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Co-Evolve4BG

Threats and Enabling Factors Mediterranean Scale: MED Scale Analysis

Ecosystems protection

- Mediterranean Scale -

MED

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OVERVIEW

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Abstract

This synthesis aims to identify the different threats to Mediterranean ecosystems and their protection strategies (enabling conditions), focusing in coastal and sea areas, in a climate change context, and their relation with tourism development. It is based mainly on the reports established by the 5 Mediterranean countries involved in this project (Spain, Italy, Tunisia, Greece, Lebanon).

An overview of the current state of ecosystems and natural resources in the Mediterranean which is also a major tourist destination in the World as well as a hotspot of biodiversity is also provided.

I. Introduction

In this synthesis, we summarize the ecosystems protection measures in the Mediterranean region, focusing in coast and sea areas, in a climate change context, and their relation with tourism development. The synthsis is based on the reports developed by the five Mediterranean countries involved in this project. The geographical distribution of these countries (Figure 1) should allow to have representative data over the entire Mediterranean Sea, one country to the West (Spain), one country to the East (Lebanon), two countries on the northern shore (Italy and Greece) against only one country on the southern shore (Tunisia). Nevertheless, this imbalance of representativeness between the northern shore and the southern shore could lead to a lack of data, mainly for Egyptian coasts, especially since Egypt is a major tourist country in the Mediterranean, in addition to the discharges of the waters of the Nile River in the Levantine basin. In addition, the lack of consistency and complete data in the national reports does not allow real comparisons to be made between the five countries involved in this synthesis.

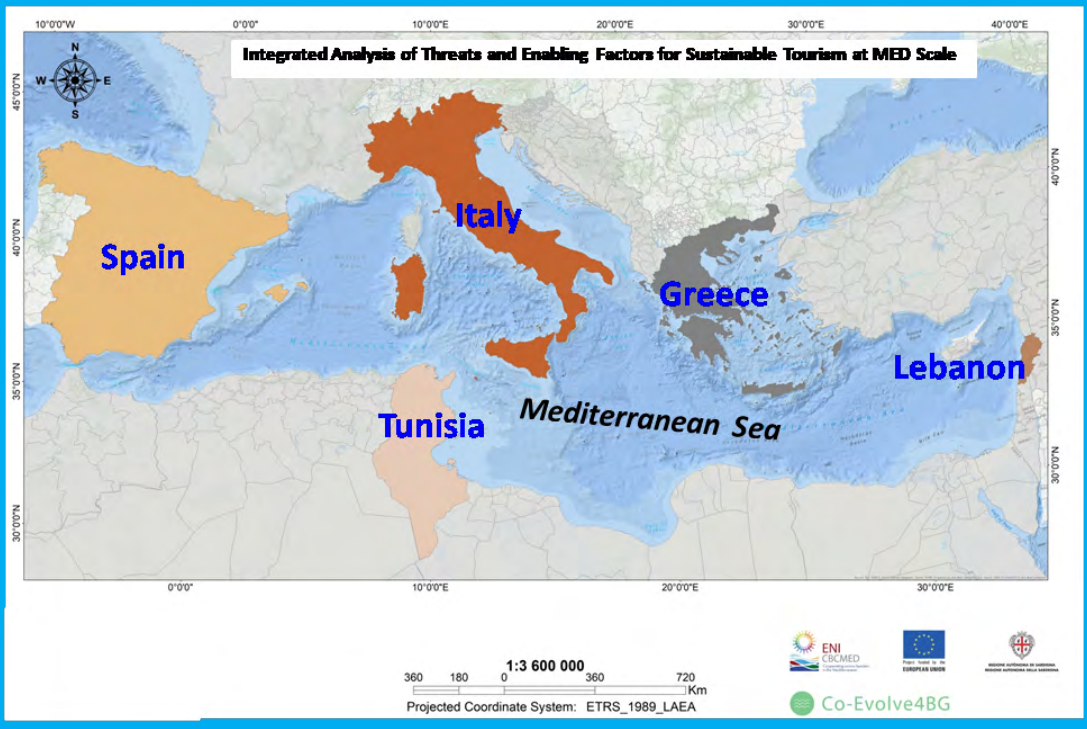

Figure 1. Countries involved in this study

Costal areas in the five countries are different, particularly in terms of geomorphology and biological richness.

Greece is composed of more than 3,000 islands and has, thus, the longest coastline in the Mediterranean region (15,000 Km). This gives Greek ecosystems a mosaic of marine habitats and high biodiversity (Pekakis and Delioglani, 2021). With more than 7,500 km of coastline, Italy has a large proportion of its territory overlooking the sea and characterized by a high degree of heterogeneity. The coasts are either high and rocky, or low and sandy. Coastal environments are narrow transition zones between marine and terrestrial ecosystems and are therefore dominated by strong environmental gradients that vary according to the distance from the sea (Pozzi et al., 2021). Spain is considered a maritime country, since it has an extension of coast close to 10,000 km (the major part of which is open to the Mediterranean and the other to the Atlantic), so the exploitation of marine waters and their resources has a great economic importance (Marin et al., 2021). The Tunisian coastline extends over 2,290 km, islands included. Its continental shelf is narrow in the North with a rocky bottom, extended in the South with a sandy-muddy bottom, and moderately extended in the East with alternating sandy-muddy and rocky bottoms (Jarboui, 2021). As for Lebanon, its coast extends over approximately 225 km and is open to the Levantine Basin at the East of the Mediterranean Sea (Msayleb et al., 2021).

Due to its long/rich history, its geographic location (linked to 3 Continents and 3 Oceans), a unique combination of a temperate climate, rich heritage and culture, exceptional natural resources and proximity to major outbound markets, the Mediterranean (with around 150 million residents on sea coasts) remains the first tourist destination in the World, with more than 300 million arrivals of international tourists accounting for around 30% of the total number of international tourists in 2014 (Fosse et al., 2016; Afli, 2021a, b). This number has increased from 58 million in 1970 to almost 314 million in 2014, with a forecast of 500 million by 2030 (UNWTO, 2015). More than the half of these arrivals are in coastal areas, mainly in summer time aggravating the concentration of anthropogenic pressures on the coasts. In the Mediterranean, the tourism is nature-based, which is often involving excursions to natural sites and wilderness areas, to developing countries where a large portion of the world's biodiversity is concentrated (Olson, 2001). This type of tourism which focuses on the natural environment exerts a number of pressures on the natural resources on which they rely (Msayleb et al., 2021a, b). The tourism sector in the Mediterranean is traditionally highly developed in the northern, in particular France, Italy and Spain. But for a few decades, it has experienced significant growth in several countries of the southern and eastern Mediterranean, such as Egypt and Turkey. The top five tourist destinations in the Mediterranean Region represent alone nearly 83%

total international tourist arrivals in the region in 2014, with different proportions (France: 84 million, Spain : 65 million, Italy : 48 million, Turkey : 40 million and Greece : 22 million) (Fosse et al., 2016). However, international tourist arrivals in 2020-2021 remained 72% lower than in 2019 following the COVID19 pandemic (UNWTO, 2021).

