Project co-financed by the European Regional Development Fund

CO-EVOLVE

Promoting the co-evolution of human activities and natural systems for the development of sustainable coastal and maritime tourism

Deliverable 3.5.1

Review on the current status of coastal ecosystem services

Activity 3.5

Threats co-evolution - Mediterranean scale: Pollution and Ecosystems

WP3

CNR – ISMAR

Programme cofinanced by the European Regional Development Fund

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The authors are grateful to Daniel Depellegrin for providing useful suggestions and data sources.

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1. Introduction and scope of work

The aim of this deliverable is to report on the current status of coastal ecosystem services in Europe, with a focus on the Mediterranean basin.

To do so, this deliverable draws mainly on the knowledge gained in several projects and studies carried out recently in the European context, and it also describes case studies which exemplify assessments of specific coastal ecosystem services.

The deliverable is structured in a general part, where the concept of ecosystem services and its classification are reported; a focal part describing those ecosystem services relevant for the coastal systems and which touristic activities are supported by them; and last, a case study section, where examples from the countries involved in the project CO-EVOLVE are presented.

The findings of this deliverable will be used to frame the subsequent analyses, in particular by helping identifying on the one hand the major threats caused by touristic activities and their impact on each of the selected coastal ecosystem services, and on the other hand the major pressures limiting the sustainable development of coastal tourism.

2. Definition and classification of ecosystem services

2.1 General description of ecosystem services

Ecosystem services (ESS) arise when ecological structures (e.g. raw material such as sand) or functions (e.g. coastal protection, flood control) directly or indirectly contribute toward meeting human needs or wants. Such services generate benefits that contribute to overall well-being. This concept can be visualized with a simple thought experiment: in an Earth-like planet with no humans, there could be a wide array of ecosystem structures and processes, but there would be no services (Fisher et al., 2009).

One of the most accepted definitions of ESS is the one provided by Daily (1997), who consider them as “the conditions and processes through which natural ecosystems, and the species that make them up, sustain and fulfil human life”. Another famous definition was created by de Groot, who stressed the crucial role of ecosystem functions as baseline in support of human well-being (de Groot 2000).

Although the link between ecosystem services and biodiversity is still under examination, it is now clear that biological diversity in its different expressions (functional, taxonomic and so on) represents a prerogative for ESS to exist (Maes et al. 2016). For instance, those services acting as ecosystem regulation and maintenance are by definition dependent on the functional dimensions of ecosystems, and thus on the biological diversity of functional traits, and on key species in production and recycling (Braat & Brink 2008).

Even if the definition and comprehension of the above mentioned concepts is not univocal, ecosystem services are now integrated in current biodiversity policies at global and European level (CBD 2010; EC 2011a). Moreover, the European Biodiversity Strategy to 2020 considers the sustainable use of ecosystem services as underpinning element of human economies which complements the non-utilitarian conservation approach to biodiversity, thus contributing to the Europe 2020 targets. Under Action 5 of the European Biodiversity Strategy to 2020, Member States of the EU are committed to map and assess the ecosystems and their services on their national territory. With this aim, a dedicated working group (so-called MAES) of official representatives of EU Member States, mainly composed by experts affiliated to different European Commission services as well as independent scientists, has been recently established (Maes et al. 2012).

2.2 Classification of ecosystem services

The inclusion of ESS into biodiversity policies is largely the result of the Millennium Ecosystem Assessment (MA 2005) and the TEEB initiative (The Economics of Ecosystems and Biodiversity 2010). These studies have led to political acknowledgement (at the level of the United Nations) of the concept of ESS and advocate for a better understanding of the links between biodiversity, ecosystem functions, ecosystem services, their benefits and associated social and economic values as part of human well-being.

The Ecosystem Service framework, as adopted by the MA, has emerged as formal approach to describe and categorize the relationship between ecosystem and society. The MA recognizes the following ESS categories: provisioning services (e.g. food, fresh water), regulating services (e.g. climate regulation, water purification), cultural services (e.g. aesthetic, spiritual and recreational experiences), and supporting services (e.g. nutrient cycling, soil formation). On the other hand, the recent report on the economics of ecosystems and biodiversity (TEEB) acknowledges the plurality of ecosystem values and proposes a hierarchical approach for recognizing, demonstrating, and capturing the value of ESS for policy making.

Apart from the MA and the TEEB, other classification schemes have been proposed by several authors, such as Costanza et al. (1997), Daily (1997), Wallace (2007), and de Groot et al. (2002).

In Europe, the need for a more operational and comprehensive ESS classification has recently led to a common framework to categorize ESS. Such classification is called Common International Classification of Ecosystem Services - CICES (Haines-Young & Potschin 2013) and it was developed as part of the work done in Europe on ecosystem accounting. Since the CICES classification has been officially taken up by the European MAES working group, it was also adopted in the framework of CO-EVOLVE, in combination with the MA classification framework.

CICES comprises the following three ESS sections: provisioning (such as production of food and water), regulation and maintenance (such as control of climate and diseases), 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 thus it is not included in the CICES classification. Each of the ESS sections is divided into divisions, then groups, and then classes. The conceptual framework (so-called cascade model) backing CICES classification is depicted in Figure 1. In this model a ‘production

chain' links ecological and biophysical structures and processes on the one hand and elements of human wellbeing on the other, thus aiming at disentangling the pathway from ecosystems and biodiversity to human well-being.

In such cascade model one can see that, unlike the previous conceptualizations of ESS, the final services are separated by the benefits and by the associated values. Moreover, the Social and Economic System represented by goods and benefits has a direct impact on the Environment (symbolized by biophysical structures and processes) via an array of pressures. The cascade adequately shows that protection of and investment in the supporting ecosystems and biodiversity is an asset in order to maintain the sustainable flow of services and subsequent goods and benefits (Potschin and Haines-Young, 2011).

