Pollution and Other Anthropogenic Pressures Affecting Ecosystems

Greece scale

ENI CBCMED
Cooperating across borders in the Mediterranean

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Co-Evolve4BG

Analysis of Threats and Enabling Factors for Sustainable Tourism at Pilot Scale

Pollution and other Anthropogenic Pressures Affecting Ecosystems

Greece Scale

REGION OF EASTERN MACEDONIA & THRACE

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OVERVIEW

The present document was produced in the framework of **Co-Evolve4BG project "***Co-evolution of coastal human activities & Med natural systems for sustainable tourism & Blue Growth in the Mediterranean" i*n relation to Threats and Enabling Factors for maritime and coastal tourism development on a national scale" Co-funded by ENI CBC Med Programme (Grant Agreement A_B.4.4_0075).

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REVIEW

Contributors

Savvas Chrysoulidis, PhD
Geoinformatics and Spatial Analysis, Greece
Giorgos Gkiouzepas, PhD
Environmentalist, Greece
Ioanna Papaioannou, MSc
Rural Economy & Development, Greece

Reviewers

Dimitris Kokkinos, PhD
REMTH - Coastal Engineering, Greece
Maria Hamitidou, Engineer
REMTH - Directorate of Technical Projects, Greece
Gil MAHE, PhD
IRD - Montpellier, France
Emna Gargouri-Ellouze, PhD
University of Tunis El Manar, Tunisia
Artemis TSOLAKI, MSc
Head of Department for Life Long Learning, Employment, Trade and Tourism
Eirini ARGYROPOULOU, MSc
REMTH - Civil Engineer, Greece

Supervisors

Béchir BEJAOUI, PhD
National Institute of Marine Sciences and Technologies, Tunisia
Paraskevi Chouridou, MSc
REMTH - Head of Department of Development Planning, Greece
Spyridon ARSENIOU, PhD
Head of Dep. for Regional Policy Planning, at Region of East Macedonia and Thrace

LAYOUT

Khouloud Athimen, Engineer, Technical Coordinator
National Institute of Marine Sciences and Technologies, Tunisia
Houaida Bouali, Engineer
National Institute of Marine Sciences and Technologies, Tunsia
Mohamed Ali Briki, Engineer
Coastal Protection and Planning Agency, Tunisia

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Abstract

This deliverable aims to integrate research and record the Ecosystem Services (ESS), which are related to the welfare and health of humans which are linked to the well-being and health of humans which remain of paramount importance, as their value is directly linked to the quality of the environment. Their definition and classification are fundamental to understanding the concept and its meaning. Except for apparent benefits to the ecosystem, there should be a different approach to identifying both strengths and weaknesses. Also, it should highlight the different types of ecosystems that have different strengths and weaknesses and are under pressure from various threats, some of which are common. The most recent approaches avoid the risk of double-counting by distinguishing between intermediate and final services. However, integrating the two visions, environmental and economic, into a single approach can make a difference in business management and policymaking, providing a holistic approach. Marine and coastal ecosystems produce a variety of provisioning, support, regulating, and cultural services.

The integration of the ecosystem services dimension in the tourism sector is represented by exploring environmental resources regarding tourism and adopting management plans in this context. Like all the other Mediterranean countries, there are direct impacts from the beach and maritime tourism on the Greece scale. Concerning pollution, it affects water contamination (sea, lakes, rivers, sources), in most cases related to discharges of untreated wastewater due to the absence or malfunctioning of water treatment installations. Solid waste is another source of threat that mainly affects the marine environment. The growth of the tourism industry and the construction of tourist infrastructures and buildings result in the decrease of natural and agricultural areas and the general degradation of the environment, even on an aesthetic aspect. In the natural environment, fauna and flora are widely affected by tourism activity. Moreover, tourism leads to the degradation of landscapes, historical sites and monuments with modern amenities and other infrastructure facilities to become accessible and attractive for tourism. In the same context, there is the reduction of arable land and jobs in the primary sector, leading to the decline of agriculture in coastal areas with high tourist attractiveness.

Greece is involved in the Integrated Monitoring Principles, which cover, for the first time, biodiversity, invasive species, marine, and atmospheric pollution and litter, coastline, and hydrography in an integrated manner. It aims to facilitate understanding the interaction between tourism and threats on the coastal and maritime environment.

I. Classification of ecosystem services

The concept of ecosystem services refers to the ecosystems that play a vital role in human well-being, health, livelihoods, and survival (Costanza *et al.* 1997; MEA, 2005; Phillips and Sul, 2003). Ecosystem services are defined in many ways as they can be expressed as the benefits that people derive from ecosystems (MEA, 2005) or as the direct and indirect benefits of ecosystems to human health and well-being (Gowdy *et al.* 2010). The presence of people (human capital) is an essential factor in creating the conditions where an ecosystem provides benefits to them, their societies (social capital), and their artificial environment (built capital). Consequently, ecosystem services should be seen as supplying natural capital to human health and well-being, composed only by synergy with human, social, and built capital (Fig. 1).

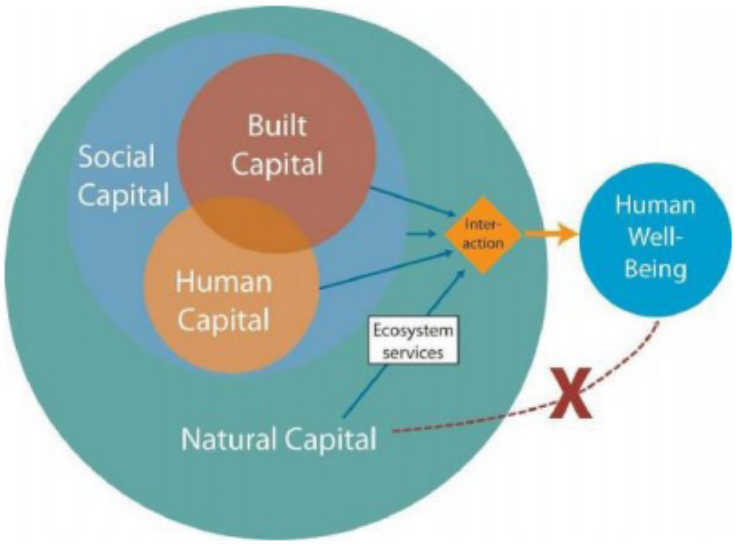

Figure 1. Interactions between built, social, human, and natural capital required to produce human well-being (Costanza *et al.* 1997)

Another approach for ecosystem services referring to the interaction between man and nature, which represents the "waterfall model" (Burkhard and Maes, 2017; Potschin and Haines-Young, 2016). This model illustrates the causal links between the ecosystem and human well-being (Fig. 2). Its biophysical formations and rules describe the ecosystem in this model. More simplistically, the biophysical formation can be specified as a habitat type (*e.g.*, woodland, wetland, grassland, *etc.*). At the same time, processes refer to the interactions and growth dynamics of the ecological system (*e.g.*, primary production). In the context of the cascade model, the ecosystem functionality is recognized as the features or functions of the ecosystem that underpins its ability to perform an ecosystem service (*e.g.*, the power of the woodland or grassland to generate a standing stock of biomass (Ruskule *et al.* 2018).

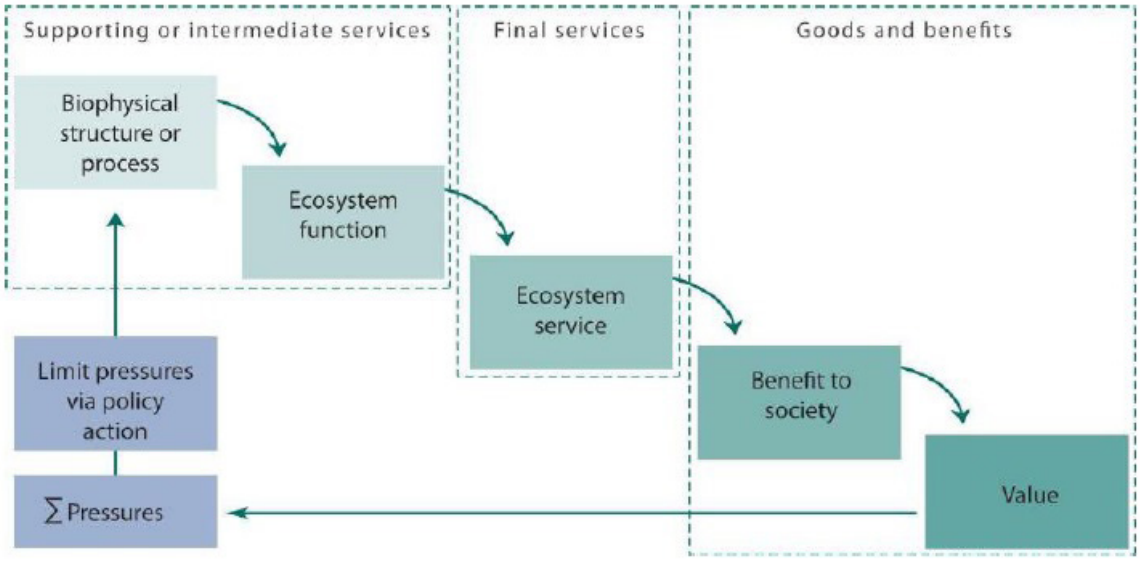

Figure 2. The cascade model (Potschin and Haines-Young, 2016)

Factors and characteristics behind the ecosystem's capacity to deliver services are sometimes named "supporting" or 'intermediate' services. In addition, while the 'final' ecosystem service is what we really can accumulate (*e.g.*, hey, timber) or obtain from the ecosystem (*e.g.*, flood protection, beautiful landscape, *etc.*). End" services directly deliver human health and well-being in relation to the benefits they support (*e.g.*, health and safety). People attribute values to the benefits. Therefore, they are also mentioned as "goods" and "products". Moral, aesthetic, or other qualitative criteria can be used to express the value.

Classification of ecosystem service is a precondition for any effort to measure, map, or evaluate them and to publish the results in a clear-cut way (Burkhard and Maes, 2017).

Plenty of different typologies and approaches are generated by classifying the ecosystem services and using various criteria. These criteria are spatial character and scale; service flow (as the cascade model); service beneficiary (private vs public); type of gain ('use' vs. 'non-use'), or whether the use of a service by somebody or a group of people influences the use by others ('rival' vs 'non-rival). One of the points of view is how can we approach the classification of ecosystem services. This approach was also the basis of the MA classification system, proposing four major categories of ecosystems (Table 1) thanks to the growing awareness in society of the various benefits that humans derive from the ecosystem.

Table 1. The four types of Ecosystem Services (MEA, 2005)

PROVISIONING SERVICES	**CULTURAL SERVICES**
Products obtained from the natural ecosystems: •Food •Wood, fuel and fibre •Medicinal plants, pharmaceuticals •Genetic resources •Ornamental resources -----	Non material benefits that contribute to wider needs and desires of society: •Aesthetic values •Spiritual and religious •Educational •Recreation and tourism -----
REGULATING SERVICES	**SUPPORTING SERVICES**
Benefits obtained from regulation of ecosystem processes, rarely given a monetary value in conventional markets: •Climate regulation •Flood control •Water regulation and purification •Bioremediation of wastes •Pollination -----	Necessary for the production of all other ecosystem services: •Nutrient cycling •Primary production •Soil Formation •Water cycling •Provision of habitat •Production of atmospheric oxygen -----

Europe has adopted a more operational and comprehensive Ecosystem Services (ESS) classification. This classification is called Common International Classification of Ecosystem Services - CICES (Potschin and Haines-Young, 2016)and it was formed as part of the work done in Europe on ecosystem accounting. CICES contains the following three ESS sections: provisioning (such as food and water production), regulation and maintenance (such as climate and disease control), and cultural (such as spiritual and recreational benefits). A fourth ESS section, namely the "supporting" section, comprises structures, processes, and functions (*e.g.*, soil formation), and hence it is not included in the CICES classification. Each of the ESS sections is divided into divisions, then groups, and then classes (Fig. 3).

European Environment Agency introduces another approach regarding the ecosystem services classification, based on their value (use - non-use), as follows:

- Use values:
  - Direct use (*e.g.*, fishing, irrigation)
  - Indirect use (*e.g.*, flood control, water purification)
  - Optional use, such as services that might be beneficial in the future (*e.g.*, genetic sources from crop improvement)

- Non-use values: such is the value that people attribute to goods, even if they never have and will never use them. It involves basic concepts as the bequest value or existence value (for example, ensuring the availability of biodiversity and well-performing ecosystems for future generations).

Greece is also characterized by a dynamic diversity of ecosystems and habitat types (Fig. 4). The ecosystems vary from semi-desert, such as the palm forest of Vai in Crete, to the cold climate of mountain forests of birch, Scots pine and spruce. There is also a wide variety of landscapes in Greece, which might be attributed to the same factors that favor the extraordinary genetic diversity, species richness and ecosystem heterogeneity, including the deep history of human appearance and civilization. This assemblage of landscapes covers the semi-arid ones from southeastern Crete, the mountainous forests and plateaus of Mt Olympus, and the Pindus range (in the central region of Greece), to the central and north European landscapes of Rodopi (Ministry of Environment, 2014).