Currently, the tourism sector plays an important role in the economies of the Mediterranean riparian countries and provides a fairly large influx of foreign currency. In addition, it contributes to the development of other economic sectors such as services, leisure, transport, communications, crafts, trade, agriculture and construction.

Nevertheless, the Mediterranean is home to many coastal ecosystems remarkably rich in biodiversity, which are often under pressure and becoming increasingly threatened. It is therefore essential to reconcile coastal ecosystems with their users for their protection, but also to ensure the sustainable development of certain vital sectors for these countries, in particular tourism (Jarboui, 2021).

This synthesis contains four parts:

- - Current state of ecosystems and natural resources in the Mediterranean
- - Pressure of tourism and other activities on Mediterranean ecosystems
- - Analysis of existing strategies and measures facing threats to Mediterranean ecosystems
- - Main findings and conclusions; common issues, their nature and gaps observed, guidelines for ecological tourism

Although this synthesis is based mainly on the five national reports established within the same framework, it is important to point out that the information collected and analyzed in this report comes, in part, from other references; scientific studies, reports and documents from organizations and institutions of interest.

II.
Current state of ecosystems and natural resources in the Mediterranean

II. Current state of ecosystems and natural resources in the Mediterranean

Coastal ecosystems in general, while representing highly relevant environments from an ecological and landscape point of view, are among the most vulnerable and most seriously threatened ecosystems in the world. In particular, the increasing degradation of dunes, which often ends by their total disappearance, has affected all coastal countries of the European Union and especially those bordering the Mediterranean. The restoration and conservation of these ecosystems is therefore a priority at the European level (Pozzi et al., 2021).

The Mediterranean Sea is a hotspot of biodiversity. It covers only 0.7% of the world's ocean area, but it is considered one of the significant marine and coastal biodiversity reservoirs since it shelters around 7.5% of the world's marine fauna, and 18% of its marine flora (Afli, 2021b). The numbers of species fall as we move eastward: 85% are present in the western basin and 45% in the eastern basin. This is because the Mediterranean biota comes from successive invasions from the Atlantic after its almost total desiccation approximately 5 million years ago. Today, due to the progressive water warming caused by climate change, there is a flow of subtropical species that penetrate through the Strait of Gibraltar. This added to the introduction of species by humans (most coming from the Red Sea through the Suez Canal in what is known as Lessepsian migration) points to a tropicalization of this Sea (Linares, 2010 in Marin et al., 2021).

In recent decades, there has been an intense withdrawal of the coastal territory by the tourism industry in most Mediterranean countries, with the expansion of banal, continuous urban agglomerations, with large buildings and completely unusual construction types for the local tradition. The abandonment of territories of historical uses, the disappearance of agricultural crops typical of the coastal areas, the abandonment of agricultural lands in favour of easier and faster earning activities, have contributed to the trivialization of the landscape, that whole and differentiated asset by which the tourist is so attracted and fascinated. The coastal strip itself, therefore, is not a renewable resource, because once it is compromised, an opportunity is lost and its value is reduced. For these reasons, it is a duty to evaluate the sustainability of programmatic activities (Progetto CAMP Italy, 2017 in Pozzi et al., 2021).

The Mediterranean is today the most important tourist destination in the world with more than 150 million tourists a year. Its coastal countries receive around a third of all international tourist arrivals. This tourism development has led to a series of environmental impacts, including pollution and destruction of the landscape, wastewater, municipal solid waste and noise pollution. Urbanization, the development

of promenades and ports, as well as defence breakwaters, in order to promote tourism can end up negatively since it causes the disappearance of the sand from the beaches (e.g., this affects about 70% of the Spanish coast) (Marin et al., 2021). These negative impacts are more severe in semi-closed areas, such as most Greek seas, since they are more vulnerable to human pressures and anthropogenic pollution and have then more limited remedial capacity. The most important marine pollution in these areas involves discharges of ship fuel, untreated discharges of municipal and industrial liquid and solid waste (mainly plastic with 80% of marine debris and metals), agricultural and stock farming effluents (Pekakis and Delioglani, 2021). Although approaches to the tourism issue from critical and environmental perspectives exist since the 70s, it took until the beginning of the nineties when sustainability in tourism was raised. Regarding the Mediterranean, it is interesting to highlight the Mediterranean Action Plan (Malta, 1999) in which the Spanish and Greek delegations presented a proposal for Sustainable Tourism in the Mediterranean Basin. At the level of coastal countries and regions, the most worrying threat in the medium term seems to be the inability to cope with the progress of soil erosion ; its protection goes through that of forests at the headwaters of river basins. With regard to coastal regions and the sea, the priority should be on coastal protection, conceived as the narrow land and sea band in which direct action can only be local and/or national, but where threats to the environment are most serious, even in the most favourable scenarios (Borrell Merlín, 2005).

The state of marine ecosystems and the main natural resources are almost identical between the five countries involved in this synthesis and are common in the Mediterranean, but certain specificities deserve to be highlighted :

- Pozzi et al. (2021) mentioned that the Italian coastal dunes are home to numerous plant communities (habitat of community interest sensu Directive 92/43 / EEC) which in recent decades have undergone strong fragmentation and alteration ; the damage caused mainly by anthropogenic activities has often proved to be irreversible. In fact, the 2nd National Report on the implementation of the Habitat Directive shows that, of the 130 habitats in Annex I present on the national territory, coastal dunes are among those that fall into the categories “inadequate” or “poor state of conservation”. During last decades, dunes has undergone a strong increase in bathing and tourism activities parallel to expansion of housing infrastructures built along the coasts (Pozzi et al., 2021). These latter, in addition to the direct destruction and fragmentation of dune ecosystems, altered the sedimentary cycles and the consequent was an increase of coastal erosion. Due to anthropogenic pressure and erosion, even the known as well-preserved coastal ecosystems are threatened and are

currently present in a much localized way. Along most of the Italian coasts, the changes that have occurred in the territory have resulted in the alteration, rarefaction or disappearance of entire plant communities and, consequently, the local extinction of typical endemic species (Acosta et al., 2007). Among the main threats faced by Italian coastal ecosystems we can identify coastal erosion, cleaning and mechanical levelling of beaches for bathing purposes, coarse and inert non-biodegradable solid materials, threats associated with the construction of artificial piers and coastal cliffs with consequent displacement of erosive phenomena in neighboring areas, urbanization, dune stabilization systems, forestation, artificial or (pseudo) natural barriers, excessive attendance due to seaside tourism, land use change and loss of ecological connections, and modifications of the coastline in relation to climate change (ISPRA, 2009 in Pozzi et al., 2021).

