

Ecosystems Protection

Djerba scale, Tunisia





Co-Evolve4BG

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

Ecosystems Protection

Djerba scale, Tunisia



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Union pour la Méditerranée
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OVERVIEW

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

This document constitutes the **Deliverable 3.1.2..12** (Ecosystems Protection –Djerba scale, Tunisia) of the **Activity 3.1.2** (Threats and Enabling Factors at localscale: Pilot Areas analysis) under the **Output 3.1** (Integrated analysis of Threats and Enabling Factors for sustainable tourism at MED scale) of the project.

REVIEW

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Abstract

The Tunisian coastal zone is generally subdivided into a linear way having a sea front and another sheltered one containing three natural systems which are the islands, the oases, and the wetlands (APAL and PNUD, 2012). Indeed, Tunisia has 250 wetlands, an oasis system spanning approximately 5,000 ha and 61 islands. Djerba Island is one of the most important islands in terms of land, biodiversity, cultural and social value.

This report aims to identify the different threats to Djerba coastal ecosystems. It is developed through the review of existing data at both the national and the regional scale. The document has been broken into different parts as follows:

Section 1 highlights the coastal ecosystems morphological characteristics in Djerba.

Section 2 focuses on coastal and maritime tourism and their effects on coastal ecosystems in the island.

Section 3 focuses on reporting Djerba coastal ecosystem evolution trends.

Section 3 and **section 4** presents some policies and strategies for both the coastal ecosystem protection and management to improve tourism in this zone.

I. Introduction

With more than 1,088 km, the governorate of Medenine coastal littoral represents nearly 28% of the Tunisian littoral.

As a part of the governorate of Medenine and as an island ecosystem, Djerba is endowed with a particular fragile natural resource that are limited and threatened by degradation and disappearance of its living species and non-biological components of the island ecosystem.

Djerba flora and fauna species represent a real heritage that must be inventoried, protected, and well preserved.

Djerba ecosystem fragility is tightly linked to several factors including the coastline's high concentration and overuse. In fact, this area is the most coveted and the most threatened concentric area that makes up the Djerbian territory. The almost 150 km long coastline is made up of different accumulation and erosion factors. Different forms of irresponsible human intervention such as the exploitation of sandy coasts for tourism have had drastic effects on this ecosystem.

On the Island north and northeast coast, the border dunes destruction by hotel facilities, the sand exploitation for construction, the Posidonia meadow destruction by trawling and chemical pollution, and finally the climate change has accelerated the movement of erosion and beach degradations. Hence, resulting in the destruction of facilities closest to the current shoreline line.

II. Characteristics and dynamics of coastal ecosystems

Situated in the governorate of Medenine, Djerba island is located about 500 km from the capital of Tunisia. It is accessible either by ferry from El Jorf in the West, or by the El Kantara Roman roadway from the city of Zarzis in the East.

With nearly 514km² of area, the island is shaped like a giant molar (Fig.1). At points, it measures 29.5 km at its longest part and 29 km at its widest part. Its coastline, which stretches over 150 km, has an irregular layout. The island is flat, with an average elevation of 20 m, and its highest point, DhahretGuellala, rises in its southern part to about 53 m. Its stepped topography is made up of high points and depressions, the surface of which is modeled by a dune morphology. The mostly sandy beaches stretch mainly between Ras Rmal and Borj El Kastil.



Figure 1. Topographic map of Djerba island

II.1. Terrestrial environment

The coastal ecosystem extends inland through an area of lagoons and sabkhas bordered by halophilic vegetation and surrounded by a crown of lowlands occupied by scattered palm trees. all grouping together in majestic clumps and constituting one of the basic elements of the landscape heritage typical of Djerba.

