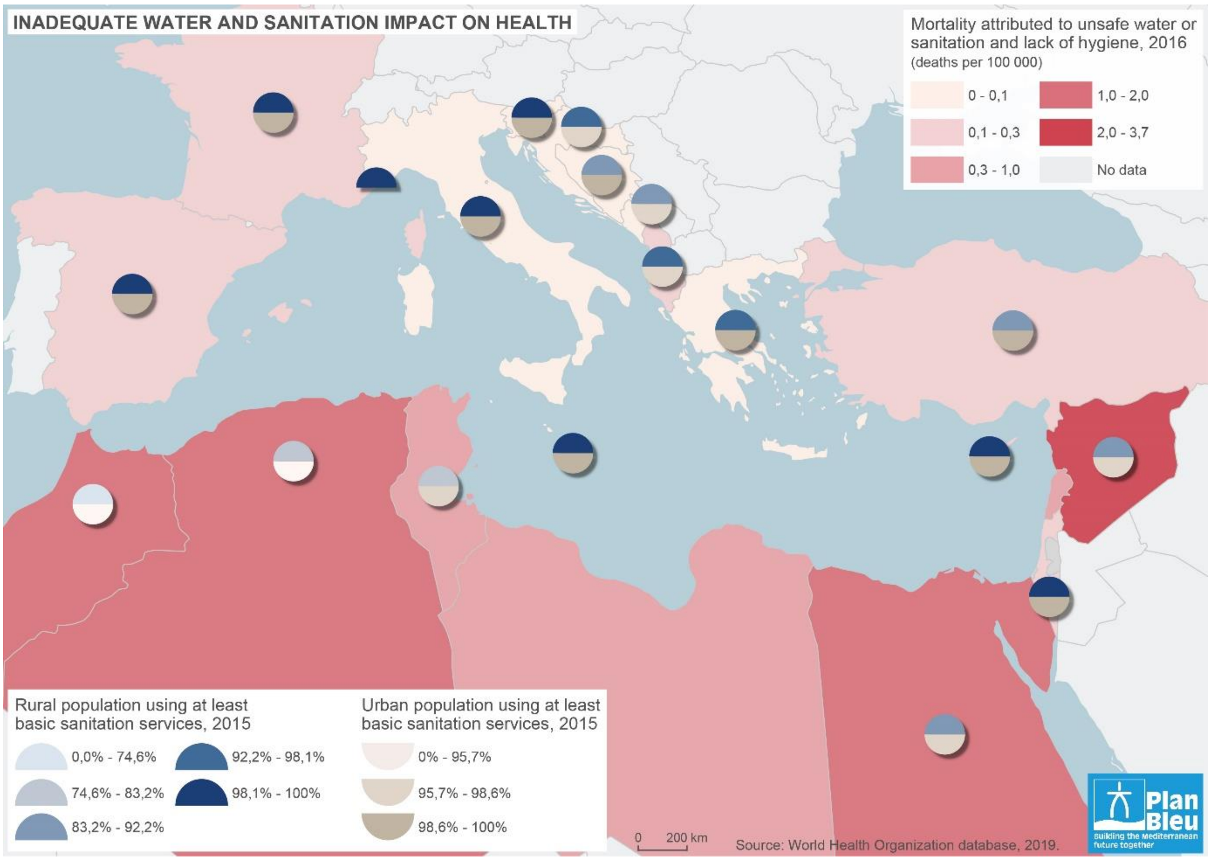

Figure 166 Impact of inadequate water and sanitation on health in Mediterranean countries, 2015-2016 (Source: WHO Global Health Observatory, 2019)

[156] This number may be significantly higher due to the fact that most WWTP are today out of service due to the ongoing conflict in the country.

More information about the Mediterranean situation with regard to access to water and sanitation can be found in chapter 6 “Food and water security”.

Box 60 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 (CFR: 0.9%). Cases have been reported from seven provinces (Wilayas). Of these, 83 have been confirmed as *Vibrio cholerae* serogroup O1 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 have 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.

7.3 Air quality is the main health concern associated to 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.

Pollutants with the strongest evidence for public health concern include particulate matter (PM), ozone (O3), nitrogen dioxide (NO_2) and sulfur dioxide (SO_2). Anthropogenic PM and NO_2 are directly related to fossil fuel combustion, causing respiratory and cardiovascular disease (among others), that can be related to premature deaths. In addition, high levels of noise can cause heart conditions and reduce cognitive function 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 micrometers), derived from transport, at 2.3 % of GDP in the MENA region and 7.4 % in Europe and Central Asia. Egypt, Libya, 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. NMCs generally show lower exposure levels, with between 25 % and 42 % of population exposed. The general trend in NMCs keeps 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 persons died prematurely in 2016 because of exposure to ambient air pollution. Estimates per country are summarized in Figure 167. As clearly reflected, the impact of air pollution on health is much higher in SEMCs than in Northern Mediterranean Countries (NMCs). Egypt is the country in the world with the highest death rate attributed to ambient air pollution (IHME).

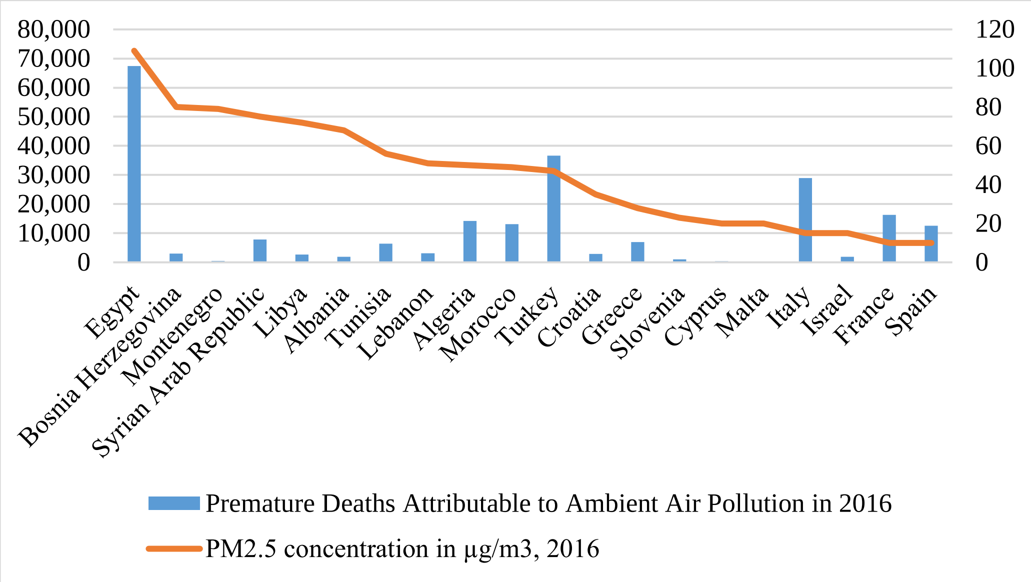

Figure 167 Premature deaths attributable to ambient air pollution in 2016 and ambient air pollution by PM2.5 microgram per cubic meter in Mediterranean countries, 2016 (Source: WHO database, 2019)

The levels of fine particulate matter to which people living in Mediterranean cities are exposed have increased in recent years, and everywhere exceed the recommended threshold values (WHO, 2016.1). Exposure to ozone is also a matter of concern, especially since the region has all the climatic characteristics favorable 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/m^3 on average daily and 100 µg/m^3 on average over 8 hours respectively. These figures, drawn up for a year considered to be rather "little polluted" 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.

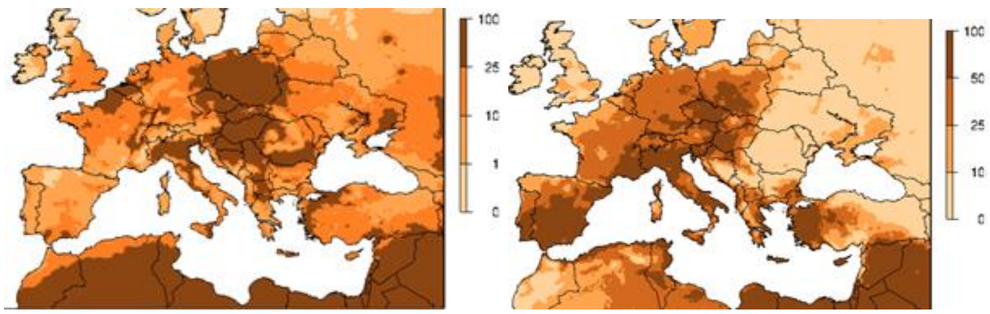

Figure 168 Left – Number of days when WHO recommended threshold of exposure to 25 µg/m^3 of particulate matter (PM2,5) was exceeded in 2016. Right - Number of days when WHO recommended threshold of exposure to ozone of 100 µg/m^3 was exceeded in 2016 (Source: Copernicus Atmosphere, European Commission, 2019)

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 of 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 varied vegetation in several countries, explain that the Mediterranean region is one of the most 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.

Air quality monitoring in the southern and eastern countries of the Mediterranean is lacking in comparison to other Mediterranean countries. Table 33 summarizes the number of urban areas that are reporting air quality data to the WHO databases. Accordingly, accuracy of assessments is linked to the number of monitoring stations.

Table 33 Number of urban areas reporting PM2.5 and PM10 per Mediterranean country (Source: WHO)

Country	Number of Urban Areas Reporting PM2.5	Number of Urban Areas Reporting PM10
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	7	7
Monaco		
Montenegro	1	10
Morocco	1	49
Slovenia	3	16
Spain	142	638
Syrian Arab Republic	0	0
Tunisia		4
Turkey	15	103

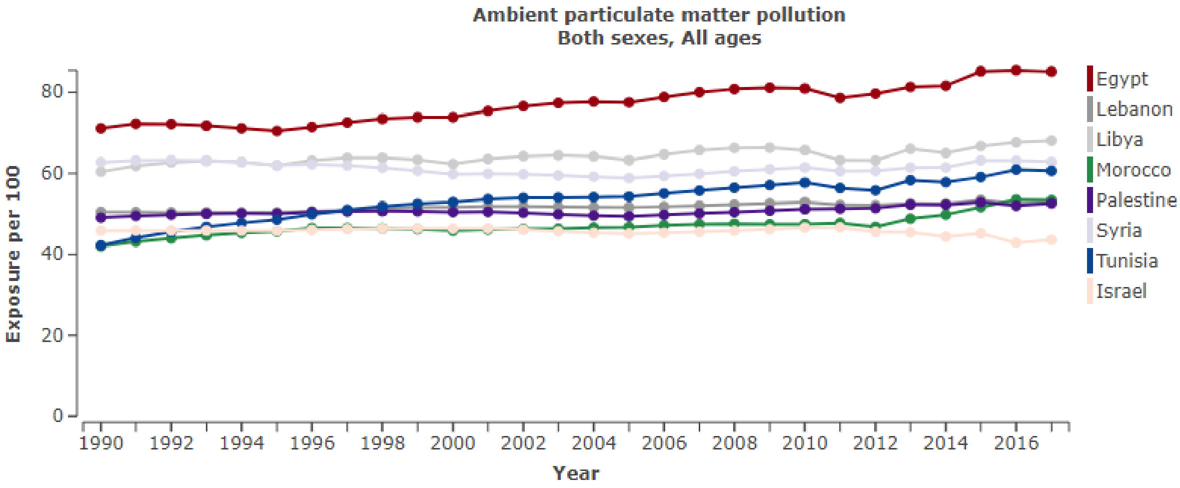

Figure 169 Exposure to ambient particulate matter PM2.5 pollution in SEMCs, in % of national population (Source: Institute for Health Metrics and Evaluation, 2018)