- Marin et al. (2021) considered that due to Climate Change, the average temperature of Spain has increased by around 1.7°C since pre-industrial time, the rise is being especially intense during the last decade. Other consequences are the lengthening of summers, about 9 days on average per decade, with summer being almost 5 weeks longer than in the early 80s ; increase in torrid nights (those in which the minimum temperature is equal to or greater than 25°C). This phenomenon is ten times more common than it was 40 years ago with increased duration of heat waves and decreased cold episodes; decrease in rainfall and changes in its annual distribution; disappearance of glaciers, which are currently present only in the Pyrenees; decrease in average river flow by 1.45% per year in the period from 1966 to 2005; expansion of the semi-arid climate, whose surface has increased to occupy almost 6% of the surface of Spain; increase in seawater temperature (0.34°C per decade since the 80s in the Mediterranean) and sea level, in addition to its acidification, more noticeable in surface waters. From all these changes a series of impacts and risks on ecological systems and economic sectors are derived, such as the decrease in water resources, impact on ecosystems and biota, increased risk of fires and desertification, impacts on human health, impacts on economic sectors such as agriculture and tourism, loss of resources, etc. (Marin et al., 2021).

- Concerning Tunisia, Jarboui (2021), noted that due to climate change, sea level rise is beginning to be clearly visible on the Tunisian coasts. Some archaeological remains show an elevation ranging from 20 to 40 cm since historical times. Similarly, records of tide gauges indicate a rise in sea level at some sites affecting

the shoreline and the morphology of the coast. This sea level rise would have more accentuated repercussions once coupled with the effects of the other climate variability (I.g. storms, erosion, sand displacement, etc.). Predictions show that a sea level rise of 55 cm will happen by 2100 for a global warming of 0.25°C per decade, thousands hectares of beaches with urban agglomerations and infrastructures will be threatened by submersion (Jarboui, 2021). A total of 1% of the Tunisian coastline is protected by structures, including embankments with rock-fill protection embankments (55%), isolated breakwaters at sea (25%) and groins to protect against marine erosion in ports. The protective structures of Tunisia's 41 ports and fishing shelters would be particularly vulnerable to an ASLR, which would generate additional management and maintenance costs. The study on the costs of environmental degradation in Tunisia carried out by the World Bank in 2004 estimates the annual costs of an ASLR at about 0.13% of the annual GDP. This cost would amount to 0.63% of GDP if direct economic losses are taken into account (Jarboui, 2021).

III.
Pressures generated by tourism and other activities on Mediterranean ecosystems

III. Pressures generated by tourism and other activities on Mediterranean ecosystems

Marine and coastal's main pressures arise from climate change impacts and more specific from sea level rise, temperature increase, changes in precipitation distribution and intensity, flooding and coast erosion. Pressure from human activities in coastal ecosystems include mainly tourism, industry, population increase and overexploitation of natural resources. All these anthropogenic activities lead to marine pollution that affects marine ecosystems already destabilized by climate change (Pekakis and Delioglani, 2021).

The seasonality of tourism in Mediterranean areas enhances pressure on the environment during summer season, including increased water demand during dry periods, mainly on its South shore. Over-pumping can cause irreversible salinisation of groundwater aquifers. Tourism also contributes significantly to municipal solid waste volumes, requiring greater effort for local authorities to manage. Commercial shipping, recreational boating and ferry transportation have increased substantially in the last decades (Pekakis and Delioglani, 2021). For example, the commercial shipping in Greece serves 120 islands, 144 ports and transport around 35-40 million passengers per year. There are 350 coastal shipping routes that serve the Greek islands with their connection to the mainland (Valavanidis, 2018).

The increased concentration of greenhouse gases has two main responses in the Mediterranean Sea : sea surface temperature enhancement and sea-level rise (Pekakis and Delioglani, 2021). In the Eastern Mediterranean, for example, during the past two decades (1990-2010), changes in the thermohaline circulation have been observed, known as the Eastern Mediterranean Transient (EMT) (Theocharis et al., 1999). In Greek seas, e.g., such changes have been attributed to a climatic shift over the Aegean Sea and have initiated a series of modifications in the hydrology, the bioinvasion, dynamics and the water's nutrient distribution (Table 1) (Painter and Tsimplis, 2003).

Table 1. Documented effects presumably related to climate change in Greek waters (Streftaris and Zenetos, 2009)

Indications	Cause
Expansion of species of tropical affinity originating from the Atlantic	Temperature increase, Shipping
Expansion of tropical- subtropical species from the Indo-Pacific	Temperature and salinity increase

Northern expansion of thermophilous fish	Temperature increase
Indications	**Cause**
Mucilage events and Harmful Algal Blooms (HABs)	NAO anomalies, temperature increase
Mass occurrence of scyphomedusae	Climatic variability circulation changes
Zooplankton abundance	Climate change
Changes in biology	Climate change
Molecular changes	Extreme temperatures

According to UNEP (2007, 2015), population growth and densification of the coastal population added to overconsumption patterns increase the demand for ecosystem services and energy, which affects biodiversity at every component (genetic, species, ecosystem) and the links between each of these components. Today, there is no marine region unaffected by humans ; moreover, 41% of the oceans are strongly affected by multiple causes (Halpern et al., 2008). Another remarkable land use in the Mediterranean is that transforming wild territory into crops, and also the intensification of these activities and the urbanization along the coasts (Marin et al., 2021).

In addition, different forms of pollution (chemical, thermal, sporadic oil spill events, sewage and hazardous waste) are caused by the intensification of maritime traffic, coastal dredging, agriculture, forestry and oil and mining extraction. Biodiversity is also threatened by invasive species, e.g during the past decades, at least 300 Indo-Pacific species, known as Lessepsian migrants, have entered the Levantine Basin giving to its communities a mixed Mediterranean-Red Sea species composition (Msayleb et al., 2021). Their main unintentionally inoculated sources are ballast waters, and the primary cause of spread of these invasive species is related to aquaculture (Cury and Morand, 2004).