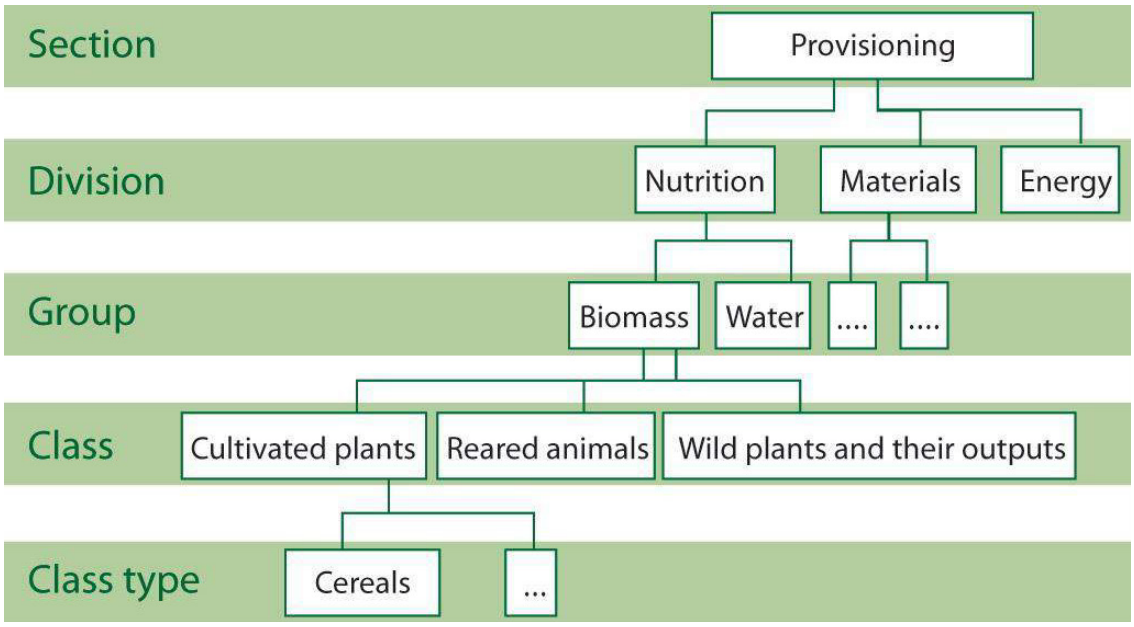

Figure 3. The hierarchical structure of CICES illustrated regarding a provisioning service (cultivated plants- cereals) (MEA, 2005)

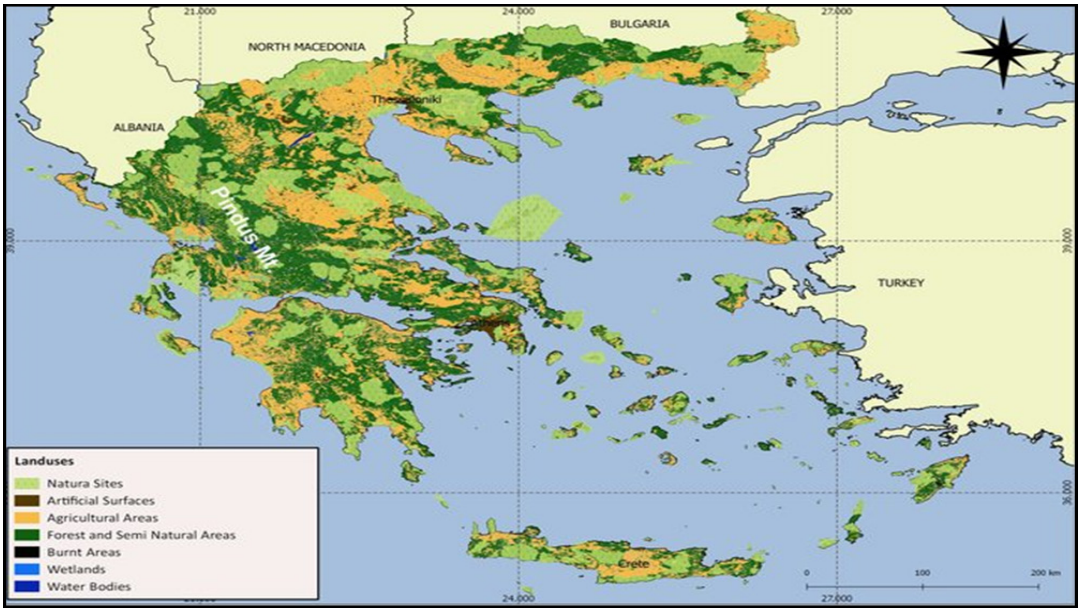

Figure 4. Land uses in Greece based on CORINE CLC 2012 and Natura 2000 network (Gemitzi *et al.* 2019)

II. Coastal ecosystems and associated services

The Mediterranean coastline has provided several ecosystem services by a variety of ecosystem types, more specifically the classification of the Mediterranean coastal and marine systems as (Drius *et al.* 2017):

Sandy shores: loose deposits of sand, gravel, or shells that cover the shoreline.

Estuaries: that section of the mouth or lower route of a river where the rivers stream joins the sea's tide.

Coastal shelf: the seabed surrounds a continent at depths up to about 200 meters, at the edge of which the continental slope drops steeply to the ocean floor.

Evergreen needle leaf forests: for instance, *Pinus* spp. associations.

Evergreen broadleaf forests: for example, *Quercus ilex* associations.

Shrublands: coastal shrublands such as *Juniperus* spp. associations.

Permanent wetlands: permanently wet systems as slacks, depressions, and lagoons.

Coral reefs: oceanic ridges or reefs consist of coral and other organic material consolidated into limestone.

Seagrass: marine meadows of flowering plants from the order Alismatales.

Swamps-floodplains: forested wetlands • Grasslands: dune grasslands and heathlands.

Table 2 records the areas (in hectares) of the terrestrial and coastal ecosystem types per Mediterranean country and their equivalence with CLC classes and CLC codes. Evergreen broadleaf forests occur extensively in all countries, with Italy hosting the most significant portion. However, sandy shores and estuaries show the lowest extents. Greece offers large surfaces of all considered ecosystems, particularly in association with the other larger countries. Table 3 presents the principal-wide ESS categories produced by each coastal ecosystem.

Table 2. Extent (hectares) per country involved in CO-EVOLVE of those Mediterranean coastal ecosystem types for which correspondence with CLC classification could be found (Drius *et al.* 2017)

Coastal ecosystem type	*CLC class*	*CLC code*	*Italy*	*France*	*Croatia*	*Spain*	*Greece*
Sandy shores	Beaches, dunes, sands	3.3.1	14,051	3,544	26	3,355	7,718
Estuaries	Estuaries	5.2.2	167	-	-	2,834	1,096
Evergreen needle leaf forests	Coniferous forest	3.1.2	78,795	39,336	29,688	176,255	223,166
Evergreen broad leaf forests	Broad-leaved forest; Mixed forest	3.1.1 3.1.3	558,517	131,114	292,269	105,798	325,538
Shrublands	Scrub and/or herbaceous vegetation associations	3.2	102,107	73,661	154,439	54,236	329,691
Permanent wetlands	Salt marshes; Intertidal flats; Coastal lagoons	4.2.1 4.2.3 5.2.1	130,796	116,327	480	34,741	44,175
Swamps-floodplains	Inland marshes	4.1.1	6,395	3,158	3,053	20,154	10,411
Grasslands	Natural grasslands	3.2.1	127,068	55,248	78,075	88,857	419,765

Table 3. List of coastal ecosystems and primarily associated ecosystem services. They are modified after Martinez *et al.* 2007 (Drius *et al.* 2017)

Coastal ecosystem types	*Coastal ecosystem services*		
	Provisioning	***Regulation***	***Cultural***
Sandy shores	Pollination Habitat/Refugia Raw material Storm protection	Disturbance regulation Erosion control	Recreation Inspiration
Estuaries	Habitat/Refugia Food production Raw material Storm protection	Disturbance regulation Nutrient cycling Biological control	Recreation Inspiration
Coastal shelf	Food production Raw material	Nutrient cycling Biological control	Inspiration
Evergreen needle leaf forests	Climate regulation Food production Raw material	Waste treatment Biological control	Inspiration
Evergreen broad leaf forests	Water supply Food production Raw material Genetic resources	Climate regulation Disturbance regulation Water regulation Erosion control Nutrient cycling Waste treatment	Recreation Inspiration
Shrublands	Pollination Food production Raw material Genetic resources	Gas regulation Waste treatment Biological control	Recreation
Permanent wetlands	Water supply Food production Habitat/Refugia Raw material Storm protection	Gas regulation Disturbance regulation Waste treatment	Recreation Inspiration
Coral reefs	Habitat/Refugia Food production Raw material Storm protection	Disturbance regulation Waste treatment Biological control	Recreation Inspiration
Sea grass	Raw material Storm protection	Nutrient cycling	
Swamps-floodplains	Habitat/Refugia Raw material Food production	Gas regulation Disturbance regulation Water regulation Water supply Waste treatment	Inspiration Recreation
Grasslands	Pollination Food production Raw material Genetic resources Storm protection	Gas regulation Climate regulation Water regulation Erosion control Waste treatment Biological control	Recreation

III. Relevance of ecosystem services (ESS) for coastal tourism

Most people associate the coastal systems with magnificent natural landscapes and a deep feeling of wellness and recreation. Coastal tourism remains one of the most favorite kinds of outdoor recreation, especially for people coming or normally living in an urban area.

The integration of the ESS dimension in the tourism sector is shown in environmental resources worldwide for tourism and management strategies. A precise and studied interaction can increase the requirements of a sustainable tourism development and safeguard these critical assets of the tourism product, which are, in the first place, the environmental, urban, and cultural aspects. This relationship has been revealed through the following salient points with a descriptive list of ESS provided by the coastal environment given here:

Cultural diversity: The diversity of ecosystems is one factor affecting the variety of cultures.

Spiritual and religious values: Many religions associate spiritual and religious importance to ecosystems or their elements.

Knowledge systems (traditional and formal): Ecosystems affect the types of knowledge systems generated by different cultures.

Educational values: Ecosystems and their components and methods produce the basis for both formal and informal education in various societies.

Inspiration: Ecosystems provide a valuable source of inspiration for art, folklore, national symbols, architecture, and advertising.

Climate value: Ecosystems provide a valuable source of climate services explored for coastal tourism sunbathing, pleasure boating, snorkeling, reef walking, and scuba diving.

Natural areas are aimed at ecotourism, which can be defined as a service related to natural areas, that preserves the original environment by ensuring the well-being of the local population and the relationships of the elements of the ecosystem.

IV. Scaling of ecosystem services to the Mediterranean scale

The Mediterranean Sea is the largest of the semi-enclosed European seas; it extends on 2,969,000 km² (0.82 % of the world's ocean surface), with an average depth of 1,460 m (maximum 5,267 m), and it is connected to the Atlantic Ocean in the west, to the Black Sea by the Bosphorus, and the Dardanelles in the north-east and to the Red Sea via the Suez Canal in the south-east. The area includes a broad array of habitats, including brackish water lagoons, estuaries, transitional spaces, coastal plains, wetlands, rocky shores, seagrass meadows, coralligenous communities, upwellings, seamounts, and pelagic systems (EEA-UNEP/MAP, 2014).

Enclosed by 22 countries that share a coastline of 46,000 km, the Mediterranean region is residence to approximately 480 million people living across three continents: Africa, Asia, and Europe. Beautiful landscapes and lush biodiversity, cultural heritage, and traditional lifestyles, coupled with favorable environmental conditions such as a mild climate, beaches, and crystal-clear seawaters have made the Mediterranean region one of the most famous tourist destinations worldwide (Fig. 5). In 2010, it is estimated at 285 million tourist visitors or 28% of international tourism in the world (EEA-UNEP/MAP, 2014; UNEP/MAP, 2012).

The Mediterranean region is one of the world's biodiversity hotspots, with many endemic species, with 10% more plant species, and 7% more marine species (Plan, 2008). Thanks to its unique biodiversity, the area can deliver a vast abundance to its inhabitants and visitors, economically translated into 26 billion €/year. This remarkable economic Figure results from an economic evolution of the ESS based on six ESS in four Mediterranean marine ecosystems (seagrass beds, coralligenous communities; areas with complex substrate areas with photophilic algae; areas with soft substrate and open sea).The service types related to the following ESS categories: provision of food resources (provisioning); amenities and support for recreational activities (cultural); climate regulation, mitigation of natural hazards, and waste treatment (regulating; Drius *et al.* 2017).

The natural environment is diverse in terms of space and time, and these modifications are vital and affect the diversity of living species. These variations must occur at an extensive range of spatial scales: climates differ on different dimension scales. To realize how environmental management influences ecosystem services, we can declare that complexity is due to the consideration of different types of "scales" - spatial scales, temporal scales, and scales of biological and human organization. Biodiversity, conservation, and management will only be productive when we realize how much the problems and the solutions depend on these scales. Climate change may be climate change at one scale, while at others, habitat loss and fragmentation or disorder must be viewed differently (Henle *et al.* 2010).

