P. Dimopoulos & I.P. Kokkoris

Role of ecosystems and their services

in the Biosphere Reserve of Parnon-Maleas

ASTROS ARCADIA 2021

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MAINALON & MONEMVASIA

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Introductory note

I am very pleased to write a few words about this edition that refers to the role of ecosystems and their services in the "PARNON-MALEAS" proposed Biosphere Reserve. An academic endeavor authored by two reputable scientists, known for their work, not only in our country but also internationally.

Three areas have been included in the UNESCO World Network of Biosphere Reserves of the Man and Biosphere Program (Man and Biosphere or MAB) in Greece, Olympus National Park, Samaria National Park and the area of Asterousia mountains. Asterousia, an area in South Crete, where I have lived and come from, was perhaps the motivation for me to agree as Chairman of the Management Body and to support the initiative of Parnon SA (Organization for Local Development) compiling the application for inclusion of the area in the network of biosphere reserves.

An enchanting area of rich biodiversity, unparalleled landscapes and unique cultural heritage of local, national but also of global importance. An area that is also a geological mosaic where various types of ecosystems are located, either in their natural wild form or formed over the years by human activity.

Our place is our future, the future of our children, while at the same time it is our history and culture. The starry plateau of Profitis Ilias, the unique Moustos, the juniper forests, the Monemvasia rock, the unique edible olive, the chestnut and the cherry, the rocks of Leonidio, the Easter balloons of Leonidio, the monasteries hanging on the rocks and on the slopes of Parnon mountain, Tsakonia, the enchanting Elafonisos and the petrified forest of palm trees, are all systems that we should care for in order to function harmoniously, equivalent to both man and nature.

A big thank you from the bottom of my heart to Professors Mr. Dimopoulos and Mr. Kokkoris, not only for the creation of this edition but also for their unwavering scientific assistance, all these years on the work of the Management Body of Parnon, Moustos, Mainalonn and Monemvasia.

Dimitrios A. Th. Milios
Chairman of the Administrative Board
of the Management Body
of Parnon, Moustos, Mainalonn & Monemvasia

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Preface

The Parnon-Maleas Biosphere Reserve is located at the SE part of the Peloponnese and includes ecosystem types, natural or cultural (i.e. shaped by human activity, such as agricultural areas, grazing meadows), from different bioclimatic and vegetation belts, as well as wetland, marine and coastal ecosystems of high significance. In addition to the important features of the natural environment, unique cultural and historical elements of local, national, and global importance are recorded in the area (e.g. traditional settlements, archaeological sites, etc.). This coexistence and all the man-nature interactions depend solely on the maintenance, supply and use of a variety of ecosystem services, i.e. all material and intangible goods offered by ecosystems (natural, semi-natural and man-made) to people, contributing to the enhancement and / or maintenance of social well-being. The Parnon-Maleas Biosphere Reserve is called upon to manage this role as well, i.e. the maintenance of the ecosystem services supply, an objective that essentially covers all the strategic goals of its institutionalization at the same time.

This handbook-guide is part of Greece's effort to implement the Action on "Mapping and Assessment of Ecosystems and their Services" (MAES) in the best possible way, offering the reader the predominant elements of the ecosystems of the Parnon-Maleas Biosphere Reserve, as well as the actual or potential supply of its ecosystem services.

P. D. Dimopoulos and I.P. Kokkoris

1. Introduction

The **UNESCO World Network of Biosphere Reserves** (**Figure 1**) includes 714 areas, spread over 129 countries. Olympus National Park, Samaria National Park and Asterousia mountain (Southern Crete) are the Biosphere Reserves in Greece. The compilation of the candidacy file of the proposed biosphere reserve «Parnon-Maleas» to be included in the biosphere reserve network is an initiative of Parnon S.A. in collaboration with the Management Body of Parnon, Moustos, Mainalon and Monemvasia. The site was selected as it meets the following criteria: (a) conservation of ecosystems, landscapes and biodiversity, (b) sustainable development, through the support of integrated economic activities from a social, cultural, and environmental point of view, (c) support of environmental education, research and monitoring projects to promote the

Figure 1. *The Parnon-Maleas Biosphere Reserve.*

value of the area, (d) participation and contribution of local government bodies and organizations.

The main medium- and long-term targets of the areas selected and included in the UNESO Network of Biosphere Reserves are to record, evaluate and highlight the relations over time of humans with the natural environment and the way in which this interaction has shaped the social, economic and natural profile of the area.

The Parnon-Maleas Biosphere Reserve is located in the southeastern part of Peloponnese and includes a) ecosystem types from different bioclimatic zones, natural or cultural (i.e. shaped by human activity, such as agricultural land, grazing meadows), b) important wetlands and marine, coastal areas. In addition to the important features of the natural environment, the area is characterized by unique cultural and historical heritage elements of local, national, and global importance (e.g. traditional settlements, archaeological sites, etc.).

This coexistence and interaction of man with nature depends exclusively on the preservation, supply and use of a variety of ecosystem services, i.e. all the tangible and intangible goods that ecosystems (natural, semi-natural and man-made) offer to man, contributing to the improvement and / or maintenance of the social well-being (see Westman 1977, Ehrlich and Ehrlich 1981, de Groot 1987, Burkhard and Maes, 2017).

The Parnon-Maleas Biosphere Reserve is also called upon maintaining the ecosystem services supply by its ecosystems, a target that covers all its establishment strategic goals. In order that this goal is accomplished the following items are required: excellent scientific documentation of a) the biophysical elements of the area (i.e. knowledge of flora, fauna, ecosystems, water resources, geological resources, etc.), b) the socio-economic environment (demographics, development trends, level of education and training), and the ongoing participation of all users in the area (i.e. residents, professionals, local authorities and decision-makers and visitors). However, in order to achieve this, substantial information (and in some cases education) of the aforementioned involved parties – users should precede. This is the only way to have a common understanding of the strategies for management, protection, and development of the Biosphere Reserve, as well as to establish a common framework of activities, operation, management, and governance of

the natural and socio-economic system of the area.

In Greece and in the European Union (EU), the ecosystem services play an important role to the Strategies for the conservation of the natural environment and biodiversity (see Strategies for Forests, Biodiversity, Agriculture, Water Resources, Climate, Integrated Development and Regional Policy). Currently, the European Green Deal (European Commission, 2019) is the main strategic tool for development in the EU. The EU Green Deal aims to transform the economy for a sustainable future, and thus integrates the ecosystem services, and highlights their importance through a proposed action plan for the implementation of the individual Strategies. More specifically, typical

Figure 2. *Panoramic picture of the Parnon-Maleas Biosphere Reserve, from Mystras region (A. Kanelidou).*

Figure 3. *QR code for access to general information on the Parnon-Maleas biosphere reserve (Archive of the Management Body of Parnon, Moustos, Mainalon and Monemvasia).*

examples of ecosystem services that the EU is called upon to protect, improve and fairly maintain within its territory, are the following: (a) production of goods (food, materials) and the creation of corresponding jobs through sustainable management of the natural resources (b) maintaining the good condition of natural ecosystems in order to provide services such as clean water, air, food, natural disasters mitigation, protection against pests and diseases, and (c) providing a variety of opportunities for leisure, research and artistic expression.

Over the last years, Greece has made significant progress in identifying, recording, assessing, and mapping the ecosystems and their services. Since 2014, Greece has been represented in the EU MAES Working Group for the coordination of the Action for Mapping and Assessment of Ecosystems and their Services (MAES Action - Mapping and Assessment of Ecosystems and their Services) among Member States; a specific working group (Hellenic Ecosystem Services Partnership - HESP) has been set up for this purpose in Greece (Dimopoulos et al. 2017). At the same time, and following the EU directives for the implementation of the MAES Action, Greece implements since 2017, an 8-years LIFE Integrated Project (LIFE-IP4 Natura), that is coordinated by the Ministry of Environment and Energy and includes Mapping and Evaluation of Ecosystems and their Services throughout the country as one of its key Actions. Through this action, in the frame of the LIFE-IP project a) the basic tools and the appropriate methodologies for the implementation of the MAES Action in Greece at the National and the local level and b) the main indicators of ecosystem services for the standardization, processing and reporting of results have been developed (Kokkoris et al. 2020, 2021).

This handbook/guide is part of Greece's effort to implement the MAES Action in the best possible way, offering the reader the key elements of the ecosystems and their ecosystem services in the Parnon-Maleas Biosphere Reserve.

2. General characteristics of the Parnon-Maleas Biosphere Reserve

The Parnon-Maleas Biosphere Reserve consists of a great diversity of relief, geomorphological structures and land uses as it includes: (a) large mountains/ mountain ranges (Mount Parnon, eastern slopes of Taygetos), (b) the Maleas Peninsula, (c) the plain of Sparta, (d) the complex hydrographic network of the area, dominated by the Evrotas river, (e) the extensive coastline and (f) the island of Elafonisos.

In the following chapters, the main characteristics of the Parnon-Maleas Biosphere Reserve related to the abiotic and biotic elements of its natural and anthropogenic environment are presented.

2.1 Natural environment

The natural environment of the Parnon-Maleas Biosphere Reserve is of high ecological and aesthetic importance, both locally (sub-areas within its boundaries, such as high mountain peaks, coastal forests, sandy beaches and wetlands), as well as nationally and globally. Characteristics of the region that make it important and constitute its main competitive advantage are also highlighted.

2.1.1 Geology

The geological structure of Parnon and the Eastern Peloponnese is in general very complex. The encountered geological formations are basically carbonate sediments mainly of the geotectonic zones of Tripolis and Pindos, but one can also find transformed volcanic rocks. Overall, they have been strongly ruptured and folded in various tectonic phases, a fact that contributes to the current picture of the complex geological structure (Ministry of Environment, Physical Planning and Public Works, 1999). Some of the area's assets are the waterfalls (**Figure 4**) and the numerous limestone caves (**Figure 5**) that have been used as a residence for the inhabitants since the Neolithic years, but also as a shelter for the locals during the German Occupation. Many of the caves are monasteries and other places of religious worship. Scattered, small or even larger caves in the area are still used today for housing sheep and goats. The complete exploration, mapping and study of the caves is a scientific challenge currently in progress in the area.

Figure 4. *Lepidas Waterfalls (Ch. Giatrakos).*

Figure 5. *Mana Cave in Poulithra (P. Hann).*

Figure 6. *Typical image from the petrified forest at Cape Malea (Archive of the Management Body of Parnon, Moustos, Mainalonn and Monemvasia).*

A special geological element of the Parnon-Maleas Biosphere Reserve is the petrified forest and geopark in the Maleas area (**Figure 6**). It has been recognized as a Geological Monument of the Aegean and concerns a palm forest which has been petrified by a very rare process of gradual calcification, due to the sea level rising.