For Djerba citizens, palm, olive, and other fruit trees such as grenadines and prickly pears are very present on agricultural land. The Djerbians had specific relationships with their environment just before the tourist boom and the turnaround that the island is experiencing today. Hundreds of thousands of palm trees on the island represent a very important heritage for the population. In fact, palms are very useful. Indeed, they are used in basketwork and for fixed fisheries barriers. Their upper part also serves as a broom. The rib (or rachis) of the still green palms, their hard part, is used to make a board game called segue and to make skewers for barbecues. This rib is also used by fishermen for making traps. When dry, the palms are used as fuel: the end part, which burns quickly, is used to start the fire and the part near the stipe as firewood. The entire palms were used in the construction of animal enclosures (zriba), huts that once served as living quarters for the poorest or as shelters for outdoor kitchens and toilets, or even (khoss) where the inhabitants generally gather. Moreover, they are now used to make parasols on beaches. The trunk of the palm tree, cut in half lengthwise (sannour), can be used for the framework of the Menzel (the typical dwelling of Djerba) and constitutes most of the beams of old dwellings and weaving workshops. It was also used in the manufacture of certain instruments of the old oil presses. The heart of palm as well, called jamar, is a dessert and the sap (legmi) is drunk fresh in the morning or fermented, like palm wine. Furthermore, the island produces several varieties of dates eaten both fresh and dried. They are also made into jams, stuffed with almond paste, and used to make cakes like makroudh. They were a fundamental element in the Djerbians' daily diets. The Jewish community also uses them for the manufacture of an alcohol drink called boukha (which is also made from figs). Their stones were crushed and used as food for camels. All these uses explain the name given to the palm tree in the Berber language of Djerba: "taghalett", which means "the precious one".

The place occupied by the olive tree, known in Djerba for millennia, is hardly less important. In fact, some rites (called 'berboursa') are still celebrated around it during marriage or circumcision ceremonies. As with the palm tree, the Djerbians make multiple use of all the parts of the olive tree: the fruits are used for the extraction of oil which is used in food and cosmetics as well as in traditional pharmacology.

On the other hand, used oil and waste oil were used to make homemade soap. The olives are also preserved for food use; several processes are used including drying, salting and brine. The stones are crushed and used in animal feed as well as the remains of pressed olives. The leaves of the olive and other fruit trees are dried and are also used as feed for livestock, and for medicinally.

The pomegranate is also a plant resource familiar to the local population of Djerba who use all its fruit, including the bark used in leather tanning. The leaves were used as livestock feed and dry branches as fuel.

The Djerbians threw almost nothing: the peelings of prickly pears, melons, watermelons, squash as well as those of vegetables with their leaves (carrots or radishes) were cut into small pieces and used for feeding cattle. Roses, some geraniums (atricchia) and orange blossoms are distilled and used in cooking, especially in desserts, as well as in

cosmetics or traditional pharmacology. The orange peels are dried, pounded and used to flavor coffee and cakes. Thus, the Djerbians systematically recycled household remains, the few non-usable waste being deposited in a large pit dug at the end of the field or orchard and covered with sand once filled (Jarbouiet *al.* 2020).

II.2. Marine ecosystem

II.2.1. Flora

The island of Djerba is an area with climatic, topographical, geomorphological, and oceanographic conditions that are very favorable to the flourishing of several plant species. Such a situation has contributed to the functioning of a remarkable natural marine coastal system, the most important outcome of which was the establishment of a microclimate constituted by the biocenosis of *Posidonia oceanica*. This phanerogam extends along the study area to the Gulf of Sirte, in Libya (Fig.2).