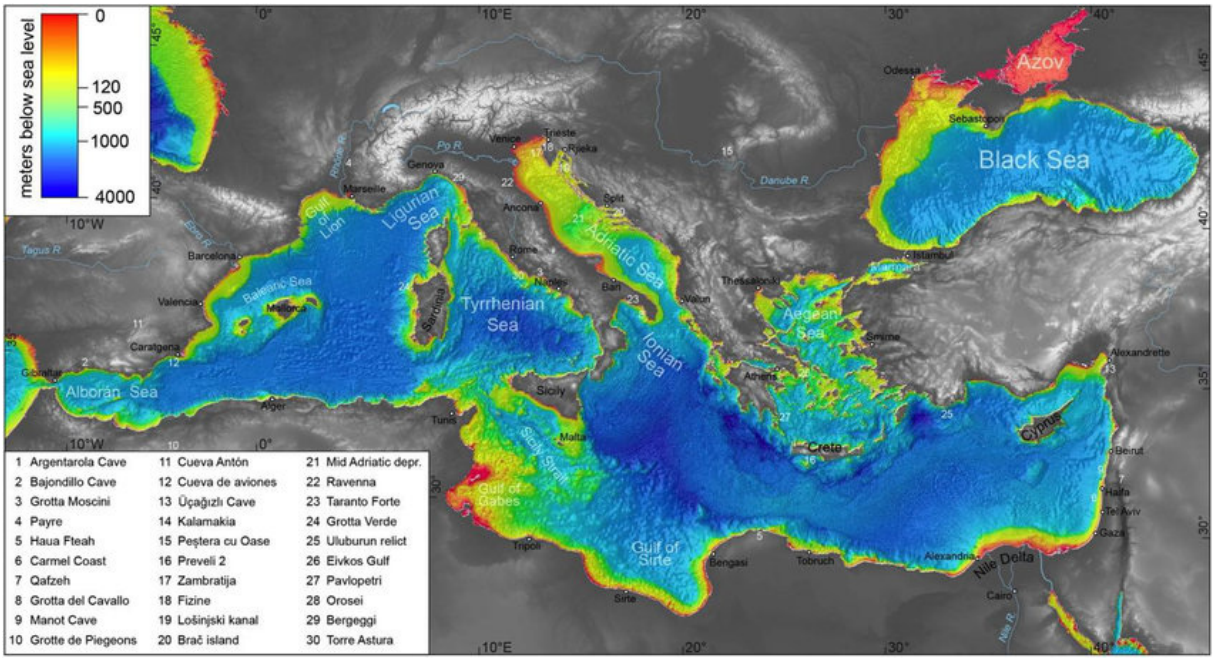

Figure 5. A topographic map of the Mediterranean Sea region with bathymetric data derived from the European Marine Observation and Data Network (http://www.emodnet.eu/). Topographic data derived from Shuttle RADAR (Benjamin *et al.* 2017)

V. Direct impacts from beach maritime tourism

The tourist activity has a vital weight in the world economy, being even the main activity responsible for the trade of many countries and the provision of services to foreign citizens. However, this activity also has its negative impacts.

- Pollution is considered one of the main negative impacts of maritime beach tourism, which is affected in several ways, such as:
  - Air pollution occurs primarily in increased automobile traffic and secondary due to energy production and use.
  - Water pollution (sea, lakes, rivers, sources) in most cases associated with discharges of untreated wastewater due to the absence or malfunctioning infrastructures of water treatment, due to the high pressure of the vast number of tourists where in most cases the tourism development is not followed by facilities improvements.
  - Solid waste is another cause of threat with discharge from recreational boats, motor boating (oil spill). There is another reliable waste origin, pollution of the environment by trash dumps (picnics, outdoor activities, forests walking, *etc.*), and the lack or the inadequacy of a waste transfer system (mainly in the form of household waste).
  - Noise pollution mainly due to traffic, cars, or the use of recreational vehicles (snowmobiles, motorcycles, motorboats, light planes, *etc.*), but also to the influx of tourists or to the ensuing entertainment (advertising podiums, beach parties, beach contests).

- Decrease or loss of natural and agricultural fields, in recent decades the extensive growth of tourism has led to accommodation, tourist facilities and infrastructures based on areas that were previously open spaces, on former natural or agricultural regions. Certain natural ecosystems (beaches, forests) are often inaccessible to the public due to their privatization by hotels or individuals.
- Destruction of flora and fauna: the different types of pollution listed below. The loss of natural and agricultural fields is responsible for the dissolution of part of the flora and fauna. The unnecessary use of natural spaces also heads to the suppression of certain flora, excessive collection, forgetfulness, and unconsciousness sometimes at the origin forest fires can be cited as an example.
- The degradation of landscapes such as natural places and historical monuments with the help of modern equipment and constructions in this tourist district generally leads to the degradation of the environment. These new establishments are not regularly in harmony with the pre-existing traditional buildings. Tourism growth is often uncontrollable and dispersed, thus leading to a transformation in the historical and natural aspects of the landscape.

- The conflicting outcomes with tourism growth are reflected in the occupation of space and the reduction of an integral part of local jobs to its advantage. There are inevitable effects of competition, which are often to the detriment of traditional activities (for instance, reduction of arable land and tourism jobs resulting in lower agricultural production).

VI. Threats and impacts of tourism on ecosystems

VI.1. Introduction

Greece has been experiencing significant economic and social developments as a complete European Union member (EU), especially in the last 30 years. But Greece's notable efforts towards economic and social convergence to other European countries have been partly matched by environmental control of various forms of pollution and improving the quality of living. Greece, in the last few years, has made much progress regarding environmental legislation and regulations. However, bureaucratic incompetence, corruption, and local authorities' inactivity to take actions for environmental law enforcement have been the causes of policy implementation problems.

In the last decade, fast economic growth and increasing income levels expanded pressures on Greece's ecosystems, where significant urbanization and coastal inhabitant trend was recorded (Fig. 6). Changes in such vital sectors as industry, energy, agriculture, transport, tourism, construction, roads, urbanization, and coastal areas are strongly affected by high environmental pollution and degradation. These fast changes diminished the advantages of environmental policies, technological development, and investment in environmental infrastructure. Although Greece has a unique natural environment and a dynamic cultural heritage, current economic growth developments increased environmental pressure; mainly from unplanned urbanization and massive housing construction in forest areas and coastal areas (islands). Additionally, it increased air emissions for electricity generation and unnecessary water use.

Greek agriculture has undergone significant transitions with a profound impact on the state of the environment (excessive use of water for fertilization, soil erosion, pollution of rivers and lakes by nitrates and phosphates). In the last decade, water quality has been undermined seriously. Although urban air quality has dramatically improved in big cities, such as Athens, Thessaloniki, and Patras, better fuel quality, promotion of public transport and less polluting private cars, some air pollutants continue above-regulated levels. National measures have increased energy efficiency, but the high market makes the task very challenging. Particulate air pollution in cities and regions with power stations and industries continues very high.

Law of nature preservation and the establishment of protected areas were improved immediately, and several management bodies were established. Attempts have been made in current years to protect marine and forest ecosystems and sensitive coastal zones. Municipal and toxic industrial waste expanded considerably; illegal waste tips still exist in many regions due to local opposition to allocate organized waste facilities. The integration of environmental affairs in economic, industrial, agricultural, and social policies to achieve cost-effective environmental protection and sustainable development is facing slow progress when Greece's fast growth demands vigorous and drastic actions. Public information, knowledge, and education about environmental protection

are changing. But implementation of national legislation is often too slow or lacking because of limited cooperation amongst ministries and agencies and lack of accurate inspection and prosecution, hindered by low numbers of environmental inspectors (National Center for the Environment and Sustainable Development, 2008).

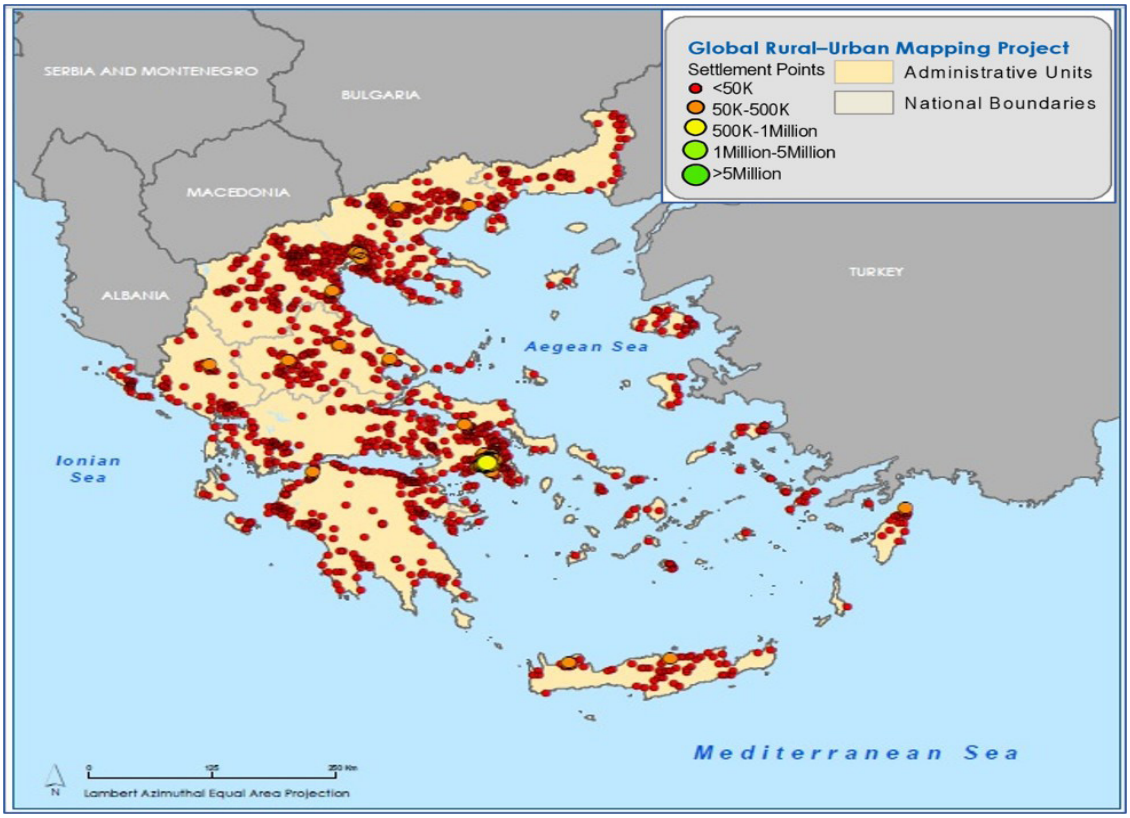

Figure 6. Greece Urban-Rural Mapping (https://sedac.ciesin.columbia.edu/)

VI.2. Threats and impacts of tourism on ecosystems

Tourist activity can have various threats and impacts on the ecosystem. Apart from the environment, tourism has adverse effects on the economy and sectors of society and culture, which are analyzed in the following contexts:

- Economic sector
- Socio-cultural sector
- Environmental Sector

In the Co-Evolve4BG project, the main context referred to the coastal and marine ecosystem threats and impacts. However, tourism is a highly complex phenomenon, which needs a more holistic approach. A short reference will become for the economic and socio-cultural sectors' negative impacts from tourism.

VI.2.1. Direct impacts of tourism in Greece on the economic sector

The economic sector is mainly experiencing positive tourism results as it remains the "heavy" industry of Greece. However, alongside other negative impacts of tourism in Greece, the main ones are:

Employment:

Tourism is an ordinarily seasonal activity (*e.g.*, in the summer months, tourism usually increases); hence it contributes to the seasonality of employment, which drives workers to unemployment during the left months. Expansion of part-time jobs in the tourism sector shows that employees cannot secure a satisfying standard of living. Frequently, the local population of a tourist destination does not have any specialization in the tourism sector, resulting in foreigners and incoming labor. As a result, local employees often earn lower wages than the local population and are often victim of exploitation by local businessmen or international tourist companies. Due to low levels of specialization and incomes in the tourism sector, mainly women and young people work, leading to inequalities in employment and services offered (Fousteri, 2012).

Money outflow and inflation:

Due to the numerous imports in a country, there is a large outflow of money. Tourism causes inflationary pressures on land values and the cost of local goods and services and has contradictory effects on the standards of living of locals (Hall and Page, 2014; Igoumenakis *et al.* 1998). Regularly, there is economic exploitation of tourists by locals for profit. The prices of commodities for foreigners/tourists and locals are different, with prices for visitors are usually much higher (Apostolopoulos and Sdrali, 2009).

Loss of financial advantages:

When many tourist facilities are owned and operated by foreigners, there can be a loss of potential financial gains for the local region and the aversion of the local population. Local "elites" can be generated if the tourist facilities and services are controlled and managed by only a few locals or families, with most of the community gaining a limited profit (Inskeep, 1991).

VI.2.2. Direct impacts of tourism in Greece on the socio-cultural sector

Greece has a wide variety of local cultures which many of them relate to the ancient history of Greece. Culture remains one of the primary reasons why tourists visit Greece, but still, there are some negative impacts in the socio-cultural sector, such as:

Degradation and commercialization of culture:

The over-concentration of tourists in a destination frequently results in the degradation of historical and archaeological sites and the change of the general cultural nature. There is usually vast commercialization of local goods and services. In addition, modifications of the cultural capital have been recorded (traditional arts, music, dance, clothing, *etc.*) to make it more understandable by tourists (Diedrich and Aswani, 2016; Fennell, 2001; Hall and Page, 2014).

Conflicts of different cultures:

Through tourism, at least two different cultures come into contact, where people have different customs, beliefs and traditions, different cultures in general and speak different languages. These different prices often conflict with the relationship between locals and tourists, resulting in a lot of opposition. In many cases, these differences can reduce the values of the tourist destination, degrade the national language and adopt tourist behaviors (Fennell, 2001; Inskeep, 1991).