2.1.2 Vegetation

Within the Parnon-Maleas Biosphere Reserve, the typical Mediterranean vegetation belts (all the plant communities that coexist in the same altitudinal zone due to their ecological affinity), are distinguished as a result of the vertical succession of bioclimatic belts, from the sea level to the high mountain peaks (peak Megali Tourla of Mount Parnon, altitude 1934 m). Considering Quezel & Barbero (1985), the following vegetation belts can be distinguished in the study area:

- Thermo - Mediterranean vegetation belt (vegetation with wild olive, carob, lentisk, Aleppo pine forests, phrygana)
- Meso - Mediterranean vegetation belt (evergreen sclerophyllous vegetation, with kermes oak, holly oak and sporadically downy oak)

Figure 7. *Lepidas Gorge (Ch. Giatrakos).*

Figure 8. *Sweet chestnut woodlands in Kastanitsa (G. Xygkos).*

Figure 9. *Partial view from the Parnon plateau (Archive of the Management Body of Parnon, Moustos, Mainalon and Monemvasia).*

- Supra - Mediterranean vegetation belt (deciduous oak forests with hungarian oak as dominant species and chestnut, fir and black pine forests)
- Mountain - and Oro - Mediterranean vegetation belt (fir- and black pine- forests up to the tree line, rocky grasslands and grazed meadows, limestone rocks and screes above the timberline)

Along streams and the river Evrotas, azonal (soil-dependent) vegetation types are scattered; their occurrence depends on the presence and condition of streams and stagnant water. Characteristic vegetation units along streams and rivers are the Platanus (*Platanus orientalis*) and Willow (*Salix* spp.) forests and galleries.

2.1.3 Flora

The Biosphere Reserve area is characterized by a high plant species diversity, but also by the presence of endemic species (at the scales of Greece, Peloponnese, locally), and other important protected species. It is noteworthy that more than 800 plant species and subspecies are recorded on Mount Parnon, of which: (a) 75 are found only in Greece (endemic to Greece), (b) 35 are found only in Peloponnese (endemic to the Peloponnese) and (c) 14 are found only on Mount Parnon (local endemics of Mount Parnon) (Tan & Iatrou 2001, Pappas et al. 2016, Arne Strid,

Figure 10. *Astragalus agraniotii (E. Kalpoutzakis).*

Figure 11. *Petrorhagia grandiflora (P. Trigas).*

Figure 12. *Asperula malevonensis (E. Kalpoutzakis).*

Figure 13. *Silene laconica (E. Kalpoutzakis).*

2021, personal communication). The local (only on Parnon) and narrowly distributed (on Parnon and neighbouring mountain ranges) endemics are the following: *Asperula elonea* (Parnon, Chionovouni, Gaidourovouni, Korakia, etc.), *Asperula malevonensis* (Parnon) *Astragalus agraniotii* (Parnon), *Centaurea athoa* subsp. *parnonia* (Parnon, Taygetos), *Cyclamen rhodium* subsp. *vividum* (Parnon, Kythera), *Minuartia pichleri* (Taygetos, Parnon, Killini, Koulochera, etc.), *Minuartia parnonia* (Parnon, Chionovouni), *Nepeta orphanidea* (Parnon), *Onopordum bracteatum* subsp. *myriacanthum*, *Petrorhagia grandiflora* (Parnon), *Potentilla arcadiensis* (Taygetos, Parnon), *Silene laconica* (Parnon), *Stachys chrysantha* (Parnon, Taygetos, Oligyrtos, Koulochera, Elafonisos, Kryoneri), *Viola parnonia* (Parnon).

Within the Maleas area, many Greek endemic species and subspecies with limited distribution are also recorded; some narrowly distributed endemics are also identified: *Silene sedoides* subsp. *runemarkii*, *Bolanthus fruticulosus, Astragalus laconicus, Scutellaria rupestris* subsp. *caroli-henrici*, *Thymus laconicus, Linaria tenuis, Campanula andrewsii* subsp. *hirsutula*, *Inula rotundifolia*, *Crocus goulimyi*.

The local endemic *Saponaria jagelii* has been recorded from the island of Elafonisos (located in only two populations on sandy beaches in the western part

Figure 14. *Jackal (Canis aureus) near the banks of a stream. Photo from a camera recording and monitoring the fauna (Archive of the Management Body of Parnon, Moustos, Mainalon and Monemvasia).*

of the island); it has been evaluated as Critically Endangered (Montmollin and Strahm 2007).

2.1.4 Fauna – Avifauna (Verterbrates)

2.1.4.1 Mammals

Thirty-two (32) species of terrestrial mammals have been reported within the Biosphere Reserve. Most of them are widespread in the area, with the exceptions of the following: (a) the roe deer (*Capreolus capreolus*), found mainly in the southern part of Parnon, (b) the otter (*Lutra lutra*), found mainly in the Moustos wetland and tributaries of Evrotas and (c) various bats, found mainly in steep, rocky habitats with cavities and smaller or larger caves. The following twelve species of mammals are priority species for conservation and belong to the Annex II of the Habitats Directive (Directive 92/43 / EEC) (Mitchell-Jones et al. 1999, Pappas et al. 2016): *Rhinolophus ferrum-equinum* (greater horseshoe bat), *Rhinolophus hipposideros* (lesser horseshoe bat), *Rhinolophus blasii* (Blasius's horseshoe bat), *Rhinolophus euryale* (Mediterranean horseshoe bat), *Rhinolophus mehely* (Mehely's horseshoe bat) *Myotis capaccinii*, *Myotis myotis*, *Nyctalus lasiopterus*,

Barbastella barbastellus, *Lutra lutra* (Otter).

The marine mammals of the area are of high importance for conservation management purposes. The Monk seal (*Monachus monachus*), the most endangered mammal in Greece and in Europe, has been recorded in the caves of Agia Irini and in scattered places of the Malea's cape. Cetaceans are recorded along the coastline with frequent presence of Rhino dolphins (*Tursopius truncatus*) in the sea section between Naples and Elafonisos (Bousbouras, 2005).

2.1.4.2 Reptiles and amphibians

There are 33 species of reptiles in the area, of which: (a) six are turtles (two terrestrial, two freshwater and two marine), (b) 14 are lizards, (c) 13 are snakes and (d) six are amphibians (two species of toad and four species of frog). All species of turtles, as well as two species of snakes, *Zamenis situlus* and *Elaphe quatrolineata*, are priority species for conservation and are listed in Annex II of the Habitats Directive (Directive 92/43 / EEC) (Maragou et al. 2015). The coastal and lowland swamps are important habitats for freshwater turtles, while the sandy beaches are the nesting habitats for sea turtles. Other species of reptiles have a

Figure 15. *House snake (Zamenis situlus) (Archive of the Management Body of Parnon, Moustos, Mainalon and Monemvasia).*

Figure 16. *Kingfisher (Alcedo atthis) (Archive of the Management Body of Parnon, Moustos, Mainalon and Monemvasia).*

relatively wide distribution, altitudinally reaching up to 1000 m; however, in certain cases, depending on local conditions of soil morphology, humidity, etc., reptile species can also be found higher. The wall lizard (*Podarcis muralis*), *Coronella austriaca*, *Zamenis situlus*, *Zamenis longissimus* and *Vipera ammodytes* have been recorded at altitudes of more than 1000 m. The distribution of amphibians depends on the smaller or larger watercourses present in the area at various altitudes. Quite often, even above 1000 m, the common toad (*Bufo bufo*) is found. However, it should be noted that due to the xerothermic bioclimatic conditions in parts of the area, suitable conditions for amphibians (wet, with storage and / or water flow) are found in very limited places.

2.1.4.3 Avifauna

The avifauna of the area is one of the most important elements of its biodiversity, as it consists of more than 240 bird species, of which 80 are considered of high priority for their conservation and are included in Annex I of the Birds Directive (Directive 79/409/EEC, currently 2009/147/EEC). The presence of the White Eagle (*Aquila fasciata*), a priority species for conservation in the EU and one

of the of the important biodiversity elements of the area (Bousbouras, 2005) is noteworthy. The importance and contribution of the Moustos wetland in the conservation of this high bird species diversity in the area should be highlighted. Moustos wetland is the first large wetland that the migratory species meet, as they move northwards; thus, many of them stop here to rest and/or winter. It is considered an important area for migratory meadowlark species, as well as for breeding and migratory predator species. Another important area, mainly for species using rocky habitats, as well as for rare and endangered bird species, is the Daphnonas ravine with it's inaccessible cliffs. According to the European Red List (2015): (a) five species are considered Endangered, i.e. *Circus macrourus* (Pallid harrier), *Limosa limosa* (black-tailed godwit), *Tringa stagnatilis* (marsh sandpiper), *Arenaria interpres* (ruddy turnstone) and *Philomachus pugnax* (ruff) b) twenty species are considered Vulnerable, i.e. *Alectoris graeca* (rock partridge), *Anas penelope* (Eurasian wigeon), *Anas acuta* (northern pintail), *Anas querquedula* (Garganey), *Aythya ferina* (common pochard), *Falco vespertinus* (red-footed falcon), *Falco biarmicus* (lanner falcon), *Falco cherrug* (saker falcon), *Milvus migrans* (black kite), *Neophron percnopterus* (Egyptian vulture), *Haematopus ostralegus* (Eurasian oystercatcher), *Vanellus vanellus* (northern lapwing), *Gallinago media* (great snipe), *Numenius arquata* (Eurasian curlew), *Tringa tetanus* (redshank), *Calidris ferruginea* (curlew sandpiper), *Alcedo atthis* (common kingfisher),

Figure 17. *The Critically Endangered species Aphanius almiriensis that is also included to the Annex II of the Directive 92/43/EEC (Archive of the Management Body of Parnon, Moustos, Mainalon and Monemvasia).*

Turdus pilaris (fieldfare), *Turdus iliacus* (redwing), *Anthus pratensis* (meadow pipit).

2.1.4.4 Fish Fauna

According to Pappas et al (2016), the following fish species have been recorded in the aquatic ecosystems of the area: *Atherina boyeri* (big-scale sand smelt), *Belone belone* (garfish), *Dicentrarchus labrax* (european bass), *Gambusia holbrooki* (eastern mosquito fish), *Lithognathus mormyrus* (striped seabream), *Mugil cephalus* (flathead grey mullet), *Parablennius sanguinolentus* (rusty blenny), *Pomatoschistus* sp. (Goby), *Salaria pavo* (peacock blenny), *Syngnathus abaster* (black-striped pipefish) and *Aphanius almiriensis* (*Almiri killifish*) which is a priority species for conservation that is included in Annex II of the Habitats Directive (Directive 92/43/EOK). *Aphanius almiriensis* is an endemic species of NE Peloponnese (found only in the area of Almiri in Corinth and in the Moustos lagoon) and has been evaluated, using the IUCN criteria, as Critically Endangered species; it is also included in Annexes II and III of the Berne Convention. The occurrence of this species highlights the importance of the area.

A total of seven (7) freshwater fish species are found in Evrotas, out of which three (3) are endemic to Greece, two are native, and two of them have been introduced in the river system (Kalogianni et al. 2020). The three endemic cyprinid species of Evrotas river are of special interest due to their limited geographical distribution and their declining population trend. For these reasons they are included in the global list of the IUCN Red List as well as in the Greek Red List. The 3 mentioned species are the following: a) the Endangered species *Squalius keadicus*, which occurs exclusively in Evrotas river and Vasilopotamos, b) the Critically Endangered *Pelasgus laconicus* (Evrotas minnow), which is found exclusively in the springs of river Alfeios, and c) the Vulnerable *Tropidophoxinellus spartiaticus*, which is restricted to river Evrotas and some other small-scale aquatic systems of North Peloponnese. Two additional native species are also found in Evrotas river: the European eel (*Anguilla anguilla*), which is also assigned to the category of critically endangered species, and *Salaria fluviatilis* (freshwater blenny), which is widely distributed in Greece.