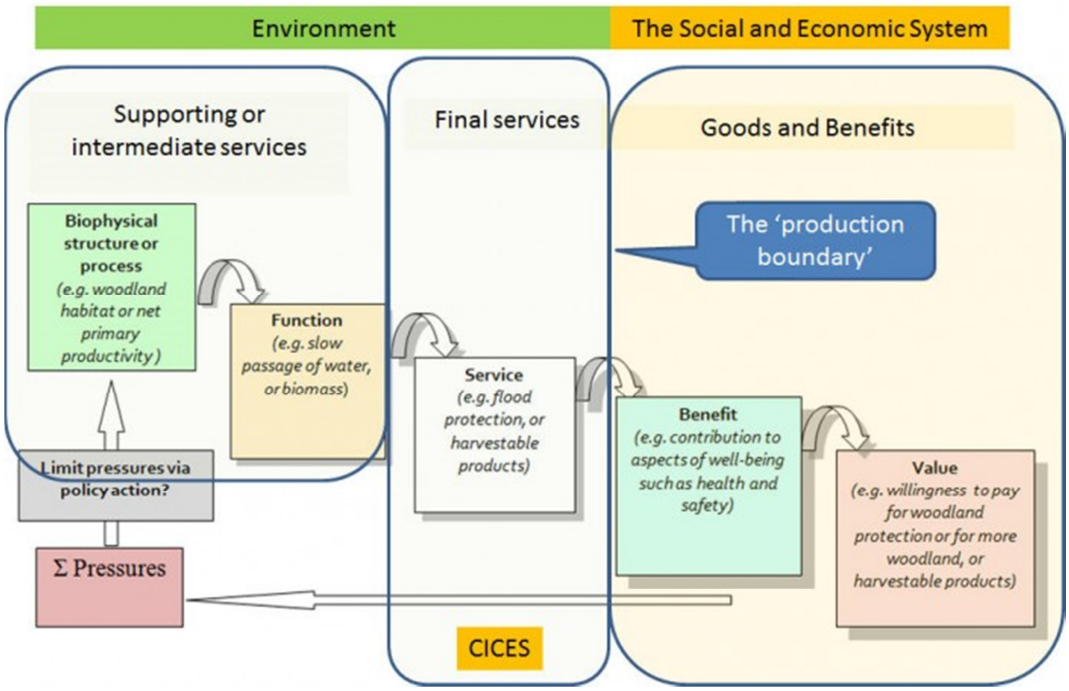

Figure 1: The cascade model adopted in the CICES framework. After: Potschin, M. and R. Haines-Young (2016)

3. Coastal ecosystems and associated services

3.1 Coastal ecosystems in the Mediterranean Basin

In order to identify the ecosystem services provided by the Mediterranean coastline, a preliminary inspection on the ecosystem types present in the study area was necessary. As a first step, we decided to adopt the global ecosystem types classification proposed by the World Resource Institute in 2001 (Burke et al. 2001). Although this ecosystem type classification is coarse, it is suitable to be connected to the associated ecosystem service typologies. The ecosystems classification was then limited to the Mediterranean coastal and marine systems on an expert base. Below, the resulting list of selected ecosystem types is reported:

- **Sandy shores**: loose deposits of sand, gravel or shells that cover the shoreline.
- **Estuaries**: that part of the mouth or lower course of a river in which the river's current meets the sea's tide.
- **Coastal shelf**: the sea bed surrounding a continent at depths up to about 200 metres, at the edge of which the continental slope drops steeply to the ocean floor
- **Evergreen needle leaf forests**: for instance *Pinus* spp. associations
- **Evergreen broad leaf forests**: for instance *Quercus ilex* associations
- **Shrublands**: coastal shrublands such as *Juniperus* spp. associations
- **Permanent wetlands**: permanently wet systems as slacks, depressions and lagoons
- **Coral reefs:** marine ridges or reefs consisting of coral and other organic material consolidated into limestone
- **Sea grass**: marine meadows of flowering plants from the order Alismatales
- **Swamps-floodplains**: forested wetlands
- **Grasslands**: dune grasslands and heathlands

A rapid survey involving the partners of the CO-EVOLVE project revealed that all the above-listed ecosystem types occur in their countries. The extents of each coastal terrestrial ecosystem type occurring in each partner country were then computed based on existing spatial information which follows the Corine Land Cover classification (CLC 2012, available at http://land.copernicus.eu/pan-european). To do so, first the coastal ecosystems were assigned to one or more CLC classes, expanded up to third level of detail. Then, the extents

by country of each CLC class were calculated in a GIS environment. The spatial reference adopted to define the boundaries of the "coastal zone" follows Lavalle et al. 2011, i.e. only those portions of coastal ecosystems occurring within 10 km landward from coastline were considered. Table 1 lists the extents (in hectares) of the terrestrial coastal ecosystem types per country and their correspondence with CLC classes and CLC codes. Evergreen broad leaf forests occur extensively in all countries, with Italy hosting the largest portion. On the other hand, sandy shores and estuaries show the lowest extents. Greece presents large surfaces of all considered ecosystems, especially in comparison with the other larger countries. Italy and France host significantly larger extents of permanent wetlands, while Spain hosts the largest portion of swamps-floodplains.

Table 1: Extent (hectares) per country involved in CO-EVOLVE of those Mediterranean coastal ecosystem types for which a correspondence with CLC classification could be found.

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

3.2 Coastal Ecosystem Services

Once the coastal ecosystem types were detected, a further step was to assess which coastal ESS are supported by each ecosystem. Table 2 shows the main broad ESS categories provided by each coastal ecosystem. A clarification of the most complex ESS categories is given here:

- “Genetic resources” are the genes and the genetic information used for animal and plant breeding and biotechnology;
- “Raw material” includes the vast range of food products derived from plants, animals, and microbes, as well as materials such as wood, jute, hemp, silk, and many other products derived from ecosystems;
- “Water regulation”: the timing and magnitude of runoff, flooding, and aquifer recharge can be strongly influenced by changes in land cover, including, in particular, alterations that change the water storage potential of the system, such as the conversion of wetlands or the replacement of forests with croplands or croplands with urban areas;
- “Waste treatment”: Ecosystems can be a source of impurities in fresh water but also can help to filter out and decompose organic wastes introduced into inland waters and coastal and marine ecosystems;
- “Biological control”: Ecosystem changes affect the prevalence of crop and livestock pests and diseases;
- “Pollination”: Ecosystem changes affect the distribution, abundance, and effectiveness of pollinators.
- “Storm protection”: The presence of coastal ecosystems such as mangroves and coral reefs can dramatically reduce the damage caused by hurricanes or large waves;
- “Climate regulation”: Ecosystems influence climate both locally and globally. For example, at a local scale, changes in land cover can affect both temperature and precipitation. At the global scale, ecosystems play an important role in climate by either sequestering or emitting greenhouse gases;
- “Erosion control”: Vegetative cover plays an important role in soil retention and the prevention of landslides;
- “Recreation”: People often choose where to spend their leisure time based in part on the characteristics of the natural or cultivated landscapes in a particular area;

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

Table 2: List of coastal ecosystems and main associated ecosystem services. Modified after Martinez et al. 2007.