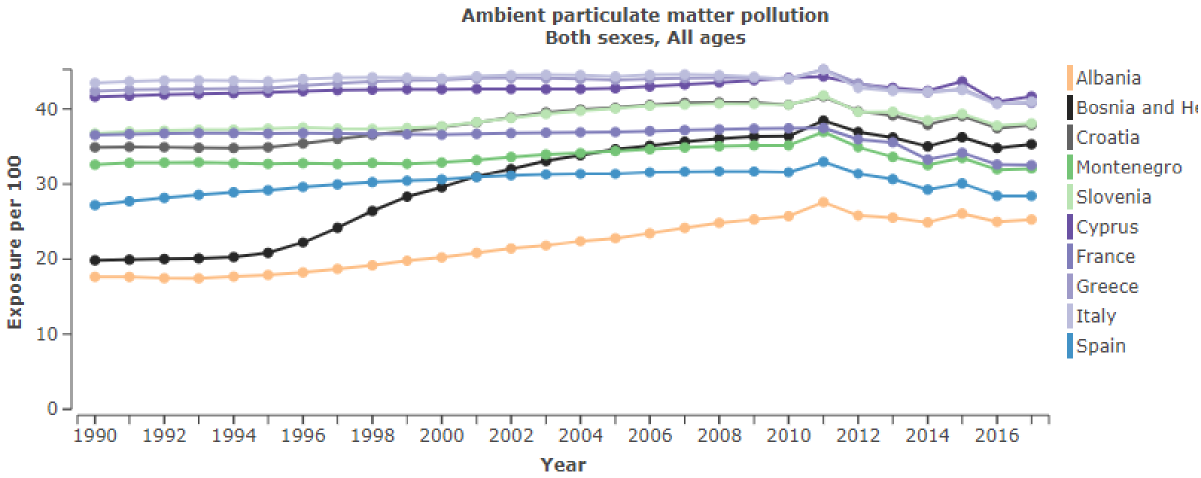

Figure 170 Ambient particulate matter PM2.5 pollution in NMCs (Source: Institute for Health Metrics and Evaluation, 2018)

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/m$^{3)}$, representing three times the regional average, with an even more extreme situation in the Cairo area, as indicated in Figure 172. In 2016, the Balkans (22 µg/m^3) are on average more exposed to particulate matter than EU countries (14.4 µg/m^3), with Bosnia Herzegovina being particularly affected (39 µg/m^3). Conversely, exposure to this type of pollution is below 15 µg/m^3 in Albania, France, Greece and Spain.

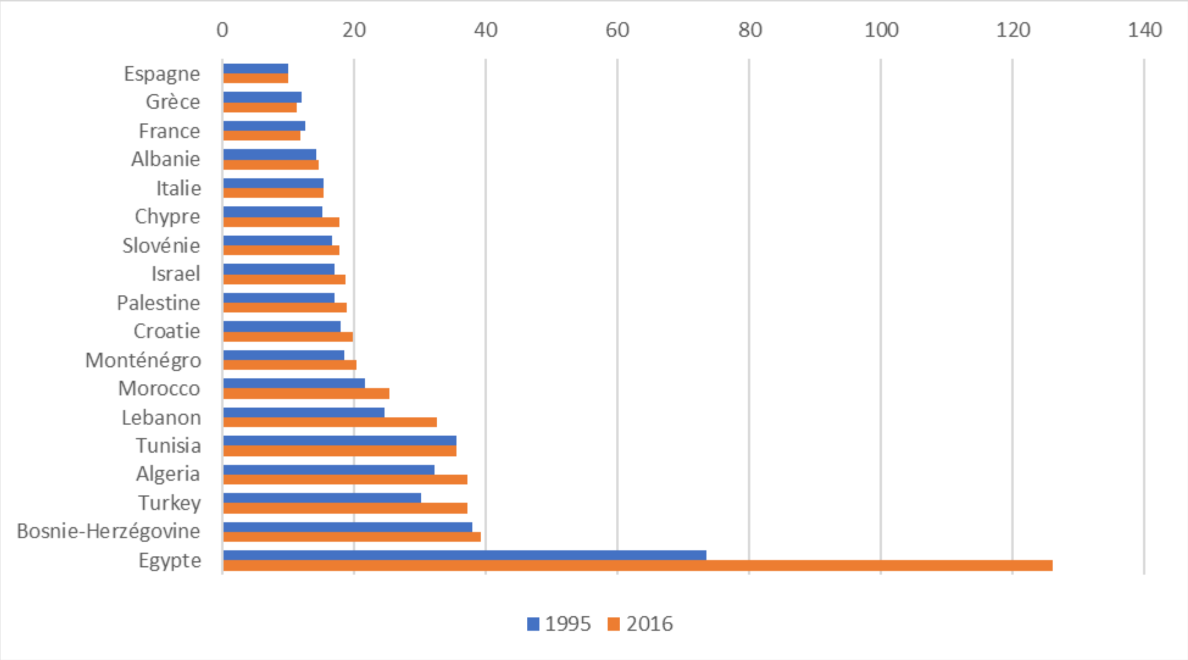

Figure 171 Annual average exposure to particulate matter (PM2.5), µg/m^3 (Source: WDI World Bank) [English graphic pending]

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 a potentially further degraded air quality.

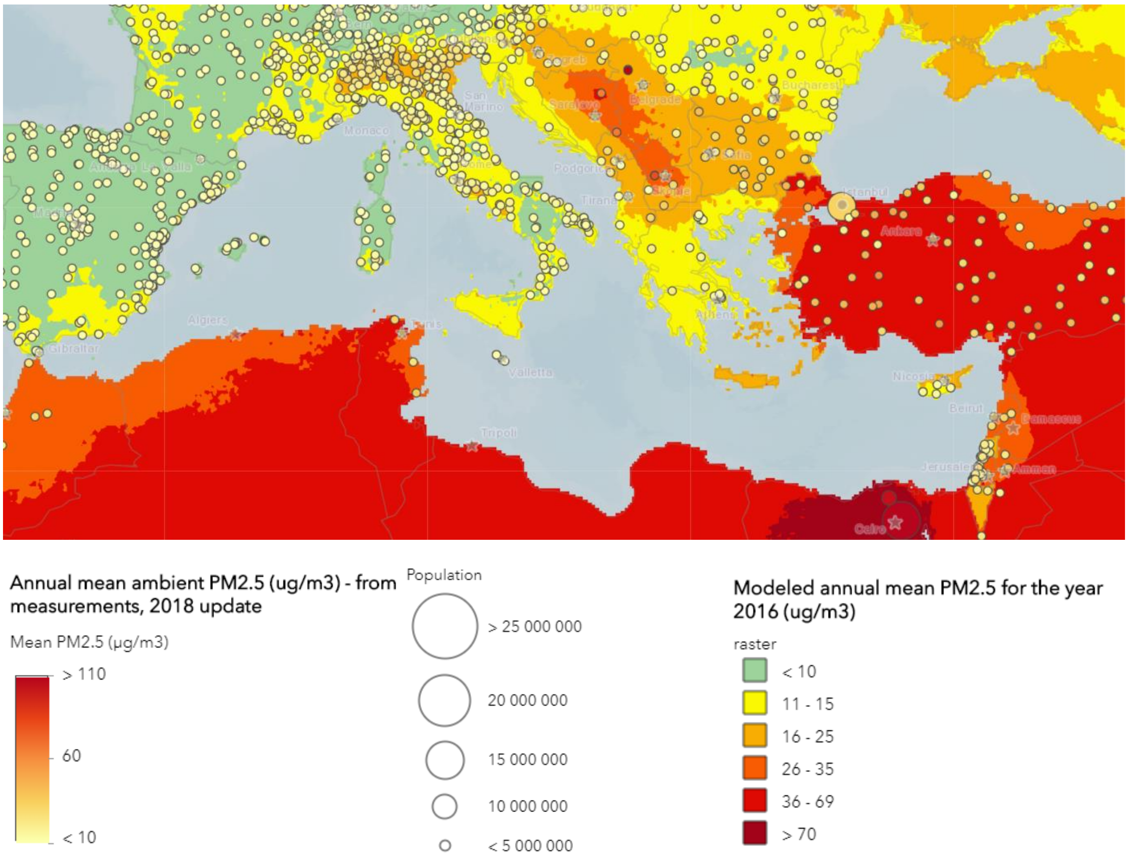

Figure 172 Air pollution in the Mediterranean region, 2018 (cities) and 2016 (country level) (Source: WHO Global Ambient Air Quality Database, 2019)

Box 61 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 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 & Lauer, 2008).

In response to this issue, IMO has established worldwide limitations for the maximum sulfur content of fuel oils (SOx and PM emissions being proportional to sulfur content in the fuel). These limits vary: inside the so-called Emission Control Areas (ECA), limits are more stringent than those applicable globally outside such areas. Mediterranean countries members of the EU have been subject, since January 2010, to a sulfur limit of 0.1% in fuels used by ships when at berth in EU ports.

On 1st January 2020, the maximum sulfur 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 sulfur oxides, particulate matter, and black carbon emitted by maritime transport operating across the globe.

Table 34 Global Sulphur Limits applicable to marine fuel

Outside an Emission Control Area	Inside an Emission Control Area
0.5% m/m* per mass starting 1st January 2020	0.1% m/m

*per mass.

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).

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 % sulfur content for marine fuel in the Mediterranean than the planned global sulfur cap of 0.5% from 2020 and the current level in the region of a maximum of 3.5 % sulfur, 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 the 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 2 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 - 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.

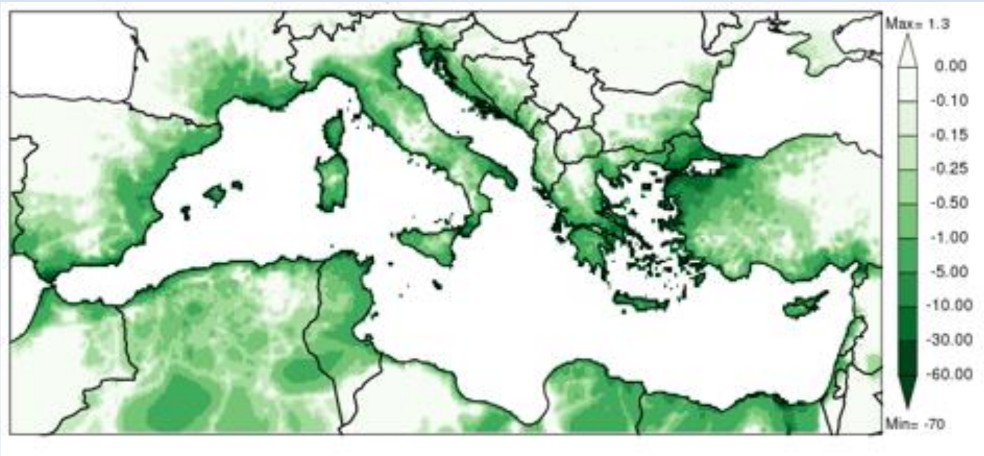

Figure 173 Relative difference (%) in concentrations of nitrogen dioxide in coastal areas between a scenario with ECA and the current situation

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 174). Preventing the generation of waste in the first place will also prevent the linked 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 are 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.

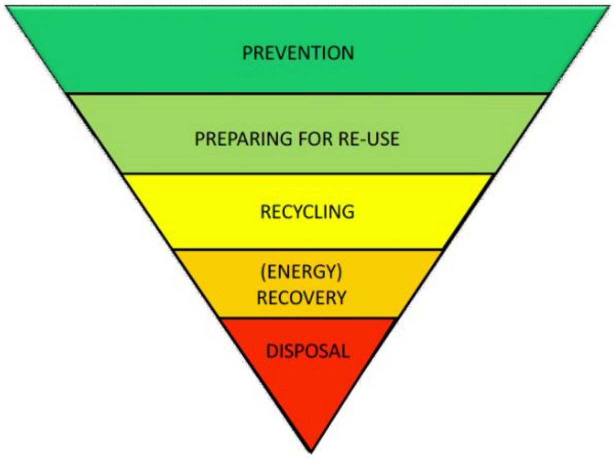

Figure 174: The waste hierarchy (Source: European Commission)

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 involves the population living in the vicinity of the plants, often more deprived than the average population and thus creating environmental health inequalities. Exposure also concerns persons 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 landfill which are the dominant treatment types of 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 contaminated water, soil or products. Uncontrolled and illegal landfills that receive waste without any selection at the origin are of highest concern. However, even controlled landfills have been reported to potentially generate health effects such as cancer and reproductive outcomes including an increase in risk of congenital anomalies.