2.1.4.5 Invertebrates

In the area, there have been recorded 104 important invertebrate species, which

belong to the following taxonomic groups: (a) Gastropods (19 terrestrial and 19 aquatic species), (b) Dithyra (3 species), (c) Isopods (3 species), (d) Myriads (2 Chilopoda and 2 Diplopoda species), (e) Spiders (2 scorpions, 2 spiders and 1 pseudo-scorpion), (f) Hexapoda (3 species of ephemeroptera, 5 species of odonata, 5 species of orthoptera, 23 species of coleoptera, 11 species of lepidoptera, 2 species of plecoptera, 1 species of trichoptera). It is noted that the total number of invertebrates is estimated to be much higher in the area. From the first results of a relevant field research in the area (Giokas et al. 2015), 28 species of lemurs, 13 species of bipeds, 3 species of scorpions and several species of spiders of the family Gnaphosidae have been identified. The high value of the area, in terms of its invertebrate diversity and biogeography, is documented by the discovery of the rare genus Eurygeophilus for the first time in Greece (but also in the Balkan Peninsula and the Eastern Mediterranean) (Simaiakis et al. 2016).

2.2 Anthropogenic environment

The Parnon-Maleas Biosphere Reserve is spatially delineated by the territories of the Municipalities of North Kynouria, South Kynouria, Monemvasia, Elafonisos, Evrota and Sparta.

2.2.1 Demography

According to the population data of the municipalities of Parnon-Maleas Biosphere Reserve (EL.STAT. 2001, 2011) a significantly decreasing trend

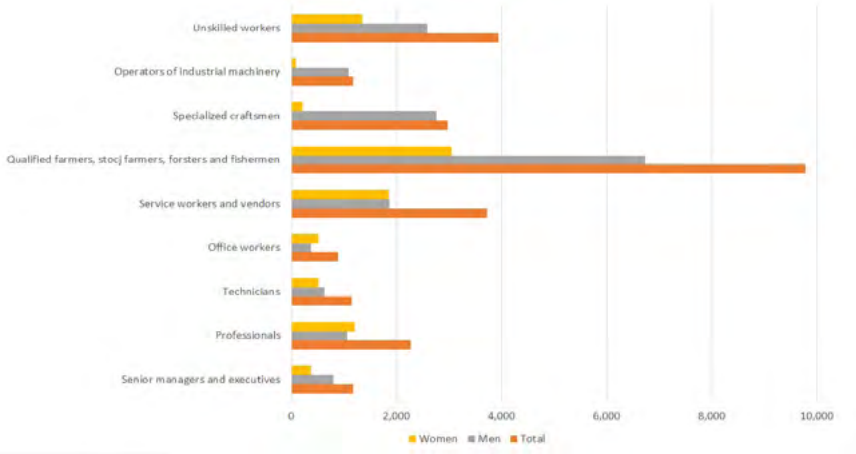

Figure 18. *The distribution of working men and women in the main categories of employment of the primary, secondary and tertiary sector (Source: EL.STAT. 2011).*

is recorded (-4.5%) in the number of permanent residents of the area. The permanent population of the area is 77,360 inhabitants, of which 39,890 are men and 37,470 are women. This population is spread over an area of 4,756.2Km^2, with an average population density of 18.53 inhabitants/Km^2. Seasonally the total population in the area amounts to 91,650 people.

2.2.2 Economic activity

The professions with the highest employment rate in the region include specialized farmers, stockbreeders, foresters and fishermen, representing 37.04% of the total self-employed citizens. Unskilled workers and craftsmen follow. Nevertheless, for the period 2001-2011 the trend for employment

Figure 19. *Agia Sophia Temple in Mystras (A. Kanelidou).*

Figure 20. *Panoramic view of the Monemvasia Castle (I. Dimitrakopoulos).*

was declining by a maximum of 36.84% in the categories of skilled farmers, stockbreeders and fishermen.

The diagram in **Figure 18** shows the distribution of working men and women in the main categories of employment in the primary, secondary and tertiary sectors.

2.2.3 Cultural environment

The presence of man in the Parnon - Maleas Biosphere Reserve dates to the Neolithic Period and is documented by various archaeological findings, such as those discovered at the Dionysus cave in Shintza. The area played a very important role in later years. Historical and archaeological findings document the development of civilization and participation in the formation of history over time, from the Mycenaean era to the present day. The presence of one of the oldest submerged cities in the world (about 5000 years old) next to the islet of Pavlopetri is noteworthy. Considering the most recent history, the battles that took place in the region during the Hellenic Revolution against the Ottoman Empire in 1821, but also the resistance against the German troops during the Second World War, could be mentioned.

The castles, the traditional settlements, the Holy Monasteries, and the Byzantine Holy Temples are the dominant elements of the cultural environment and architecture of the area (**Figure 19**).

The Castle of Monemvasia, one of the most important medieval castle cities in Greece, should specifically be mentioned (**Figure 20**).

Other important cultural elements of the area are the watermills and windmills, as well as the traditional stone-built arched bridges.

This long-standing presence of man in the region, created professions and practices that are now considered traditional of the area, such as basket weaving, pottery and the textile industry (Tsakonian weaving). Today, these practices are maintained and used as a means of manufacturing products for the area's tourism promotion and strengthening of the local income, in combination with the preparation and trade of local food products (chestnuts, dried figs, noodles, trachanas, olive oil and olives, monastic rusks, etc.).

2.3 Zonation and Protected Areas of the Natura 2000 network

Meeting the requirements of UNESCO, the Parnon-Maleas Biosphere Reserve consists of three distinct zones:

i. Core area (s): Legally delineated area, sufficient size, aiming at the conservation of ecosystems, landscapes, and biodiversity.
ii. Buffer zone (s): Encloses the core area, human activities of low to medium intensity, harmonized with the goals of preserving the natural and cultural environment and the landscape.
iii. Transitional zone: A zone where sustainable management and exploitation practices of natural resources are implemented. The main activities and settlements are supported and developed in this zone.

The Parnon-Maleas Biosphere Reserve includes eight Natura 2000 protected areas (**Figure 21**), which cover 17% of the reserve, covering an area of 68,914 ha. These areas' boundaries are also the boundaries of the buffer zones of the Biosphere Reserve and include the core areas of the Reserve. More specifically, the sites of the Natura 2000 Network in the Biosphere Reserve are the following:

i. Mountains Gidouvouni, Chionovouni, Gaidourovouni, Korakia, Kalogerovouni, Koulouchera and the area of Monemvasia Solomos Cave - hole and Ag. Stefanou tower and a marine zone up to Cape Kamili (Special Conservation Area - GR2540001).
ii. Neapolis area and Elafonisos island (Special Conservation Area - GR2540002).
iii. Evrotas Estuary, Vrontama area and Laconian Gulf marine area (Special Conservation Area - GR2540003).
iv. Eloni Monastery and Leonidion ravine - Mana Cave and Blue Lake (Special Conservation Area - GR2520005).
v. Mount Parnon and Malevi area (Special Conservation Area - GR2520006).
vi. Moustos Lagoon (Special Conservation Area - GR2520003).
vii. Mountains of Eastern Laconia (Special Protection Area - GR2540007).
viii. Evrota estuary wetlands (Special Protection Area - GR2540006).

In the western part of the Biosphere Reserve, the following Special Conservation Areas (SACs) are partially included: (a) Lagada Tripi (GR2540005) and (b) Mount Taygetos-Trachila Cave-Vatsinidis Cave (GR2550006), as well as Special Protection Area «Mount Taygetos-Lagada Tripis» (GR2550009), parts of which are included the transitional zone.

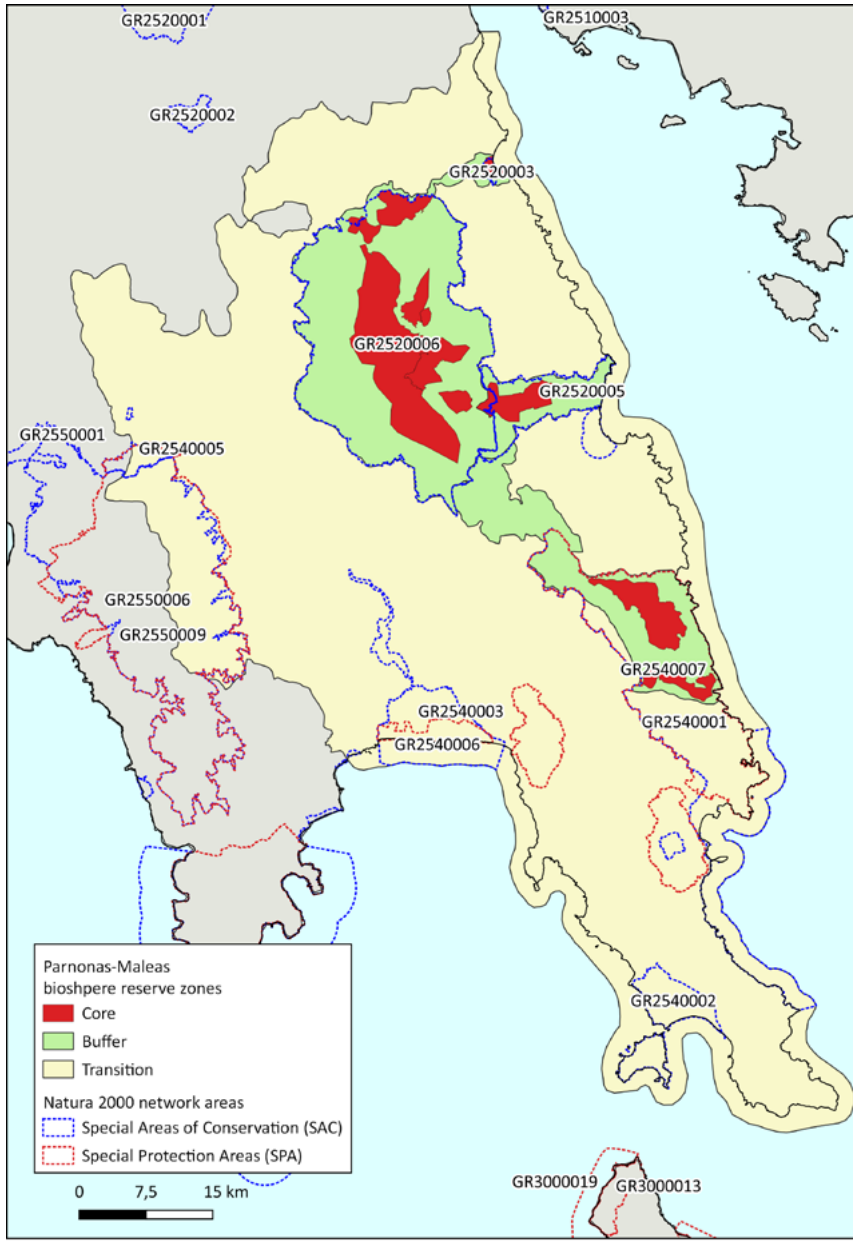

Figure 21. *Natura 2000 protected areas and zonation within the Parnon-Maleas Biosphere Reserve.*

3. The ecosystems of the Parnon-Maleas Biosphere Reserve

The Parnon-Maleas Biosphere Reserve is located in one of the most important areas of Greece, as it is documented on the basis of: a) the ecosystem types, mainly due to the high diversity of the habitats occurring in the area, b) the multifaceted relief and c) its altitudinal range (from the sea level up to 2300 m on Mount Taygetos).