Due to the loss and degradation of Mediterranean habitats, caused largely by the construction of dams and the development of coastal infrastructures, in addition to other important factors such as pollution, droughts, invasive species and overexploitation, nearly 2000 threatened species have been evaluated in the Mediterranean region, of which 19% are in danger of extinction and at least 16 irreplaceable species are extinct, some of them endemic, such as the Canarian unicolor oystercatcher (Haematopus

meadewaldoi) (IUCN, 2008 in Marin et al., 2021). The fishing activities also exert strong pressure on Mediterranean habitats and species, e.g., the fishing fleet in Greece and despite a significant decrease in the last ten years, remains the largest in the European Union. Monitoring and mainstreaming of biodiversity into fisheries is mainly done through laws, in order to control fishing inputs and methods, including restricted areas for fish juveniles, and banning of drift. Add to the Law's Regulation 1967/2006 for the sustainable exploitation of fishery resources in the Mediterranean Sea, there is an ongoing discussion on the revision of the fishing regulations for the next period. In addition, a specific Greek Law 3937/2011 is dedicated to destructive fishing (e.g., by trawling) over maerl beds and coralligenous habitats (Ministry of Environment, Energy and Climate Change of Greece, 2014 in Pekakis and Delioglani, 2021).

Figure 2 summarizes fairly well the human pressures on the marine ecosystem in the Mediterranean : tourism, coastal development, maritime transport, land-based sources of pollution, professional and recreational fishing, aquaculture, underwater mining, oil and gas industries and offshore wind energy (WWF-France, 2015). As a result, ecosystems and certain categories of marine species are particularly vulnerable to threats posed by human activity. Species remaining on the surface (including the larvae of many commercial fish) are vulnerable to oil and other floating pollutants and increased ultraviolet radiation. Species requiring more than one habitat for development are threatened even if only one of these habitats is disturbed.

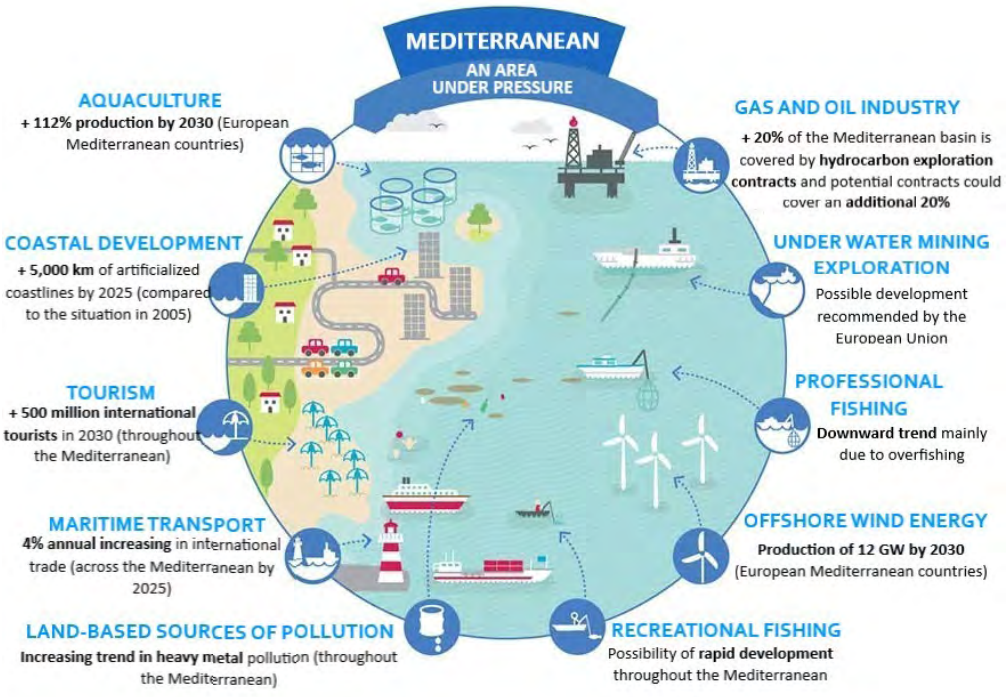

Figure 2. Macroeconomic trends in the Mediterranean basin (WWF-France, 2015 in Fosse et al., 2016)

There is a synergy between all of these pressures, which can lead to certain phenomena becoming more pronounced. For example, overfishing associated with the fact that there are no unexploited areas left, causes fish populations to collapse even faster. The loss of essential habitats, such as spawning areas or nurseries, also prevents some species from completing their life cycle (Cury and Morand, 2004). Contrary to popular belief, marine species are no less vulnerable to disturbance and overexploitation than terrestrial species: the drastic decrease in marine and ocean dwellers is less visible and perceptible, but very real and worrying (Jarboui, 2021).

Furthermore, it is important to note that the main consequence of climate change is the sea level rise, which causes flooding and destruction of habitats that cause important ecological damage. In addition, there is an issue related to water acidification. The CO2 that dissolves in the ocean forms carbonic acid, which acidifies the seawater whose pH has been constant for 300 million years. Acidification will cause problems for calcified plant organisms and marine invertebrates : some will no longer be able to build their skeletons and others, such as squid, may have difficulty transporting oxygen in their bloodstream, which has become more acidic (Jarboui, 2021). Otherwise, William and Victoria (2008) evaluate several approaches to discern the impact of ocean acidification on calcifying plankton, over basin scales. Finally, climate change also decreases the great movement of ocean waters, the global thermo-hyaline circulation, because it depends on water temperature and salinity (Cury and Morand, 2004).

The main problems that threaten marine and coastal biodiversity in the Mediterranean remain the urbanization, the overexploitation of natural resources, the proliferation of alien species, the increasing maritime traffic, and the pollution of the marine ecosystems. In a climate change context, this has led to the loss of the biodiversity, the growing scarcity of the most sensitive endemic species and the degradation of unique coastal and remarkable habitats (Afli, 2021b). These anthropogenic activities can have combined/cumulative effects more intensified (UNEP, 2015). As example, the different human pressures shown in Figure 3 have been assessed according to their impact on 8 marine ecosystem components, namely, seabirds, cetaceans, seals, fish, biologically derived rock and reef habitats, coastal sedimentary habitats, continental shelf sedimentary habitats, and deep sea habitats (UNEP, 2015). This assessment tracks changes in status in response to these pressures, and provides guidance on pressures for new or amended regulations (Jarboui, 2021).