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-1990's) show solid evidence for detectable risks of stomach, colon, liver and lung cancer. Some evidence was also found for an increased risk of congenital anomalies and associations between birth outcomes (preterm birth and spontaneous abortion) in relation to increased level of exposure to incinerators (WHO, 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 practices of urban and hazardous waste disposal 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 activities of waste collection, treatment and disposal, despite only anecdotal evidence, are identified to 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 concerned areas (WHO, 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 human health in exposed populations living in surrounding areas of disposal of such waste or being involved in its treatment. Whereas 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), behavioral alterations, as well as DNA damage and chromosomal aberrations in lymphocytes (WHO, 2015).

In addition to the mentioned health hazards, waste management practices also interfere with “soft” health issues linked to well-being, such as annoyance due to odor, 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 175). 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 heat waves (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 heat waves, 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 next decades will depend on the adaptive capacity of the Mediterranean population groups through acclimatization, adaptation of the urban environment to reduce heat-island effects, implementation of public education programs and health system preparedness (Smith et al. 2014). Increased population life expectancy implies that the health protection of elderly people will become a major challenge for all Mediterranean countries under heat wave conditions. Increased mortality was found among people over 65 years in Athens, Greece at high and very high temperatures (Paravantis et al. 2017). During the severe heat wave in France in summer 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).

Climatic change contributes to the transmission potential of vector-borne diseases since the life-cycle dynamics of the vector species, pathogenic organisms and the reservoir organisms are all sensitive to weather conditions. The rates of replication, development, and transmission of pathogens depend more strongly on temperature relative to other host-pathogen interactions. In recent years, several outbreaks of different vector-borne diseases have been documented in the Mediterranean region. There is high certainty that the recent observed climatic trends will contribute to the future transmission potential of vector-, food- and water-borne diseases in the region. Predicting the consequences of climate change for 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, that 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 (Vezzulli et al. 2012, Roiz et al. 2015). Floods also cause personal injuries, enteric infections, allergies and asthma, increase 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 provision 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), as well as 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 a modification in the geographic distribution range of some plant species, extension of the 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 et al. 2017), may deprive some population of drinking water, which may have serious health consequences.

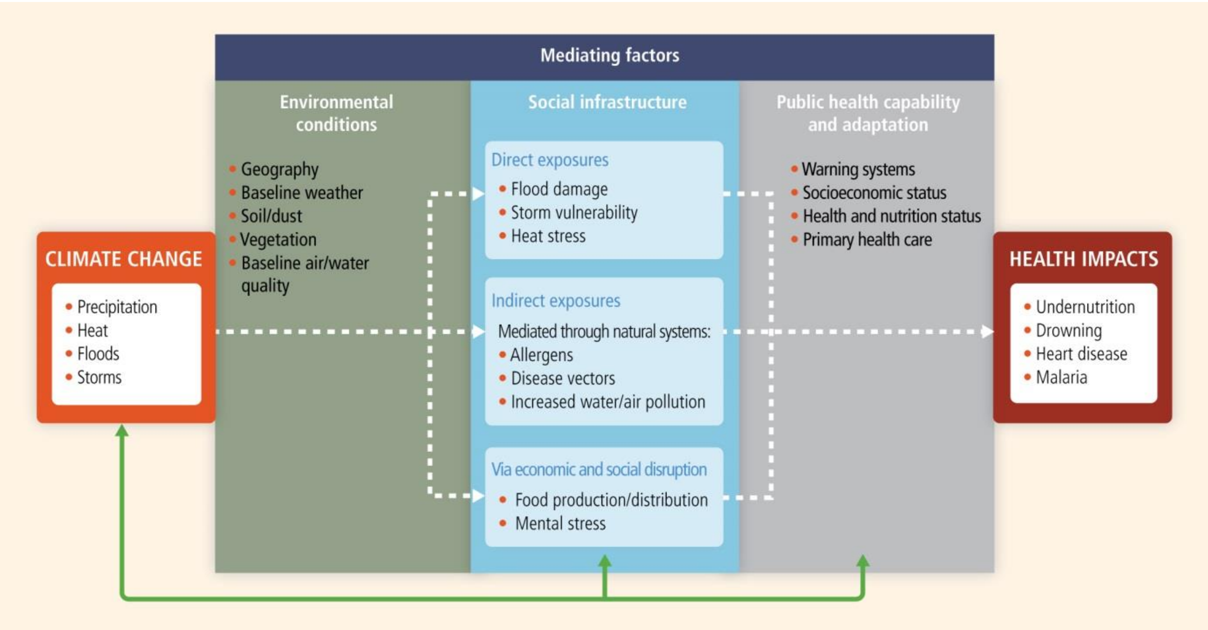

Figure 175 Conceptual diagram showing primary exposure pathways by which climate change affects health (Smith et al 2014).

Human health in the Mediterranean is much conditioned by societal trends and political situation. In some countries and regions, poor sanitary conditions increase a 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 people migrations, which influence 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, dam construction on large Mediterranean rivers, may enhance natural cycle transmission of infectious agents (Rodriguez-Arias et al. 2008, Roche et al. 2015).

7.6 Environmental health management in emergencies

7.6.1 Natural hazards

The Mediterranean basin is a zone of tectonic and volcanic activity as a result of 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 an earthquake of magnitude 7.4 struck the Kocaeli area in northwest Turkey generating a tsunami within the Sea of Marmara, with casualties of more than 13,000 people, more than 27,000 injured and over 54,000 buildings damaged (Ansal et al., 1999). The 28th December 1908 Messina, Italy earthquake with a magnitude of 7.1 is the most destructive 20th and 21st century earthquake in Europe, with a death toll of more than 80,000 people (Meschis et al, 2019). Figure x provides an overview of seismic hazards in the Mediterranean basin. Seismic risks concentrate 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 (Pescaresi et al., 2017).

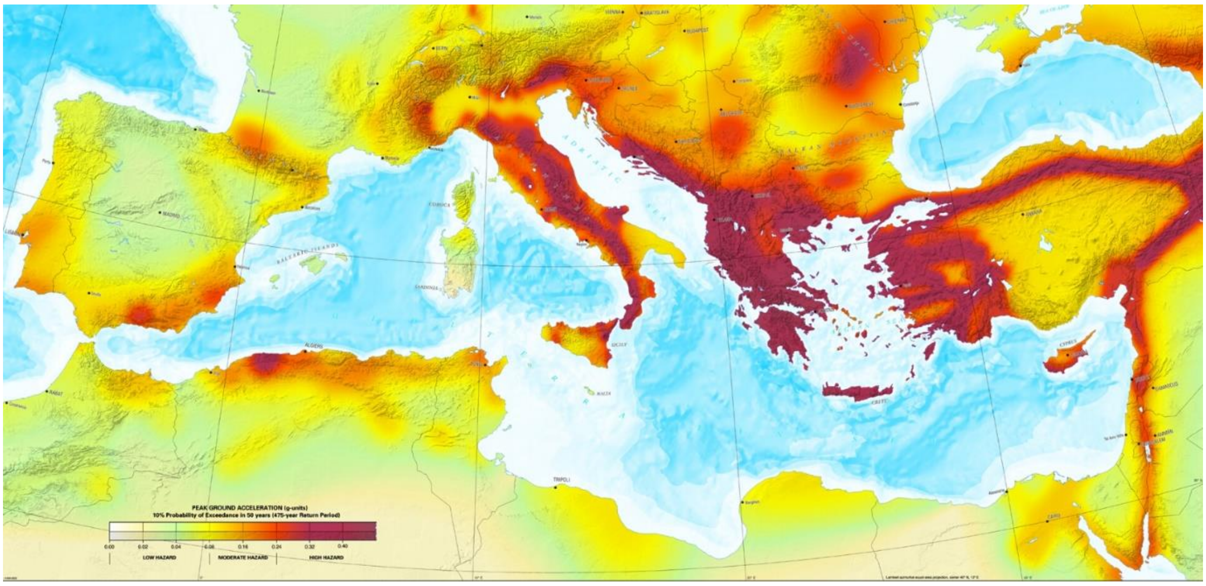

Figure 176 Seismic hazards in the Mediterranean basin (Source: European Seismological Commission, 2003)

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 (2.7 thousand square kilometers in 2015, with a significant increase over the 1975-2015 period) (Pescaresi et al., 2017).

The two principal mechanisms that generate tsunamis in the Mediterranean are earthquakes and submarine slides, although volcanic eruption and collapse could not be ignored as potential mechanisms as well. A recent study (Samaras et al., 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, the event of an earthquake in the eastern Hellenic Arc, which has a high seismic activity, is projected to leave around 10 to 80 minutes for a warning for Heraklion (Crete, Greece), 60 to 160 minutes of warning time for Athens (Greece), and between 65 and 130 minutes for Alexandria (Egypt), (Sorensen et al., 2012).

7.6.2 Man-made emergencies

In addition to natural disasters, man-made emergencies, conflicts, and disasters occur in the Mediterranean, including chemical or radiological incidents, and complex emergencies such as wars or civil disturbance. 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 et al., 2015):

- Targeting of industrial facilities and critical infrastructure: Damages of 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.
- Heavy damage to residential areas and exposure to hazardous building rubble: The pulverization of building materials containing cement dust, house-hold waste, medical waste, asbestos and other hazardous substances can pose 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 toxics 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 couple 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 man-made emergencies

Box 62 Early tsunami warning system

Natural hazards – volcano events, earthquakes and tsunamis – cannot be prevented nor accurately predicted. But 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 notable 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 man-made disasters, disaster risk management frameworks can be applied at international, national and local level. 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).

Box 63: 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.

An effective mainstreaming of environmental and ecosystem considerations into all phases of disaster risk reduction and management frameworks, including into humanitarian programmes, remains challenging. It has however a high potential to largely strengthen resilience and lead to improved outcomes for people and ecosystems.

7.7 Marine and coastal environment 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 (Depledge et al., 2013; Bowen et al., 2014; 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 the population and the goods and services provided by our seas and oceans (Depledge et al., 2013; Fleming et al. 2014). Such 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 wellbeing (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 (https://sophie2020.eu/) and some at a local or regional level such as the Oceans & Human Health Chair in Roses (www.oceanshealth.udg.edu). 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, or tsunamis, we 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 supplied 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). However, 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 quality 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 the benthic ones, 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, polychaetas, ascidians, mollusks and cnidarians (Uriz et al., 1991). Despite the human health benefits provided by the benthic species, these are impaired by a wide variety of human activities including bottom trawling, impacts related to recreational activities (e.g. anchoring) and other factors including microbial and chemical contamination and sea warming.

7.7.3 Provision of leisure opportunities

The Mediterranean coastal areas provide environments for practicing 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 snorkeling have been built upon the exploitation or contemplation of different marine species. The value of leisure in natural settings to humans is multiple and includes physical and psychological benefits (Gascon et al. 2017). New research about how recreational activities conducted in the nature can improve mental attention and other psychological aspects of health such as mood and stress levels are gaining significance (reviewed by Lloret, 2010). Pollutants such as heavy metals, dioxins and polychlorinated biphenyls (PCBs); and toxins from HABs, are affecting however the recreational use of coastal marine waters in the Mediterranean (LLoret, 2010).