This chapter presents the characteristics of natural and man-made ecosystems in the Parnon-Maleas Biosphere Reserve. For the presentation of the ecosystems, the categorization - typology was developed and adopted in Greece for the implementation of MAES Action in the country (Kokkoris et al. 2020, Verde et al. 2020), following the standards and guidelines of the EU Directorate-General for the Environment (see Maes et al. 2013) and the relevant typology proposed by the European Environment Agency (EEA, 2020). More specifically, the ecosystem types in Greece consist of 21 categories that include the 129 habitat types (natural and man-made) recorded in Greece (Annex I, Directive 92/43/EU and Greek habitat types), based on their ecological characteristics (Table 1).

Sixty-two (62) natural habitat types are recorded within the Biosphere Reserve (corresponding to 65% of the total of 93 natural habitat types found in Greece (Oikom Ltd., 2018). The anthropogenic ecosystem types (15 of which have been characterized as traditional), are located in scattered settlements within the natural vegetation units, concern crops (trees are predominant) and small urban centers (towns and cities). The combination of the above elements forms the special mega-landscape of the area, that includes a wide range of purely natural (e.g. in the high mountain peaks) and cultural landscapes (e.g. traditional crops and settlements).

The different ecosystem types assigned to each of the respective categories, i.e. man-made and natural ecosystem types, are presented in detail below.

Table 1. *Typology of ecosystem types classification based on previous studies (Kokkoris et al. 2018, EEA 2020, Kokkoris et al. 2020).*

MAES Ecosystem category (Level 1)	MAES Ecosystem category (Level 2)	Ecosystem types for mapping and evaluation in Greece (Lev-el 3)	Habitat type codes
Terrestrial	Urban	Dense to medium dense Urban Fabric (IM.D. 30%–100% + industrial, commercial, public, military and private units)	1010, 1011, 1012, 1032
		Low-density Urban Fabric (IM.D. 0%–30%)	1013, 1020, 1021, 1040, 1041
	Cropland	Arable land	1050, 1051, 1056, 1057, 1059, 1062
		Permanent crops	1060, 1061, 1066, 1067, 1068, 1069
	Woodland and forest	Temperate deciduous forests	9110, 9130, 9140, 9150, 9180, G91K, G91L
		Mediterranean deciduous forests	91M0, 9280, 9250, 9310, 9350, 9260, 925A
		Floodplain forests (Riparian forest/Fluvial forest)	92A0, 92C0, 92D0, 91E0, 91F0
		Temperate mountainous coniferous forests	9530, 951B, 91BA, 91CA, 95A0, 9410
		Temperate mountainous coniferous forests	2270, 9540, 9560, 9290
		Mediterranean sclerophyllous forests	9340, 934A, 9320, 9370
		Mediterranean sclerophyllous forests	9270
	Grassland	Grassland	6110, 6170, 6220, 6230, G628, 6290, 62A0, 62D0, 6420, 6430, G645, 6510, 651A, 1070, 1058
	Heathland and shrub	Moors and heathland	4060, 4090, 5360, 5420, 5430
		Sclerophyllous vegetation	2250, 5110, 5150, 5160, 5210, 5230, 5310, 5330, 5340, 5350
	Sparsely vegetated land	Sparsely vegetated areas	8130, 8140, 8210, 8220, 8230, 8310, 8320, 8330, 2240, 2260, 9620, 8250, 1064, 1091
		Beaches, dunes, sands	1210, 1240, 1410, 2110, 2120, 2220, 2230, 2210, 21B0
		Bare rock, Burnt areas, Mines	1030, 1031, 1090
	Wetlands	Inland and coastal saline marshes	72A0, 72B0, 2190, 1310, 1410, 1420, 1430, 1510, 1440
		Peat bogs	7140, 7210, 7220, 7230
Freshwater	Wetlands	Rivers and lakes	1080, 3130, 3140, 3150, 3170, 3240, 3250, 3260, 3280, 3290, 3190
Marine	Wetlands	Marine	1110, 1120, 1130, 1150, 1160, 1170, 1180, 1310

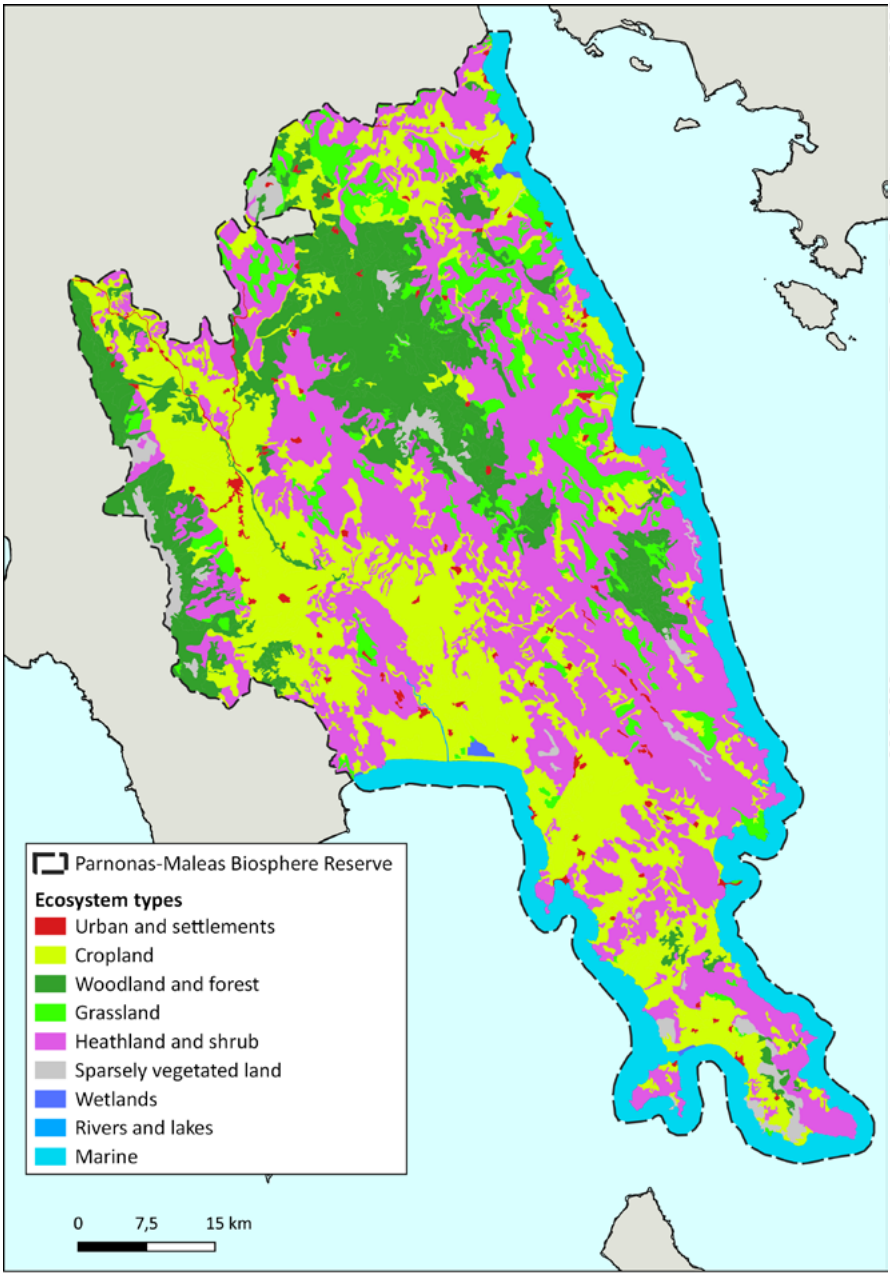

Figure 22. *Map of ecosystem types in the Parnon-Maleas Biosphere Reserve.*

3.1 Anthropogenic ecosystem types

3.1.1 Urban areas

Within the limits of the Biosphere Reserve is included the urban center of Sparta, as well as smaller cities (Astros, Leonidio, Skala, Molai, Monemvasia, Neapoli, Elafonisos) and scattered coastal, plain, semi-mountainous and mountainous settlements, with their accompanying infrastructures, which are divided into two main groups of ecosystem types (MAES level 3): (a) Dense to moderately dense urban areas (IM.D. 30-100%) and (b) Low density urban areas (IM.D. 0 -30%). The corresponding habitat types are presented in **Table 2**.

***Table 2**. Ecosystem types and habitat types assigned to the urban category.*

Ecosystem Category	Ecosystem Type for Mapping and Assessment in Greece	Code according to the Greek mapping system of non-natural ecosystems
Urban	Dense to medium dense Urban Fabric (IM.D. 30–100%)	1010: Cities and towns. 1011: Villages and settlements. 1012: Community services. 1032: Building sites. 1041: Sports and leisure facilities.
	Low density Urban Fabric (IM.D. 0–30%)	1013: Secondary settlements 1021: Agro-industrial and on-shore aquaculture structures. 1029: Port areas. 1030: Mineral extraction sites, dump sites etc.

***Figure 23.** Panoramic view of the settlement of Kastanitsa (mountainous Arcadia, Mount Parnon) (Archive of the Management Body of Parnon, Moustos, Mainalon and Monemvasia).*

3.1.2 Crops

The area hosts many different types of crops with olive and citrus groves predominating. Vine crops are also important, mainly for the production of local

Figure 24. *Typical crops of citrus (oranges) in the area of Skala, in Laconia (Archive of the Management Body of Parnon, Moustos, Mainalon and Monemvasia).*

Figure 25. *Characteristic areas with cultivation of olive trees (light-colored surfaces) in alternation with the natural vegetation (Archive of the Management Body of Parnon, Moustos, Mainalon and Monemvasia).*

wines. Crops in the area include both relevant categories of ecosystem types: (a) Arable land and (b) Permanent crops. The habitat types in the area included in these categories are presented in **Table 3.**

Table 3. *Ecosystem types and habitat types in the cropland category.*

Ecosystem Category	Ecosystem Type for Mapping and Assessment in Greece	Code according to the Greek mapping system of non-natural ecosystems
Cropland	Arable land	1050: Non-irrigated arable land (homogenus). 1051: Non-irrigated arable land (mixed). 1056: Permanently irrigated arable land (homogenus). 1057: Permanently irrigated arable land (mixed). 1062: Abandoned arable land.
	Permanent crops	1060: Vineyards. 1066: Orchards and plantations (homogenus). 1067: Orchards and plantations (mixed). 1068: Olive groves (homogenus). 1069: Olive groves (mixed).