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

A more detailed description on the cultural services is provided in Chapter 4.

A brief overview of the main coastal ecosystems and related services occurring in the four European Sea Basins is presented in the following paragraphs, with a special focus on the Mediterranean Sea.

North Eastern Atlantic

The major topographical features in the North Eastern Atlantic are the Mid-Atlantic Ridge (the Azores and Iceland are its highest points) and the Greenland-Scotland Ridge (which separates the Atlantic Basin from the Nordic Seas). This large marine region includes a diverse range of environmental conditions and different ecosystems, which greatly vary in diversity and depth. The coastline of the North Eastern Atlantic encompasses a great diversity of habitats, including rocky shores, marshes, estuaries, mud flats and sand flats in intertidal areas. Bedrock outcrops and bedrock platforms with kelp (e.g. Bristol Channel) can also be found. Kelps are hugely important as primary producers, habitats and repositories of marine biodiversity and secondary productivity, as natural coastal defence, and as nursery ground for exploited species (Steneck et al. 2002). Salt marshes and kelp forests alleviate the damage caused by flooding and storm events, by altering wave motion and providing a buffer against surges through wave damping and attenuation, and by reducing the velocity of breaking waves (Lovas & Torum 2001). Kelps as primary producers and habitat providers play a key role in the maintenance of fish stocks and ecosystem structure and therefore indirectly help to sustain regional fisheries and the coastal communities they support (Smale et al. 2013).

Baltic Sea

The Baltic Sea is a large brackish-water pool, characterized by narrow and shallow straits connecting it to the North Sea, and a large drainage basin bringing a large amount of fresh water runoff into the sea. The Baltic Sea provides many goods and services that contribute to human wellbeing (Ahtiainen & Öhman 2013). These include, for example, fish stocks, biodiversity, and water quality and climate regulation. Fish is a major provisioning ecosystem service type of the Baltic Sea used for consumption (Garpe 2008): the main species caught on a commercial basis are cod, sprat, herring and salmon. Moreover, genetic resources are important aspects of ecosystem services (Bailey 2011), although much of the original genetic variation in Baltic salmon has already been lost due to extinction of individual populations and reduction in population sizes (Palmé et al. 2012). The Baltic Sea is also a

relevant recreation area for the people living in the surrounding countries. The most common activities are swimming, sport fishing and spending time at the beach. In Sweden, the number of recreational fishermen is estimated to be one million (Swedish EPA 2009). Tourism industry is of vast importance, having estimated to have an annual turnover of 90 billion euros, and to provide employment for ca. 2 million people.

Black Sea

The Black Sea is an almost enclosed basin connected to the Aegean and Mediterranean Seas via the narrow Bosphorus Strait only. It has a total coastline length of 4,869 km, it covers an area of 436,000 km^2, and it has a volume of 555,000 km^3 and maximum depth of 2,258 m with variable topography (DEVOTES 2014). It is a unique and very vulnerable ecosystem under strong anthropogenic pressure - wastewater discharges and runoff, pollution, oil spills, anthropogenic eutrophication, and overfishing (Toneva 2015). Its fauna species diversity is approximately three times lower compared with the Mediterranean. Shipping, fishing, agriculture, tourism, land based industry and infrastructure are the most important human uses in the region (Knight *et al*., 2011). Seafood, air purification and climate modification were recognised as relevant ESS categories (Fletcher et al. 2014). Concerning cultural services, a number of ESS categories was recently detected and characterized: aesthetic information, recreation, inspiration for art and design, and cultural heritage (Fletcher et al. 2014).

Mediterranean Sea

The Mediterranean Sea is the largest of the semi-enclosed European seas; it extends from 30°N to 45°N and from 6°W to 36°E for 2,969,000 km^2 (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 by the Strait of Gibraltar 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 region comprises a wide array of habitats, including brackish water lagoons, estuaries, transitional areas, coastal plains, wetlands, rocky shores, sea grass meadows, coralligenous communities, upwellings, seamounts and pelagic systems (EEA 2014; Knights et al. 2011). Surrounded by 22 countries that share a coastline of 46,000 km, the Mediterranean region is home to around 480 million people living across three continents: Africa, Asia and Europe. Attractive landscapes and rich biodiversity, cultural heritage and traditional lifestyles, coupled with favourable environmental conditions such a mild climate, beaches and clear seawater

have made the Mediterranean basin one of the most popular tourist destinations in the world. In 2010, it accounted for 285 million tourist arrivals or 28% of international tourism in the world (UNEP/MAP 2012; EEA 2014). The Mediterranean region is one of the global biodiversity hotspots, with a large number of endemic species, 10% of higher plant species and 7% of marine species (UNEP/MAP-Plan Blue 2008). Thanks to its unique biodiversity, the region is able to deliver an immense richness to its inhabitants and visitors, economically translated into 26 billion €/year. This impressive figure arose from an ESS economic assessment (Mangos et al. 2010) based on six ESS present in four Mediterranean marine ecosystems (sea grass meadows; coralligenous communities; hard substrate areas with photophilic algae; soft substrate areas and the open sea). The service types belonged 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). Moreover, the distribution of the obtained economic value among countries was investigated, showing that 8 countries account for about 90% of the overall benefits resulting from marine ecosystems: Italy, Spain, Greece, France, Turkey, Israel, Egypt and Algeria (Figure 2).