Governance aspects related to 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 the health risks. There is a need to further address the interactions and the value of marine ecosystems for human health and wellbeing among researchers, policy makers, healthcare providers and public health practitioners, and the general public.

Box 64 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 have excellent or good quality in 2018. Over a three years period, comparing to 2015, the situation has generally remained relatively stable with some bathing sites improving and some deteriorating in quality. A notable exception is however Albania, where 40 % of bathing sites had poor quality in 2015 compared to only 20 % in 2018. Data in other Mediterranean countries is currently lacking.

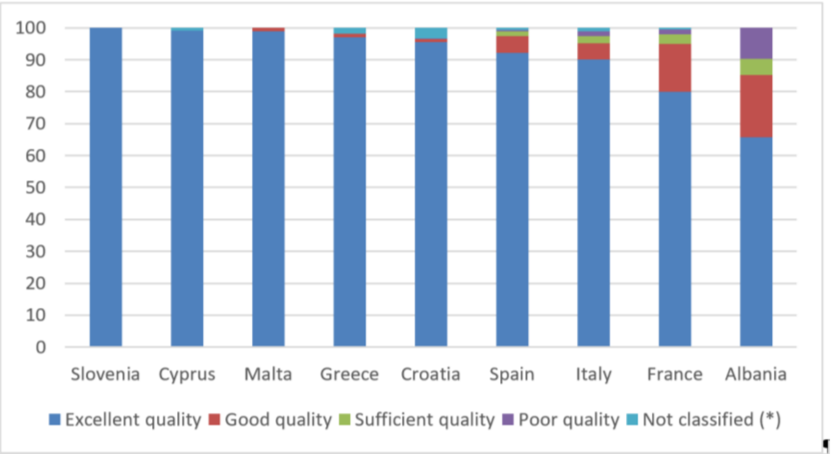

Figure 177 Coastal bathing water quality in 2018, including all maritime façades for multi-façade countries (Source: EEA, 2019)

Concreate measures, mainly the installation of sewage treatment plants to reduce, among others, the fecal pollution in coastal waters, has been a success in the Mediterranean Sea, with the support from UNEP/MAP. The last decade has seen an increase in domestic wastewater depuration in a number of countries, demonstrating the benefits of implementing the LBS protocol and other environmental measures to reduce pollution. Despite these positive developments, some few improvements are still to be made.

7.8 The medical sector impacts the environment

The previous sections have shown how environmental conditions impact human health. However, the environment-health nexus also includes interactions between the health sector itself and the environment. Health-care activities produce a magnitude of different kinds of waste: infectious waste contaminated for example 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 and 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 which 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 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 WWTPs are not specifically designed to remove pharmaceutical residues (Kümmerer et al., 2009). Reuse of treated domestic wastewater for irrigation contributed to pharmaceutical contamination in groundwater on Mallorca (Rodriguez-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 et al., 2012). Sweetwater 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 waterflows. 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 clinic and household waste. Landfill leachate on the island of Mallorca contained up to 27 000 ng/ l total concentration of pharmaceuticals (Rodriguez-Navas et al., 2013).

Data on the toxicity of pharmaceuticals regarding marine organisms is generally lacking. However, 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 et al., 2014). Pharmaceuticals are present in marine ecosystems as mixtures and combined with other contaminants which complicates the study of their effects, including on 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 65 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 the linked 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, chronic presence of subtherapeutic quantities in natural environments raises serious concerns about the development of antibiotic resistance in bacteria and of bacteria being able to degrade antibiotics (Grenni et al., 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 below lists nine priority areas of intervention aiming at improving human health via improving the state of the environment.

Figure 178 Nine priorities for action to improve human health by improving the environment (Source: WHO, 2016.2)

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 intersectoral 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) Sub-Regional Representation for Central Asia, and the World Health Organization (WHO) Regional Office for Europe, the "there is only one health" approach is promoted, calling 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 has been 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 » and those of emerging concern) exist in some places, but the Mediterranean is far from having complete comparable datasets about all relevant substances in all places, at regular coherent intervals. 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 endeavor and can involve many cases of disproportionate costs with regard to 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. Passing from a logic of pollution concentration to a logic of flows and impacts that take consideration of the long-term can help to yield more targeted decision-making.

8 Draft Chapter 8: Governance

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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 elaborated 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 rely 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, parliamentarian…). 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 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 evaluation 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 some notable exceptions

8.1.1 Global environmental agreements

Environmental governance became a global issue in the UN Conference on the Human Environment in 1972 (Stockholm Conference), which decided to create the United Nations Environment Programme (UNEP or UN Environment). To date, hundreds of Multilateral Environmental Agreements (MEAs) have been negotiated with the support of UN Environment.

Many of 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), Waste (Basel Convention), and noxious 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. 18 regional sea programmes (14 of which based on legally binding conventions) also support environmental governance in all oceans.

In addition, UN Environment 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[157]), protect coral reefs (e.g. The International Coral Reefs Initiative/ICRI[158]), develop marine protected areas (MPAs) and reduce marine litter.

Box 66 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, however, 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. 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.

Ratification of Multilateral Environmental Agreements (MEAs) is generally high throughout Mediterranean countries. The Convention on the protection of World Cultural and Natural Heritage, Basel Convention, Convention on Biological Diversity, Framework Convention on Climate Change (UNFCCC) and 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 CITES (on international trade of protected species), Bonn Convention on the Conservation of Migratory Species, AEWA (African-Eurasian Migratory Waterbird), ACCOBAMS (Cetaceans) and Stockholm Convention (persistent organic pollutants).

[157] 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. See: https://www.unenvironment.org/explore-topics/oceans-seas/what-we-do/addressing-land-based-pollution/governing-global-programme

[158] The International Coral Reef Initiative (ICRI) is an informal partnership among States, international organisations 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.

However, some conventions or their protocols remain under-ratified, with less than 50% of the Mediterranean countries having adopted them (Table 35). It is the case in particular of the Nagoya Protocol[159], Minamata Convention[160], Aarhus Convention[161] and Espoo Convention[162].

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 patters) and cannot be fully addressed by responses negotiated through environmental governance only.

Table 35 Ratification of Multilateral Environmental Agreements (MEAs) in Mediterranean countries (Source: United Nations Treaty Collection, accessed on February 13th, 2019)

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	*	*	*

[159] 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)

[160] Minamata Convention on Mercury (2017)

[161] 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.

[162] 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.

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		*	A A		AA		d			*				*			*	*		

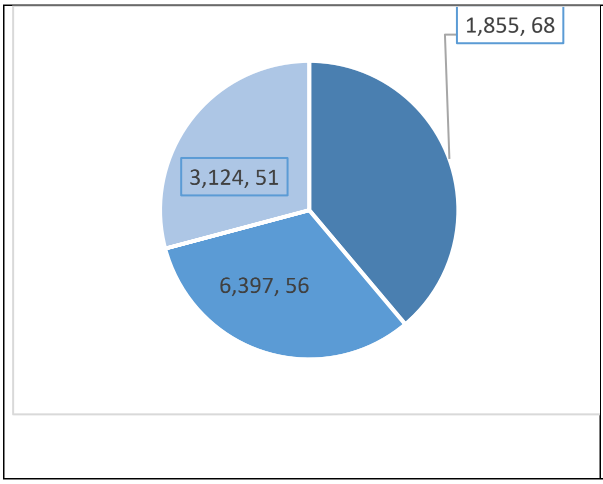
*Accession: the state accepts the offer or the opportunity to become a party to a treaty already negotiated and signed by other states.	
A - Acceptance	Ratification
AA - Approval	Signature
d - Succession	No signature

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 only have minor negative social and environmental impacts, or at least net positive social and environmental impacts. Environmental Impact Assessments (EIAs) constitute such a tool and take place at the project level. They are distinguished from Strategic Environmental Assessments (SEAs) which apply to development plans, programs and policies.

While all Mediterranean countries have adopted legislation requiring EIAs, around three quarters of Mediterranean countries also require SEAs by law. In absence of adopted legislation or while developing the latter, some Mediterranean countries have implemented pilot applications of SEA (Egypt, Morocco, Tunisia), as shown in Figure 179 below.

EIA implementation status, % of countries with EIA as a legal requirement, 2018	SE(S)A implementation status, % of countries per implementation status, 2018



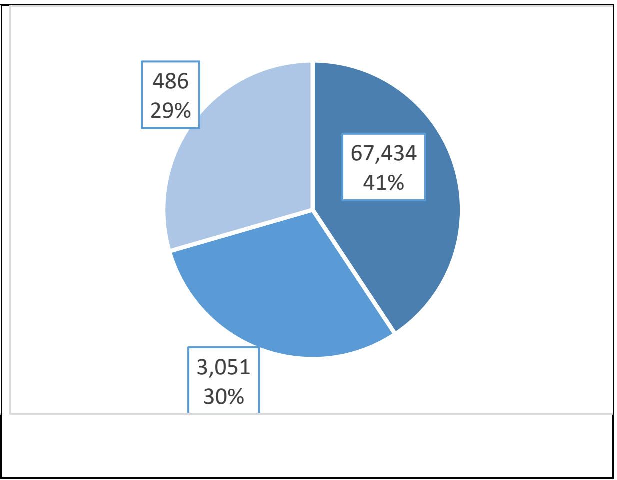


Figure 179 Implementation status of EIA and SEA in the Mediterranean, 2018

Table 36 Legal requirements for EIA and SEA in Mediterranean countries[163]

Country	EIA requirement	SEA requirement
Albania	Law No 10 440, dated July 7, 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-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 SEA.
Croatia	Environmental Protection Act, OG No. 82/94, 128/99. Ordinance on EIA, OG no. 59/2000, plus amendments in no. 136/2004 (replaced 1997 Decree) - define necessary steps in EIA process and transpose the EC EIA Directive	Implementation of SEA is set in the Regulation on Strategic Environmental Assessment of Strategies, Plans and Programmes on the Environment (Official Gazette, 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)	N.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 programs, 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	Decree n. 152/2006 (so-called Environmental Code) that transposed the SEA Directive, as

[163] Members of the European Union apply the rules of the 1985 and 2002 Environmental Assessment Directives or even more stringent regulation.

	the EIA by Law 349/1986	further amended and supplemented by Legislative Decree n. 4/2008 and by Legislative Decree n. 128/2010
Lebanon	Decree of 2012	Decree of 2012
Libya	Law No. 15 of 2003 awaiting implementation decrees	Not yet enacted
Malta	Legal notice 412 of 2017	Legislation 549.61 entitled Strategic Environmental Assessment Regulations (2005) under the parent act, Environmental Protection Act
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
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, Nos. 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.
Syria	Draft decree from 1995 and Syria environmental law n.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

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[xlvii]. This is the case for the Espoo Convention, the Kiev Protocol and the CBD of 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 programs, 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 its proposed projects and appropriate arrangements to ensure that the environmental consequences of its programs and policies are duly taken into account.

In the recent past, assessment and planning tools have been evolving to adopt more and more integrated approaches of assessment, drawing together biophysical and socio-economic aspects. In this sense, EIA and SEA increasingly include social and health impacts and change to Environmental and Social Impact Assessment (ESIA) and Strategic Environmental and Social Assessment (SESA).

There is currently no comprehensive assessment of 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 the uptake of the recommendations resulting from these assessments remain challenging but key to achieving transformative change.

8.1.3 Environmental measures in non-environmental agreements

Besides multi-lateral 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 **Fish Stocks Agreement** (FSA) (1995) also negotiated in the framework of the UN.