Xenophobia and criminal acts:

The local population often acquires feelings of xenophobia, which often leads to conflicts with tourists. Moreover, tourism contributes to the increase of drug use, alcoholism, crime, begging, as well as the spread of sexually transmitted diseases, such as AIDS, mainly when there is prostitution in the local society, which leads to creating a specific type of tourism (Fennell, 2001; Inskeep, 1991; Venetsanopoulou, 2006).

VI.2.3. Direct impacts of tourism in Greece on the environment

Tourism involves many activities that harm the environment. These impacts can be direct, where the effects come straight from the main touristic activity, or indirect. The results come from touristic activities that depend on the primary activity or vice versa and affect the local, regional, or regional international levels. At the same time, they appear when the tourist growth of an area exceeds the limits of reception capacity. In addition, the environmental impact of tourism is divided into three categories of infrastructure, impacts caused by:

a. the visit of tourists in an area and their transportation from, to and within that area.

b. the activities of tourists

c. the construction, operation, and maintenance of tourist infrastructure.

Environmental impacts are considered complex, as they are not produced only by tourism but also by other activities directly or indirectly linked to tourism (*e.g.*, transport, services, trade, *etc.*). In addition, it is not assured to have all the environmental pressures that will be mentioned below, as every site has different characteristics that can be affected (Inskeep, 1991).

VI.2.3.1. The atmosphere and climate change

The unrestricted use of internal combustion vehicles used to transport tourists and the increase in the burning of fossil fuels for energy production add to the rise of air pollution. Significantly, the atmosphere can be overwhelmed by tourism activities, either straight, through transport, or indirectly, by energy consumption in several facilities (*e.g.*, kitchens, central heating, cooling facilities, *etc.*).

In addition, transportation of all types (air, road, and rail) extends in a tourist destination when the number of visitors and their flow increases. Hence, in some areas, particularly in those where there are notable tourist attractions, air pollution is increasing due to tourists' unnecessary use of transport. Moreover, in open areas where there is no vegetation, contamination in the form of dust and airborne particles can be produced, resulting in a risk to the public health of both residents and tourists. In addition, air emissions change the atmosphere's composition and therefore affect climate change and stratospheric ozone depletion (Igoumenakis *et al.* 1998; Inskeep, 1991).

At the same time, tourism has been recognized as contributing to climate change through burning fossil fuels. More specifically, the combustion of fossil fuels liberates carbon dioxide (CO2), nitrogen oxides (NOX), hydrocarbons (HC), carbon monoxide (CO), soot/tobacco (C), sulfur chemicals (mainly sulfur dioxide). SO2), non-volatile hydrocarbons (NMVOC) and water vapor (H2O). These emissions (Fig. 7) change the composition of the planet's atmosphere and affect biochemical cycles. They also have complex and interactive effects on the biosphere and, above all, on their transformation through physicochemical processes. In addition, the above emissions are associated with the phenomena of acid rain and photochemical pollution (Tsartas *et al.* 2010).

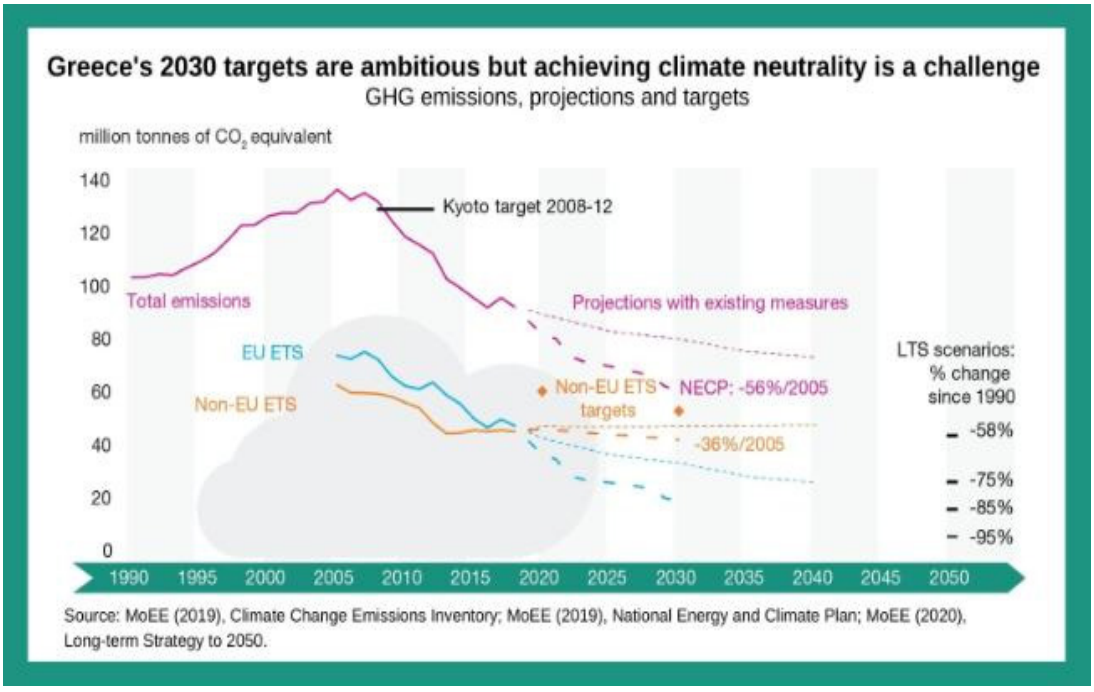

Figure 7. Greece's Green House Gas emissions, projections, and targets (MoEE, 2019)

In conclusion, just as the tourism sector contributes to climate change, so too is presumed to affect tourism. In other words, climate change will cause a potential shift in the choices of tourists for their destinations, resulting in travel to regions with lower temperatures and therefore to areas with better thermal comfort. So, climate change can lead to:

a. damage to coastal tourist infrastructure,
b. deterioration of tourist infrastructure due to insufficient natural sources (*e.g.*, lack of snow at ski resorts),
c. saline water, as mentioned above,
d. reduction of available water due to decreased rainfall, and
e. reduction of ecotourism infrastructures and activities.

VI.2.3.2. Energy resources

The usage of energy (Fig. 8) in the tourism sector is divided into two categories:

a. The use of energy for the transportation of tourists from, to, and within the tourist destination and the neighboring areas, where the means of transport may be ships, aircraft, trains, tourist buses, private vehicles (cars), and motorcycles, which all need fuel to run. Therefore, there is an increase in the need for fossil fuels, resulting in the exhaustion of energy reserves (Gössling and Peeters, 2015).

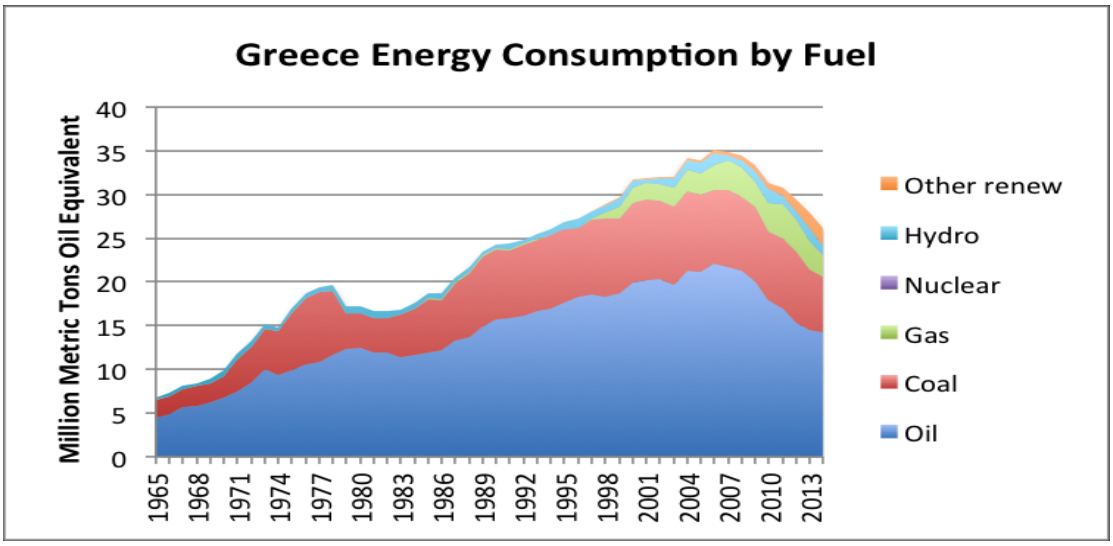

Figure 8. Greece's fuel energy consumption, based on BP Statistical Review of World Energy data, 2015

a. The use of energy by tourists in the accommodation of the tourist destination, in their activities, for their food, *etc.* (Gössling, 2002), Energy consumption in the destination is categorized into two types:

1. energy consumption in accommodation, which is related to heating, air conditioning, cooling, lighting, cooking, cleaning, the use of electrical and electronic devices, but also to desalination and fluid waste management.
2. energy consumption tourist activities, which involves the actions of tourists, which include visits to places of interest for recreation, attractions such as archaeological sites, museums, *etc.*, places of entertainment such as cinemas, restaurants-bars, *etc.* and in sports activities such as diving, golf, horse riding, *etc.*

In conclusion, the tourist development of a territory is also linked to the increase in energy consumption, which requires an increase in energy production. In regions and periods of high tourist traffic, energy consumption increases markedly, leading to negative effects on the environment (Tzoufi, 2010).

VI.2.3.3. Water resources

Water is considered as one of the most valuable natural resources. Water resources are universally used in the tourism sector, so it is obvious that tourism has a notable impact on the aquatic environment. More respectively, water is used both for cleaning and drinking and other services to tourists. At the same time, significant quantities are consumed for aesthetic reasons, such as watering gardens and green spaces of accommodation and other tourist infrastructures. Many species of plants in hotel gardens, foreign to the natural environment of the area, need massive amounts of water to be irrigated, which leads to pressures and problems, because these plants do not have coping mechanisms, like local species, that will protect them from drought during the summer months. In addition, there is a significant demand for water for the construction of tourist infrastructures, to produce food, fuel, and other consumer goods, such as soaps, shampoos, *etc.*, for the extraction of raw materials and eventually, during the production of energy. The above water uses often conflict with the local water needs of other sectors/uses, such as agriculture, livestock, natural ecosystems, *etc.* (Gössling *et al.* 2012).

Frequently, groundwater resources (Fig. 9) are used through drilling to satisfy the increased needs of tourists and residents. This fact weakens the aquifer, affecting the region's overall development. Dense and deep boreholes quickly deplete groundwater aquifers and, in many cases, can cause the entry of seawater (salinization), making the water unsuitable for many uses and, particularly, domestic consumption. This is remarkably the case in the Mediterranean islands, without Greece being an exception. Consequently, in Greece nowadays, water is carried to many islands (*e.g.*, Heraklion - Cyclades), either by special tankers or in the form of standard bottled water, as their water resources are very limited by over-pumping. The salinization of water reserves causes even salinization of agricultural lands, which are irrigated with these reserves, resulting in catastrophic effects on production and the soil balance of the local ecosystem (Tsartas *et al.* 2010).

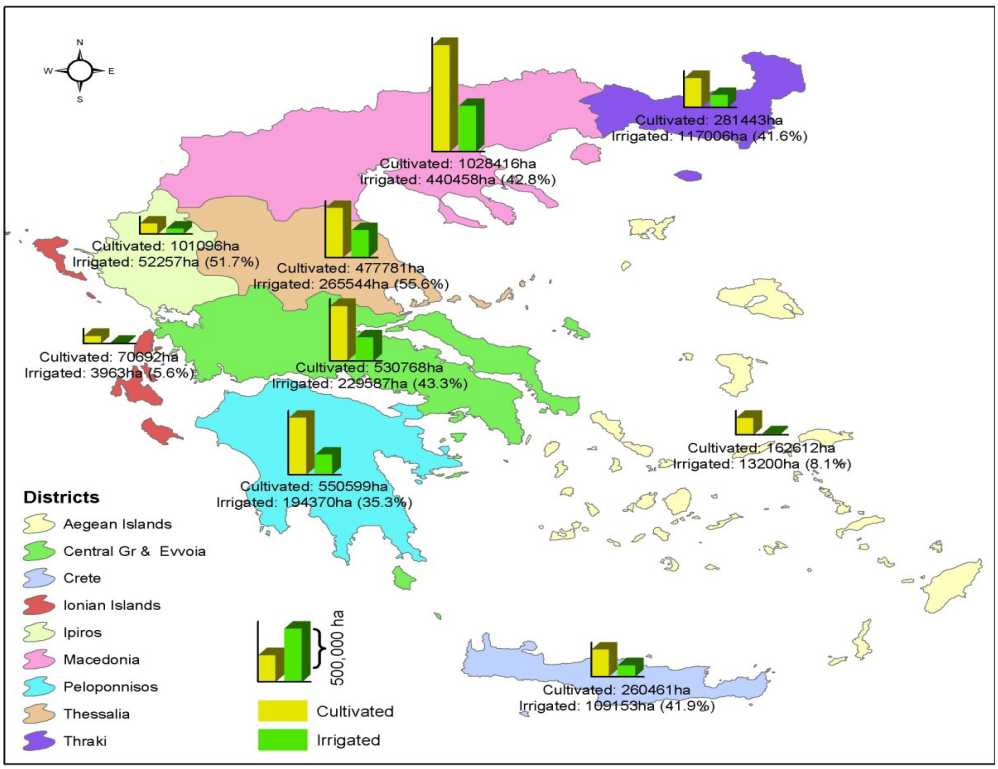

Figure 9. Irrigation Systems Performance in Greece (EASAC, 2013)

In addition, the tourism sector relates to the disposal of waste in the aquatic environment either from tourist facilities or from tourist activities, which leads to aquifer contamination, harming ecosystems, and public health. The coasts and the marine areas are under significant pressure due to waste. Many tourist units pollute the waters, throwing raw sewage into the sea, damaging aquatic plants and aquatic fauna (Igoumenakis *et al.* 1998)

VI.2.3.4. Noise Pollution

Noise pollution, mainly caused by transport, such as planes, cars, buses, and various recreational vehicles, boats (*e.g.*, yachts), is a tremendous and growing problem for tourist areas. Noise levels increase in proportion to the increase in the number of visitors to a tourist destination, remarkably in areas where many tourist vehicles and attractions are concentrated. Extreme noise can reach disturbing or unpleasant levels, causing stress and health problems for tourists or locals (Fig. 10). In addition, it causes disturbances in the wild, especially in sensitive areas, such as protected areas. For example, noise from transport can cause some species to move away from the surrounding area or alter the physical behavior of animals (Inskeep, 1991).