Despite these economic estimates, uniform quantitative data on the overall ESS provided by the marine and coastal Mediterranean ecosystems is not yet available (Mangos et al. 2010); however, Tempera et al. (2016) recently detected and analysed the ESS classes supplied specifically by the Mediterranean sea beds. For the purpose of the study, the Mediterranean Sea was split into four sub-regions: Western Mediterranean Sea, Ionian Sea & Central Mediterranean, Adriatic Sea and Aegean-Levantine Sea. The selected services - according to the hierarchical CICES classification - are listed below:

<u>Provisioning Services</u>

1.1 Nutrition

1.1.1 Biomass

1.1.1.4 Wild animals and their outputs

1.2 Materials

1.2.1 Biomass

1.2.1.1 Fibres and other materials from plants, algae and animals for direct use or processing

1.2.1.2 Materials from plants, algae and animals for agricultural use

1.2.1.3 Genetic materials from all biota

Regulation & Maintenance

2.1 Mediation of waste, toxics and other nuisances

2.2 Mediation of flows

2.2.1 Mass flows

2.2.2 Liquid flows

2.2.2.1 Hydrological cycle and water flow maintenance

2.2.2.2 Flood protection

2.3 Maintenance of physical, chemical, biological conditions

2.3.1 Lifecycle maintenance, habitat and gene pool protection

2.3.2 Pest and disease control

2.3.2.2 Disease control

2.3.4 Water conditions

2.3.4.2 Chemical condition of salt waters

2.3.5 Atmospheric composition and climate regulation

2.3.5.1 Global climate regulation by reduction of greenhouse gas concentrations

Cultural Services

3.1 Physical and intellectual interactions with biota, ecosystems, and land-/seascapes [environmental settings]

3.1.1 Physical and experiential interactions

3.1.1.2 Physical use of land-/seascapes in different environmental settings

3.1.2 Intellectual and representative interactions

3.1.2.1 Scientific

3.1.2.2 Educational

3.1.2.5 Aesthetic

3.2 Spiritual, symbolic and other interactions with biota, ecosystems, and land-/seascapes [environmental settings]

3.2.1 Spiritual and/or emblematic

3.2.2 Other cultural outputs

The Western Mediterranean Sea is the most relevant among the four sub-regions concerning the provision of biomass, aesthetic value, and the regulation of mass flows. It also sustains 35% of the global climate regulation through the reduction of greenhouse gas concentrations at European level (hereafter referred as “total”). The Ionian Sea and the

Central Mediterranean area supply 13% of the total disease control and 12% of atmospheric composition and climate regulation total capacity, while their role is lower for the provision of other ESS. The Adriatic Sea contributes with a 10% of the total capacity to deliver the following ESS categories: materials from plants, algae and animals for agricultural use; mass flows; aesthetic value. Last, the Aegean-Levantine Sea contributes mostly to pest and disease control (20%), atmospheric composition and climate regulation (18%), and to spiritual and/or emblematic value (20%).

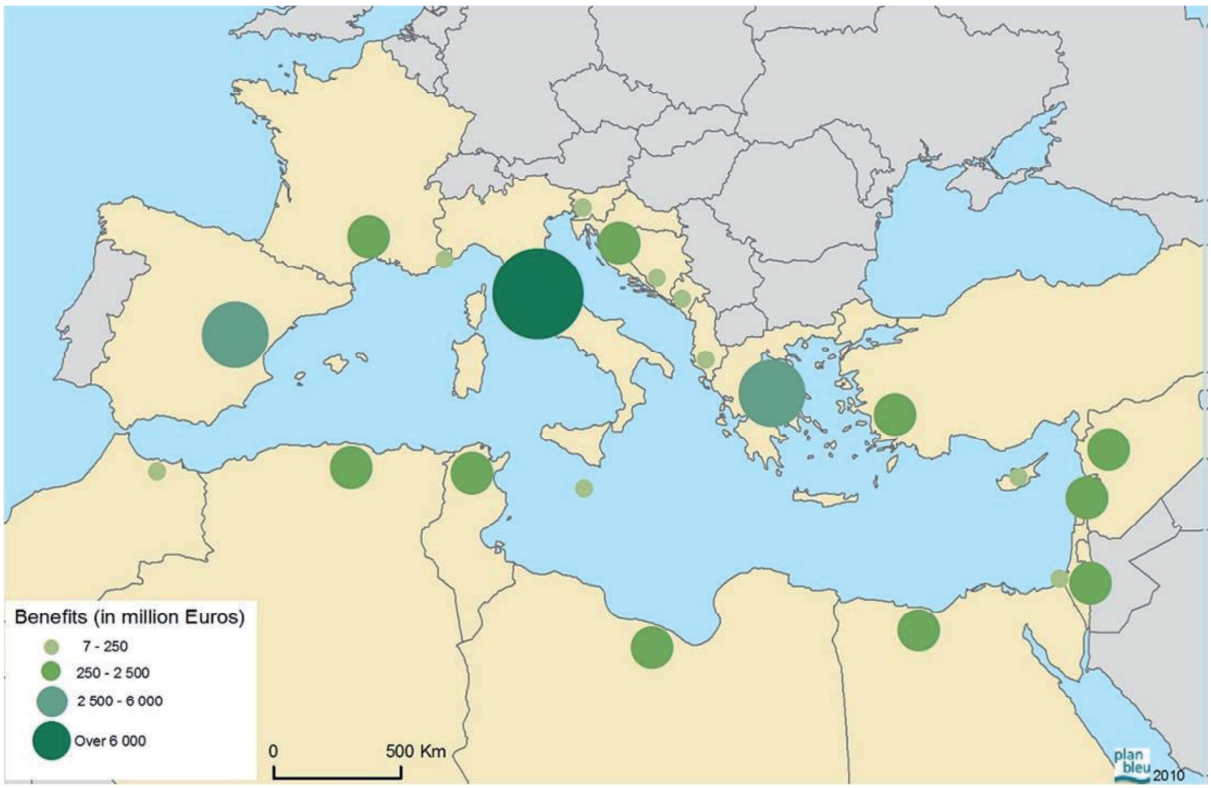

Figure 2: Distribution of the economic benefits provided by six marine ESS. Source: Mangos et al. 2010