While UNCLOS is implemented mostly through national action, recent initiatives in the framework of the UN General Assembly are considering more coordinated approaches of the governance and of the 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 specialised areas, the **International Maritime Organization** (IMO) and **Food and Agriculture Organization** (FAO) work 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) of damage (Fund Convention), ship scraping (Hong Kong Convention), and dumping (London Convention and Protocol). The FAO, apart from following the implementation of the FSA, 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 (IPOA-IUU, 2001)[xlviii], 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 to date, but implementation and enforcement gaps remain

The UN Environment Regional Seas Programme (1974) inspired in 1976 the Barcelona Convention for the Protection of the Mediterranean Sea against Pollution (Barcelona Convention), that became in 1995 the Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean with a wider scope.

Box 67 The 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 Mediterranean Action Plan 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 Mediterranean Action Plan (MAP) as the institutional framework for cooperation in addressing common challenges of 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)[xlix]. Furthermore, the Convention for the Protection of the Mediterranean against Pollution (Barcelona Convention), adopted in 1976, was amended in 1995 as 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, Syria, Tunisia, Turkey and the European Union.

The 22 Contracting Parties to the Barcelona Convention (Box 67) decide on the 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 its 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 of the decisions and recommendations of the Contracting Parties. It ensures the good functioning of the MAP system, 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 and seven implementing components: MED POL Programme, under the Coordinating Unit, Athens; 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 help Parties to 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 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 taking into consideration equitable 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[l].

The Barcelona Convention urges Contracting Parties to adopt individually or jointly 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 (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 below shows the current status of ratification of the Barcelona Convention and its Protocols by the individual Contracting Parties. The 1995 Dumping Protocol is the only Protocol not yet into force out of seven Protocols. Three of the six Protocols in force are only 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), Offshore Protocol (8 ratifications) and Hazardous Waste Protocol (7 ratifications).

Table 37 Ratification of Barcelona Convention and Protocols by the individual Contracting Parties

Contracting Parties / *Legal instruments*	Albania	Algeria	Bosnia and Herzegovina	Croatia	Cyprus	European Union	Egypt	France	Greece	Israel	Italy	Lebanon	Libya	Malta	Monaco	Montenegro	Morocco	Slovenia	Spain	Syria	Tunisia	Turkey
Barcelona Convention	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
and Amendments	■	■		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Dumping Protocol	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■	■	■	■	■	■
and Amendments	▨			▨	▨	▨	▨	▨			▨			▨	▨		▨	▨	▨	▨	▨	▨
Emergency Protocol	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■	■	■	■	■	■
Prevention and Emergency Protocol		■		■	■	■		■	■	■	■	■		■	■	■	■	■	■	■		■
LBS Protocol	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
and Amendments	■			■	■	■		■	■	■	■			■	■	■	■	■	■	■	■	■
SPA Protocol	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■	■	■	■	■	■
SPA and Biodiversity Protocol	■	■		■	■	■	■	■			■			■	■	■	■	■	■	■	■	■
Offshore Protocol	■			■	■	■							■				■			■	■	
Hazardous Wastes Protocol	■													■		■	■			■	■	■
ICZM Protocol	■			■		■		■		■		■				■	■	■	■	■		

Instrument of ratification, adhesion approval or accession deposited and Convention or Protocol entered into force	■
No instrument of ratification, adhesion, approval or accession deposited	
Instrument of ratification, adhesion, approval or accession deposited but Protocol has not entered into force yet	▨

Under Article 26 of the Barcelona Convention, the Contracting Parties shall transmit reports on: (a) the legal, administrative and other measures taken by them for the implementation of the Barcelona Convention, its Protocols and the recommendations adopted by their meetings, and (b) the effectiveness of the measures so 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 launching 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).

Box 68 Main findings from national implementation reports of the Barcelona Convention, reported for 2016-2017 (Source: UNEP/MAP, 2019)

Based on the received national implementation reports 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 of notification, exchange of information and consultation among the concerned 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 the research on, access to and transfer of environmental sound technology, including clean production technologies. Also, less than half 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.

Dumping Protocol. The Protocol for the Prevention of Pollution of the Mediterranean Sea by Dumping from Ships and Aircraft, was adopted in 1976 and is 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 wastes or other matter. To that end, a "black- and grey-list" approach" is applied, under which the dumping of wastes or other matter listed in Annex I to the Protocol ("black list") is prohibited (Article 4), the dumping of wastes 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 wastes or other matter, the 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 wastes or other matter listed in Article 4.2 of the Protocol: dredged material, fish waste, vessels (until 31 December 2000), platforms and other man-made structures at sea, and inert, uncontaminated geological materials. Applications to the designated national authority to dump the listed wastes 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 wastes and other matter listed in the 1995 Protocol[li]. These Guidelines contain step-by-step procedures to evaluate wastes and other matter considered for sea disposal. The Mediterranean Pollution Assessment and Control Programme (MED POL) assists Contracting Parties in meeting their obligations under the Dumping Protocol[lii].

Box 69 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 in most reporting Contracting Parties, the prohibition of dumping of wastes or other matter, as well as the establishment of the required permitting system are in place and in 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 location and method. 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.

Prevention and Emergency Protocol. The Protocol Concerning Cooperation in Combating Pollution of the Mediterranean Sea by Oil and other Harmful Substances in Case 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 is 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 noxious substances pollution incidents. Contracting Parties to the Prevention and Emergency Protocol are required to have contingency plans, either nationally or in co-operation with other countries, backstopped 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 request to ensure adequate port reception facilities (Article 14) and the obligation to define national, regional or sub-regional 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)[liii]. This comprehensive Strategy is complemented by other measures addressing specific issues under the Protocol[liv]. 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[lv].

Box 70 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 highlight 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 noxious substances (HNS) have been adopted in nearly all reporting Contracting Parties. Reporting procedures to ensure that those required (e.g. ships, aircrafts, 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 in 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 in many reporting Contracting Parties. Port reception facilities are available and meeting the needs of ships, including pleasure crafts, in nearly all reporting Contracting Parties. Many reporting Contracting Parties have assessed and taken measures to reduce the environmental risks, including via Vessels Traffic Systems (VTS), and the designation and management of Particularly Sensitive Sea Areas (PSSAs). In most reporting Contracting Parties measures dealing with places of refuge for ships in distress have been adopted. Responses strategies for marine pollution incidents are in place in many reporting Contracting Parties. National contingency plans cover both oil and HNS in half of the reporting Contracting Parties. The Prevention and Emergency Protocol's requirements in terms of dissemination and exchange of information have been generally achieved and should be further promoted.

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 is 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 by from land-based sources and activities, by the reduction and phasing out of 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 sea-water uses (Annex II). Regional Action Plans and National Action Plans, containing specific measures and timetables, have been developed to implement the LBS Protocol[lvi]. Among them, the Regional Plan on Marine Litter Management in the Mediterranean stands out. It is a legally binding instrument pioneer 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% of beach litter by 2024[lvii]. The Mediterranean Pollution Assessment and Control Programme (MED POL) assists Contracting Parties in meeting their obligations under the LBS Protocol.

Box 71 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 Land-based Sources (LBS) pollution and phase-out Persistent Organic Pollutants (POPs), as well as environmental monitoring programmes including effectiveness evaluation of measures under the Protocol are reported to be in place in most of the reporting Contracting Parties. Findings however highlight ongoing difficulties in data collection and the need for capacity building.

In 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 in place a system of inspection 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.

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, Annexes 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 abreast with the evolving status of species. Regional Action Plans with specific actions to take 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[lviii]. The Specially Protected Areas Regional Activity Centre (SPA/RAC) assists Contracting Parties in meeting their obligations under the SPA/BD Protocol[lix].

Box 72 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, taking 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 the **effectiveness of management** of SPAs, 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.

Offshore Protocol. The Protocol for the Protection of the Mediterranean Sea against Pollution Resulting from the Exploration and Exploitation of the Continental Shelf and the Seabed and its Subsoil, the Offshore Protocol for short, was adopted in 1994 and is 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[lx]. The Protocol provides for the Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea (REMPEC) to play an important coordinating role.

Box 73 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 offshore activities are subject to prior authorization as required by the Offshore Protocol in all reporting Contracting Parties. In 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 requested by Article 9 of the Offshore Protocol. Legal and regulatory measures are reported to be in place in 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**.

Hazardous Waste 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 is in forced since 2008.

The overall objective of the Hazardous Waste Protocol is to protect human health and the marine environment against the adverse effect of hazardous wastes. The provisions of the Protocol address the following principal aims: (1) the reduction and, where possible, the elimination of hazardous wastes generation (Article 5), (2) the reduction of the amount of hazardous wastes subject to transboundary movement (Article 5), and (3) a regulatory system applying to cases where transboundary movements are permissible (Articles 6 and 9). The Mediterranean Pollution Assessment and Control Programme (MED POL) assists Contracting Parties in meeting their obligations under the Hazardous Wastes Protocol.

Box 74 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 highlight that all reporting Contracting Parties indicated having adopted measures to reduce to a minimum and possibly eliminate the amount of hazardous wastes 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 Wates

Protocol in cases of transboundary movement of hazardous wastes is reported to be in place in all reporting Contracting Parties. Restrictions on the export and import of hazardous wastes are indicated to be in place in 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.

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 at ensuring the sustainable use of the coastal zone (Article 8) to 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)[lxi]. The Priority Actions Programme Regional Activity Centre (PAP/RAC) assists Contracting Parties in meeting their obligations under the ICZM Protocol[lxii].

Box 75 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. Legal measures for controlling urban development along the coastline are defined in all reporting Contracting Parties, but the **enforcement and control** of the application of these measures, in particular the 100-meter setback zone, remain a challenge.

In line with 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. However, 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 in 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 a 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 the resilience and adaptive capacity, first of all to sea level rise. The establishment of the 100-meter setback zone is considered as extremely useful.

Awareness raising, education, training and international cooperation are deemed crucial for making progress. The cooperation established via the preparation of the Common Regional Framework for ICZM is recognised as important and further support is deemed crucial, especially with regard to **Marine Spatial Planning** (MSP) and **adaptation to climate change**.

8.3 Other regional cooperation mechanisms, including stakeholders networks, call for strong synergies and collaborations

8.3.1 Institutional cooperations

Various UN entities and other IGOs are active in the field of Mediterranean environmental protection. The MAP-Barcelona Convention system cooperates with several of them. To this end, 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 organisation 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 socio-economic reform and modernisation on the basis of equality and mutual respect for each other's" (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 North, South, and East Mediterranean countries. The scope of this governance framework includes a 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 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.[164] The adoption of an ecosystem-based approach for fisheries by FAO has prompted cooperation between RSPs and RFMOs in various parts of the world, the Mediterranean being one of them. A Memorandum of Understanding (MoU) has been signed in 2012 between MAP and GFCM that 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 wholly 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) that aims to achieve or maintain the Good Environmental Status (GES) in all areas under sovereignty and jurisdiction of EU MSs, the Maritime Spatial Planning Directive, and many other directives directly or indirectly aimed to 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 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 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 environmental impact assessments (EIAs) in certain circumstances involving transboundary activities.

Bilateral or multilateral cooperation, for instance **Union of Arab Maghreb** (UAM) or **League of Arab States** (LAS), support growing cooperation in the broader region on issues linked to sustainable development and environment.

[164] The ICCAT is also responsible for managing tuna in the Mediterranean.

At 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 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) that is one of the 15 regional initiatives recognized under the Ramsar Convention.

Three of the five **UN Regional Economic Commissions** are covering Mediterranean countries, i.e. UN Economic Commission for Africa (ECA), UN Economic Commission for Europe (ECE), and UN Economic and Social Commission for Western Asia (ESCWA). Those convene regional fora for Sustainable Development, supporting peer learning processes and the implementation of the 2030 Agenda/SDGs. They are also undertaking 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.

In addition to regional or subregional cooperations, **national initiatives** multiply, with several coastal States working on the preparation of a national maritime policy including 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 of progress towards stronger integration of national policies and regulations. Such 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 marine environment and management of marine resources.

Box 76 Addressing pollution from ships through regulations and collaborations

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 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 coherency between international and regional levels, the Barcelona Convention Regional Activity Centre dealing with the prevention of pollution from ships REMPEC is hosted by IMO.