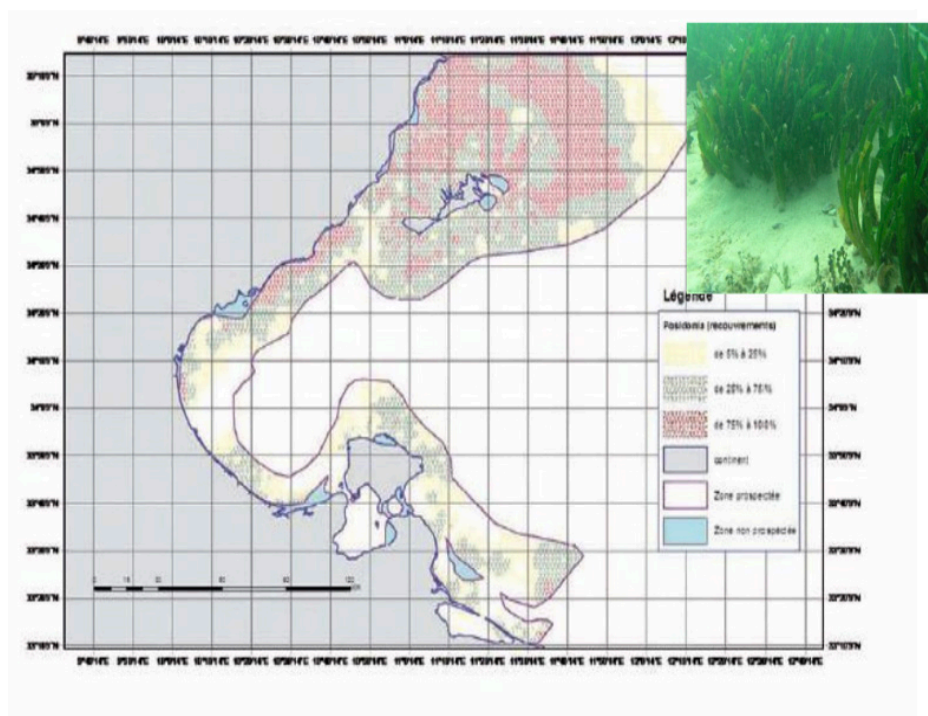


Figure 2. *Posidonia oceanica* distribution in Gabès Gulf

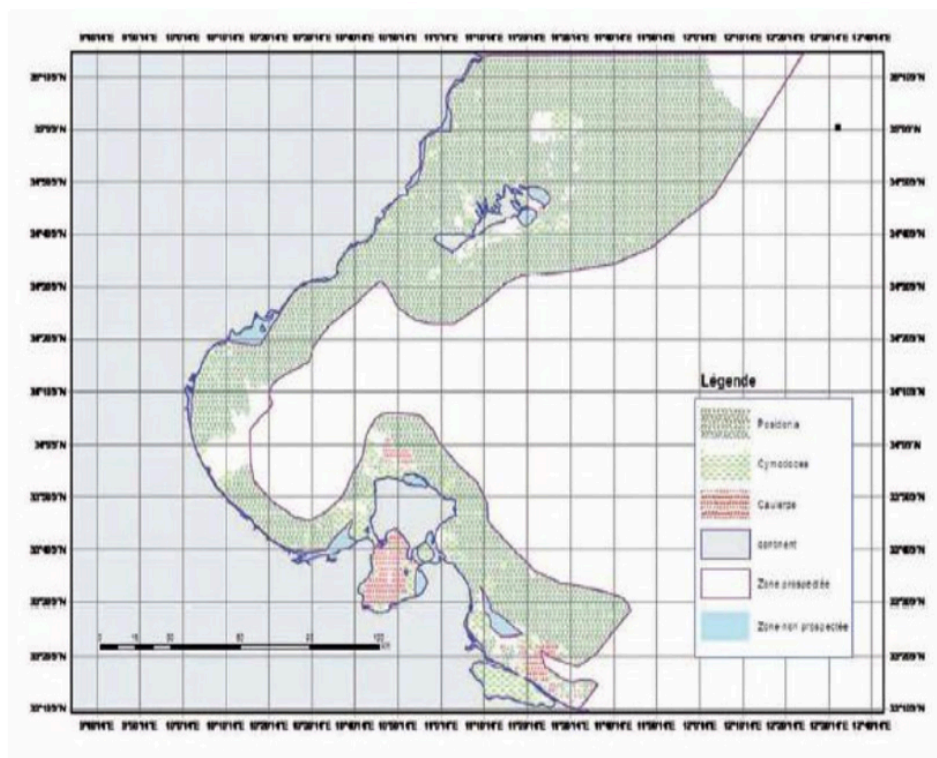


Figure 3. Marine phanerogams from the Gulf of Gabes
(Ben Mustapha and Hattour, 2015)

Several algae species such as *Cystoseirashiffneri* (endemic to the Mediterranean), *Cystoseiramediterranea*, *Cystoseirasauvageana*, *Phymatolithon calcareum*, etc. are also present in the area. Moreover, the presence of the seagrass *Cymodocea nodosa* was signaled in the region (Fig. 3).