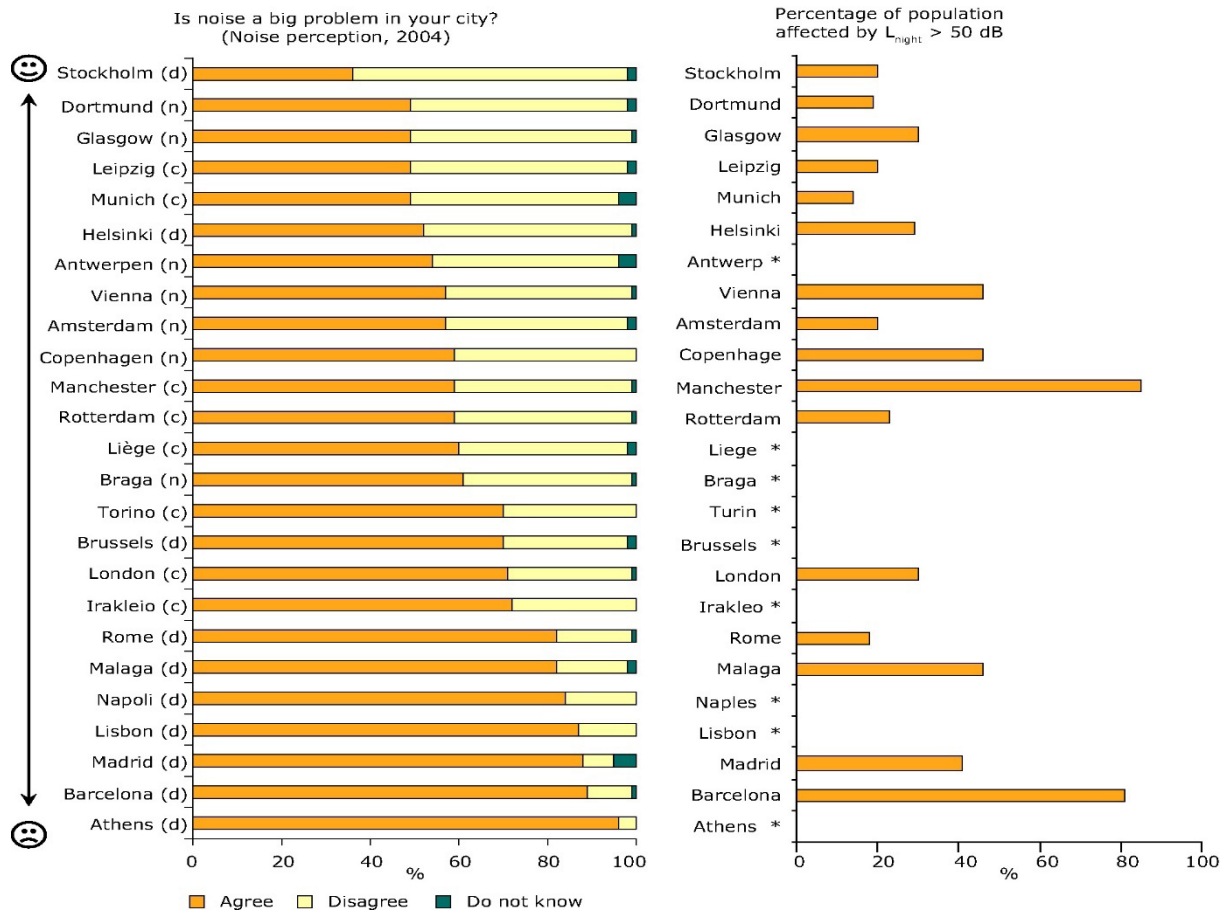

Figure 10. European Union research about Noise Perception (https://www.eea.europa.eu/)

VI.2.3.5. Degradation of Landscape/Aesthetics (Visual and Aesthetic Pollution)

Tourist facilities and infrastructures, such as hotels and other accommodations, regularly differ from the surrounding natural features and the local architecture of the tourist destination. As a result, the landscape degrades and becomes repulsive either for tourists or for locals. The coverage of living space by the natural environment for the primary and accompanying facilities of the tourism sector, such as marinas, platforms, and protective barriers, changes the countenance of the coastal areas. Visual pollution can also come from other sources. Significantly, the use of inappropriate building materials, poor layout of tourist facilities, insufficient or improper spatial planning, as well as the use of vast and unsightly billboards, poor maintenance of buildings and outdoor space, uncontrolled disposal, and the lack of cleanliness of the area can lead to aesthetic pollution and degradation of the landscape (Inskeep, 1991).

Moreover, the ungoverned tourist development brings about radical changes in many coastal settlements. They change from charming fishing villages to urban areas, with concrete sea fronts and high-rise apartment buildings. Typical cases of this type in Greece are Agios Nikolaos in Crete and Itea in Fokida (Tsoulidou, 2013).

VI.2.3.6. Earth / Soil Pollution

The primary natural resources of the soil are forests, wildlife, fertile soil, minerals, fossil fuels, *etc.* Expanded tourism and leisure facilities have enhanced the pressure on these resources. In the tourism sector, intervention in the environment to satisfy the needs of tourists cannot be bypassed. Therefore, the increased tourism growth increases the pressure used on the soil and the earth's resources (Fig. 11). The development of tourist facilities and infrastructures for accommodation, water supply, recreation and restaurants generally include sand mining, beach erosion, ground and soil erosion, and soil degradation when new roads and airports are constructed. For instance, poor planning, in combination with the location of port works, breakwaters and other structures on the shoreline, affects soil formation processes, leading to coastal erosion (Gössling, 2002; Tsoulidou, 2013).

In addition, significant effects on the subsoil result from the deposition of solid waste from hotel units or waste from tourists inside or outside tourist accommodation. Eventually, holiday homes destroy open land, as this causes soil fragmentation, while camping in areas that are not suitable for this use can lead to soil compaction, destruction of vegetation, but also other similar problems on the soil.

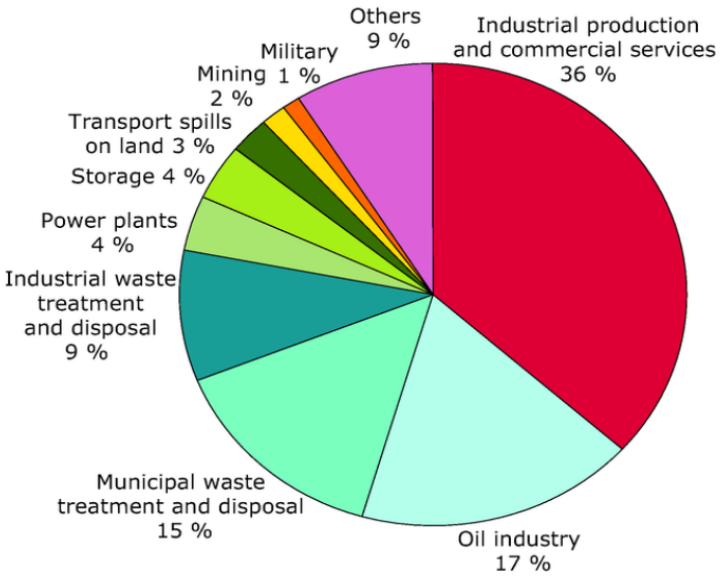

Figure 11. Overview of economic activities causing soil contamination in some WCE and SEE countries (https://www.eea.europa.eu/)

VI.2.3.7. Ecosystems Degradation - Flora and Fauna Disturbance

Every ecosystem is diverse, some ecosystems withstand high pressures without degradation, while others are less resilient, and even small changes can have many adverse effects (Fig. 12). However, tourism growth should not be avoided in areas with low resilience if there is proper planning, as these places are expected to have abundant natural resources. Persistence is also associated with scarcity. More specifically, the scarcer a natural resource or ecosystem is, the greater its value and the lower its resilience to change.

Tourism direct and indirect effects on natural ecosystems are divided into three categories:

- changes in the functioning of ecosystems,
- changes in the structure of ecosystems - loss of biodiversity and
- declining population of rare species.

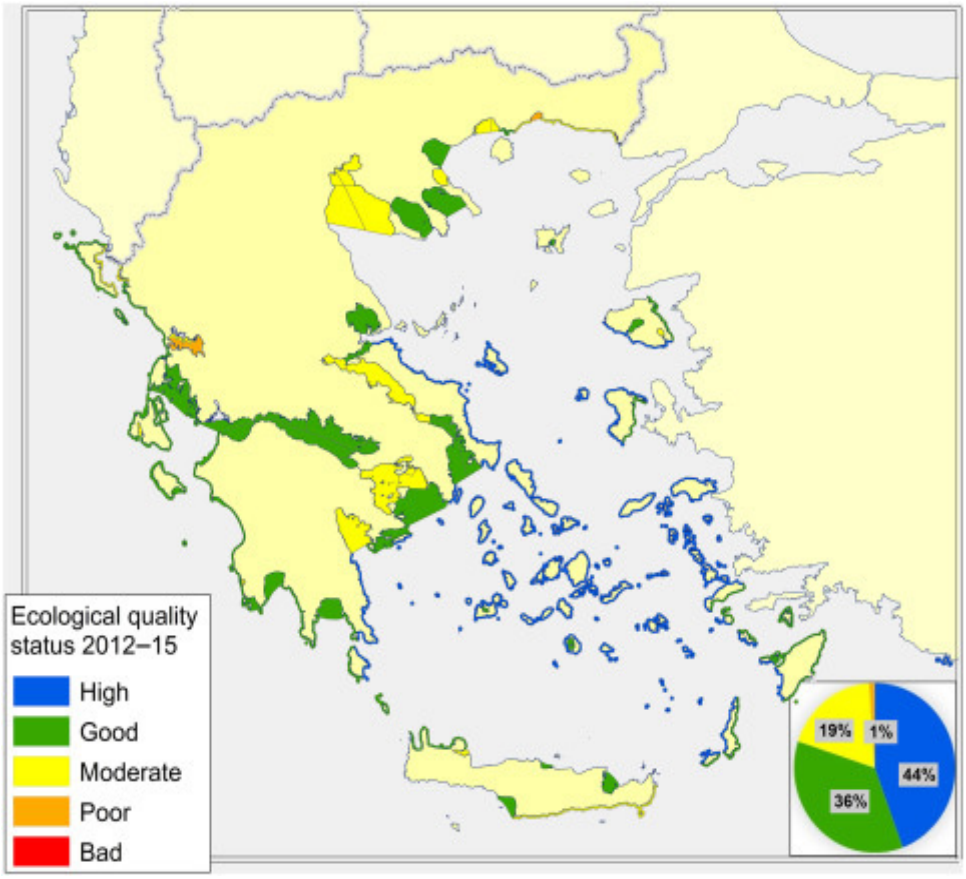

Figure 12. Ecological Quality Status in Greece Coastal area (Simboura *et al.* 2019)

Regarding the first category of negative impacts, the function of ecosystems is affected by several activities, such as the construction and expansion of tourist infrastructure, construction, growth, and maintenance of roads and generally all infrastructure projects, as they intervene in the hydrological cycle, microclimate, and species communication: hence limiting the space of ecosystems and disturbing it. In addition, the location of roads affects the fauna of each region due to noise, while the exhaust gases harm its flora. The expansion of tourism infrastructure or the road network occupies a vast territory, often destroying the ecosystems, mainly coastal, when the projects are located at a short distance from the coast and affect the sedimentary cycle.

Furthermore, ecosystems can be degraded by the leisure activities of tourists. For example, in Greece, ornithologist tourists are interested in migration, wintering and breeding. Consequently, they can often stop the incubation and reproduction of the species and disturb the birds, because of which they leave their nests, stop seeking food, and be forced to leave their natural habitats (Fennell, 2001). Another significant activity of tourists is fishing in coastal areas, particularly underwater fishing and contributing to the extinction of certain fish species. In addition, many tourists are collectors who collect birds, insects, butterflies, *etc.*, contributing to the reduction of flora and fauna of the tourist destination. At the same time, the extensive use of land by campers can create the destruction of existing vegetation.