As regarding Mediterranean lagoons and estuaries, useful indications on the main ESS supplied were retrieved from a recent Pan-European review, which analysed 14 case studies where ESS were identified and their relative importance was assessed (Lillebø et al. 2016). The case study sites of pertinence for the Mediterranean Basin were Lesina (IT), Mar Menor (ES) and Amvrakikos (EL). Some provisioning ESS were identified for these sites, namely: wild animals and their outputs; animals from in situ aquaculture; fibres and other materials from plants, algae and animals for direct use or processing; genetic materials from all biota; surface water for non-drinking purposes; and ground water for non-drinking purposes. With

regards to the “regulation” class, a wide range of ESS was detected: bio-remediation and filtration/sequestration/storage by micro-organisms, algae, plants, animals; dilution by atmosphere, freshwater and marine ecosystems; mass stabilisation and control of erosion rates; buffering and attenuation of mass flows; flood protection; maintaining nursery populations and habitats; pest control; decomposition and fixing processes; chemical condition of salt waters; and global climate regulation by reduction of greenhouse gas concentrations. All cultural ESS classes were also revealed in the three lagoon systems.

An economic valuation for a set of ESS delivered by wetlands was performed in the framework of the Med-ESCWET project, which was launched in 2013 by Plan Bleu, in partnership with Tour du Valat. The project did seek to promote the use and restoration of ‘natural infrastructure’ as climate change adaptation measures, rather than the artificial infrastructures (Dubreuil & Dutreix 2017). Ecosystems services such as carbon sequestration, flood control and coastal protection were measured in four case studies across the Mediterranean Sea: Étang de Vic (FR), Lonjsko polje floodplain (HR), Burullus Lake (Egypt), and Yeniçağa peatlands (Turkey). Results indicated that the presence of natural wetland allowed saving ca. 1.5 billion € in the case the Croatian floodplain, which is equal to the cost estimate for installing artificial retention-basins along the whole coastline.

Mediterranean coastal dunes’ ESS capacity has been scarcely investigated so far. If we exclude a few studies focusing on carbon storage potential and habitat provision of dunes along the Adriatic Sea coastline (Drius et al. 2016; Jones et al 2008), little quantitative information exists to date. However, thanks to a comprehensive review analysing the ESS supplied by coastal dunes at European level and their relative importance, it was possible to obtain a subset of ESS for the Mediterranean area (Everard et al. 2010). This expert-based ESS list includes sand extraction, climate regulation, water regulation (through water storage), storm protection, water purification and waste treatment, habitat provision, and of course recreation.

4. Relevance of ESS for coastal tourism

4.1 General description

Many people engage in some outdoor recreational activities, both in the form of daily activities in the nearby green spaces or as an overnight touristic experience. Thus, recreation and tourism represent a major opportunity and nexus for managing the interaction between ecosystems and people, including the development of environmental awareness and the growth of appreciation and support of ecosystems protection. Recreational activities offer an opportunity for many people to experience the benefits of ESS directly. Recreation and tourism supply the society with crucial values, such as physical exercise, aesthetic experiences, intellectual stimulation, inspiration, and other contributions to physical and psychological well-being (Daniel et al. 2012).

Coastal tourism is among the most favourite kinds of outdoor recreation, as in most people's mind coastal systems are associated to great natural sceneries and a deep sense of wellness and relaxation. Both are relevant cultural services, particularly for those individuals coming or normally living in an urban context, where daily stress on one side and loss of identity on the other side are more likely to occur.

Nevertheless, cultural services such as recreational value, cultural heritage and landscape aesthetics rely on those types of ESS that are able to sustain the coastal ecosystems functionality *per se* in the long term, such as the provisioning and regulating services. Among these, it's worth mentioning a few examples: erosion protection; maintaining nursery populations and habitats; micro and regional climate regulation.

Considered the above-mentioned centrality of cultural ESS for the society, their evaluation is essential for highlighting where the benefits for maritime economic sectors such as coastal tourism (and more generally for society) are, and how they might have changed in time. Current regulations like the EU Maritime Spatial Planning Directive (Directive 2014/89/EU) and the Marine Strategy Framework Directive (Directive 2008/56/EC) need therefore to be supported and guided by an ecosystem approach which takes into adequate consideration also the role of cultural ESS (Liquete et al. 2016).

A more detailed descriptive list of the cultural ESS supplied by coastal environment is given here:

- Cultural diversity. The diversity of ecosystems is one factor influencing the diversity of cultures.
- Spiritual and religious values. Many religions attach spiritual and religious values to ecosystems or their components.
- Knowledge systems (traditional and formal). Ecosystems influence the types of knowledge systems developed by different cultures.
- Educational values. Ecosystems and their components and processes provide the basis for both formal and informal education in many societies.
- Inspiration. Ecosystems provide a rich source of inspiration for art, folklore, national symbols, architecture, and advertising.

4.2 Touristic activities and related ESS

The main coastal touristic activities occurring in the Mediterranean area were identified for the purpose of this review. These activities are also, in some cases, suitable measurements or indicators of the coastal cultural services reported in the previous section. The CO-EVOLVE partners were asked to detect which coastal touristic activities occur in their country, and to rank the importance of each one at the country level, based on their expertise. The outcome is reported in table 3. An 'X' was assigned for low importance, a 'XX' for medium importance and a 'XXX' for high importance.

Overall, recreational swimming and sun bathing were the most relevant coastal touristic activities revealed in all countries. The French and Croatian partners assigned a higher importance score to sports like sailing, kayaking and walking compared to the other partners. On the other hand, little or medium importance was assigned by the CO-EVOLVE partners to more nature-related activities, such as observation of insects and snorkelling and to the utilization of natural resources. However, Italy, France and Greece regarded the use of molluscs/crustaceans very important. In general, low importance was assigned to plants if compared to animals (birds). Relaxation was considered very relevant by all partners but Spain. Croatia was the only country acknowledging the high relevance of quietness. Lastly, cultural touristic activities such as scientific and dissemination initiatives were regarded as of relatively scarce relevance by the five partners.

Table 3: Coastal touristic activities in the Mediterranean basin, and their relative importance per country.