In addition, different species of macrophytes are present in the area such as *Sargassum vulgare*, *Dictyopterispolypodioides* and *Penicilluscapitatus* (Ben Mustapha and Hattour, 2015). Finally, these authors noted the presence of 27 species of ciliated protozoa belonging to different classes.

Moreover, Driraet *al.* (2008) have shown that Djerba represents a strategic location in the Gulf of Gabès, marked by phytoplankton development, mainly diatoms and dinoflagellate cysts. These two taxa represent 83.6% of the total phytoplankton detected in the Gulf of Gabès (122 species). These species belong to five different classes including 49 dinoflagellates species, 45 diatom species and six cyanobacteria species.

II.2.1. Fauna

The establishment of four fishing ports (Ajim, HoumetEssouk, Boughrara and Hassi Jellaba) and landing sites bear witness to the rich fishery of the surrounding areas. Indeed, Djerba is very important in terms of marine fishing for the country and conceals

an important biodiversity. Several marine fauna species find a favorable habitat there. As a result, the island waters constitute a breeding ground for several species of sharks (*Carcharhinus plumbeus*, *Mustelus mustelus*, etc.) (Bradaï et al. 2016). Cetaceans, in particular the bottlenose dolphin (*Tursiops truncatus*), are frequently observed there and interact with several fisheries (Bradaï, 2000; Ben Naceur et al. 2004). The sandy beaches represent a wintering and feeding area for loggerhead (*Caretta caretta*) and green (*Chelonia mydas*) turtles (Jribiet al. 2007).

The area of Djerba is home to many fish species such as *Pomatoschistus tortonesei*, *Sciaena umbra*, *Fistularia commersonii*, *Kyphosus sectator*, *Parexocoetus mento*, *Pisodonophis semicinctus*, *Sphyrna chrysotaenia*, *Helicolenus dactylopterus*, *Conger conger*, *Merluccius merluccius*, *Merluccius merluccius*, *Merluccius merluccius*, *Mullus barbatus*, *Mullus surmuletus*, *Solea aegyptiaca*, *Mugil cephalus*, *Liza aurata*, *Liza saliens*, *Liza ramada*, and groupers (*Epinephelus marginatus*, *Epinephelus caninus*) (Echouikhi et al. 2014).

It is also home to several offshore aquaculture sites that produce the two species: *Sparus aurata* and *Dicentrarchus labrax*.

Seabed are characterized by a significant number of bivalve species, the most important ones are *Ruditapes decussatus*, *Cerastoderma glaucum*, *Musculista senhousia*, *Pinna nobilis*, *Fulvia fragilis* and the non-native species *Pinctada radiata* as well as the two gastropods *Luria lurida* and *Erosaria turdus* are known in the area. (Lakhrech et al. 2018; Ben Mustapha and Hattour, 2015).

According to Lakhrech et al. (2018), other species of gastropods are present, namely *Bursatella leachi* which was captured in the west and the east of Djerba between 10 and 31 m depth, on the degraded herbierium and the dead mat of *Posidonia*, and on *Cymodocea nodosa* cover in the southwest of Djerba.

Crab species such as *Maja squinado* have been reported in this area (Ben Mustapha and Hattour, 2015). The blue crab *Portunus segnis* has intruded around the island and is the subject of trap fishing.

The two most sought-after species of cephalopods in the fisheries of the Gulf of Gabès, namely the cuttlefish *Sepia officinalis* and the common octopus *Octopus vulgaris*, are also present and are exploited in the various fishing ports around the island of Djerba (Fig.4).



Figure 4. Octopus fishery in Djerba

Decapod shrimps are represented by the native species *Penaeus kerathurus* and the two non-native species *Metapenaeus monoceros* and *Trachysalambriapalaestiniensis*. Echinoderms are represented by *Paracentrotus lividus* and polychaete annelids by the species *Filigranaimplexa* (Lakhrech et al. 2018).

Finally, sessile invertebrates' sponge is represented and fished such as *Spongia officinalis*, *Hipospongia communis* and *Spongia zimocca* (Molinier and Picard, 1954; Zaouali, 1971a; Jarbouiet et al. 2020; Fig.5).