8.3.2 Stakeholders mobilisation

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 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 as relevant at all stages of the policy-making and implementation are particularly crucial, because the current situation requires systemic changes of behavior 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 and action. In particular women who 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[lxiii]. 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 trends today and tomorrow.

Since Rio 1992 and the 2015 Paris Agreement, stakeholder mobilization on sustainable development goals has bloomed, with the emergence of numerous stakeholder networks and governance fora. In the Mediterranean, networks often gather stakeholders of similar profile, and governance fora often focus on a specialized theme. Interrelations between different types of stakeholders and across governance fora are generally limited in time and dependent on externally funded projects. Few exceptions include the Egyptian Sustainable Development Forum at national level, *Parlement de la Mer* in the French Region of Occitanie at the local level, and - at the regional level - the Mediterranean Commission for Sustainable Development, which has recommended to create a Mediterranean Forum on Sustainable Development. Efforts are required to develop long-term or permanent interlinkages.

Since its inception 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 relations with civil society organizations by granting them Observer and Partner status, thus encouraging their participation in MAP meetings and activities, while 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 procedure for admission as MAP Partners of the international, national, and local civil society organizations/NGOs.

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 apply 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 for Education for Sustainable Development (MSESD) and its Action Plan[lxiv], 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 national level[lxv]. Being a Party to the Aarhus Convention significantly contributes to country's efforts to promote citizen-centred and environmentally sound policies.12 of the 22 Contracting Parties to the Barcelona Convention are Parties to the Aarhus Convention (Table 35). The Aarhus Convention is open for accession by any UN Member State[165]. The familiarization with and possible accession to the Aarhus Convention requires first and foremost a strong political will from the governments to fulfil the commitments concerning access to information, public participation and access to justice in environmental matters.

[165] For States which are not Members of UNECE accession requires an approval by the Aarhus Convention's Meeting of the Parties. In recent years, Parties to the Aarhus Convention have made clear their strong encouragement for countries outside the UNECE region to join.

8.3.3 Multi-level governance, local governments

Multi-level governance involves planning and management at the local level as a coherent scale at which natural resources management and more generally sustainable development can be implemented.

In 2014, different levels of local planning could be distinguished in Mediterranean countries:

- Countries having institutionalized local planning in their governance of planning and funding (Europe, Albania, …)
- Countries having institutionalized local planning in their planning governance but without projects, being entirely funded by public funding sources (Morocco);
- Countries which have tested local planning via sectoral approaches or specific agenda funded by the concerned sector and external budget (Tunisia prior to 2014);
- Countries testing local planning via an international project or program via a technical Ministry (Algeria);
- Countries testing local planning via international funding without direct involvement of the public sector (Lebanon);
- Countries in which the centralized governance system does not currently allow for this type of planning (Egypt, Libya).

Table 38 Local planning types in SEMCs, [date to be confirmed] (Source: updated based on Chazée et al, 2017)

Country	Type of planning	State of local planning process
Algeria	Sectoral-community level- special funds	Local planning at test level
Egypt	Sectoral	No local planning, few projects
Lebanon	Sectoral-local	Local planning being implemented via projects
Libya	Sectoral	No
Morocco	Sectoral-community level- special funds	Institutionnalization of local planning ongoing
Tunisia	Sectoral- spatial-regional- special funds	Decentralization process ongoing
Turkey	Sectoral local-special funds	Projects ; Regional agencies established
Syria	Sectoral	Under discussion

Institutionalization of local planning at the national level is important because it is a condition for sustainable financial flows of national budget. In fact, as long as local planning is not institutionalized at the state level, its implementation is not factored in in the national budget system. As a result, its funding needs to stem from a sector or international and bilateral donors.

Empowering local authorities, as relevant, is a condition for successful local planning and management for change towards sustainability. Another important factor is the way the environmental dimension is taken into account in local planning processes.

Many sustainable development strategies and commitments are designed and adopted at the national or international level, but it is at the local scale that concrete action for conservation and management of natural resources for human wellbeing 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. Coordination between local administrations and central and decentralized sectoral technical services, as appropriate, requires further capacity building and implementation support to become more fluid and effective. At this stage, a gap often remains between the ambition of international agreements and their implementation at the local level.

Box 77 Environmental action in local development plans in Algeria, Lebanon and Morocco

A recent study focusing on local planning in Algeria, Lebanon and Morocco (Chazée et al., 2017) shows that local planning actions with a focus on environmental issues or having a positive impact on the environment represent between 15 % and 23 % of all local planning initiatives contained in local development plans. If including projects with potential positive impacts on the environment, these shares amount to 51 % in Algeria and 30 % in Lebanon. Most of these local planning actions concern water management (Algeria, Lebanon, Morocco), others address soil management (Algeria), or quality of life (Morocco).

In addition to this partial consideration of environmental issues in the studied local development plans, the study revealed that the **local operators in charge of local planning generally have a limited knowledge of environmental stakes, processes and concepts** (such as the DPSIR framework), **as well as of international environmental agreements** and linked national strategies, plans and commitments.

With observed and projected environmental and climate changes, local resilience and local risk management have become more challenging than ever. The exposure to environmental and climate risk, the resilience and the adaptive capacity of local communities vary largely around the Mediterranean basin. Therefore, local planning approaches are best tailored to reflect these specificities by integrating locally held knowledge about specific local contexts. Increasing resilience can 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 eco-tourism sectors, creating jobs and diversifying the economy, can be further strengthened and supported. The value chain approach promotes the participation of local producers which individually are "vulnerable", to group and act collectively to overcome market barriers and increase revenue. The local value chain approach can also help identify opportunities towards a more circular economy.

8.3.4 Towards strengthened cooperations

From the analysis of the evolutions of global and regional governance in the last years, some trends are emerging and call for evolution of the environmental governance in the Mediterranean region. There is a clear trend to the multiplication of governance fora in the Mediterranean, at all scales, many of them aiming at supporting 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 MAP – Barcelona Convention system, despite its many positive outcomes, can succeed in achieving its environmental objectives only by addressing at the same time 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 therefore seems that *integration* should be further developed to bring more consistency into regional/Mediterranean environmental governance and efficiently mobilize it towards achieving SDGs in the region. It should be considered along several axes, including:

- *Integration of regional governance*, establishing stronger links between all relevant regional frameworks, particularly the MAP 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 local/municipal level;
- *Land-sea integration*, through better taking into account land-sea interactions and related governance issues.

Such an evolution should be in line with the trend observed at global level to move from fragmented governance of maritime affairs towards a more inclusive governance of sustainable development, fully considering protection of marine environment and natural heritage as a primary policy objective.

8.4 Agenda 2030 and SDGs renewed the recognition of the transversal 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 an 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 socio-economic 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. Indeed, 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 regard 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 sub-regional 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 the multi-stakeholder advisory body, to assist the Contracting Parties to the Barcelona convention in their efforts to integrate environmental issues in their 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 on Sustainable Development (MSSD), which was adopted by the Contracting Parties in 2005 and 2016.

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, sub-regional, national and local levels.

Box 78 The Regional/Mediterranean Dimension as a Bridge Between Global Processes and National Policies for Sustainable Development

The 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 socio-economic 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 allows to look 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 exchange of experiences 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 (VNR) presented to the UN High-level Political Forum (HLPF). The SIMPEER pilot edition was carried out in 2016-2017 with the participation, on a voluntary basis, of France, Montenegro and Morocco. The second edition is on-going with Albania, Egypt and Tunisia.

Developed through a highly inclusive process in which all Contracting Parties and key stakeholders had the opportunity to participate, the MSSD aims at providing a strategic policy framework to secure a sustainable future for the Mediterranean region; adapting international commitments to regional conditions, guiding national strategies and stimulating regional cooperation in the achievement of sustainable development objectives; and, linking the need to protect the environment with socio-economic development.

As highlighted by its subtitle "Investing in environment sustainability to achieve social and economic development", the vision of the MSSD[lxvi] is based on the principle that socio-economic 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 socio-economic 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 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 impact severely the Mediterranean. The MSSD also introduces emerging approaches that help in turning political will into reality: e.g. Green/Blue economy approach combined with Sustainable Consumption and Production (SCP).

The MSSD follows a structure based on six objectives that lie in the interface between environment and development; the three first objectives of the Strategy reflect a territorial approach, while the three other objectives are crosscutting ones[166]. 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 its implementation and measuring its effects, as well as the governance prerequisites. A monitoring system is also provided through the establishment of a Mediterranean Sustainability Dashboard, including socio-economic indicators aligned with SDG indicators.

[Section on National Strategies for Sustainable Development pending, including the following table:]

Table 39 Overview of National Strategies for Sustainable Development [pending]

Country	*NSSD adopted (date/ in preparation/ no)*	*Title of NSSD*	*NSSD integrates 2030 Agenda (yes/no)*	*NSSD in revision (yes/no)*	*Comments*
…	…	…			
…					

[166] The six MSSD objectives: 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.

8.5 Research, innovation and education for sustainable development progress; but disseminating those progress is a key challenge for a sustainability transition

8.5.1 Research and Innovation for Sustainable Development in the Mediterranean

Education, research, innovation and capacity building are inherently interlinked 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 development of skills through capacity building, research and innovation could strengthen and support significantly the different 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, safeguarding, at the same time, environmental integrity and social cohesion and well-being.

Despite the fact that the Mediterranean was for millennia the cradle of knowledge generation, education, research and innovation, and without ignoring the excellent records of several Mediterranean countries, the region as a whole, in the modern times, is lagging behind, in comparison with other areas, e.g. Northern Europe or US.

In the second half of the 20th century, many strong national academic and research institutions are relatively well connected with the industrial and other economic activities in the countries and deploy efforts to collaborate at many levels with other nations. Some Mediterranean-wide organizations were established, playing a role for support of science, technology or institution building and international governance, such as the CIESM (*Commission Internationale pour l'Exploration Scientifique de la Méditerranée*), 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 the information technologies and the role of the international cooperation schemes, which are by far better supported financially for research and innovation than for education.

Within the MAP – Barcelona Convention system, MEDPOL 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 been connected also to educational activities of Universities or other appropriate scientific institutions. Although, science and research are not directly in the scope of the Barcelona Convention and its protocols, a series of programmes and projects coordinated by MAP are in the border line between applied research and policy formulation and implementation. One of them is the MedPartnership (2009-2015), the GEF MAP Strategic Partnership for the Mediterranean 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 catalyze policy, legal and institutional reforms along with investments.

The follow up of MedPartnership is being developed within the MedProgramme[lxvii], 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 (EIB) and one development bank (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 development by the countries of National Action Plans defining the hotspots of 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 for instance. 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) (Ex 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-Mediterranean GSO, was tasked to make 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 emphasised 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.

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. This was followed by signing association agreements between the EU and the 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), Jordan (2010), Morocco (2005), and Tunisia (2004).

A milestone in the 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 EU 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 communication 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 will 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. On that occasion, 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) constitutes 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 the resources point of view, the most important instruments for regional Mediterranean cooperation. Research and innovation for sustainable development are of high priority for these instruments[lxviii].
- **The Cross-Border Cooperation for the Mediterranean** (CBC-Med) programme currently implemented under the ENI aims at strengthening cooperation in the Mediterranean area during the period 2014-2020.

- **The Interreg MED Programme** (funded by the European Regional Development Fund, the Instrument of Pre-Accession and national co-funding) aims at promoting 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 of the people and organizations involved and enhanced coordination between different types and scales of research and innovation programmes, including EU-funded ones.
- The need for strengthening 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 more effectively data and outputs produced by research and innovation projects through suitable platforms.
- The need for enhancing efficient science to policy communication via capacity building activities targeting policy and decision-makers.
- The need for developing 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 key objective to support the introduction and implementation of the concept of sustainable development through formal (schooling systems) and non-formal/in-formal (awareness raising) channels, taking into account the relevant experience of preexisting environmental education.