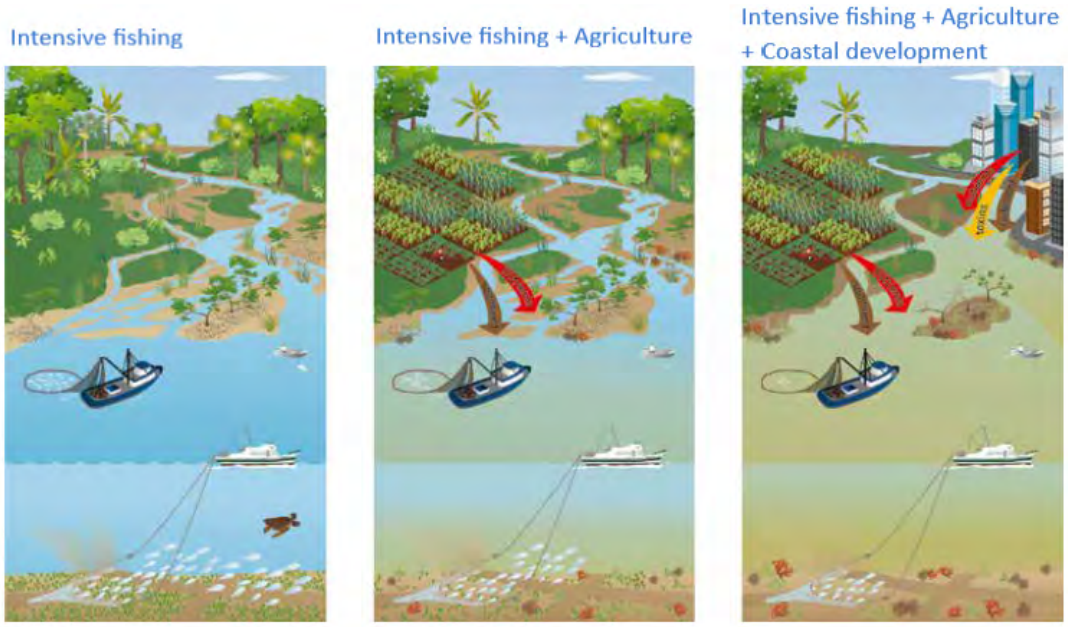

Figure 3. Combined/cumulative effects of anthropogenic activities on the marine ecosystem (UNEP, 2015)

A GIS (Geographic Information System) tool should be used to model how the different uses may affect particular habitats, giving state planners a way to predict impacts before permits are issued. The evaluation criteria are multiple and may vary depending on the case. Smit and Spaling (1995) propose 6 criteria for assessing cumulative impacts; they are temporal accumulation, spatial accumulation, the type of disturbance, accumulation processes, functional effects, and structural effects.

Considering pollution, despite progress made by Mediterranean countries in general, in reducing water and air pollution during the recent years and the reduction in the use of plastics (e.g., plastic represents 80% of marine debris in Greece (UNEP, 2016)) and the promotion of adaptation to climate change and the circular economy, pollution levels remains high. In Spain, e.g., about 34% of the peninsular surface undergone critical nitrogen inputs, indicating a high risk of eutrophication for its ecosystems. The use of plant protection products is also a major source of contamination in the mediterranean. Also, air pollution induce pressure on ecosystems and biodiversity because of the direct toxicity on organisms and because of the alteration it can cause to the biogeochemical cycles of ecosystems (water acidification) that can lead to changes in the composition and structure of plant communities, loss of biodiversity and degradation of ecosystem services. Nitrate pollution of inland waters, mostly derived from agriculture, affects key places for the conservation of biodiversity (Marin et al., 2021).

The tourism and leisure activities have a great importance to the environment, due to pleasant climate and the beaches of great attraction. Similarly, fishing, shell fishing and aquaculture have a great socio-economic impact. In the analysis of pressures carried out in the aforementioned strategy, physical pressures and pressures due to substances, garbage and energy are distinguished. Physical pressures refer to temporary or reversible physical disturbances of the seafloor that cause damage to the structure, functions and processes of ecosystems and that affect different species and habitats. The human activities that cause this pressure are the restructuring of the morphology of the seabed by dredging or depositing materials, the installation of cables for the transport of electricity and communications, fishing and shell fishing (both professional and recreational), marine aquaculture, marine transport, tourism and leisure infrastructures. Within the physical pressures, the loss of the marine substrate or habitats due to the sealing or modification of the bottom profile is also contemplated. This modification of the profile may be due to the extraction of sediments from the seabed and the creation of artificial beaches, while the sealing is produced by the construction of infrastructures whether they are port, coastal defence (especially transverse ones such as breakwaters), artificial reefs, hydrocarbon exploitation platforms, cemented wind farms and other structures installed offshore. Because of these disturbances, the alteration and destruction of benthic communities could occur. There is also a risk of the resuspension of toxic substances that can pass through the trophic food web. As for the pressure produced by contributions of substances, garbage and energy, the materials contemplated are nutrients (especially nitrate and phosphate), organic matter and other polluting substances from urban or industrial discharges, from rivers, discharges of dredged material, atmospheric deposition and discharges from ships. These discharges suppose in most cases an increase in the activity of the decomposing organisms that causes the decrease of the available oxygen. Depending on the substance of the spill, it can also lead to the contamination of the ecosystem by toxic substances (Marin et al., 2021).

Jarboui (2021), mentioned that the Tunisian coastline, which is home to 76% of the population, 87% of the industrial activity and 80% of the tourism activity, is subject to strong pressures that jeopardize the rational management of its natural resources and therefore its sustainability, in addition to climate change, and more particularly the accelerated rise in sea level. The protection of the public maritime domain and marine ecosystems is currently experiencing a certain revival of interest because of the disastrous consequences of industrial establishment, abusive exploitation and a strong attraction of an ever growing public for the coast, the sea and related leisure activities. However, such protection is subject to difficulties which arise mainly from the consideration of often contradictory concerns, between the general interest and

particular interests, between industrialists, fishermen and yachtsmen, and between coastal protection and the development of activities related to the sea. It is a delicate issue on which the effectiveness of the protection of the coastline and the public maritime domain depends (Jarboui, 2021). It should be remembered here that the DPM in Tunisia is made up of all public goods belonging to public persons, which are assigned for public use, and which are located near the sea or implanted in the interest of maritime navigation, whether natural or artificial (Ben Cheik, 1996). Moreover, it has been accepted that the coastline is a wider space than the maritime public domain, defined by Law n° 95-72 and Law No. 95-73 of 24 July 1995 creating APAL, in its article 1 as being "the contact zone that concretizes the ecological, natural and biological relationship between land and sea and their direct and indirect interaction" (Jarboui, 2021).