Regarding the second category of effects, tourism contributes to the transformation of the structure of ecosystems and the reduction and loss of biological diversity. More specifically, the increase in wastewater contributes to eutrophication due to changes in the composition of the bio community of ecosystems. Eutrophication is an environmental problem that occurs in lakes or closed shallow bays under certain conditions. Essentially, there is an excessive swelling of the nutrient concentration of nutrients caused by the enrichment of the water with nutrient runoff from fertilizers and detergents. The result of eutrophication is the change of flora and fauna of the wetlands. Similar changes in the composition of flora and fauna are found in terrestrial ecosystems. An example is the change in the structure of plant communities on the beach, which is due to bathers, parking, movement of vehicles, *etc.*

Additionally, when tourists take specific traits, they overwhelm the plants and soil, which often results in destruction, leading to loss of biodiversity. These disasters are more intense as tourists arbitrarily change the fixed routes.

In conclusion, concerning the third and final category of impacts on ecosystems, tourism activities may hinder sensitive biological processes affecting rare species. This happens mainly in areas of unplanned and intense tourist activity. For instance, the tourist demand for wildlife souvenirs is growing, resulting in hunting, and poaching in the Mediterranean and Greece. Marine life is in peril. The excessive tourist development on sandy shores hinders the reproductive processes of animals that need sand to hatch their eggs (*e.g.*, the *Caretta caretta* turtle, which lays its eggs on the beach) when there is a lot of tourist traffic in Zakynthos). In addition, motorsports negatively affect rare mammals, driving them away from sea areas (*e.g.*, *Monachus monachus* seals). Another

example is the limited opportunity for reptiles to move, such as *Vipera lebetina*, to the islands of Milos and Kimolos, due to housing development and tourism-related infrastructure. Eventually, concerning endemic plants, when no protection measures are applied, there is a risk for them due to tourism development (Tsartas *et al.* 2010).

VI.2.3.8. Light Pollution

Light pollution has been one of the increased growth environmental crises in the past few decades until today. Principally created by poorly designed and placed artificial lights in outside areas used extravagantly, light pollution has negatively impacted today's ecosystem and people's lives. However, this issue is often overlooked despite the pollutants and wastes generated, somewhat due to people's necessity for artificial light sources at nighttime.

The same oversight occurs in the tourism industry, whether it is the streetlights provided to guide people at night or the unnecessary use of light for public entertainment. Artificial lights are gradually used as an add-on effect to a tourist package. As a result, many tourism developments have hindered the night sky quality without proper care.

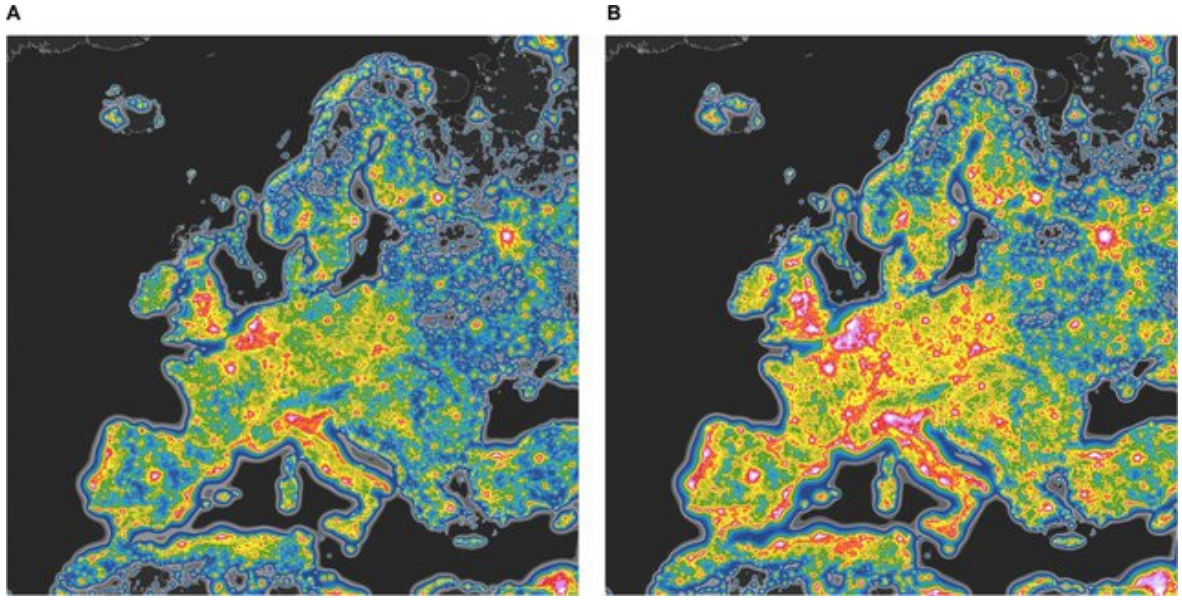

Figure 13. Maps of Europe's artificial sky brightness, increasing twofold steps, as a ratio to the natural sky brightness (assumed to be 174 mcd/m 2). (A) The map shows the artificial sky brightness in V-band, as in the other maps. (B) The map shows the forecast of the perceived sky brightness for a dark-adapted eye after a transition toward 4,000K CCT LED technology, without increasing the photopic flux of currently installed lamps (Falchi *et al.* 2016)

VI.2.3.9. Invasive species

Invasive species are defined as alien species with the capacity to increase in regions away from their normal distribution area if they are disbanded in the new locations. Globally, invasive alien species are recognized as significant threats to biodiversity in terrestrial, freshwater, and marine ecosystems. In Greece, invasive/alien species causing problems for indigenous species and biodiversity have already been recorded. This fact makes the approval of preventive measures a crucial priority, starting with the studies and detection of invasive alien species already present in the country and the monitoring of their entry into the Greek seas, to take the necessary measures to stop the spread of invasive species. Their invasion begins with an intentional or accidental introduction and then the alien species escape in the terrestrial, freshwater, or marine environments. Accordingly, it is needed to raise public awareness about the threat presented by alien species intrusions. Dealing with invasive species' negative impacts on biodiversity requires early detection, continuous monitoring, steps to limit their consequences to biodiversity, and efficient implementation of the CITES Convention. The first step towards an action plan depends on the classification and mapping of alien species invasions in Greece.

The eastern Mediterranean (Fig. 14) is particularly vulnerable to biological invasions because of its crossroads between the Ponto-Caspian and the Indian Sea/Red Sea regions, the maritime traffic Dardanelles, Gibraltar and Suez, and the existence of large and numerous fish and shellfish farms. As a result, Greek waters can function as a gateway, exhibiting an excellent distribution in Greek waters (Fig. 10) for the dispersal of marine alien species, either from the Levantine to the Adriatic and Western Mediterranean or from the Black Sea to the eastern Mediterranean. The flow of alien marine species introductions in the Mediterranean Sea is increasing (Zenetos *et al.* 2011). The extent of alien species was initially established in the Levantine to separate biogeographic regions such as the Aegean. In addition, the scientific community has multiplied its attempts to examine alien intrusions into coastal ecosystems because endemic biodiversity is in danger.

In 2010, ten species earlier known as casual and questionable immigrants had verified viable populations and spread to several Greek coasts. Of the 237 alien species recorded in Greek waters, 127 are established; 59 are casual records; 20 are cryptogenic and 31 are questionable records. Most alien species belong to Mollusca (47 species: 19.8%), followed by fish (41 species: 17.3%), Polychaeta (38 species: 16.0%), macroalgae (33 species: 13.9%), and Crustacea (31 species: 13.1%). Most newly introduced and recorded species come from tropical and subtropical areas of the Pacific, Indian or Atlantic oceans. The grown rate of introductions of warm water species proves the previous findings connecting the introduction rate in the eastern Mediterranean to climate change. Although many of the newly inscribed species are Lessepsian immigrants spreading in the Aegean Sea, the role of shipping is gaining significance as a vector of alien species' transfer in the Aegean Sea (Fig. 15).

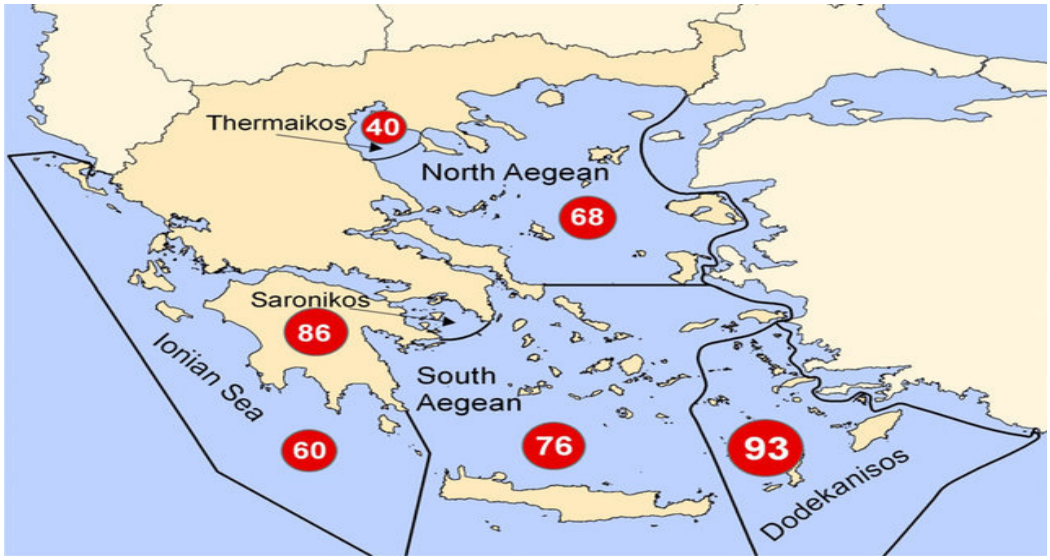

Figure 14. The pattern of alien species distribution in Greek seas (Zenetos *et al.* 2011)

Some of the invasion species (www.naturagraeca.com) that cause problems and upset the balance of marine and coastal ecosystems with a negative effect on tourism are:

Plants

The Silver-leaved Nightshade (*Solanum eleagnifolium*) descends from America: the silver-leaved nightshade has covered all scrub habitats. A remarkably adaptive plant -one centimeter of the root can give a complete plant, threatens the specific type of Mediterranean ecosystems, thriving where there should be thyme, oregano, and other indigenous shrubs. It is detected mainly in southern Greece, especially in the islands, without any systematic attempt to exterminate it.

Sea Fish

The Silver-cheeked Toadfish (*Lagocephalus sceleratus*). A dangerous fish, migrant from the Suez Canal. Some organs of the species (skin and entrails) are very toxic and can cause death if eaten. Incidents of fatal poisoning have been reported in Lebanon. At the same time, it is a fearless fish that strikes any threat. Its quantities are constantly increasing in the southern seas, and it seems that with rising temperatures, it will soon spread further north.

The Dusky Spinefoot (*Siganus luridus*). This expansive fish took its Greek name from the Germans, as it appeared here at WW2. It has since expanded all over South Greece, creating enormous difficulties for coastal anglers. The daily migration of flocks from deep to shallow areas traps thousands in the nets. Fishers often dump their nets because the first dorsal ray of the Dusky Spinefoot carries a toxin that creates swelling and pain, so it is nearly impossible to dislodge thousands of them from a net.

Crabs

Sally Lightfoot (*Percnon gibbesi*). A crab that was transferred to Greece through clinging to large ships. It expands rapidly across Greece's seabed, stripping the rocks of every organism that can be eaten. A particularly fast crab with cryptic behavior; that makes it very difficult for predators to catch.

Nudibranchs

The Spotted Sea Hare (*Aplysia dactylomela*). This large nudibranch has managed to expand to all temperate and tropical waters of the planet. It belongs to the same genus as three other native species of the Greek seas. However, its defensive behavior, which involves the secretion of purple ink, makes it resistant to any native predator, thus gaining a survival advantage over our own "sea hares." Now it is found in the largest and most important seabeds of Greece.

Corals

Oculina Patagonia. This coral first appeared in the Mediterranean in 1966, coming from the coasts of North America. Although it spreads gradually, it is now encountered more and more often by scuba divers. One of its characteristics is that it applies alongside the rigid substrate. In good conditions, it can give colonies up to one meter, displacing any other living animal or algae attached to rocks.

Algae

Caulerpa racemosa. One of the most famous and old cases of invasion has so far destroyed vast parts of our seabed. *Caulerpa* comes from Australia and has escaped to the Mediterranean from the Monaco Institute of Oceanography laboratories. It is particularly threatening to *Posidonia oceanica* beds because it creates a dense web that literally "drowns" any organism that tries to grow.