3.2 Natural ecosystem types

There are 18 natural ecosystem types in the area (MAES level 3), a fact that highlights the uniqueness of the Biosphere Reserve, as well as the challenges involved in managing and protecting this great natural wealth - reserve of natural capital. For each ecosystem type in the area follows a detailed description and presentation.

3.2.1 Woodland and forest

Five different ecosystem types (MAES level 3) are included in the woodlands and forests category, which include 13 different forest habitat types as shown in **Table 4**. More specifically, coniferous and deciduous forests are recorded, with the forests of Greek Fir and Black Pine dominating the mountainous landscape, while at lower altitudes, scattered oak forests and chestnut forests are recorded. Juniper forests are also scattered within the area. The kermes oak forests dominate up to medium altitudes, while in the lower ones they alternate with the holly oak forests, the olive and carob woodlands and the Aleppo pine forests. Juniper forests are recorded on the sandy beaches, with the most representative ones located in Elafonisos. Forests and galleries with plane trees, willows, poplars, oleanders, tamarisks and wicker are located in the riparian and waterside areas.

Figure 26. *Mediterranean deciduous forests – Oak tree forest at Karyes, Lakonia (Annex I code: 91M0) (Archive of the Management Body of Parnon, Moustos, Mainalon and Monemvasia).*

Table 4. *Ecosystem types and habitat types assigned to the woodland and forest category.*

Ecosystem Category	Ecosystem Type for Mapping and Assessment in Greece	Code of Directive 92/43 (Annex I) habitats and of habitats of Greek importance
Woodland and forest	Mediterranean deciduous forests	91M0: Pannonian-Balkanic turkey oak- sessile oak forests. 9260: *Castanea sativa* woods. 9350: *Quercus ithaburensis* subsp. *macrolepis* forests.
	Floodplain forests (Riparian forest/Fluvial forest)	92A0: *Salix alba* and *Populus alba* galleries. 92C0: *Platanus orientalis* and *Liquidambar orientalis* woods (*Plantanion orientalis*). 92D0: Southern riparian galleries and thickets (*Nerio-Tamaricetea* and *Securinegion tinctoriae*).
	Temperate mountainous coniferous forests	9530: (Sub-)Mediterranean pine forests with endemic black pines. 951B: *Abies cephalonica* forests.
	Mediterranean coniferous forests	9540: Mediterranean pine forests with endemic Mesogean pines. 9560*: Endemic forests with *Juniperus* spp.
	Mediterranean sclerophyllous forests	9320: Olea and Ceratonia forests. 9340: *Quercus ilex* forests. 934A: Greek *Quercus coccifera* woods.

Figure 27. *Mediterranean deciduous forests – Chestnut forest in Kastanitsa (Annex I code: 9260) (G. Xygkos).*

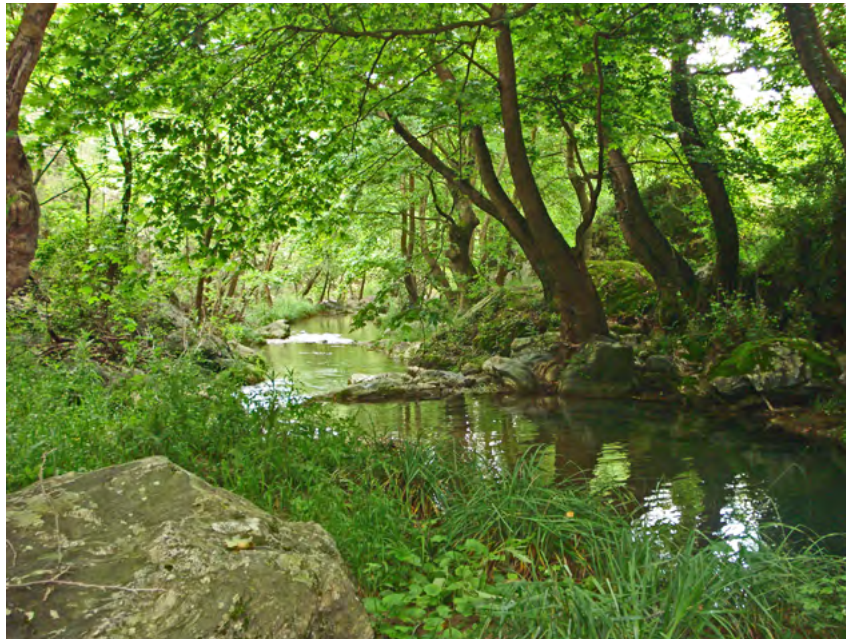

Figure 28. *Riparian forests – Plane tree forest at Spilakia stream – Platanos, Arcadia (Annex I code: 92C0) (Archive of the Management Body of Parnon, Moustos, Mainalon and Monemvasia).*

Figure 29. *Mountainous temperate coniferous forests - Black Pine Forest in Parnon (Annex I code: 9530) (Archive of the Management Body of Parnon, Moustos, Mainalon and Monemvasia).*

Figure 30. *Mediterranean coniferous forests-Aleppo pine forest in Platanos area, Arcadia (Annex I code: 9540) (Archive of the Management Body of Parnon, Moustos, Mainalon and Monemvasia).*

Figure 31. *Mediterranean mountainous conifer forests - Forest with Syrian juniper in Xirokambi area, in Parnon (Annex I code: 9560) (Archive of the Management Body of Parnon, Moustos, Mainalon and Monemvasia).*

Figure 32. *Mediterranean evergreen sclerophyllous forests – Holm oak forests, Korakovouni mountain, Arcadia (Annex I code: 9340) (E. Kalpoutzakis).*

Figure 33. *Mediterranean sclerophyllous forests - Greek kermes oak forests, on mount Parnon (Annex I code: 934A) (E. Kalpoutzakis).*

3.2.2 Grasslands

There are two distinct grassland habitat types in the area (**Table 5**): (a) one of the above the timberline vegetation units, which is also a priority habitat for conservation at the EU level (Annex I code: 6230), with its unique flora (e.g. presence of endemic species, medicinal species e.g., yolks, etc.) (**Figure 34**) and (b) one wetland habitat, recorded in the wetlands of the area and to a very limited extent. More specifically, the meadow/grassland habitat types of the area are respectively the following:

Table 5. *Ecosystem types and habitat types in the Grassland category.*

Ecosystem Category	Ecosystem Type for Mapping and Assessment in Greece	Code of Directive 92/43 (Annex I) habitats
Grassland	Grassland	6230*: Species-rich Nardus grasslands, on siliceous substrates in mountain areas (and sub mountain areas, in Continental Europe) 6420: Mediterranean tall humid herb grasslands of the Molinio-Holoschoenion.

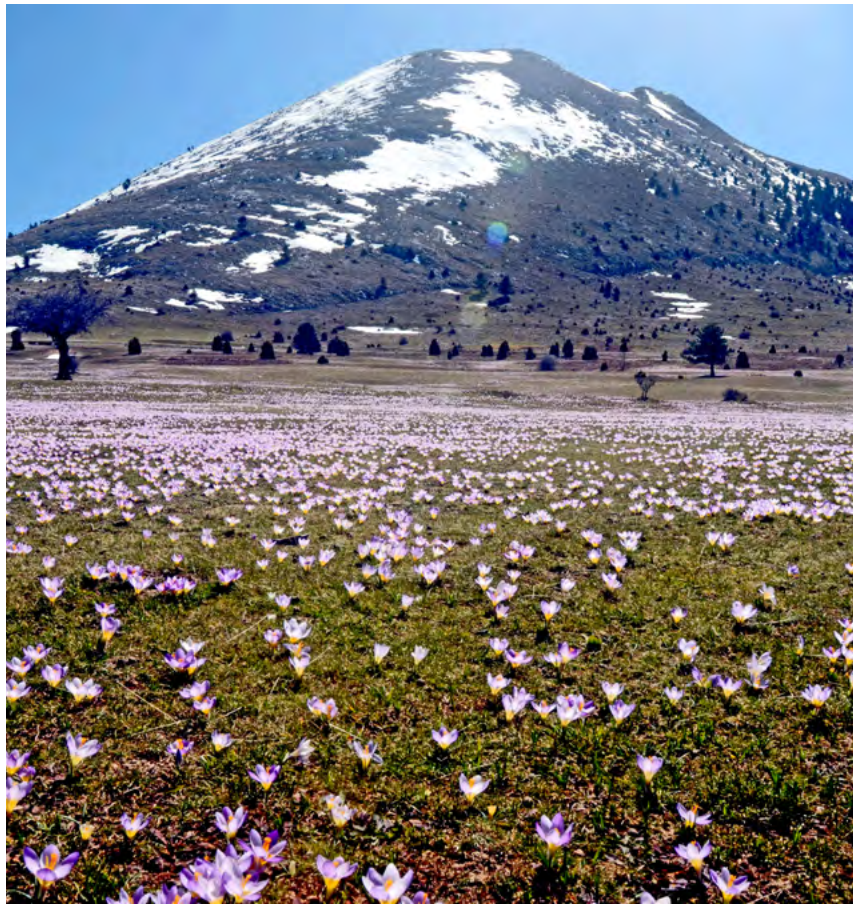

Figure 34. *The priority habitat of the above the timberline chionophilous meadows, on Mount Parnon (Annex I code: 6230) (G. Milis).*

3.2.3 Heathland and shrub

The heathland and shrubs of the area consist mainly of sclerophyllous vegetation of evergreen-broadleaved species in extensive areas, often in the form of low scrubs (garrigues) with gaps, rich in plant species and phryganic vegetation units, from the lowlands to the middle altitudes. Above the timberline, areas with sparse low scrubs and juniper trees are recorded, while around and up to the high peaks, scrubs with thorny and grassy species, rich in biodiversity and endemic plant species are recorded.

Figure 35. *View of the habitat type 4090 with Stipa pulcherrima in the Megali Tourla area (F. Xystrakis).*

Figure 36. *Phrygana with Sarcopoterium spinosum in the area of Zarakas (Source: http://parksprotection.eu/).*

Figure 37. *Arborescent matorrals with Juniperus spp. on the plateau of mount Parnon (Annex I code: 5210) (Archive of the Management Body of Parnon, Moustos, Mainalon and Monemvasia).*

Table 6*. Ecosystem types and habitat types assigned to the Heathland and shrub ecosystem category.*

Ecosystem category	Ecosystem Type for Mapping and Assessment in Greece	Code of Directive 92/43 (Annex I) habitats and of habitats of Greek importance
Heathland and shrub	Moors and heathland	4090: Endemic oro-Mediterranean heaths with gorse.
		5420: *Sarcopoterium spinosum* phrygana.
	Sclerophyllous vegetation	5150: *Pteridium aquilinum* stands.
		5210: Arborescent matorral with *Juniperus* spp.
		5330: Thermo-Mediterranean and pre-desert scrub.
		5340: Garrigues of Eastern Mediterranean.