In 2018, Tunisian exports of fishery products reached 26,983 tons in quantity or 20.1% of total production for a value of 527.3 million dinars. During the same year, the Tunisian fishing fleet had 14,515 units of which 980 are non-active, or 6.8%. In terms of numbers, it appears that more than 92% of the Tunisian fishing fleet is made up of coastal boats, i.e. 13,376 units including 6,139 motorized coastal boats (BCM) and 7,237 non-motorized coastal boats (BCNM). The trawlers number 420 units, followed by sardine vessels with 412 boats and 39 tuna vessels. According to the regions, it appears that the southern region is home to more than 55% of the national fleet, all boats included. The activity of this fleet is supported and guaranteed by a fairly developed port infrastructure. In total, 57 fishing ports are scattered along the Tunisian coast, including 12 deep-sea ports that can accommodate large fishing units such as trawlers, sardine and tuna vessels (Tabarka, Bizerte, La Goulette, Kélibia, Sousse, Monastir, Teboulba, Mahdia, Chebba, Sfax, Gabès and Zarzis). The others are coastal ports that house the coastal fishing units and provide adequate services for this type of boats. In addition to this port infrastructure, there are several landing sites scattered all along the Tunisian coast, particularly at the level of lagoons and areas with difficult access. In 2018, the fishing activity was carried out by 50,201 fishermen (and 36,000 indirect jobs), 75% of whom are purely coastal fishermen and 50% are located in the southern region, while the northern and eastern regions account for only 26% and 24% of the total workforce, respectively (Jarboui, 2021). These activities have caused the overexploitation of the fishing resources, particularly benthic resources, and have degraded the quality of the coastal marine ecosystems. As an indication, the Posidonia meadow in the Gabes gulf is in continuous decline and this is particularly due to the pollution by phosphates and damage caused by trawling in shallow waters areas. Moreover, the zones of shallow depths are silting up, more and more, consequently losing its biodiversity (Jarboui, 2021).

It should be noted that fishing activity in Tunisia continues to suffer from many problems related to the scarcity of resources, the lack of enforcement of regulations as well as the inadequacy of a strategic vision and institutions capables of responding to them (Jarboui, 2021).

IV.
Analysis of existing strategies and measures facing threats to Mediterranean ecosystems

IV. Analysis of existing strategies and measures facing threats to Mediterranean ecosystems

The EU nature directives, that is, the Habitats and Birds Directives (EU, 1992, 2009), coordinate conservation efforts for more than 2000 species and habitats through EU Member States. Its overall goal is to restore or maintain these species and habitats in a favorable long-term conservation status. At the heart of these policies is the Natura 2000 network, which covers almost 20% of the EU's terrestrial waters and 10% of marine waters, making it the largest coordinated network of nature conservation areas in the world (Marin et al., 2021).

Recognizing the importance of climate change for the Mediterranean region, in 2008 the countries involved in the Barcelona Convention signed the Protocol on Integrated Coastal Zone Management (ICZM) of the Mediterranean, prioritizing adaptation to climate change. The Marrakesh Declaration, adopted by the Barcelona Convention in November 2009, highlights the need for immediate action to address the serious effects of climate change on ecosystems and resources. Later on, in 2011, the European Union introduced the "biodiversity strategy to 2020", which include six main targets including the reinforcement of the sustainable use of fisheries resources and ensuring good environmental status of the marine environment, fighting Invasive Alien Species, and help to avert global biodiversity loss. Lately, in 2019, the European Union enacts the biodiversity strategy for 2030 which is a comprehensive, ambitious and long-term plan to protect nature and help reverse the degradation of ecosystems. The strategy aims to put Europe's biodiversity on a path to recovery by 2030 and contains specific actions and commitments, mainly to establish a larger EU-wide network of protected areas on land and at sea, and to introduce measures to tackle the global biodiversity challenge (Pekakis and Delioglani, 2021).

The Integrated Coastal Zone Management is a tool for the governance of the coastal area that ensures the participation of a wide range of partners while taking into consideration the interactions between the natural resources of the maritime and coastal areas, the socio-economic constraints, and the possible conflicts of interest of the different sectors concerned (the ICZM Protocol signed in Madrid 20-21 January 2008 by the contracting countries including South European, North African and Middle East countries and entered into force on 24 March 2011). This Protocol is the first supra-state legal instrument aimed at encouraging Mediterranean countries to move towards an integrated approach to coastal management in order to better manage their coastal zones and to face current and new coastal environmental challenges. An action plan for the implementation of this ICMZ Protocol between 2012 and 2019 was also adopted in February 2012 (Jarboui, 2021). In practice, the ICZM has allowed the coordinated implementation of the different policies of the Mediterranean countries

that affect the coastal zone and that are related to activities such as nature protection, aquaculture, fisheries, agriculture, industry, offshore wind energy, maritime transport, tourism, infrastructure development and climate change mitigation and adaptation. This management was aiming to give an "ecosystem-based approach" that respects the limits of natural resources and ecosystems, contributing to sustainable development (Marin et al., 2021). Several programs have been conducted in this ICZM framework by the Mediterranean contracting countries in different related topics, and the results obtained are generally encouraging and have contributed to mitigating the impact of anthropogenic nuisances and safeguarding certain habitats/species.

For the plastic debris, European countries bordering the Mediterranean Sea are expected to gradually start implementing single-use plastics Directive 2019/904 from the European Union, into its national waste management policy from 2021 (Charitou et al., 2021).

The policy of the Mediterranean countries in terms of conservation of the environment, biodiversity and natural sites, has been centered for several decades on ecological tourism which respects the environment. Thus, it is particularly important to more coordinate tourism and public use policies in these countries in natural sites for the objectives of conservation and the restoration of the Mediterranean coastal ecosystems. But this poses often problems of conflicts between protection instruments and the sustainable tourism plan (Jarboui, 2021).

In the Mediterranean countries in general, fishing is restricted during some periods, such as spawning season to protect habitats and marine organisms. More stringent restrictions are applied in protected areas and priority habitats, such as the Posidonia meadows, and shallow depths (< 50m). However, the non-compliance with regulations and restrictions that have been set is a common phenomenon in Mediterranean countries. Nevertheless, in the European countries, the fisheries and aquaculture are governed by European Union policy, namely the Common Fisheries Policy (OECD, 2020), which regulates the sector and imposes restrictions based on conservation needs both of species and habitat types (Pekakis and Delioglani, 2021).

Several projects in the Mediterranean regions involve citizens for the monitoring of the quality of coastal ecosystems, e.g. (Jarboui, 2021) :

- Vigie-Nature Project : Founded and supported by the National Museum of Natural History (France);
- GEIR Project : Group of Invasive Species of La Réunion, (Groupe Espèces Invasives), France";

- • BIOLIT Project : The observers of the coastline (Les observateurs du Littoral), France ;
- • BioObs Project : Basis for the Inventory of Underwater Observations (Base pour l'Inventaire des Observations Subaquatiques).