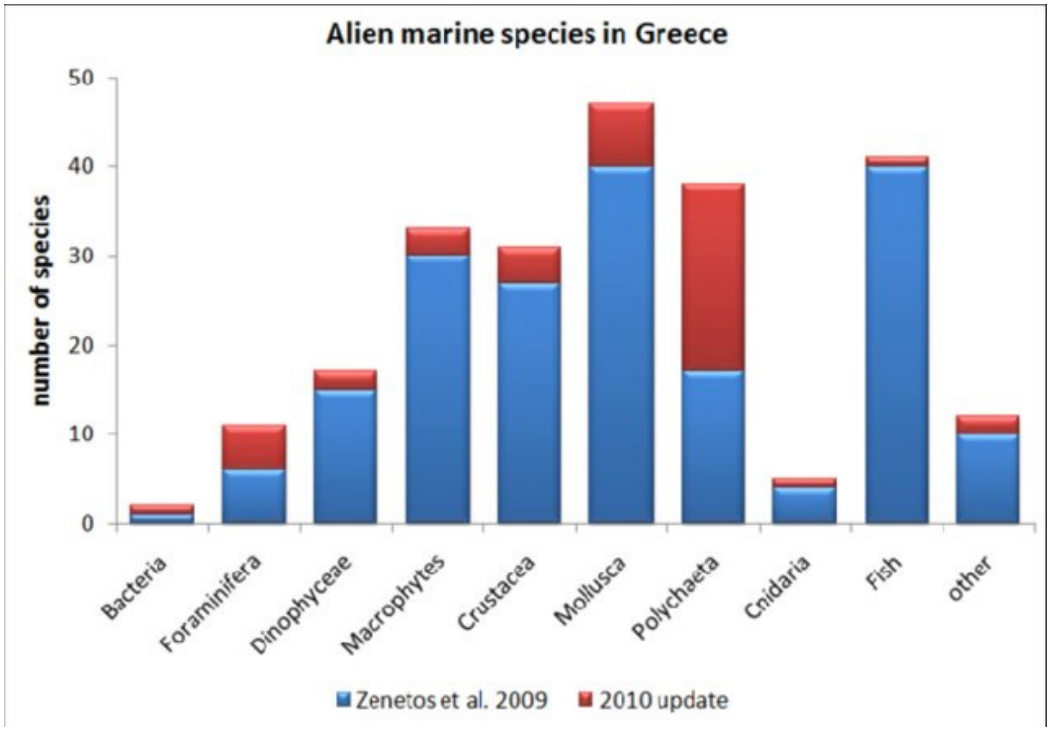

Figure 15. Breakdown of marine alien species in Greek Seas per taxonomic group (Zenetos *et al.* 2011)

VI.3. Environmental pressures due to tourism by category of ecosystems in Greece

The environmental pressures of tourism are also linked to the characteristics of an area or its category where the ecosystem belongs to. It is worth mentioning that several strains can occur in more than one category of ecosystems. Then, the types of areas in Greece that receive low or high pressures from the tourism sector are presented.

VI.3.1. Islands

The risk of creating environmental pressures is greater on the islands' ecosystems due to their size, making them more vulnerable to pressures.

Mass tourism (*e.g.*, swimming, sunbathing) is the one that predominates in the islands of Greece due to the activities it involves, as they are suitable for many people in a comparatively small geographical area.

Freshwater is not unlimited on the islands, and tourists consume more significant quantities than the local population. Consequently, due to the extreme consumption of local freshwater sources, the cost of water supply to the islands is increased. In contrast, large desalination plants that can solve the supply problem often impede other forms of industrial activity. In addition, fresh water is required for adequate wastewater

treatment. Many visitors to the islands provide enormous volumes of wastewater. The use of saltwater in biological treatment systems prevents the proper biological decomposition of wastewater. If discharged into the marine environment can cause significant damage to marine life and the health of swimmers/tourists.

Moreover, another environmental pressure of tourism on the islands is the destruction of protective sand dunes. This destruction caused by building structures or even walking on the sand dunes can damage the vegetation that stabilizes them, following the gradual erosion of the beach. Moreover, the breakwaters created on the islands, apart from the visual pollution they cause, have been shown to cause beach erosion from one point to another. Disposal of waste is another problem on the islands, where the area available for such use is de facto limited and usually within walking distance of the tourist activities themselves. Also, landfills on the islands may cause the transport of contaminants/pollutants into the water, especially when groundwater reserves are close to the earth's surface.

VI.3.2. Coastal areas

A coastal area is often a famous tourist destination, mainly for mass tourism. Most Mediterranean tourist destinations are characterized by intensive development and extensive urbanization, and large-scale infrastructure construction. For this reason, they are under a lot of pressure. The environmental impact in these areas combines the tourism sector and other human activities.

The development of coastal areas is like the development of islands regarding the environmental problems that occur. The main distinction is that coastal areas usually have access to more resources, while the islands' resources are primarily limited (*e.g.*, freshwater). Especially, in the islands, during the peak months, there is a great demand for water due to the increase of consumers. Coastal aquifers usually have low capacity, resulting in powerful pressures in a short period. Over-pumping of coastal aquifers causes salinization of water, a problem that is not reversible. Lowland areas around sandy environments are areas that are particularly sensitive to salinity hazards. Regarding the water quality in the coastal zones, there are various point sources of pollution related to tourism (*e.g.*, sewers of settlements and large hotel units). Other sources (diffusing pollution) are bungalows, restaurants and leisure facilities, but also large crowds of tourists (swimmers) on the banks (Tsartas *et al.* 2010).

A significant environmental problem is the pollution of coastal areas, due to arbitrary and out-of-control camping, as campers often do not respect the environment and cause serious problems (*e.g.*, litter pollution, visual pollution from the tents, loss of flora due to the infringement of various areas, removal of fauna from the site due to high noise levels), thus altering the natural environment (Igoumenakis *et al.* 1998). As mentioned in the previous section, in many cases, tourism can contribute to the loss of essential habitats and the reduction of biodiversity, especially in coastal areas. In addition, due to uncontrolled fishing in many coastal regions, the risk of loss of marine fauna is significant.

In conclusion, another significant environmental problem is coastal erosion. The development of yacht ports, breakwaters, and other structures on the coastline, can bring about changes in sediment deposition from the currents and in the beach area, resulting in coastal erosion. Also, the uptake of building materials, such as sand puts significant pressure on individual coastal ecosystems. Finally, out-of-bounds housing development and the extensive coverage of cement or asphalt areas near marinas are likely to destroy ecosystems and the relationship between land and sea (*e.g.*, sea turtle breeding and other similar issues) (Tsoulidou, 2013; Tzoufi, 2010).

VI.3.3. Rural and urban areas

As for the rural areas, tourists visit them as they seek more traditional forms of hospitality. This trend is due to the development of specific forms of tourism and mainly agrotourism, an alternative type of tourism. In recent years, these forms are preferred by visitors, as rural areas are more easily accessible than in the past. Due to declining agricultural prices, numerous farmers in several parts of the world have been forced to turn their farms into agrotourism businesses. This form of tourism broadly provides an extra income to farmers and does not bring significant environmental impact. However, some implications are worth mentioning. More specifically, arbitrary construction is a problem that happens in rural areas. Random construction is mainly associated with constructing tourist accommodation and holiday homes.

Moreover, intense land development affects tourism occupying land and water and the various investments in the agricultural sector. In other words, tourism operates "holistically" in the areas where it is developed since it demands more and more space for its activities and infrastructure. In addition, the phenomenon of changing land uses or activities is frequent, which leads to the urbanization of land and the conversion of the rural environment. For example, many rural areas have been transformed into agglomerations to meet tourist demand for hotels, accommodation, recreation areas, *etc.* The cause of this situation is the lack of an appropriate policy for land use and the lack of control.

Concerning urban areas, tourism activity is not the leading cause of environmental change in urban areas. The infrastructure of urban centers is designed to meet the requirements of many people. However, in areas where the infrastructure is inadequate to meet the needs of residents or in areas where the number of tourists is disproportionate to permanent residents, tourism can cause significant environmental problems.

VI.3.4. Environmental Protected and Sensitive areas

The wide variety of species and ecosystems in nature is an invaluable natural asset. It must be transmitted to future generations without being degraded. Today, the risks associated with the preservation and protection of a variety of species, are increasing Consequently, with the accelerated growth of mass tourism, the creation of national parks was considered crucial. The initial purpose was not to create another travel

destination but to protect the environment. The protection of the environment was linked to the restriction of human presence and intervention, as it was taken for granted that any activity would lead to the change of natural habitats, pollution, and overexploitation of natural resources (Fousteri, 2012).

In addition, protected and sensitive areas are suitable places for leisure, education, and above all, ecotourism infrastructure. Their goal is to stimulate the local economy and society and the financial support of the function of the protected area. The everyday objects of the creation of protected areas are the preservation of natural and cultural characteristics with the support of the local community. Notably, they include:

a. habitat protection,
b. conservation of genetic biodiversity,
c. preservation of natural, traditional, and cultural characteristics,
d. promotion of education at a local and broader level,
e. strengthening of scientific research, and
f. sustainable management of natural resources (Fousteri, 2012).

Another objective of the protection of natural resources wealth is to provide people with the opportunity to enjoy nature in appropriate and organized places within the framework of environmentally friendly regulations (Fennell, 2001).

The protected areas remain under high pressure from tourists, as they visit them to enjoy the natural capital. The protected areas are associated with ecotourism, a form of tourism initially considered a mild form. Still, in the last years, many tourists often cause various problems and poses risks to ecosystems.

There are different protected and sensitive areas (*e.g.*, natural parks, national parks, birdwatching parks, coastal areas, wetlands, aesthetic forests, nature reserves, and mountains). Due to the different characteristics of each region, environmental pressures vary. When there is a concentration of many people and vehicles in an area, the risk of air pollution, waste, or noise pollution increases. It has been observed that when tourists visit a site, even a protected one, they throw their garbage in the area without being interested in the health of the protected species in the area.

Protected areas are considered the main method (means) of conserving biodiversity worldwide. Accordingly, another significant environmental pressure of tourism in these areas is the loss of biodiversity of diverse ecosystems. More specifically, the invasion of foreign/alien species in protected areas, *e.g.*, from the clothes of tourists or the tires of vehicles, *etc.*, may bring about changes in the population dynamics of the species, with the result that the population of some species often decreases, when the foreign species cannot interact with the local ones. In addition, these areas are “inhabited” by wildlife species, and for this reason, the number of visitors is increasing. This fact causes problems in the reproduction of the species due to the reduction of its population.

If this phenomenon persists, then it is very likely that the protected area will die out. At the same time, visitors to protected areas asregions influence the flora that “dwells” there, as tourists, when they repeatedly take specific paths, it is possible to destroy not only their vegetation, but also the paths themselves.

VII. Threats caused by coastal and maritime tourism

Threat indicators caused by coastal and maritime tourism are a part of the European Indicator System that studies sustainable management of destinations by presenting tourism stakeholders with an accessible and valuable toolkit.

The European Tourism Indicator System is intended for tourism destinations. It is created as a locally owned and led process for monitoring, managing, and enhancing the sustainability of a tourism destination. It has been developed due to lessons learned from previously existing Indicator System initiatives and fine-tuned due to feedback from field testing in several destinations in Europe.

The system is made up of a set of Indicators, a Toolkit, and a Dataset. It is drawn up as an instrument that any destination can pick up and implement without any specific requirement or knowledge. It can be a helpful way to track destination performance, make better management decisions and influence adequate policies (Miller *et al.* 2013).

The indicators are used by the most interested departments, including stakeholders, to measure and monitor their sustainability management processes in CO-EVOLVE 4BG and this deliverable is related to ecosystem services (Table 4).

European Tourism Indicator System detailed indicator reference sheets for sustainable destinations. The monitoring network shows that treated and untreated water discharges are the main source of threats in the coastal zone with a strong flow of untreated water in summer due to the overflow of water discharges into the marine area adjacent to the tourist zone. Table 9 shows that the Greek port needs more ballast water control by The International Convention for the Control and Management of Ships' Ballast Water and Sediments, *i.e.*, the adoption of the Convention on February 13, 2004 and its entry into force on September 8, 2017. The Convention recognizes that aquatic invasive/alien species pose a significant threat to marine ecosystems, and shipping has been recognized as the main route for introducing species into new environments. The introduction of new alien/invasive species has been overwhelming in many parts of the world. Quantitative data show the percentage of bio-invasions is continuing to grow at an alarming rate. However, the Ballast Water Management Convention, adopted in 2004, targets to obstruct the spread of dangerous aquatic invasive organisms from one area to another by setting standards and procedures for managing and controlling ships' ballast water and sediments. Many guidelines and principles have been produced to promote the implementation of the Convention (https://www.imo.org/).

Table 4. Threat indicators caused by coastal and maritime tourism

ETIS/ Environmental Impact Optional Indicators	Co-Evolve threat Indicators	Co-Evolve4BG threat Indicators
Water Management		Water pollution: treated, partially treated, and non-treated water rejects
Reducing Transport Impact		Ballast water reject control
Climate Change		
Solid Waste Management	Unitary waste production compared to overnight stays	SW generated by tourists (Qwt)
Energy Usage		
Landscape and Biodiversity Protection	The natural land cover surface over artificial land cover surface	
Light and Noise Management	Artificial sky brightness N. people exposed to road noise over 55 dB	
Bathing Water Quality	Bathing water quality	

VIII. Pressures to coastal ecosystems

The major threats to the coastal landscapes of Greece are common along the Mediterranean coastal zone. These threats are linked to uncontrolled coastal development, urbanization with pressures on the coastline, increasing national and international flows of mass tourism, to atmospheric, aesthetic and noise pollution, to soil degradation, underwater pollution and salinization, invasive flora and fauna species, and unplanned or over-exploitation of natural resources, in particular freshwater. These findings are assessed using the Landscape Character Assessment (LCA), a tool for landscape. Limitation pressures with loss or modification of wetland habitat affects hydrology and sedimentology as well as contamination and pollution. In this case, pressures connect to changes in environmental state, such as eutrophic state, hypoxia, erosion, and which threaten the sustainability of coastal and marine ecosystems. There are also changes in the form of the ecology, such as the loss of plants and seagrasses and the general disturbance of marine protected mammals. Changes in the structure and function of the wetland ecosystems affect ecosystem services that are often underestimated. The loss of ecosystem services affects human welfare and the control of climate change by coastal wetlands.

Indirect pressures, such as sea-level rise, further increase these cumulative impacts and multi-stressors.