Touristic activities	Italy	France	Croatia	Spain	Greece
Nature observation					
Observe birds	XX	XX	XX	XX	XX
Observe fish & cetaceans	X	XX	X	XX	X
Observe scenery	XX	XX	XX	XX	XX
Observe other animals/insects	X	X	X	X	X
Observe plants	X	XX	XX	XX	X
Recreation					
Swimming	XXX	XXX	XXX	XXX	XXX
Sun bathing	XXX	XXX	XXX	XXX	XXX
Cycling	X	XX	XX	XX	X
Running	X	XX	XX	XX	X
Dog walking	X	X	X	X	X
Walking	X	XXX	XXX	XXX	X
Snorkelling, scuba diving	X	X	XX	XX	X
Angling, spearfishing	X	XX	XX	X	X
Nautical sports *(sailing, water-skiing, kayaking…)*	X	XXX	XXX	XX	X
Natural resource use					
Use of plants (e.g. *Limonium* spp.)	X	X	X	X	X
Use of birds *(hunting is included)*	XX	XX	X	X	XX
Use of molluscs/crustaceans	XXX	XXX	XX	X	XXX
Sense of freedom					
Quietness *(for example through natural sounds)*	X	XX	XXX	X	X
Relaxation	XXX	XXX	XXX	XX	XXX
Education					
Scientific activities	X	XX	XX	X	X
Dissemination activities *(e.g. Nature guided tours, exhibitions in visitor centres…)*	X	XX	XX	XX	X

5. Scaling of ESS to the Mediterranean area

This section includes examples of activities and studies directly or indirectly related to ESS identification and evaluation. The examples are located in the Mediterranean countries involved in CO-EVOLVE and in other southern Mediterranean countries. Some of the initiatives are focused on citizen science activities and educational programmes which proved to start mainstreaming the concept of ESS. Others describe studies aiming at assessing the economic value of ESS. Although the economic valuation of ESS is not an integral part of the CO-EVOLVE project, it represents a relevant issue in the framework of ESS assessments, and for this reason it was included in the review.

5.1 Spain

Example 1. - Economic valuation of ESS in the Catalan coastal zone

A study on the economic valuation of ESS in the Catalan coast assessed a range of ESS supported by coastal, marine and terrestrial ecosystems (Guillermo 2007). Going into details, beaches and dunes, seagrass bed and saltwater wetland were analysed. For beaches and dunes, disturbance regulation provided the highest economic benefit (67,400 $/ha/year), followed by aesthetic and recreation benefits (36,687 $/ha/year). Seagrass beds supplied the society with nutrient cycling, which was worth 24,228 $/ha/year, while continental shelf supplied, in order of economic relevance, nutrient cycling (1,787 $/ha/year), water supply (1,287 $/ha/year), cultural value (86 $/ha/year) and biological control (49 $/ha/year). Last, saltwater wetland supplied waste treatment (13,376 $/ha/year), disturbance regulation (766 $/ha/year), habitat refugia (497 $/ha/year), and aesthetic and recreation (64 $/ha/year).

Example 2. - Testing the recreational value of Minorca Beaches

A commonly used technique to evaluate the recreational value of a certain site of environmental significance is the so-called travel cost method, which relates the importance people assign to an area based on the distance they are willing to cover to visit it. The method relies on surveys based on respondents' choices to visit a recreational site, where data on the cost of travelling, number of visitors, and accommodation costs are specified. This technique produces reliable and useful knowledge for tourism policy, as demonstrated for instance in a case study carried out on 51 beaches of Minorca Island (702 km^2, 92,000

inhab.), a site where sea-side tourism is the main source of income (1,44 M tourists in 2016), accounting for nearly two-thirds of its gross domestic product (Riera et al. 2011). In this work, the welfare impact of a set of beach closures due to oil spill was estimated on a total of 573 individuals. Interviewees were asked to indicate their travel cost details such as fuel costs, tolls, and the value of travel time. In addition, their willingness to pay to avoid the recreational loss of the beach they frequented was investigated. In this way, it was estimated that the loss of opportunity to frequent a certain beach in Minorca Island due to oil spill would have produced a total welfare loss of at least 6,000 € per day (referred to peak season). This example reveals the economic relevance non-market assets can embed, thanks to their significant recreational value.

In another study (Pérez-López & Roig 2006) carried out in Minorca the authors calculated the annual economic value of beaches. Since it is an asset for which there is no market, they applied a contingent valuation method that simulates a market through a survey of potential consumers, where people are asked about their willingness to pay for the use of beaches. In the case of Minorca, the annual economic value through the application of the contingent valuation method was estimated at 33 million Euros. This theoretical estimation gives us an idea of the importance of beaches as the main natural system of promotion of the "Sun and Beach" tourism typology, which sustains the economy of the island. The study concludes that, taking into account the results obtained from the survey, it is necessary to preserve and maintain these spaces in good landscape and environmental conditions, in order to maintain quality tourism associated with beach tourism, as well as to differentiate it from other coastal tourist destinations.

5.2 France

Example 1. - “Sentinelles de la biodiversité” - A participatory approach to reinforce the provision of cultural ESS

The Hérault Department recently launched a participatory approach called “Sentinelles de la biodiversité” to reinforce the scientific research of its region and to create a deeper connection between citizens and biodiversity assets. Since ten years the terms “sustainable development” and “biodiversity” have entered into the daily lives of French citizens. Although these terms are not completely understood by people, they are aware of the changes the planet is undergoing and of the impact of human activities on nature. Knowledge of this

heritage becomes a key issue for spatial planning and the preservation of the environment. Universities and research centres in Montpellier are at the forefront of international research in the fields of agronomy, ecology and water sciences. In recent years, biological sciences have seen the development of initiatives to open research to public participation. The naturalistic community with its networks of volunteers has shown the way and today the rise of citizen science initiatives which draw on the expertise of these associations by blurring the boundaries between professionals, associations and the general public can be seen. With "Sentinelles de la biodiversité", the Hérault Department invites the French citizens to observe and take care of ordinary nature in their daily environment, for future generations, and to share and disseminate scientific knowledge, enhancing in this way cultural ESS such “knowledge systems” and “educational values”.