3.2.4 Sparsely vegetated land

The area, mainly due to its large altitudinal range and geomorphology, includes a wide variety of areas with sparse vegetation. Extensive formations of sand dunes and rocky beaches and coasts are recorded in the coastal zone. The rocky slopes with chasmophytic vegetation are located at all altitudes; the

Figure 38. *Mediterranean salt marshes (Juncetalia maritimi) in the area of Evrotas (Annex I code: 1410) (Archive of the Management Body of Parnon, Moustos, Mainalon and Monemvasia).*

Figure 39. *White dunes with Ammophila arenaria in Elafonisos (Annex I code: 2120) (E. Iliadou).*

Figure 40. *Limestone rocky slopes with chasmophytic vegetation in the Leonidion ravine (Annex I code: 8210) (F. Xystrakis).*

biodiversity and its conservation value in these habitats increase significantly in the mountainous zones. In the mountain ridges, in addition to steep, rocky places, which are very important for biodiversity also exist extensive surfaces with screes, that host specialized plant taxa unique at such habitats.

Table 7. *Ecosystem types and habitat types assigned to the sparsely vegetated land ecosystem category.*

Ecosystem Category	Ecosystem Type for Mapping and Assessment in Greece	Code of Directive 92/43 (Annex I) habitats and of habitats of Greek importance
Sparsely vegetated land	Beaches, dunes, sands	1210: Annual vegetation of drift lines.
		1240: Vegetated sea cliffs of the Mediterranean coasts with endemic *Limonium* spp.
		1410: Mediterranean salt meadows (*Juncetalia maritimi*).
		2110: Embryonic shifting dunes.
		2120: Shifting dunes along the shoreline with *Ammophila arenaria* (white dunes)
	Bare rocks, burnt areas, mines, dump, land without current use	8250: Rocky substrate with no vegetation.
		9620: Riverbed with no vegetation.
	Sparsely vegetated areas (other)	8140: Eastern Mediterranean screes.
		8210: Calcareous rocky slopes with chasmophytic vegetation.

3.2.5 Wetlands

The wetlands in the area are mainly represented by the Moustos lake/lagoon, along the coastline from Cape Astros to the Koukouras river, at the mouth of the Vrasiatis torrent and by the wetland of Fokianos Bay, as well as the Strongyli lagoon in Lakonia. These wetlands include a wide variety of individual wetland habitats, such as salt marshes with tamarisk trees or with rushes or with halophytes, freshwater marshes with reed thickets and cattail species, all gradients from swamps to mudflats. In detail, the habitat types included in the wetlands of the area are presented in **Table 8**.

Figure 41. *The river Evrotas, with permanent flow and the characteristic dense riparian vegetation with Salix spp. and Populus alba on its banks (Annex I code: 3280) (Archive of the Management Body of Parnon, Moustos, Mainalon and Monemvasia).*

Table 8. *Ecosystem types and habitat types assigned to the wetlands ecosystem category.*

Ecosystem Category	Ecosystem Type for Mapping and Assessment in Greece	Code of Directive 92/43 (Annex I) habitats and of habitats of Greek importance
Wetlands	Inland freshwater and saline marshes	1410: Mediterranean salt meadows (*Juncetalia maritimi*). 1420: Mediterranean and thermo-Atlantic halophilous scrubs (*Sarcocornetea fruticosi*). 72A0: Reed thickets.

3.2.6 Rivers and lakes

The predominant water element in the mainland part of the Biosphere Reserve is the river Evrotas, with its contributing tributaries and numerous streams. Small seasonal water bodies and swamps are recorded near the shores and scattered in the area. In detail, the habitat types included in the rivers and lakes of the area are presented in **Table 9**.

Figure 42. *The coastal swamp and the bay of Fokianos (Archive of the Management Body of Parnon, Moustos, Mainalon and Monemvasia).*

Table 9. *Ecosystem types and habitat types within the category Rivers and lakes.*

Ecosystem Category	Ecosystem Type for Mapping and Assessment in Greece	Code of Directive 92/43 (Annex I) habitats and of habitats of Greek importance
Rivers and lakes	Rivers and lakes	1080: Water reservoirs, areas of water retention.
		3170: *Mediterranean temporary ponds.
		3280: Constantly flowing Mediterranean rivers with Paspalo-Agrostidion species and hanging curtains of *Salix* and *Populus alba*.

3.2.7 Marine areas

The Biosphere Reserve includes sea areas along the coastline and consists mainly of coves with shallow sandy bottoms, *Posidonia oceanica* meadows and, in some places, rocky outcrops, as well as the characteristic lagoon of Moustos. In detail, the habitat types included in the marine areas of the area are presented in **Table 10**.

Figure 43. *Natural landscape (Archive of the Management Body of Parnon, Moustos, Mainalon and Monemvasia).*

Figure 44. *Cultural landscape (N. Copage).*

Table 10. *Ecosystem types and habitat types assigned to the Marine areas' category.*

Ecosystem Category	Ecosystem Type for Mapping and Assessment in Greece	Code of Directive 92/43 (Annex I) habitats and of habitats of Greek importance
Marine	Marine	1110: Sandbanks which are slightly covered by sea water all the time.
		1120*: Posidonia beds (*Posidonion oceanicae*).
		1150: Coastal lagoons.

3.3 Natural and Cultural Landscape

In the Parnon-Maleas Biosphere Reserve, the diversity of the natural and man-made ecosystem types form a special landscape with characteristics more natural and more anthropogenic-cultural at times. According to the European Landscape Convention, a landscape is defined as "a zone or an area as perceived by locals or visitors, the visual characteristics and character of which are the result of natural and / or cultural (i.e. human) actions «(COUNCIL OF EUROPE 2000, Chapter 1, Article 1, Par. 38). This definition reflects the idea that landscapes change over time, as a result of the forces of nature and human use acting on them. This definition also emphasizes on the fact that a landscape forms a "whole", whose natural and cultural components exist and act together, at the same time, and not separately or distinct in time.

The **natural landscape** is the result of various intertemporal interactions of biotic, abiotic, and anthropogenic parameters throughout history. It is a complex and multifactorial function, in which abiotic (e.g. geomorphology, geological substrate, climatic conditions) and biotic (e.g. vegetation, flora, fauna) characteristics, as well as human activity on earth (e.g. construction works, road construction, crops, pollution), participate to a greater or lesser degree. However, the dominant feature of the natural landscape is the dominance of natural vegetation units / land cover units.

The term **cultural landscape** describes an area with strong (as an action and / or as a result) interactions between man and the environment. In other words, the cultural landscape is the result of culture in the natural landscape. Not only in the European Union countries, but also in the rest of the world, the use of this term in the context of integrated management of the natural environment is

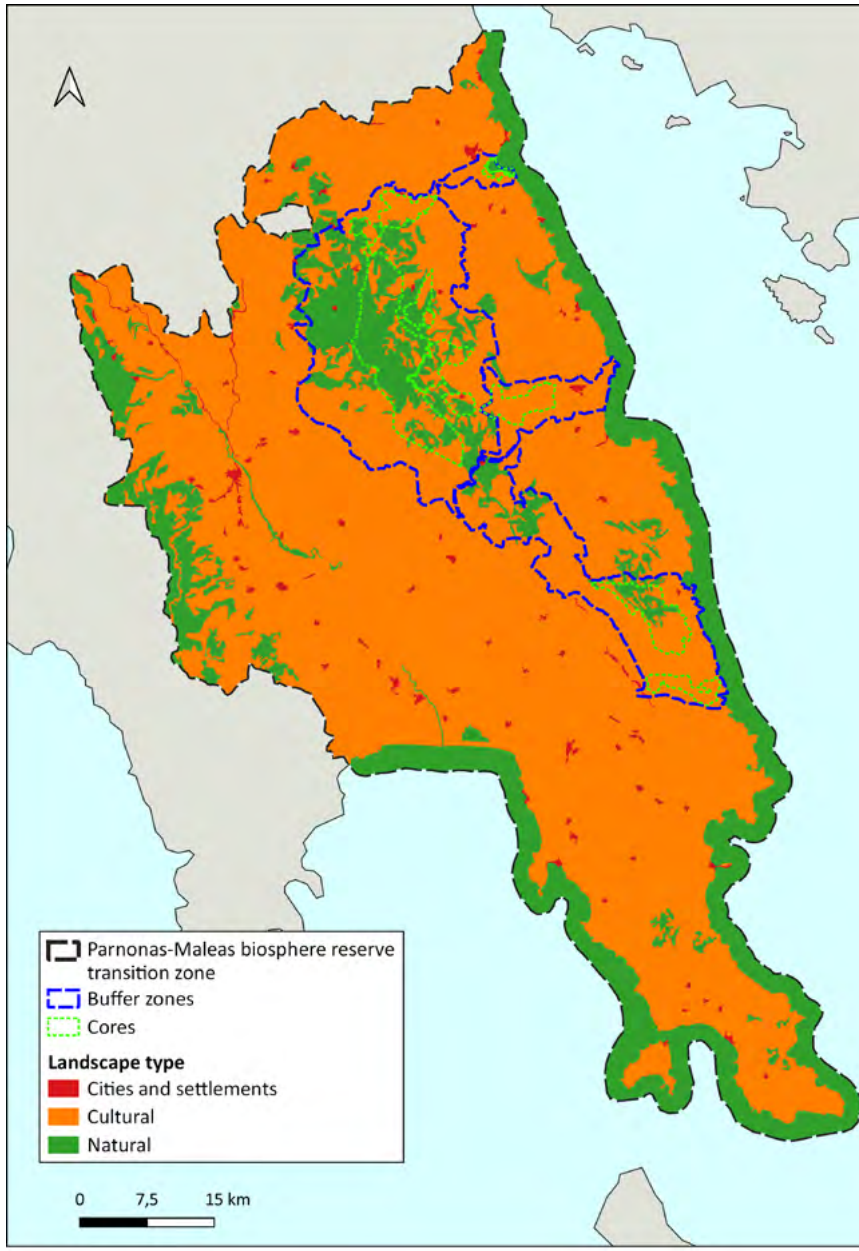

Figure 45. *Distribution of cultural and natural landscapes in the area of the Parnon-Maleas Biosphere Reserve.*

now widespread and is related to recording, spatial planning, architecture, economic development, and conservation of biodiversity. In our country, the use of the concept of cultural landscape is still at an early stage, with only a few studies to record, map and evaluate them (Vlami et al. 2017).

Figure 45 shows the distribution of natural and cultural landscapes in the Parnon-Maleas Biosphere Reserve, following the approach by Vlami et al. (2017). We observe that the core zone areas, but also those of the peripheral zones, are covered to a significant degree by cultural landscapes; this fact highlights the importance of the Reserve and its biodiversity elements that are under protection, in relation to its objectives for sustainable and integrated landscape management, combined with high natural value, human activity and cultural heritage.

3.4 Naturalness

The term "naturalness" is used to describe the degree of human impact on a natural ecosystem. For example, high naturalness areas are considered the ones with very difficult access by humans, such as inaccessible mountain ridges, roadless mountain forests, coastal and mountainous rock cliffs, etc.

3.5 Culturalness

The term "culturalness", when considering the environment and the landscape, refers to the degree of human influence and use. For example, pastures or rivers that are used for energy production (e.g. watermills, etc.) are considered as areas of high culturalness; the same goes for natural landscapes where complex path networks as well as crop areas are located.