To curb the degradation of ecosystems caused by human pressures, different measures have been taken by Mediterranean coutries, ranging from the adoption of strategies, plans and programs to actions of awareness and environmental education, as well as concrete actions of conservation, restoration and fight against threats. In Spain, e.g., conservation strategies are regulated by article 57 of Law 42/2007 on Natural Heritage and Biodiversity and by article 11 of Royal Decree 139/2011, for the development of the List of Wild Species in Special Protection Regime and the Spanish Catalogue of Threatened Species (Marin et al., 2021).

For Invasive Exotic Species, Spain has established a specific Catalogue that has been modified in 2019 by adding four new species of fauna, and the scope of application of two plant taxa has been extended to the Canary Islands. In 2020, three new species were attached to the Spanish Catalogue (Rugulopteryx okamurae, Acacia melanoxylon and Reticulitermes flavipes). Six strategies have been adopted that focus on management, control and possible eradication guidelines for the fight against exotic species that pose a greater risk to the natural environment and biodiversity, such as the Action Plan on the ways of introduction and propagation of these invasive alien species (Marin et al., 2021).

In Tunisia, the Coastal Protection and Development Agency (APAL, non-administrative public establishment, created by law N°95-72 promulgated on 24/07/1995) is the state body called upon to implement the State's policy in the field of coastal protection and development, to protect the public maritime domain against encroachments and illegal occupations, and to give its approval to any development and equipment project on the coast before its execution and this, within the framework of consultation with the stakeholders. The APAL is increasingly involved in the preservation of the resources necessary for the development of tourist activity. The management of the coastline and more precisely of the Maritime Public Domain is one of its major manifestations (Jarboui, 2021).

In Tunisia, before the promulgation of the town planning code in 1994, coastal management was based on the boundaries of the Public Maritime Domain established by decrees dating back to French colonization. Thus, the encroachment on the DPM by some tourist establishments have taken place, e.g. in the Tabarka region, tourism

started in 1992, with hotels built in dune and pre-dune areas, which is normally prohibited by the laws relating to the respect of the Maritime Public Domain. This has prompted hotels to sought to mitigate the phenomenon of erosion by riprap or sand artificial recharging, such as the case in Djerba. This prompted the public authorities to revise the old DPM boundaries by introducing new boundaries reinforced by the promulgation of the urban planning code in 1994 which imposed a setback from these boundaries, namely 25 m minimum in areas already covered by a development plan and 100 m minimum for future areas to be developed (Jarboui, 2021). On another level, Tunisian citizens are increasingly involved in programs related to the environment, they are involved in scientific projects to monitor the quality of marine ecosystems ; e.g. the National Stranding Network (RNE, established in 2004 for marine turtles and cetaceans), Project ADMIR Gabès (2016-2017, against the Degradation of the Environment and the Resources in the governorate of Gabès) (Jarboui, 2021).

The political measures undertaken by the Tunisian State to face the threats to the Tunisian marine ecosystems are essentially translated into actions and decision making. The latter are, in the majority of cases, coordinated and executed by the services of the competent authorities, via the organizations and institutions concerned, e.g. several actions have been undertaken by the Tunisian authorities, with the support of international cooperation (as GIZ, UNDP, WB), mainly on capacity building and the awareness of the sectorial actors and the large population on the major challenges and risks incurred by the coast (Jarboui, 2021).

Pozzi et al. (2021) mentioned that the key tools for the management and protection of Italian coastal areas are :

- Spatial plans (Regional Landscape Plan, Regional Environmental Landscape Plan, Regional Government Plan, Territorial Coordination Plan of the Province, Municipal development plans and Spatial and land-use plans)
- Water Catchment Management Plans
- Flood Risk Management Plans
- Hydrogeological Plans
- Regional Water Protection Plans
- Regional Coastal Plans
- Protected coastal ecosystems (National Parks, Regional Natural Parks, Nature Reserves).

Marin et al. (2021) noted that the main regulation in relation to the conservation of the Environment in Spain is Law 42/2007 of December 13, on Natural Heritage and Biodiversity, which establishes the basic legal regime for the conservation, sustainable use, improvement and restoration of natural heritage and biodiversity. This law provides a series of instruments for the planning and knowledge of natural heritage and biodiversity, such as the Guidelines for the Management of Natural Resources, the Strategic Plan for Natural Heritage and Biodiversity and the Spanish Inventory of Natural Heritage and Biodiversity.

Pekakis and Delioglani (2021) mentioned that there are a total of 1.249 protected areas in Greece (Figure 4), 446 Natura 2000 sites and 90 Sites of Community Importance (Habitat Directive) - as well as 803 sites designated under national laws, so it is clear that the protected area network in Greece is strongly influenced by Natura 2000 sites, which make up 50% of the total area covered by protected areas.

As part of its European and Mediterranean commitments, Greece has developed in 2014 The National Biodiversity Strategy and Action Plan (NBSAP) with its 15 year of duration (2014-2029) and has set 13 general targets to be achieved, including the biodiversité conservation, the ecosystem restoration, the establishment of protected areas, the conservation of the genetic resources, the prevention and minimisation of the impacts of climate change on biodiversity, the protection of biodiversity from invasive alien species, the sustainability of tourism, etc. The NBSAP includes several actions on the compatibility of tourist activities with biodiversity conservation. Key actions include developing ecotourism and agro-tourism, establishing frameworks for infrastructure development, especially in protected areas, and defining monitoring indicators (Pekakis and Delioglani, 2021).

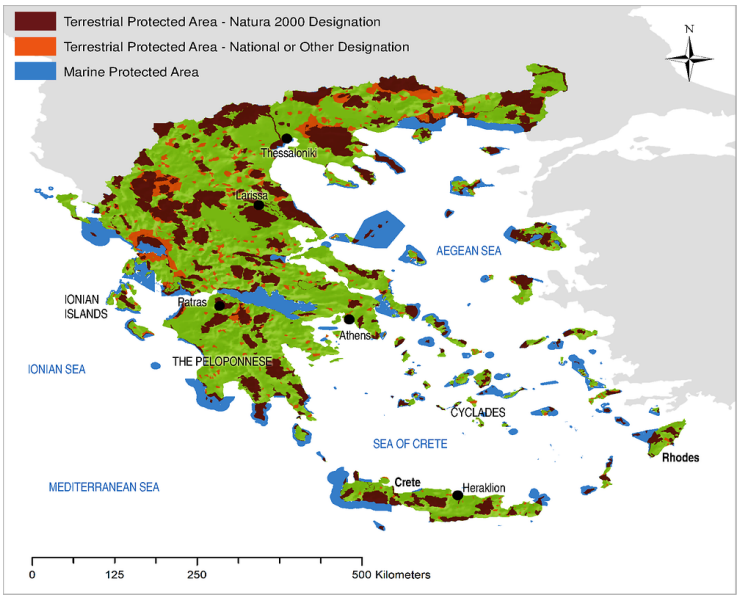

Figure 4. Network of protected areas over Greece (UNEP-WCMC and IUCN, 2019: The World Database of Protected Areas in Pekakis and Delioglani, 2021)