Source: http://www.herault.fr/environnement/sentinelles-de-biodiversite

Example 2. - BioLit: Coastal monitors - A national participative science program on coastline biodiversity

BioLit (BIOdiversité du LITtoral) is a French participative science program aimed at improving and disseminating insight into coastal biodiversity. This initiative was created and supported by the “Planète Mer” association, while the Marine Station of Dinard is responsible for its development, with the support of a scientific council in partnership with environmental and sustainable development education structures, and with local authorities, government departments, and managers of protected spaces and natural resources. The aim is to monitor through citizen involvement the coastline’s health, contributing in this way to the identification and development of indicators for monitoring the quality of coastal environments. Various actions are foreseen by the initiative: measures to promote coastline biodiversity (such as photos of rare or protected coastal species) and to create a network of coastline alerts against invasive species, marine litter, and other threats.

Depending on location and on the time of year, the priorities of the actions may change. Through these observations, citizens and tourists can get not only better informed on the coast conservation status, but they can also themselves contribute to raise awareness on these issues, and hopefully be involved in the process of finding adequate and shared solutions. The initiative can be seen as an indirect example of cultural ecosystem service provided by the unique biodiversity features of the coastal environment.

Source: http://www.biolit.fr/attention-menace.

5.3 Italy

Example 1. - Guidelines for Marine Environmental Education – an initiative from the Italian Ministry of the Environment, Land and Sea and the Ministry of Education, University and Research

The Italian Government launched in 2015 an initiative aiming at guiding the environmental education programme for compulsory school. For each school grade, different approaches have been proposed to guide teachers towards the principles of sustainable development. A special section dedicated to marine nature conservation has been produced, where children attending nursery and primary school shall learn basic principles on how to sustainably use marine water resources and how to preserve their integrity in the long term. In the guidelines a conceptual map linking the preservation of sea and of water resources to their sustainable exploitation is shown.

To support the guidelines use, a series of technical information sheets containing information on the major ESS supplied by the Italian natural systems is also provided.

Source: http://www.minambiente.it/pagina/linee-guida-educazione-ambientale

Example 2. - The CAMP Italy Project: an example of promotion of sustainable eco-tourism from Emilia Romagna

The CAMP Italy Project (*Coastal Area Management Programme*) was launched by the Italian Ministry of the Environment, Land and Sea with the goal to develop strategies and procedures for the rational exploitation of coastal resource and for the protection of the environment. One of the pilot actions foreseen in this project is the development and exploitation of new forms of sustainable tourism in protected National areas. In the “Delta del Po” Park (Emilia-Romagna) two tasks were performed within this action: on the one hand, coastal tourists got involved in the active preservation of the protected area through citizen science initiatives, thus passing the message of respect and enjoyment of the natural heritage. On the other hand, new naturalistic - cultural paths able to increase the potential of the sites to be promoted were built. To achieve these aims, informational seminars were organized, in relation to different targets, especially schools, citizens and economic operators (e.g. lifeguards, traders, etc.). The seminars aimed to disseminate the principles and actions of the project and, more generally, to spread the culture of citizen science. In the preliminary phase, all the instrumental resources that already exist for the recognition of animal and plant species were identified and networked among themselves. On the basis of

these ones, special media and digital guides were studied, so to lead to the discovery of some ecosystems and animal and plant species which characterize them. These guides are free to download and can be used for recognition in the field of animal and plant species, also by those who are not particularly expert; they represent a kind of operational tool that can also allow any citizen to contribute to research indicating the presence, or disappearance, of a given species in a particular environment. The information can then be shared on the activity's blog.

Source: http://www.camp-italy.org/the-project/sustainability-of-socio-economical-pressures-in-the-coastal-area/development-and-exploitation-of-new-forms-of-sustainable-tourism-in-protected-natural-areas-emilia-romagna

5.4 Greece

Example 1. - Environmental education in the Marine Protected Areas

The environmental education is integrated in the educational programmes of compulsory school through mostly primary and secondary school. Different approaches can be identified in different grades including field trips and visits to environmental protection centres (observatories, centres dedicated to natural sites of special interests etc.). Specific examples include two Marine Protected Areas, Zakynthos National Marine Park (http://www.nmp-zak.org/en) and National Marine Park of Alonissos (http://alonissos.gr/en/marine-park/overview.html). These schemes were put in place in order to avoid further degradation of key ESS (habitat provision) provided by the coastal systems occurring in the protected areas. For instance in Zakynthos, which is the most important breeding site of the Loggerhead Turtle (*Caretta caretta*), the coastal nesting grounds along sandy beaches are disturbed by tourism development, and unfortunately the peak of tourist season coincides with the nesting season for the vulnerable Loggerhead Turtles. Therefore, environmental education is the only way to minimize further loss of such natural capital, without compromising the area's economy.

Example 2. - Visitors' perceptions on the management of a key marine species

Tourism has important impacts, both positive and negative, on the management of coastal areas with high biodiversity value. It is therefore important to investigate visitors' perceptions concerning environmental policy alternatives for these areas along with the factors

influencing these perceptions. A study set in the highly touristic coastal area of Rethymno assessed visitors' perceptions of an important nesting ground for loggerhead sea turtles, listed in the Natura 2000 network. The work focused on the level of environmental awareness of visitors and their perceptions of two proposed policy instruments which will secure funding for the improvement of the environmental management of the area: an entrance fee to the beach and a tax to be levied on local accommodation costs. According to the results of the study, awareness of the existence of the Natura 2000 site needs further efforts through an effective governmental communication strategy. Average Willingness to Pay (WTP) was also explored for the two policies, estimated at €1.13 for the daily accommodation tax and €1.59 for the entrance fee. The study concludes that the accommodation tax would be a more appropriate policy for the management of Rethymno beach taking into consideration visitors' perceptions and the current level of trust (Jones et al. 2011).