Multiple sources of pressure continue to be a significant presence in the Greek Mediterranean seas, and their combined effect is of growing concern. Ever-increasing maritime and coastal activities cause considerable damage to the seabed and coastal habitats. Fishing pressure is reducing, but in recent years there is straightforward overfishing practice affecting ecosystem equilibrium. Pollution by nutrient enrichment and contaminants remains an environmental challenge, mainly with more and more non-treated water rejects. Non-indigenous/ invasive species are spreading, and their impact is not fully assessed. Sea pollution presents a central pressure that is wieldy affected by population increase in the coastal areas.

VIII.1. Human activities along the Mediterranean coastline

The Mediterranean coastline differentiates a significant activity classified according to its pressure impact in most previous assessments with the approach of the CO-EVOLVE project. Greece is defined as one of the most biodiverse countries in Europe and the Mediterranean, maintaining a high level of endemism. Until now, there has been no national-level action framework aimed at preventing the loss of biodiversity and the degradation of vital ecosystem services, such as the provisioning of food, pollination, water purification, protection from flooding, *etc.* The preservation of the biological wealth of Greece, at the national level, is a constitutional commitment in which, even if it is not available, it is worth investing in. Moreover, Greece is bound to contribute to European and global initiatives to prevent biodiversity loss. in Accordance with Article 6 of the

Convention on Biological Diversity, which Greece has ratified, including these principles, and responding to these obligations have prepared / processed the National Biodiversity Strategy and the corresponding Action Plan in anticipation of the following years.

It seems that in recent years Greece has achieved good results in environmental conservation, as evidenced by the rankings[1] of the Yale University Environmental Performance Index (EPI), where Greece is 25th out of 180 assessed countries (Fig. 16) – among the "best performing countries in environmental sustainability". In Greece, the priority of human activity is:

Water resources

Water is overexploited principally from catchment areas that affect hydrodynamics, nutrient supply, and sediment composition environment. In the maritime zone, the absence of continental inflow, primarily through the construction of dams, causes a decrease in the accumulation of sandy deposits before the littoral drift carries, a short-term depletion of sand settles in these areas. As less sand accumulates on the shoreline, the beach sediment resources will consequently influence the rate of accumulation of drill dunes, which is expected to decrease over time. Other changes related to water resources can cause significant changes in the coastal landscape, such as the construction of saltworks and the excavation of water channels that cross the land to transport waste or water to the sea.

Agriculture activity

Agriculture is the primary economic sector, although the tourism sector has developed enormously in recent decades along the Greece coastline. Much of the coastal zone is either agricultural (where the ground permits) or natural/semi-natural, mainly where the topography is hilly. However, some of the higher landscapes are, in places, terraced, mainly in the islands. On the other hand, the coastline includes various aspects of land use depending on the degree of urbanization in several biotopes typical of coastal areas. In Greece, agricultural intensification can also lead to freshwater pollution due to the extravagant use of water for irrigation. This will undoubtedly affect water availability and scarcity.

In addition, water pollution mainly occurred through over-fertilization, which could pollute groundwater. In coastal agricultural areas, over-exploitation of water can lead to the intrusion of saltwater into freshwater bodies (Peloponnisos case study), often resulting in irreversible degradation of the water quality, which becomes brackish or saline. Measures necessary to ensure the rational use of water should be taken. Losses through evaporation and runoff should be minimized. Water quality in freshwater aquifers should also be monitored regularly.

1 The 2020 Environmental Performance Index (EPI) provides a data-driven summary of the state of sustainability around the world. Using 32 performance indicators across 11 issue categories, the EPI ranks 180 countries on environmental health and ecosystem vitality.

Industry

An apparent pressure on the coastal areas of the peninsula is development, which manifests itself in private residential, vast leisure and relaxation complexes; this type of industry is well established in different regions of Greece. Indeed, as an example, the development of high-density tourism such as dense interior development in several Aegean islands and especially in Crete.

Fishery and aquaculture[2]

Greek aquaculture is dominated by marine finfish farming in offshore cages, specifically of gilthead sea bream and European sea bass, with a combined production capacity of about 110,000 tons in 2015. The culture of Mediterranean mussels follows this with an annual production capacity of up to 35-40,000 tons in 2015. After several crises, mainly because of an imbalance between supply and demand, the marine fish sector has been restructured to double its production by 2030. To succeed in this goal, strategies including targeted research, development, and innovations to optimize production; product diversification; and regarding marketing activities in the growth of new projects, such as farmer groups, are under consideration. Freshwater species and extensive lagoon aquaculture have growth potential essentially linked to the reduction in the availability of natural sources (water, wild stocks). Sea fish is the main animal product exported by Greece and accounts for around 11% of total national agricultural exports (which account for 19 percent of the entire Greek exports).

Marine fish farming in Greece provides 12,000 jobs (scientists, technicians, workers), mainly in remote and isolated regions. in some cases, it is the main employer, and the wealth of the local community largely depends on its activities. An additional 5,000 jobs exist in the value chain and peripheral actions. Within the aquaculture sector, marine finfish and mussels account for 85 percent of the primary labor employment, with 7 percent in freshwater and 8 percent in the lagoon aquaculture activities. As a result, Greece maintains an enormous fishery fleet (Table 5).

For 2003, marine fish farming has a larger market portion than wild-caught fish. In 2013, 69% of total fishery products came from agriculture, which is expected to grow in the future. The number of wild fisheries is declining and the only option is aquaculture.

Greek exports of agricultural products contribute approximately €555.8 million ($628.4 million) to the Greek economy, or 19% of total Greek exports. The export of farmed fish products, including prepared products, makes up about 11 percent of total Greek agricultural exports. Fish is the most exported Greek animal product, with a net trade

balance of an evaluated EUR 172.2 million (USD 194.7 million) to the national economy in 2014. Its addition to the gross national product was about 0.32%.

2 http://www.fao.org/fishery/countrysector/naso_greece/en

Despite the large production volume, mussel farming had a limited contribution due to low selling prices; with more than USD 6.36 million. It is estimated that this could be more than doubled if the industry operated under optimal production conditions.

Maritime transport

Greek shipping has thrived since ancient times thanks to the unparalleled skills of its seafarers. Their modern-day successors have proven that Greeks have the sea in their blood, evolving successfully despite the highly cyclical nature of the global shipping industry. Today, the Greek shipping industry continues to successfully navigate one of the most competitive sectors in the world. This, along with the ongoing development of Greece's national network of ports, is boosting the country's role in global transport.

According to the United Nations Conference on Trade and Development (UNCTAD), the fleet controlled by Greeks represents about 18% of the worldwide tonnage capacity. This is impressively disproportionate, considering Greeks make up just 0.15% of the global population.

Table 5. The Greek fishing fleet by category of length (OECD, 2017)

Overall LENGTH (m)	NUMBER OF VESSELS	GROSS TONNAGE (GT)
0,00-5,99	5.187	3.502,84
6,00-11,99	8.930	25.194,14
12,00-17,99	443	7.856,43
18,00-23,99	239	11.615,65
24,00-29,99	147	15.722,84
30,00-35,99	28	5.969,00
36,00-44,99	3	1.239,00
45,00-59,99	—	—
60,00-74,99	—	—
75 & more	—	—
No engine (of the above)	200	95,74

Overall LENGTH (m)	NUMBER OF VESSELS	GROSS TONNAGE (GT)
0,00-5.99	5,187	3,502.84
6,00-11,99	8,930	25,194.14
12,00-17,99	443	7,856.46
18,00-23,99	239	11,615.65
24,00-29,99	147	15,722.84
30,00-35,99	28	5,969.00
36,00-44,99	3	1,239.00
45,00-59,99	-	-
60.00-74,99	-	-
75 & more	-	-
No engine (of the above)	200	95.74

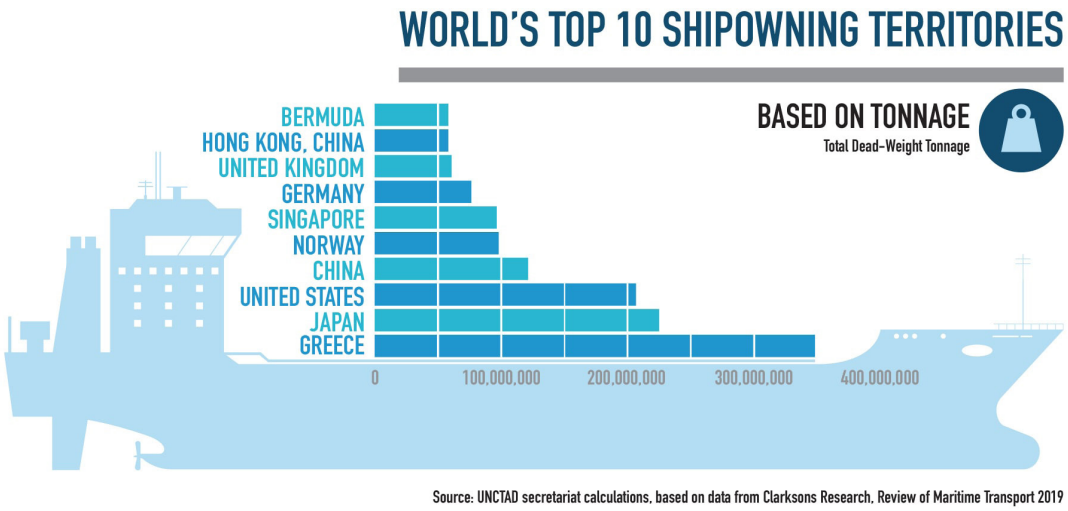

Figure 16. The World's Top 10 ship owning territories in tonnage capacity (www.greeceinvestorguide.com/sectors/maritime/)

Figure 17. Greece's Yale University Environmental Performance Index (EPI) ranks

VIII.2. Threat indicators on and by tourism

Regarding ecosystem services (ESS), threat indicators on and by tourism are proposed on Table 6 of environmental indicators.

Table 6. Proposed environmental indicators

ETIS / Environmental Impacts Optional Indicators	Co-Evolve threat Indicators	Co-Evolve4BG threat Indicators
Reducing Transport Impact		
Climate Change		
Solid Waste Management	Unitary waste production compared to overnight stays	SW generated by tourists (Qwt)
Sewage Treatment		Sewage Treatment
Water Management		Water pollution
Energy Usage		
Landscape and Biodiversity Protection	Natural land cover surface over the artificial land cover surface	
Light and Noise Management	Artificial sky brightness N. people exposed to road noise over 55 dB	
Bathing Water Quality	Bathing water quality	

IX. Pollution and anthropogenic pressure parameters

In the frame of the Co-Evolve4BG project, a set of parameters has been developed to provide an overview of the trend of evolution of the coastal ecosystems at both national and Mediterranean scales, in the light of Pollution and anthropogenic pressures. This set is composed of 5 parameters, as presented in Table 7. Data linked to these parameters were collected at both national and regional scales.

Table 7. Pollution and anthropogenic pressure parameters

Parameters	Description
Name of offshore platform	Provide the name of the offshore platform
Location of offshore platform	Provide the location of the offshore platform (Longitude, Latitude)
Area of Offshore Platform	Provide the area of the platform
The annual capacity of production of the platform (Gaz/Oil) (million cubic meters/thousand) (bbl)	Determine the mean production of oil/gas in the platform (the unit is the Barrel)
Name of the Industrial Unit	Provide the name of the Industrial Unit
Location of the Industrial Unit	Provide the site of the Industrial Unit (Longitude, Latitude)
Area of the Industrial Unit	Provide the area of the Industrial Unit
The annual capacity of production of the Industrial Unit	Determine the mean production of the Industrial Unit
Effect of maritime/Coastal tourism on ECOSYSTEMS (Yes/No)	Determine the effects of coastal/marine tourism on the ecosystem

X. Conclusions

This deliverable is based on documentary research, academic studies, and bibliographical references, which study and analyze the characteristics of the Greek coastline and what kind of impacts cause the tourism, and what type of impacts caused by tourism, as one of the most frequent anthropogenic activities in the marine and coastal environment. In the Greek context, we have identified the main threats affecting the stability of coastal and marine areas regarding ecosystem services and tourism.

Ecosystem services need an implied interest in distinguishing between them and their affiliated gains as critical tasks identified by the user community in the Mediterranean Sea.

Consideration of global environmental resources for tourism is the main topic of ecosystem services related to their benefits in the coastal and marine environment. The scale of Greece could have a direct impact on coastal beach tourism, such as cultural diversity. The ecosystems provide a rich source of inspiration for art, folklore, national symbols, architecture, and recreation. Natural spaces could be described as provided service rendered in relation to the environment by guaranteeing the well-being of the local population and the relationships of elements of the ecosystem.

Ecosystem threats and impacts of coastal and marine tourism typologies have been classified based on the adverse effects on atmosphere and climate change, energy and water resources, aesthetic, visual, atmosphere, noise, soil, and light pollution degradation of ecosystems - disturbance of flora and fauna and invasive species. Their impacts have been studied in specific ecosystems such as islands, coastal, rural, urban, and protected areas.

The results of this deliverable indicated that the main impacts of the coastal tourism typology have been achieved, the performances of which is represented in a direct environmental impact. Effects primarily affect freshwater quality, solid waste management, eutrophication, soil, noise, aesthetic and light pollution, and threats affecting wetlands and Maritime's biological diversity.

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PARTNERS

ASSOCIATES PARTNERS

Bs partage 95 05 05 15
Design and Editing