Figure 5. Sponge fishery in Djerba (Djabou, 2006)

Overfishing has caused reductions in fauna biodiversity, in fish abundance, biomass and species richness. It can also disrupt ecosystem functioning, leading to changes in biological assemblages and the degradation of marine ecosystem services (Worm et al. 2006). Invasive species represent an added pressure on ecosystem functioning and fisheries. Among the exotic invasive species detected in the Mediterranean Sea (Galil, 2000; Zenetos et al. 2005), several have been recorded in Tunisian coastal ecosystems and specifically in the Djerba region like decapods, bivalves, and crabs (Fig.6).



Figure 6. Invasives species in Djerba (a): *Pinctada radiata*; (b): *Portunus segnis* (Worm et al. 2006)

The impact of *Portunus segnis* on the clam's stock is an example of, on the one hand, the interaction between invasive species and the native resources and on the other hand, of its influence on artisanal fisheries.

III. Coastal and Maritime Tourism and its effects on ecosystems

According to the United Nations Environment Program UNEP (2007), both the population growth and the coastal population densification in addition to the overconsumption patterns, all contributed to the increase in the demand for ecosystem and energy services which greatly threaten biodiversity. They affect every component of biodiversity: genetic, species, and ecosystem variability and the links between each of these components.

Djerba island consists of three administrative boundaries: The municipality of Ajim (118.56 km²), the capital Houmet Souk (176.54 km²) and the town of Midoun (194.38 km²). The last two municipalities, Houmet Souk and Midoun, include more than 99% of the total tourist activity of the island of Djerba (Fig.7).

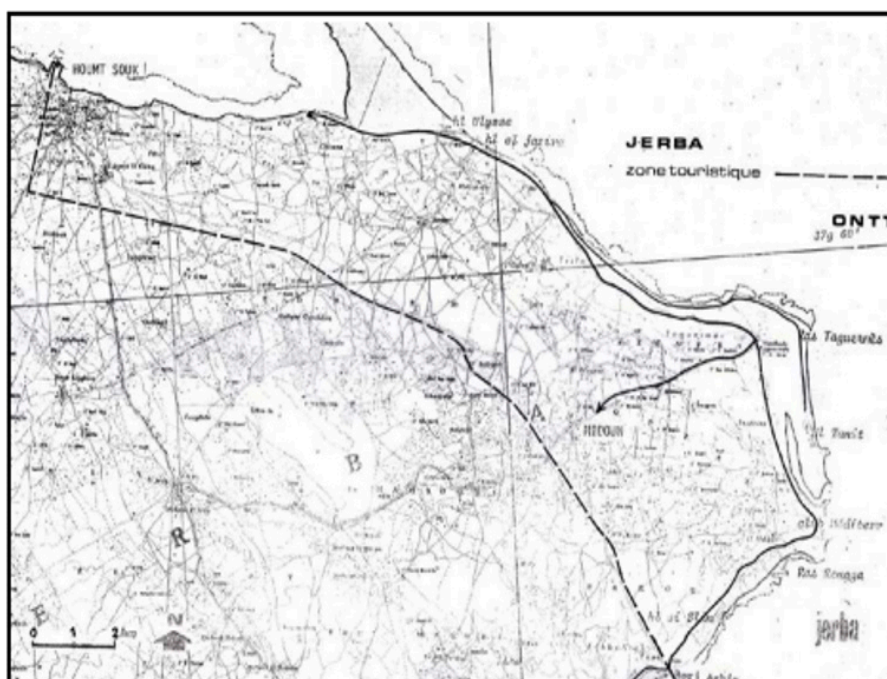


Figure 7. Touristic area in Djerba island (Anonymous, 2011)

Djerba has about twenty kilometers of sandy beaches, located mainly at the eastern end of the island, hence its nickname “Golden sands island”. The most beautiful beaches are in the North-East (Sidi Hacchani, Sidi Mahrez and Sidi Bakkour), in the East (between Sidi Garrous and Aghir), in the South (near Guellala) and in the West (Sidi Jamour).

The first tourist company was the Mediterranean Club, in 1954 starting the first phase of tourism on the island, whose beaches were more and more frequented.