Greece has achieved a large part of these objectives, whether on the institutional level (creation of institutions, areas management, establishment of a national gene bank, marine protected areas and biodiversity databases) or on the level of acquisition/analysis of data (several projects) (Pekakis and Delioglani, 2021). Greek Government has already applied some of the above measurements, in order to face the relevant threats to ecosystems, in the last decade, with the financial assistance of the European Union. Also, the National Programme for the Environment assisted by regional activities dealt with water quality and pollution in coastal areas. Additionally, the program LIFE-Nature for coastal areas was involved with many projects for management of environmental problems (Valavanidis, 2018). Program LIFE contributes to the sustainable development and achievement of the goals and objectives of the Europe 2020 strategy. Finally, under the supervision of the Ministry of Environment and Energy, online tools (visualization via maps) have been designed, which include either dataset with the boundaries of 244 Special Conservation Areas (Habitats Directive 92/43) or 202 Special Protection Areas (Birds Directive 2009/147) (Pekakis and Delioglani, 2021).

V.
Conclusion

IV. Conclusion

The Mediterranean countries are more or less advanced in term of ecological tourism. Their sustainable tourism plans encourage green tourism, sub-segments of particular interest such as bird watching, cetacean watching and actions such as the promotion of products based on natural heritage that can intensify tourism activities in Marine Protected Areas. In this sense, it is necessary to reconcile tourist uses with the respective existing regulations concerning the most sensitive and fragile elements of the territory (Protected Natural Areas), such as the need for permits and authorizations to carry out any tourist activity in the network, and therefore to regulate the activities and practices of green tourism in national parks that are sources of conflict. In addition, the various sectorial actions and strategies established by these countries need to be made consistent in order to establish complementarity between them, hence the need to put in place a Regional Climate Change Strategy aimed at a sustainable and coherent integration of mitigation and adaptation components in these countr's development policies (Jarboui, 2021).

The protection of marine ecosystems could be considered as a primary factor in the sustainable development of tourism. Indeed, the tourist community is always looking for a diversification of actions and programs (e.g. excursions, leisure). This diversity could only be provided by varied and in good ecological condition ecosystems.

In general, Marine Protected Areas (MPAs) are useful tools for implementing ecosystem-based management, by regulating the different human uses in a given area. They can correspond to small, highly specialized areas (such as wilderness reserves protecting a fish species from overfishing), to large, complex areas with multiple uses (Jarboui, 2021).

For many countries, tourist activity is a godsend for employment and foreign currency resources. However, in recent years, this activity has demonstrated its limitations on many levels (Abdennadher, 2014). In order to move away from the traditional modes of massive productivity in this sector, new branches can be envisaged to diversify the modes of attraction, such as the involvement of tourists in citizen scientific activities which could represent an asset for integrating sustainability in the tourism sector. It is an authentic model of a tourism that respects the environment, also qualified as responsible tourism, even ethical. Thus, scientists can then be assisted, including, by the general public (mainly eco-volunteer tourists) or associations. The motivation of these actors can be a determining factor for the scope and quality of certain studies (Neil et al. 2010). According to IPBES (2019), it is estimated that one million species will be would extinct in a span of decades if pressures continue at the current level,

finding us in the sixth mass extinction (Marin et al., 2021). The excessive development of tourist coastal infrastructure (including large hotels, malls etc.) affect coastal areas, by removing large amounts of water, causing soil and water pollution, consuming energy, and altering the landscape. Also, recreational activities like off road vehicle driving in coastal areas (dunes/beaches), the illegal use of speedboats, scuba diving and snorkeling, wind surfing or fishing may damage or destroy natural habitats or disturb sensitive species. So it is clear that, there is a need that those activities took place in areas where they have been approved by competent authority. Last but not least, the important population raise during the touristic season affects the marine and coastal ecosystems in multiple ways. One issue is that overcrowded beaches can disturb the flora and fauna that live on beaches and shallow waters. Additionally, the rising of population means garbage quantities increasing at coastal areas (Pekakis and Delioglani, 2021).

In Tunisia, a National Committee for Climate Change was established in 1996 within the framework of a UNDP regional capacity development program. It was an informal entity responsible for coordinating work related to climate change mitigation and participation in international negotiations. It was to support the work of the National Commission for Sustainable Development (CNDD). Currently, the INM is finalizing the downscaling modeling work of climate projections for Tunisia. But, the integration of climate change into sectorial development policies remains limited because there is no national cross-sectorial structure dedicated to the formulation of national policies on climate change mitigation and adaptation and to the harmonization of efforts made at the level of the different sectors (Jarboui, 2021).

The tourism can be unsustainable if practiced in mass amounts. However, many alternative types of tourism and recreational activities have developed worldwide, and can be generalized in the entire Mediterranean basin. Figure 5 reveals the comparison between the sustainable and unsustainable Ecotourism. These types promote sustainability in terms of tourism. Ecotourism constitutes one of these types. It is also known as nature tourism. In Lebanon, e.g., it has registered a significant increase in the number of ecotourism providers since 1991. As a result of designating nature reserves and protected areas in Lebanon, ecotourism has shown progress. For instance, around 56,000 visitors entered the Lebanese nature reserves in 2004, contributing to a growth of around 56% from the year 2000 (MoE and UNDP, 2011 in Msayleb et al., 2021).

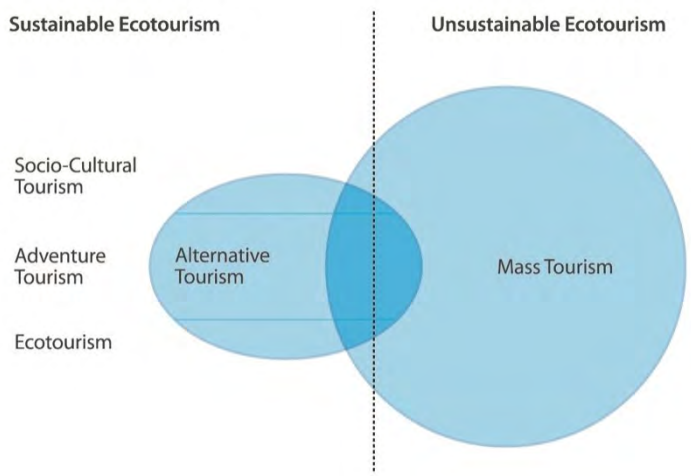

Figure 5. Sustainable versus unsustainable ecotourism (Dimopoulos, 2017)

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