The First International Working Conference on “Reorienting Environmental Education for Sustainable Development” was organised jointly by UNESCO, UNEP/MAP, MIO-ECSDE and the University of Athens (1996) and marked the needed appropriate change 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 essential in supporting the implementation of the sustainable development agenda.

From 1998 up to Johannesburg Summit (2002), the educational community of the Mediterranean gained a valuable experience through the participation in regional networks and projects, sharing of knowledge and practices, co-creation and making the agenda on policy and pedagogy of ESD more specific and concrete. The decision about the UN Decade on ESD, suggested in Johannesburg Summit (2002), was prepared and promoted in synergy 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[167]. The UN Decade on ESD (2005-2014) provided a solid framework for mainstreaming, boosting and applying ESD. It was suggested that Regional ESD Strategies are adopted to help countries in introducing and implementing ESD[lxix]. The Mediterranean region was the first to respond to this call, drafting the

[167] 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

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 and participatory process, it is yet unevenly implemented in the various countries. An Action Plan for the implementation of the MSESD serving as a flexible framework for the fulfilment of the countries' national ESD but also regional/global agendas was developed and adopted in 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 for the promotion of sustainable development. In many countries, inter-ministerial committees established for the promotion and implementation of the SDGs include also the promotion of ESD. The majority of the countries has already elaborated 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, the cooperation involving ESD research needs further mainstreaming and enhancement and it should be considered a main priority. It is equally important to enhance the "citizen science" orientation, including a cooperative inquiry and participatory action research approach as a means to shift from "research on/about people" to "research with people".

Despite the gradual progress achieved in the application of ESD, some common challenges are identified by most of Mediterranean countries. The strengthening of the much needed **interdepartmental and cross-sectoral collaboration** and the effective **coordination of the various initiatives on ESD** is one of 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 continuation of efforts, at regional level, connecting the regional to the national and local, including as a major tool the "trainings of trainers" 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[168], CIGESMED[169]). 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 of action.

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[168] Citizens' Network for the Observation of Marine Biodiversity

[169] Coralligenous based Indicators to evaluate and monitor the "Good Environmental Status" of the Mediterranean coastal waters.

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 programs, or is held by local communities and practitioners. However, this information is often insufficiently or ineffectively transmitted to public and private decision-makers, leading to significant amounts of knowledge that is “wasted”. Given the diffuse nature of information sources and data collection processes, the abundance of information remains to be effectively articulated to feed into commonly agreed observatories as well as monitoring and surveillance frameworks at 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. Making the transmission of project results to common existing platforms and the generation of data and knowledge in consistency with agreed methodologies a condition for project funding can be a major lever of action.

In the Mediterranean region, despite the development of various instruments for scientific cooperation (in research and innovation), with a 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 entry costs and limited capitalisation across 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 conceived as the UN Mediterranean knowledge platform to provide and share data, information services and knowledge for the benefit of the Mediterranean Action Plan components and Contracting Parties. Its scope is to: (i) Provide access to Reporting system; (ii) Harmonise 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 & 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.

- 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.

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. UN Environment 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 of their research needs and expectations, their analysis of issues and current policymaking processes and bottlenecks, while scientists can clarify the scope of their research and the way it can be translated into recommendations and concrete measures (Figure 180).

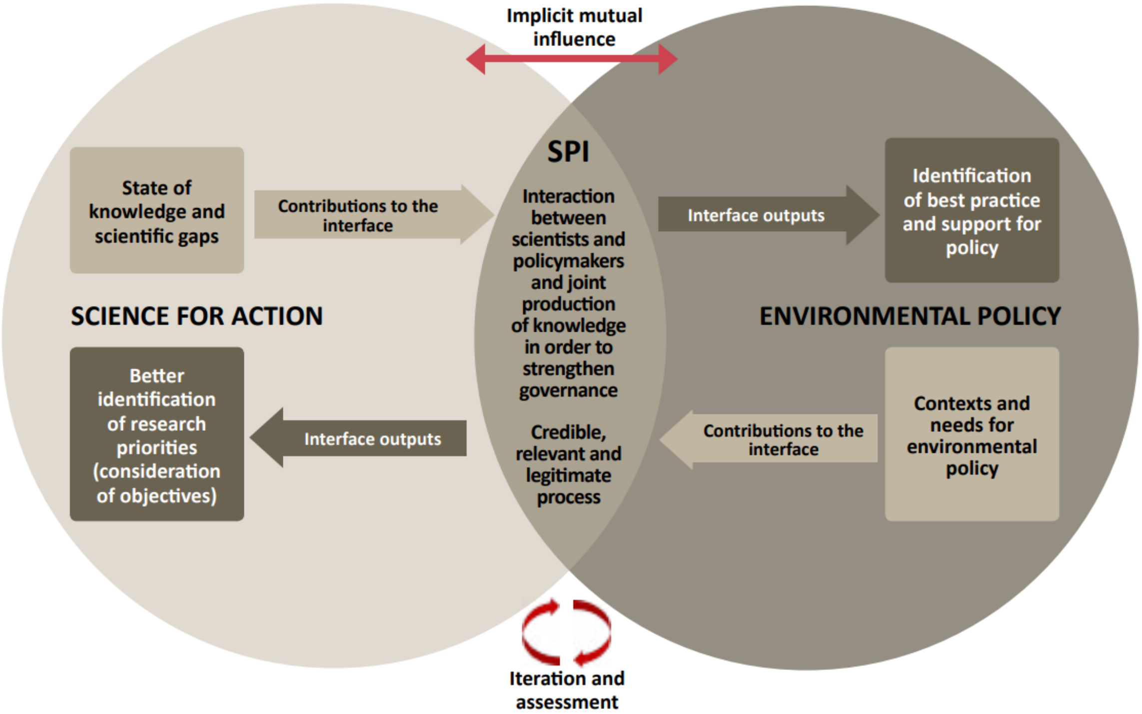

Figure 180 Designing optimal Science Policy Interfaces

Cooperation is not between 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” between these two spheres to promote regular interactions and collaborations.

In the Mediterranean, the SPI approach is incorporated into a number of environmental institutions, networks and projects. Science policy interactions allowed to achieve many results at both national (e.g. drafting of National Action Plans to address pollutions) and regional (e.g. MSSD Review Process) levels. To go beyond punctual exchanges, the Contracting Parties called for a stronger SPI and for efforts to structure relationships between the 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).

However, this dialogue can be hindered by communication barriers between the scientific and political spheres. For instance, research timeframes are generally very different from policymaking timeframes. Policy decisions sometimes need to be made very quickly, whereas research can take years. Moreover, the production of knowledge is sometimes unbalanced since some fields are more financed and documented than other because of a lack of initial discussion between scientists and policymakers to better identify where the efforts should be put.

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 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 the multiplication of 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 a key priority.

- On **integrating 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 administrations in charge of 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 strength 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 target, as demonstrated by the mobilization on blue, green and circular economy. Enhanced communication about the stakes associated with degradations or increasing inequalities on environmental, social and economic components via evaluations of key ecosystem services and socio-economic impacts can contribute to a better integration of environmental issues in decision-making.

- **Territorial approaches** have been successfully strengthened with decentralization moving forward in some countries, and advocacy for local decision-making progressing through various fora. Local authorities play for example a crucial role in planning and implementing concrete climate change mitigation and adaptation measures. However much remains to be done in empowering local governments, as applicable.

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 Abeba agreement: national and international, public and private, conventional and non-conventional, micro-credit…); (ii) incentives for technological and social innovations development and dissemination / scaling-up, (iii) awareness raising, education, labelling and voluntary agreements, as well as training programs; 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 coherent ensembles allows to assess and share expected co-benefits and trade-offs of decisions and to discuss them with concerned stakeholders. This will also allow to identify ways in which potential adverse effects of measures can be mitigated, ideally through 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 regional Mediterranean level, the upcoming seventh step of the EcAp roadmap aims at developing coherent action plans and programmes of measures for achieving Good Environmental Status (GES) of the Mediterranean Sea and coast and can be an occasion to re-think policy mixes in the region.

Appropriate funding mechanisms are a vital part of policy mixes. Many regional strategies, programs and plans for sustainability are conceived 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 population continues to grow in SEMCs. However emerging challenges, including climate change, are also expected to require considerable public and private investment, with early action a condition to prevent major later costs. On other environmental policies, including biodiversity conservation, while investment costs may be limited, funding of 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 "*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 behavior 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. Those "external costs" may include natural resource depletion, environmental degradation, health impacts or social impacts.

Table 40 Number of types of policy instruments in National Action Plans (NAPs) of some Mediterranean countries (Source: UNEP/MAP, 2017)

	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
Palestine	14	23	1	6	51	95
Tunisia	22	0	25	0	28	75
TOTAL	91	157	63	70	267	648

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 the 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 40 shows the number of economic instruments used in NAPs in some non-EU Mediterranean countries and Table 41 indicates the economic instruments in use and planned in the same countries.

Table 41 Economic instruments in use and planned in some non-EU Mediterranean countries (Source: UNEP/MAP, 2017)

Country	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, tires, 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); EIs not effective in changing behaviors	Development of economic instruments to address marine litter, disposal of inert wastes and separate collection of wastes
Egypt	Incentives provided to industries to adopt cleaner production technologies Pollution taxes and fines (enforcement; low tariffs)	Application of Eis 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 ODSs, 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, 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, NCF Tax exemptions/ reduced rates for pollution abatement, recycling	Achieve cost-recovery levels for water charges Introduction of water pollution tax

Acceptance and taking of ownership of concerned stakeholders of economic instruments for environmental management can be strengthened through demonstrating and communicating on the economic and social (including health) benefits of measures, including the comparison to scenarios of inaction. Natural capital, ecosystem and ecosystem services accounting could contribute here and should hence be further developed as a component of national accounts.

Subsidies are another way of influencing market signals. It has been recognised 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 over-use (depleting aquifers, reducing flows in some rivers) and encouraging investment in unsustainable uses.
- 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 however 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 “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 global level after a period of significant decrease), and **groundwater extraction**. **Adequately targeting direct consumption supports to 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 issues of concern for sustainability in the Mediterranean has greatly increased throughout the last decades. However, much of this knowledge is neither generated nor managed in a harmonized way but generally of diffuse nature and 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 to efficiently follow-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 IMAP**, to fill priority knowledge gaps[lxx]; 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), to provide integrated information for the effective design of measures to achieve GES.

The prevalent 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 put into relation with environmental state and impact information via permanent knowledge sharing platforms that exceed 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 stakes, including economic and employment benefits and impacts, as well as operational, social, cultural and behavioural aspects, associated with sectors or issues addressed. This most likely requires working with the private sector and local communities of targeted sub-regions. It also requires strengthened knowledge in the field of **behavioural sciences**, as sustainability can only be reached via profound modifications of human behaviour at all levels.

Furthermore, information about responses and their effectiveness to tackle 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 to existing surveillance networks.

For any type of knowledge sharing, developing sustainable platforms and networks can only be achieved via **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 conceive agile, mutually beneficial and long-term institutional set ups. This would in particular apply to necessary long-term science policy interfaces.

Box 79 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 Program 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 the 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 more than 70 Universities and research institution from the Mediterranean countries. In the field of research and innovation "**PRIMA**" is an example of 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 food value chain as a driver of regional- local development. In the field of Education for Sustainable Development, SDSN Mediterranean understands that innovative and 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 effect 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 towards waste. In the field of IT innovation tools SDSN Mediterranean promotes the **Prima Observatory on Innovation** (POI) in Agri Food. POI is a digital platform designed to monitor and report on the state of research, innovation, and education within the context of Agri-Food development in the Mediterranean area.