As early as 1975, tourism increased sharply and in the 1980s it really took off to become the main economic activity of the island. The spaces allowing the construction of large hotel units reached an average occupancy rate of around 68% in 1999, placing Djerba in second position among tourist sites in Tunisia (Bernard, 2002). Djerba has become one of the main touristic regions of Tunisia thanks to several assets such as its breathtaking geographical coast's location, offering many ideal sites for hotel units construction, as well as its strong diversity and its cultural and landscape richness.

In 2005, the tourist area stretched for more than 20 km between Aghir in the south and Houmet Souk in the north. However, the large number of beds used only during summer and the excessively low prices induced by competition. In fact, all the latter factors do not allow the aging hotel stock to provide good maintenance. Hence, leading to a clientele decline. To maintain and develop tourism, local players are in favor of enriching the offer by creating new activities (golf course, casino, museum, thalassotherapy, or amusement parks). These offered activities are tennis, recreational fishing, and scuba diving, *etc.* while several water resorts offer water skiing, jet skiing or parasailing. A marina also allows mooring pleasure boats (Neifar, 2005).

In 2019, Djerba had 135 hotels (compared to 48 in 1987) with a capacity of around 37000 beds for just under 7.5 million overnight stays. Besides, the customers' loyalty rate (those who stay there several times) is around 45 percent. The sector employs some 76000 people, although the number of direct and permanent jobs only corresponds to some 15000 jobs, which are often precarious because they are seasonal.

Both Djerba-Zarzis international airport and road infrastructure have contributed to making it an important tourist center and an economic growth generator for the region (GODEM, 2010). In 2018, the increase in the number of overnight stays compared to the previous year amounted to more than 3 million for the Djerba-Zarzis region (Hanachi, 2018).

Even though tourists visit attractions and go sightseeing, most of them usually do not leave the coastal zone in Djerba. It is crucial to mention that Djerba island suffers from an important tourist traffic and overloading its related problems (water stress, excess waste, shoreline developments). This represents a part of research on the natural environment's quality deterioration.

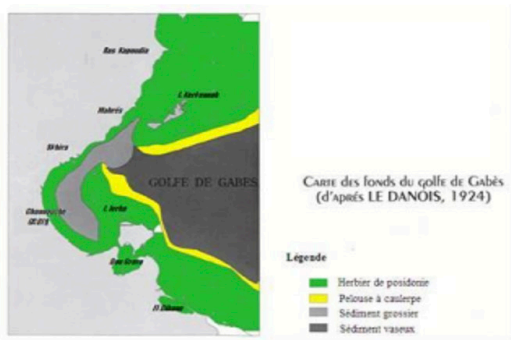
An example is the phanerogam covering Djerba island. The mapping of this taxon since 1924 has revealed an important decrease. In 1988, all the marine space around the island was covered with *Posidonia oceanica* phanerogam with high density (> 75%).

The last *Posidonia* cartography cover (Ben Mustapha, 2015) limited this species in a few atolls in the north between Ras Rmel and Midoun with a density of 25 to 50% (Fig.8).

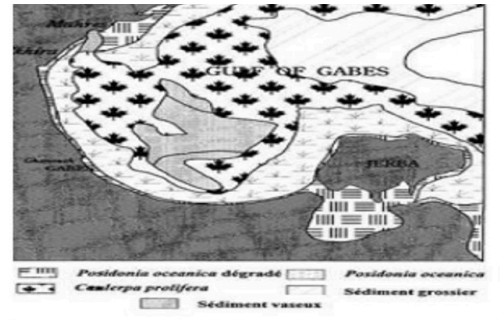
In the terrestrial area the disappearance of plant and animal species due to human irresponsible activities continues at an alarming rate. The resulting threat to biodiversity is also due to the abandonment of traditional local varieties of many plant species such as barley (*Hordeum*), commonly called "beldi", well adapted to the island climate and resistant to salinity. The millet (*Pennisetum*) as well is better known under the name

“droo”, and it is a food crop that survives only in a few limited areas. The same as the variety “matata” from the palm tree which exists nowhere else than on the island of Djerba, yet it is threatened by extinction due to irresponsible human actions. Furthermore, the destruction by uprooting or by incineration of ancestral palm, olive and carob trees represents serious damage to the ecosystem.