3.6 Synergies and sustainability

In the Parnon-Maleas Biosphere Reserve, a high percentage of landscapes (inside and outside the protected areas) consists of formations created by human action, such as crops, grazing scrubs, meadows, and settlements. These semi-natural and artificial ecosystems, or other relatively man-made elements in the landscape (e.g. stone walls, hedges, irrigation, and drainage ditches, etc.), are very important for the conservation of biodiversity, and often some species (e.g. migratory birds) depend on them.

As reported by Dimopoulos et al. (2017) and by reviewing literature and the available experiences in Greece, the Mediterranean and Europe, the following general conclusions and findings emerged:

- Cultural landscapes reflect the interdependence of people, social structures, the time history of evolution and land use change, but also the ecosystems associated with them in areas where human action has sculpted the landscape.
- There is a serious lack of perception and understanding of protection and management needs in the cultural landscapes of Greece.
- The protection of cultural landscapes is not an easy task and is related to a wider spatial scale, compared to the individual ecosystems; the protection also includes intangible features and values, such as the historical and the aesthetic value of areas.
- The case of cultural landscapes of Greece located within protected sites of the Natura 2000 network is of particular interest.

Summarizing the above, emerges a need for synergistic actions to manage, protect and promote both natural and cultural landscapes, in order to meet the objectives of both the Biosphere Reserve and the sustainable management of the area as a whole.

4. Ecosystem Services

4.1 Conceptual Framework

The term "ecosystem services" refers to «the benefits that humans derive from nature» (MA 2005), or to «aspects of ecosystems that are actively or passively used to achieve human well-being» (Fisher et al. 2009). According to the most recent definition: **the ecosystem services (ES) are the contributions of ecosystem structure and function (in combination with other inputs) to human well-being (Burkhard & Maes 2017)**.

All ecosystem services are produced, supported, and ensured by the diversity and functionality of ecosystems. Anthropogenic pressures, on the one hand, led to ecosystem changes (e.g. soil change, climate change), and on the other hand, man provides the ecosystems with significant additional inputs (such as fertilizers, energy, crops or knowledge to improve them); thus man assists and supports the provision of ecosystem services (Burkhard et al. 2012 a, 2014). Currently, there are many publications that highlight and suggest **ecosystem services as a new and potentially powerful concept, to guide the sustainable growth and equitable development strategies and policy decisions for natural resources management** (e.g. Costanza and Folke 1997, MA 2005, Müller et al. 2010, TEEB 2010, Abson et al. 2014). Thus, many Non-Governmental Organizations (NGOs), companies, landowners, landscape architects and decision makers have adopted this idea and are trying to integrate it to a greater or lesser degree, in their activities and decisions. At the same time, networks related to ecosystem services are constantly emerging nationally and internationally (e.g. BEES, CoPNL, ESCOM, IPBES, ESP, HESP).

The EU Biodiversity Strategy urges the Member States to map and assess ecosystems and their services in their territory (EC 2011). The EU has developed a conceptual framework for the evaluation of ecosystem services, linking socioeconomic systems to ecosystems through the flow of ecosystem services and through the parameters of change that affect ecosystems, either because of using the services, or as indirect effects generally due to human activities (Maes et al. 2013) (Figure 46). In Figure 46, more «arrows» can be added to connect the different elements of the frame, as well as more details on each of its elements for specific purposes and by specific users, if required. More

specifically, ecosystems are shaped by the interaction of communities of living organisms (biological communities) with the abiotic environment. Biodiversity - the diversity of all life on earth - plays a key role in the structural organization of ecosystem that is necessary to maintain the basic processes of the ecosystem and to support its functions.

In the proposed conceptual framework, socio-economic systems related to human well-being consist of three parts: (a) benefits, (b) value and (c) response. The benefits are the positive changes in the human well-being from the fulfillment of our needs and desires. The transition from benefits to values is complex in the real world and their appreciation by humans varies depending on their location, relative scarcity or abundance, life expectancy, age, cultural background. The response includes stakeholders affected by the provision of ecosystem services, either as providers or as beneficiaries / users, or as stakeholders who need to change land use or other management practices that affect ecosystems and their services.

The functions of an ecosystem are defined as the capacity and / or ability to provide ecosystem services. Ecosystem services, in turn, come from ecosystem functions and represent the existing flow of services for which there is a demand. For the purposes of the Conceptual Framework, ecosystem services also include ecosystem goods.

People reap the benefits of ecosystem services (goods and services). These benefits include inter alia, nutrition, access to fresh air and water, health, safety, enjoyment, and affect (increase) human well-being, which is the primary goal of managing socio-economic systems. Focusing on benefits means that ecosystem services can be subjected to economic valuations. However, not all benefits to humans and societies from ecosystems can be measured in economic terms. Therefore, it has been deemed necessary to include other values, such as the value of health, social value, or the value of preserving the environment (e.g. biodiversity, landscape, etc.).

Unlike the functions of the ecosystem, ecosystem services require human access and demand. Healthy or «virgin ecosystems» and wilderness areas, with an excellent (or near-excellent) ecological conservation status, are highly functional, but may provide fewer ecosystem services than less «virgin» ecosystems e.g. close to large urban centres, just because there is minimal de-

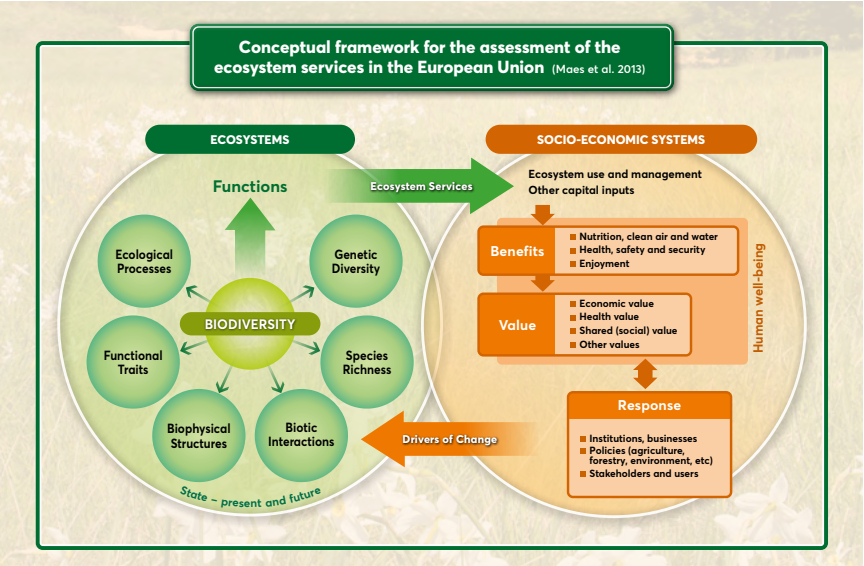

Figure 46. *Conceptual framework for the assessment of ecosystem services in the EU (Maes et al. 2013).*

mand for these services (e.g. a remote Scandinavian forest may offer fewer recreational services than a green urban area such as an urban park). However, "virgin" ecosystems are the basic but also fragile elements of the European territory, that can provide other important services (e.g. life cycle maintenance or carbon sequestration) and are therefore of great social value. It is hence important to include a complete set of services and ecosystem value dimensions in ecosystem services assessments.

At the same time, the growing demand for ecosystem services accounting and effective support for decision-making is now the main driver of research into ecosystem services.

Ecosystem services are divided according to the Common International System for the Classification of Ecosystem Services (Haines-Young & Potschin 2013) (adopted and followed by the EU), into three main categories: (a) provisioning, (b) regulating and maintenance and (c) cultural. The thematic content of each category (Braat & de Groot 2012), as well as typical examples from the Parnon-Maleas Biosphere Reserve follows.

4.2 Provisioning services

Provisioning services include all goods and products that come from ecosystems and depend on the existence and conservation of biotic and abiotic resources. These are material goods that can be exchanged or traded, as well as consumed or used directly by users. In the category of provisioning services, three major service sectors are identified:

i. **Nutrition**: Includes all ecosystem outflows used directly or indirectly asor food, including drinking water.

ii. **Materials:** Includes all materials provided by ecosystems that are directly used or required for the construction of other goods. Water also belongs to this category for all its uses, except drinking (e.g. irrigation, industrial water, etc.).

iii. **Energy**: Includes all biotic and abiotic elements provided by ecosystems to produce all different forms of energy (e.g. mechanical energy from animals, biomass to produce fuels, renewable sources, etc.).

Provisioning services are often produced, consumed, or used in different areas. They are generally transported from the place of production (i.e.from supply) to the place of consumption (i.e. to demand). Supply is more common and easier to map, as it is spatially clear and depends directly on the structure and function of the ecosystem, while demand is a function of various socio-economic parameters (Burkhard & Kruse 2017).

4.3 Regulating and maintenance services

Regulating and maintenance services refer to all those ways in which ecosystems control, regulate and/or modify the biotic or abiotic parameters that determine the environment in which man lives and works, i.e. all aspects of the environment. These are the outflows of ecosystems that are not consumed, but affect the performance of individuals, communities, and their populations, but also their activities. In the category of regulating and maintenance ecosystem services, three major service sectors are identified:

i. **Waste, toxic and other nuisance mitigation**: Includes all services provided by various living organisms and ecosystems to detoxify or simply dilute substances that are mainly the result of human activity.

Figure 47. *Chestnut production from the chestnut forests (chestnut) of the area (G. Xygkos).*

Figure 48. *Traditional drying of figs – typical product of the area (G. Milis).*

Figure 49. *Beekeeping. A traditional agricultural activity that, except from boosting income, contributes also to the conservation of biodiversity, through the action of pollinators (bees) (Archive of the Management Body of Parnon, Moustos, Mainalon and Monemvasia).*

Figure 50. *Stock farming. Wetland areas provide valuable supply services for biomass and nutrients for farmed animals in the area (Archive of the Management Body of Parnon, Moustos, Mainalon and Monemvasia).*

Figure 51. *Rocky, coastal areas, with high concentrations of the medicinal plant and with high nutritional value of the plant Crithmum maritimum (sea fennel), in southwest Elafonisos (I.P. Kokkoris).*

ii. **Flow mitigation (air, liquid, solid masses)**: covers services such as regulating and maintenance of the mass of soil and snow, protection against floods and storms.

iii. **Conservation of physical, chemical, and biological conditions**: ecosystems are recognized in providing the necessary conditions for sustainable living, including soil formation, climate control, pest and disease control, pollination, and the functions that habitats perform as breeding grounds.

The service sectors mentioned above are further divided into classes and class types. This hierarchical classification allows the respective services to be distinguished according to the type of study and the available means.

Figure 52. *Protection of the coastline from erosion (mitigation of flows), through the succession of sand dune ecosystems (Archive of the Management Body of Parnon, Moustos, Mainalon and Monemvasia).*

Figure 53. *Conservation of biodiversity, through the maintenance of good condition of sand dunes. The picture shows a nest of the sea turtle Caretta caretta (Pounta Neapoli) (I.P. Kokkoris).*

4.4 Cultural services

Cultural services include all the intangible outflows of ecosystems that have symbolic, cultural, or spiritual significance. Two major areas are identified in the category of cultural services:

i. Physical and spiritual interactions with living organisms, ecosystems and terrestrial / marine landscapes.
ii. Spiritual, symbolic and other interactions with living organisms, ecosystems and terrestrial / marine landscapes.