5.5 Croatia

Example 1. - Cruise tourism environmental impacts - The perspective from the Adriatic Sea

The Mediterranean Sea is an increasing market for cruise tourism, which is a growing sector of the travel and recreation industry. In 2006 The Mediterranean region made 18% of the world cruise market (McCalla & Charlier 2006). Yet the environmental impacts of cruise vessels on the host environment can be significant, and are likely to increase together with this rising tourism sector. Examples of pressures are ballast water pollution, greywater pollution, air pollution, noise, sewage, and oil pollution (*http://www.marineinsight.com/environment/*). The absence of any international coordination of the industry at the region level leaves it open to exploitation, especially considering the lack of effective pollution control mechanisms in most States. The Adriatic Sea, and Croatia in particular, is of growing interest to the cruise industry. As such Croatia can serve as an example of the strategies and practices that will be implemented to respond to such environmental impact (Carić & Mackelworth 2014). Carić H. (2011) has proposed a series of mitigation measures to be applied to the Port of Dubrovnik, in order to better sustain the loads of impact factors caused by ship cruises. Management of communal services through mapping activities, quantification of solid waste, and use of a more environmentally friendly

fuel are some of the measures highlighted. The development of an effective system should be initiated via local decision-makers that should formally commit to environmental quality and ensure effective protection.

Example 2. - Sustainable Tourism and Economic Instruments: the case of Hvar, Croatia

Tourism has important economic, social and environmental implications that should not be overlooked in evaluating the impacts of the tourist industry on a region. This is especially true for coastal regions, whose vulnerability due to climate change effects is generally not taking into account when planning new touristic resorts or expanding existing ones, with the risk of depleting ecosystem services in the long term, and thus the economic benefits for the region itself. In order to face congestion and pollution caused by tourism activities in sites of environmental significance, different strategies can be put in place. Such strategic measures have included the use of “ecolabelling”, the use of “ecotourism”, and the raising of taxes on tourists in order to raise the revenues to correct the environmental damage caused. This latter case refers to the so-called environmental taxes, or eco-taxes, which are placed on a good or service to internalize some, or all, of the external (also hypothetical) costs of the activity undertaken (Taylor et al. 2005). An example is provided by the tourist eco-charge in Hvar, Croatia, which is levied on the number of days spent on the site, regardless the hypothetical volume of pollution produced. The growth of eco-tourism, of certification schemes (such as EU blue flag scheme) and of pro-active environmental management suggest that environmental quality may form an important part in the consumer’s consumption decision.

5.6 Non EU Mediterranean coastline

Information on the current situation of cultural ESS provided by the coastal ecosystems occurring in the non EU Mediterranean countries was difficult to retrieve, due to time constraints and difficulties in obtaining non-published data. Therefore, in this section only a brief overview of some recent initiatives and studies for protection and sustainable coastal management is presented.

Morocco

In Morocco, *Le Haut Commissariat aux Eaux et Forêts et à la Lutte Contre la Désertification* is charged with the management of protected areas for the entire country. In 1996, this department approved a Master Plan for protected areas, which identified about forty coastal areas as sites of biological and ecological interest. Twelve areas are located along the Mediterranean coastline of Morocco. In 2004, the Moroccan Ministry of Spatial Planning, Water and Environment in cooperation with PAP/RAC conducted a feasibility study to launch a CAMP (*Coastal Area Management Programme*) for the Moroccan Mediterranean coastal zones. The feasibility study resulted in a project proposal to develop a 'Plan d'Aménagement Côtier' for the area Rif Central. This CAMP project, which ended in June 2010, included the development of an ICZM (Integrated Coastal Zone Management) strategy.

The project "MedWetCoast", related to ICZM and funded by the Global Environmental Facilities and *Le Fond Français pour l'Environnement Mondial* (FFEM) was active between 1999 and 2004. The main project objective was to contribute to the preservation and sustainable use of wetland biodiversity in the non EU-Mediterranean area and achieve and demonstrate this in a set of fifteen important sites. The sites covered six Mediterranean countries, namely Albania, Egypt, Lebanon, Morocco, Palestinian Authority and Tunisia. Two sites which formed part of the Moroccan MedWetCoast project are the Estuary of the Moulouya River and the Nador Lagoon; other ICZM related projects for the two sites were funded in the period 2006-2008 under the SMAP III programme (Short and Medium Term Priority Environmental Action Programme) of the European Union.
Source:
https://ec.europa.eu/maritimeaffairs/sites/maritimeaffairs/files/docs/body/morocco_01_en.pdf

In 2015 a scientific work supporting the sustainable management of Moroccan coastal tourism through the assessment of ESS loss was published (Flayou et al. 2015). The study was carried out in the coastline of Tétouan and predicted the economic loss for the coastal tourism sector due to beach degradation. In particular, the annual loss due to sand extraction was estimated in 76 Million $ between 2015 and 2048.

Algeria

The Taza National Park includes one of the most popular tourist destinations in the country, namely the Jijelian coast, which hosts over 5 million visitors every summer. Through the SEAMed project (WWF 2016), Taza National Park aims to implement a policy of sustainable

tourism in the park in partnership with the coastal municipalities, promoting its natural land and marine areas. The project has engaged key stakeholders from the private and non-profit sector in order to develop sustainable tourism activities in the region. The project contributed to the implementation of new sustainable tourism activities in the area. In details, new underwater trails were established in collaboration with the local diving clubs who are in charge of the management of the trails; “Pescatourism” activities were initiated and professional fishermen have been trained and sensitized on the benefits of limiting fishing effort while promoting sustainable forms of artisanal fishing. Moreover, diversification of tourism and promotion of traditional culture and sustainable nature-based activities have been developed through a participative approach with local communities, tour operators, local authorities and the park staff. In addition, terrestrial routes have been established to alleviate intensive tourism and promote rural areas. Last, the project supported the institution of a local association that now manages the Maison du Terroir at Chréa.

Tunisia

In the framework of the SEAMed project (WWF 2016), a pilot study in Cap Negro-Cap Serrat was carried out to increase the capacity of local NGOs to plan sustainable coastal tourism activities. To this aim, numerous training courses as well as information and communication activities, particularly for stakeholders (governmental and non-governmental), were organized. Local NGOs gained expertise and tools to influence local decisions and to resolve solutions to their conflicts of interest; an NGO platform was also created to facilitate these processes. The project contributed also to increasing awareness of students and teachers, and to promoting the Marine Protected Areas to the local population. Last, eco-tourism activities were put in place, among which a website, an eco-tourism map and a promotional video.

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