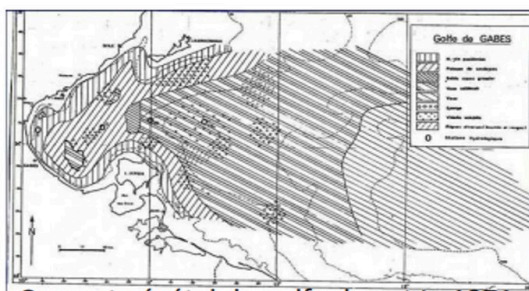
In Djerba, the circum-littoral is now seriously threatened both by the second line hotel and the spontaneous para-hotel facilities induced by the seaside tourism development on the coast. In addition, the unorganized limestone ridge exploitation which surrounds the island and protects the ‘menzels’, has aggravated the phenomena of silting up and salinity of the water table over a large part of the island. The destruction of tabias part through the trails modernization and road construction has increased the soil erosion and the flooding risk (Jarboui et al. 2020).



Couvert végétal du golfe de Gabès 1924



Couvert végétal du golfe de Gabès 1970



Couvert végétal du golfe de Gabès 1971



Couvert végétal du golfe de Gabès 1988

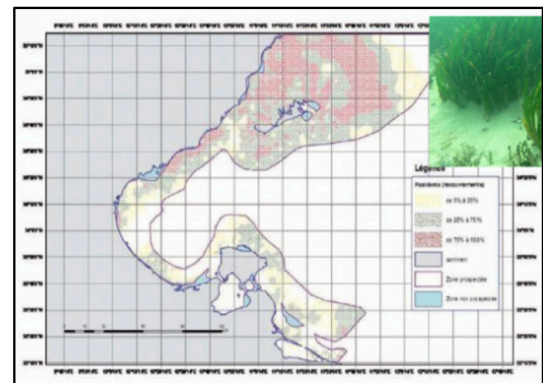
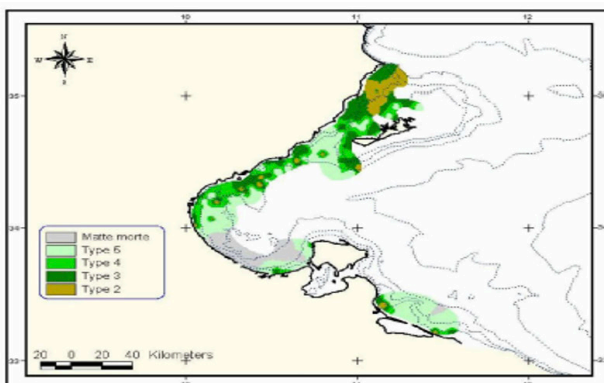


Figure 8. Evolution of phanerogam cover around Djerba Island (1924-2014)

IV. Ecosystems changes and effects on Coastal/ Maritime Tourism

Human activities within an ecosystem can often overlap and intensify their impacts that can be highly detrimental throughout years.

By looking at such cumulative effects, it is possible to assess the total effect of various human actions on an ecosystem, as well as the capacity of the ecosystem to maintain the expected services .

The analysis of impacts regarding their causes enables a tailor-made management response to be provided. The set of management responses adopted within the framework of ecosystem-based management must be considered and may involve compromises when management choices overlap. Indeed, multiple-use management does not always lead to opportunities that are described as “win-win”. In fact, something can be lost when something else is gained, and this involves assessing the trade-offs between different uses. Planners can use spatial analyses to predict overlapping threats and to develop a better understanding of the effects and interactions of multiple stressors. For example, to consider cumulative effects, specialists may need to begin by building regulatory mechanisms that encourage or require goal setting and assessment in different sectors.

Today, there is no marine region unaffected by humans and about 41% of the oceans are strongly affected by multiple causes (Halpern *et al.* 2008).

Different forms of pollution (chemical, thermal, sewage and hazardous waste) are caused by maritime traffic intensification, coastal dredging, agriculture, forestry and oil and mining extraction. In addition to what could be described as traditional sources, climate change issues are also being grafted onto these sources.