To design efficient measures, it is key to conduct ***ex-post*** **evaluation of measures and policies** to identify successes, failures, and difficulties in the way environmental issues are addressed. Evidence from *ex-post* appraisal, can largely contribute to better informed and more effective policies, more interdisciplinary approach and accountability, and potentially reduce the regulatory burden. Rather than general processes and statistics alone, ex-post evaluation should consider some practical applications on the ground, and discuss with practitioners to identify lessons learned, adaptations implemented 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; but it is only partially implemented and does not currently allow to draw conclusions 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 application of 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 Protocols under the Barcelona Convention) for 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; however, 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 non-submitted or incomplete national reports. The Barcelona Convention does not provide for a sanctioning mechanism in case of non-compliance. Strengthening the fulfillment 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 80 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 salinas around the Berre lagoon and is an important wetland site. The site is threatened by tourism as well as by urban and industrial development, 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 et al., 2009).

Enforcement also remains limited at 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. 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[lxxi]), 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 sub-regional collaborations (e.g. on illegal discharge at sea) can serve as examples for upscaling surveillance and legal action on environmental regulations.

Box 81 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 judicial cooperation have developed with regard to detecting and sanctioning intentional pollution from maritime transport. The Mediterranean Network of Law Enforcement Officials (MENELAS) relating to the International Convention for the Prevention of Pollution from Ships (MARPOL) explores the possible development of regional jurisdictional and judicial cooperation in the Mediterranean. It also discusses a potential 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 is also considering the possibility of accompanying this judicial cooperation with the creation of a regional "Blue Fund", to which a part of the pecuniary sanctions would be transferred. Stakeholders mention 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.

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 principle, environmental prejudice, non-regression on environmental regulations, environmental prevention…; and adopting effective legal and administrative mechanisms to implement these principles;
- 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 stakes; with both a general awareness programme and specialized trainings;
- developing cooperation and synergies with other MEAs Compliance Committees in areas of common concern including joint activities to promote and facilitate compliance;
- exploring the (potential) role of non-state actors, such as NGOs and broader civil society, in the enforcement of environmental regulation; and
- developing judicial cooperation at Mediterranean level.

Box 82 Climate change litigation and the role of civil society

Several cases of judicial litigation have been recorded in European Mediterranean countries, 40 of which at the European Court of Justice, 13 in Spain and 4 in France[lxxii]. One of the trends in climate change litigation is related to holding governments to their legislative and policy commitment, thereby enforcing climate engagements via legal action.
The most famous of such cases took place in the Netherlands[lxxiii], 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 GHG emission 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 expecting judgment.

Box 83 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 disregard 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 181 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 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.

Draft Conclusions

The progress achieved throughout the last decade in developing and improving sustainable development policies, strategic frameworks, action plans and other initiatives and improved knowledge on ecosystems and their role for human wellbeing has not been sufficient to reduce pressures on and degradation of the Mediterranean coastal and marine environment. It has also not allowed to help Mediterranean coastal populations adapt to current and projected environmental and climate change and to increase their resilience. To reach commonly set goals and objectives such as GES of the Mediterranean coast and sea and more largely SDGs in the region, and to avoid or at least mitigate projected systemic failures, current trajectories must be urgently corrected. This requires radical changes in behavior at all levels and in all areas, the main driver for the increasing pressures and degradation being our production and consumption patterns.

The needed systemic transition cannot be brought about by policy-makers alone. It is a shared responsibility of all stakeholders including civil society, the private sector including the banking system, the science community, judicial systems etc. Fostering participation of actors and taking advantage of mobilization of stakeholders to engage into dialogue and coordinated action will improve outcomes of policy-making at all levels. The current mobilization of youth for sustainable development must be seized as an opportunity for policy-makers to facilitate the taking into account of the long term into policy-making. Scientists are increasingly collaborating towards organized science-policy interfaces such as IPCC, IPBES or, at the Mediterranean level, MedECC to provide clear scientific messages to policy-makers. Judicial systems increasingly deal with environmental and climate litigation and support the enforcement of sustainability regulation, while the private sector holds a powerful role in funding and inventing sustainable lifestyles.

A major opportunity for fostering the needed transition within the Barcelona Convention system is the urgent passage from planning and engagement in measures to their implementation and effective enforcement on the ground in collaboration with local authorities, when appropriate. Implementation and enforcement are lagging behind the ambition of commonly agreed objectives and measures and limit their comprehensiveness and the major achievements in environmental diplomacy in the region. The effective enforcement of agreed actions requires adequate monitoring and evaluation, to ensure that measures are leading to the desired effects and to make potential necessary adjustments. Articles 26 and 27 of the Barcelona Convention provide for such monitoring and evaluation. Strengthening a more rigorous fulfillment of the provisions of the Barcelona Convention represents an opportunity which can be seized by Contracting Parties, together with the Secretariat and the Convention's Compliance Committee in order to close the adaptive policy cycle from planning, to implementation, enforcement, monitoring and evaluation, to adapting the commonly agreed measures. The imminent threat of severe damage of ecosystems and irreversibility calls for the urgent implementation of corrective measures in application of the precautionary principle (Article 4.3.a of the Convention) "by virtue of which where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation".

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[xxxviii] Including Palestine

[xxxix] World Development Indicators

[xl] Food and Agriculture Organization and World Bank population estimates

[xli] Plan Bleu computations, national sources (referring to NUTS 3 or equivalent)

[xlii] [Source pending]

xliii *[To be completed with a section on engagement and mobilization of/in countries]*

xliv Clarify this paragraph

xlv Plan Bleu computations, national sources (referring to NUTS 3 or equivalent)

xlvi Source to be mentioned.

xlvii 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)

xlviii http://www.fao.org/3/a-y1224e.pdf

xlix See UNEP(OCA)/MED IG. 6/7. Barcelona Resolution on the Environment and Sustainable Development in the Mediterranean Basin. UNEP, Athens 1995.

l Parties, the Secretariat or the Compliance Committee could 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 addressed to the Compliance Committee by the public and observers.

li See (1) Updated Guidelines for the Management of the Dredged Material, 2017 (COP Decision IG. 23/13); (2) Guidelines for the Management of Fish Waste or Organic Materials Resulting from the Processing of Fish and other Marine Organisms, 2001 (UNEP(DEC)/MED IG.13/5); (3) Guidelines for the Dumping of Platforms and other Man-Made Structures at Sea, 2003 (UNEP(DEC)/MED IG.15), and (4) Guidelines for the dumping of inert uncontaminated geological materials, 2005 (UNEP(DEPI)/MED IG.16). The text of the Guidelines is available at UNEP/MAP website: http://web.unep.org/unepmap/meetings/search-meeting-documents

lii See UNEP/MAP, 2015, MED POL Programme for the Assessment and Control of Marine Pollution in the Mediterranean. Athens.

liii See 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. The text of the 2016-2021 Strategy is available at REMPEC website http://www.rempec.org/

liv See the Regional Strategy addressing Ship Ballast Water Management and Invasive Species, 2012 (COP Decision IG.20/11) and the Guidelines on the Decision-Making Process for Granting Access to a Place of Refuge for Ships in Need of Assistance, 2008 (COP Decision IG. 17/10). The text of both instruments is available at REMPEC website http://www.rempec.org/

lv See REMPEC website http://www.rempec.org/

lvi See (1) Regional Action Plans on Persistent Organic Pollutants (POPs), (COP Decisions IG. 19/8, 19/9, adopted in 2009 and COP Decision IG. 20/8.3, adopted in 2012); (2) Regional Action Plans on the Reduction of Biochemical Oxygen Demand (BOD5) from urban waste water and in the food sector (COP Decision IG. 19/7, adopted in 2009 and COP Decision IG. 20/8.2, adopted in 2012); (3) Regional Plan on the Reduction of Inputs of Mercury, (COP Decision IG. 20/8.1, adopted in 2012); and (4) Regional Action Plan on Sustainable Consumption and Production in the Mediterranean, (COP Decision IG. 22/5, adopted in 2016). For the text of the Action Plans consult UNEP/MAP website http://web.unep.org/unepmap/meetings/search-meeting-documents

lvii See COP Decision IG. 21/7: Regional Plan on Marine Litter Management in the Mediterranean, 2016. The text of the Action Plan is available at UNEP/MAP website http://web.unep.org/unepmap/meetings/search-meeting-documents

lviii See (1) Action Plan for the conservation of Cartilaginous Fishes (Chondrichthyans) in the Mediterranean Sea, 2013 (COP Decision IG. 21/4); (2) Updated Action Plan concerning Species Introductions and Invasive Species in the Mediterranean Sea, 2016 (COP Decision IG. 22/12); (3) Updated Action Plan for the Conservation of Cetaceans in the Mediterranean Sea, 2016, (COP Decision IG. 22/12); (4) Action Plan for the conservation of Marine Vegetation in the Mediterranean Sea, 2012 (COP Decision IG. 20/6); (5) Action Plan for the conservation of Bird Species listed in Annex II of the SPA/BD Protocol in the Mediterranean, 2013, (COP Decision IG. 21/4); (6) Action Plan for the management of the Mediterranean Monk Seal, 2013 (COP Decision 21/4) (7) Action Plan for the conservation of Mediterranean Marine Turtles, 2013 (COP Decision IG. 21/4); (7) Updated Action Plan for the conservation of the Coralligenous and Other Calcareous Bio-concretions in the Mediterranean Sea, 2016 (COP Decision IG. 22/12), and (8) the Dark Habitats Action Plan, 2013 (COP Decision IG. 21/4). For the text of the Action Plans consult UNEP/MAP website http://web.unep.org/unepmap/meetings/search-meeting-documents For further information, consult SPA/RAC website http://www.rac-spa.org/

[lix] See SPA/RAC website http://www.rac-spa.org/

[lx] See COP Decision IG. 22/3: Mediterranean Offshore Action Plan, 2016. The text of the Action Plan is available at REMPEC website http://www.rempec.org/

[lxi] COP Decision IG. 20/2: Action Plan for the Implementation of the ICZM Protocol (2012-2019). The text of the Action Plan is available at UNEP/MAP website http://web.unep.org/unepmap/meetings/search-meeting-documents For additional information, consult PAP/RAC website https://www.pap-thecoastcentre.org/

[lxii] See PAP/RAC website https://www.pap-thecoastcentre.org/

[lxiii] Examples, illustrations to be included.

[lxiv] http://ufmsecretariat.org/wp-content/uploads/2014/05/Mediterranean-Strategy-on-Education-for-sustainable-development-.pdf; http://www.esdmedcyprus.pi.ac.cy/files/ENG_Action_Plan.pdf

[lxv] Owing to their cross-cutting nature, the implementation of the Aarhus Convention and of 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, most importantly, 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).

[lxvi] "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"

[lxvii] The MedProgramme is not just "another" project. It is the final step of a clear, politically supported and technically consistent path, which will provide an example to establish similar and even bigger operative partnerships between countries, international organizations, financial institutions, the private sectors and NGOs.

[lxviii] Under ENI a project entitled SWIM-H2020 SM (Sustainable Water Integrated Management and Horizon 2020 Support Mechanism 2016-2019) was funded, aiming to contribute to reduced marine pollution and a 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, Palestine, [Syria] and Tunisia).

[lxix] This was actually acknowledging the pioneering work of the UNECE region which has managed to prepare a Strategy adopted in Vilnius in 2005 benefiting from the UNECE Strategy.

[lxx] identified in the 2017 MED QSR

[lxxi] UNEP, 2019, Sand and sustainability: Finding new solutions for environmental governance of global sand resources. GRID-Geneva, United Nations Environment Programme, Geneva, Switzerland. See for example Box 2, p25.

[lxxii] UNEP, 2017, The Status of climate change litigation: A global review

[lxxiii] Where 900 citizens sued the national government for its revision of GHG emission reduction goals constituting a violation of its constitutionally imposed duty of care.