The above two divisions can be further broken down into groups, classes, and class types. This hierarchical classification allows the respective services to be distinguished by criteria such as whether it is a physical or mental activity.

Figure 54. *Traditional land uses - an element of cultural identity (Archive of the Management Body of Parnon, Moustos, Mainalon and Monemvasia).*

Figure 55. *Lime kiln (N. Michael).*

Figure 56. *Holy Monastery of Agia Kyriaki Vamvakou (Archive of the Management Body of Parnon, Moustos, Mainalon and Monemvasia).*

Figure 57. *Traditional, (semi) extensive livestock farming in the peak area of Meganailias on Mount Parnon - a characteristic element of the cultural identity of the area. (E. Kalpoutzakis).*

Figure 58. *The beach of «Simos» in Elafonisos that combines the high aesthetic value of the landscape with the significant biodiversity in the sand dunes in inland locations (I.P. Kokkoris).*

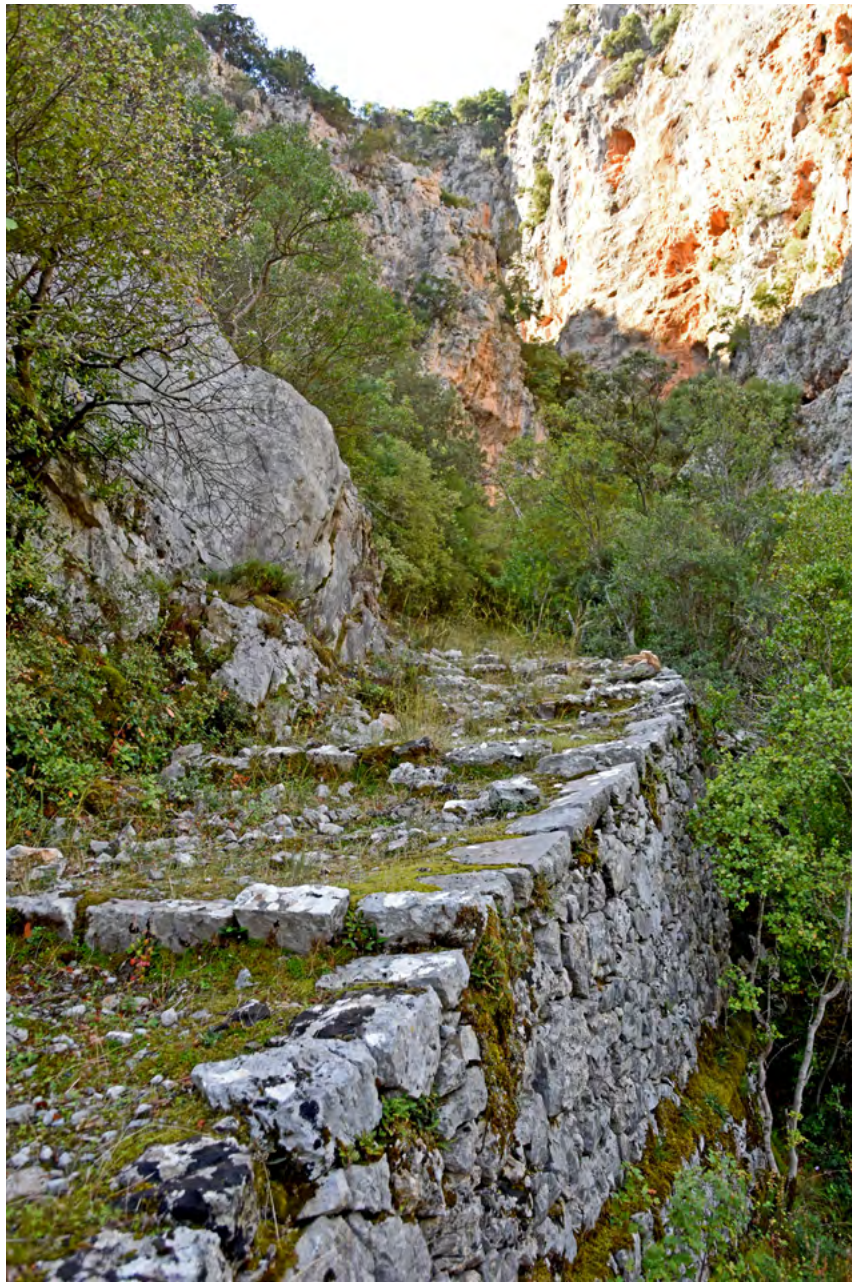

Figure 59. *Traditional path to the ravine Dafnona, South Kynouria made of stones (W. Copage).*

5. Strategic planning and integrated management

The recording, mapping and assessment of ecosystem types and the ecosystem services they provide, is one of the main tools for elaboration of the strategic planning for the integrated management of an area. The zonation of the Parnon-Maleas Biosphere Reserve aims at: a) achieving the rational management of the area and its natural resources, b) posing the Reserve Area in a developmental model with the following pillars: protection/conservation of the environment, sustainable use of resources and knowledge production through synergies and collaborations.

At the same time, having in mind the expected or estimated demographic, economic and social changes, but also the climate crisis, it is proposed that a plan of concrete steps be incorporated, in order to achieve the goal of integrated management in the best possible way, utilizing the best available data, resources and practices accordingly. (**Figure 60**).

Prerequisites for the success of this project are the following: interaction and contribution of all stakeholders in the process of policy making, as well as organizational and managerial decision making. In order for this process to be effective, the available data, scenarios (models) and methodologies must be fully understood and adapted to the profile of the participants. This need is met using the conceptual framework of ecosystem services, where the

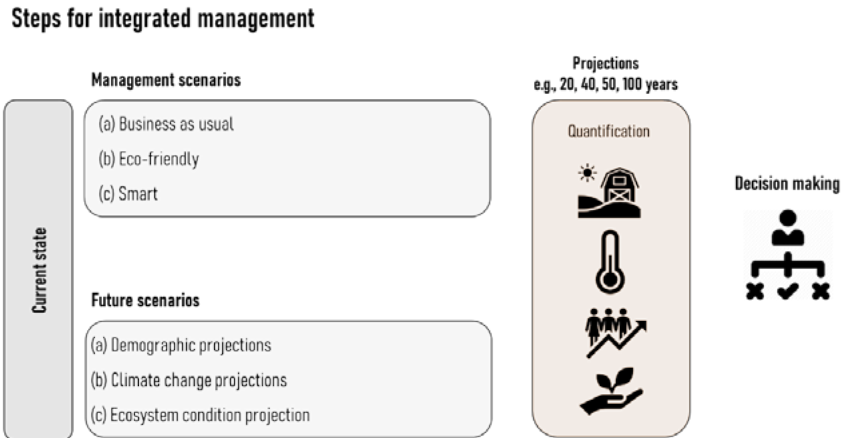

Figure 60. *Steps for integrated management.*

benefits and disadvantages of each possible design option, in terms of the ecosystems condition and ecosystem services provided or potentially provided, are quantified.

At the same time, maintaining good ecosystem condition, biodiversity and ecosystem services is a source of direct and indirect jobs:

- Direct jobs: related to management aiming at biodiversity conservation, e.g. biologists, foresters, ethnologists, agronomists, geologists, environmentalists, and national park rangers.
- Indirect jobs: affecting and significantly affected by biodiversity, e.g.fishermen and water workers.
- Indirect job growth: jobs depending on biodiversity and quality of natural ecosystems, e.g. travel agents, biotechnologists and researchers in the pharmaceutical industry.

Many attempts, using different methods, have been made, to assess the economic benefit that ecosystem services offer to human: for example, it is estimated that the forests of Greece offer provisioning (such as wood, food), regulating (such as atmosphere cleaning) and cultural services (such as leisure) worth €4.8 billion annually. Inland ecosystems are estimated to provide services worth €8.2 billion per year. In the European Union, biodiversity conservation directly supports an ever-increasing number of jobs.

At the EU-27 level, around €144 billion (in turnover) and 1.6 million jobs are related to tourism; this depends on the quality of the natural environment (e.g. the choice of destination for recreational fishing and touring)

In addition, around €100 billion (in turnover) and 960,000 jobs across the EU are related to organic farming, sustainable forestry, renewable energy and water abstraction.

At the same time, the positive effects of tourism and leisure on the European economy were calculated on the basis of multipliers generated by Eurostat 's consolidated input-output tables. Non-commercial leisure-related benefits, on the other hand, were calculated based on a Natura site approach.

The total employment opportunities provided by the Natura 2000 network were calculated by implementing a land-use approach, which began to escalate based on the extent of each land-use. Based on these estimations: the value of

leisure visits to Natura 2000 sites is estimated at €5-9 billion / year, based on the willingness of visitors to pay for all tourism and tourism-related expenditures. Leisure supported by the Natura 2000 network was between €50 billion and € 85 billion (as of 2006), expenditure related exclusively to visitors attracted to Natura 2000 sites (i.e. around 21% of Natura 2000 visitors) ranged from €9 billion to €20 billion in 2006 (generated by around 350 million visit days). The total expenditure provided by tourism and recreation supported between 4.5 and 8 million full-time jobs. The benefits generated by site visitors to the Natura 2000 network could support 800,000 to 2 million full-time jobs. This figure is comparable to the total of around 127 million full-time jobs in the EU-27 (2009) and around 13 million tourism jobs (2008).

Figure 61. *The main steps of the interactions between policy makers, stakeholders and scientists, which demonstrate the need for frequent exchange of information throughout the process. Although this process is depicted as a cycle, in many cases these steps overlap and interact (IPEBS, 2016). Photos from the Environmental Assessment Agency the Netherlands, Thinkstock, KK Davies and IISD / ENB (http: // www. Iisd.ca/ipbes/ipbes3/12jan.htm).*

The sites of the European Natura 2000 network had supported an average of around 12 million full-time jobs per year in the EU during the period 2006-2008. More specifically:

- 1.5 million jobs in agriculture
- 70,000 jobs in the forestry sector
- 200,000 jobs in the fisheries sector
- 3.1 million leisure jobs (excluding employment generated by hotels and restaurants), and
- 7 million jobs in other sectors

According to Eurostat, the average gross annual earnings of full-time employees in all sectors of the EU were €12,236 in 2006. Based on this figure, the 11,870,000 jobs supported by the Natura 2000 network provide income of around €145 billion per year. This must, however, be considered a rough estimation for two main reasons:

The total employment supported by the Natura 2000 network was calculated by applying an upscaling of data related to the dominant activities in an area and reported to the Natura 2000 network database. Thus, these estimates are subject to a relatively high degree of uncertainty, given the relatively little baseline information from which the estimations were derived, and the multiple uncertainties associated with the data collection process. The figures used (€12,236 per full-time position) do not take into account the spatial distribution of the Natura 2000 sites in the EU.

It is easy to understand that the management of the Parnon-Maleas Biosphere Reserve (which includes protected areas, but also extensive areas of crops and man-made land) is a complex and multifaceted goal, which can and should be the dominant tool of integrated, fair and efficient use of natural and man-made resources of the reserve, as well of the wider area.

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