Biodiversity is also threatened by invasive species. The main unintentionally inoculated sources are ballast water that is transported across the seas in ships’ tanks and is recharged without following costly and all-too-frequently avoided discharge procedures. However, the primary cause of the invasive species spread is related to aquaculture (Cury and Morand, 2004).

On the other hand, climate changes have a direct and quick influence on some ecosystems like islands.

In Djerba, the rise in sea level will affect around 2750 ha of rangelands and 1040 ha of agricultural land, including 700 ha of arboriculture and 19 ha of annual crops (Fig.9).



Figure 9. Land-use in submersible areas in Djerba

The island vulnerability comes not only from the importance of the lands that will be lost but also from the economic value of its lands which today support high human densities and varied economic activities, and which are called upon to support in the future a greater anthropogenic pressure.

V. Policies, plans, programs and recommendations

V.1. Institutional framework

Currently, a multitude of Tunisian institutions and organizations are intervening into the coastal ecosystems either through a transversal and integrated planning and management of the space or through a sectoral exploitation strongly influencing the use of space and its natural resources. In fact, three main Ministries are particularly concerned with the coastline and coastal ecosystems issues, namely the Ministry of the Environment and Sustainable Development, the Ministry of Equipment, Housing and Spatial Planning and the Ministry of Agriculture, Hydraulic Resources and Fisheries.

Ministry of Environment and Sustainable Development:

It oversees all the following issues:

Protecting the environment

Safeguarding nature

Promoting life quality

Establishing the foundations of sustainable development in the general and sectoral policies of the State

Improving the living environment

Implementing the rules of good ecological governance in all sectors of activity

Combating pollution.

The Ministry has two technical departments: The General Directorate for the Environment and Quality of Life and the General Directorate for Sustainable Development. With respect to the coastal areas, the agencies, and organizations through which the Ministry works to formulate and implement the country's environmental policy are as follows:

- **National Agency for Coastal Management (APAL):** This is a non-administrative public institution created by law n° 72-95 of July 24, 1995. It is called upon to implement the state policy in the field of the Tunisian coastline protection and development, as well as to protect the public maritime domain against encroachments and illegal occupations. Moreover, it is in charge of giving its approval to any development and equipment project on the coast before its execution and within the framework of consultation with stakeholders.
- **National Agency for Environment Protection (ANPE):**

It is a public establishment of industrial and commercial nature, created under the law n° 88-91 of August 2, 1988. Its supervision as well as its initial mission were substantially revised by the law 92-115 of November 30, 1992, and,

because of the Ministry creation in charge of environmental and sustainable development. It is also responsible for participating in the elaboration of the government's general policy in terms of pollution control and environmental protection. Besides, it is concerned with measures implementation through specific and sectoral actions as well as global actions within the framework of the national development plan. In addition, the ANPE should propose to the competent authorities any measure of a general or specific nature designed to ensure the government's policy implementation on pollution control and environmental protection, and in particular measures to ensure the environment preservation and to strengthen the mechanisms leading to it, and in general to propose measures to prevent risks and natural or industrial disasters. ANPE Ensure polluting discharges control and monitoring, as well as treatment plants of those discharges. It collaborates with other stakeholders on research concerning Environment Protection and supervises national monitoring networks on Air, Water, and polluted sites quality (RNSQA, COPEAU and SITPOL). Finally, it is also responsible for combating all sources of pollution and nuisance, and all forms of environmental degradation.

- **Tunisian Observatory of Environment and Sustainable Development (OTEDD):**

It is under ANPE supervision. In fact, its main mission is to assist decision-making by assessing the state of the environment and sustainable development indicators in Tunisia. The OTEDD is also in charge of collecting data and information from the various ministries, producing statistics and indicators on the environment, and developing and implementing information systems relating to the environment and sustainable development.

- **National Waste Management Agency (ANGED):**

Created with the aim of contributing to the citizen's living environment improvement through the environment protection and its resources preservation by controlling and managing waste. It encourages waste recycling, waste energy recovery and waste material valuation.

- **National Sanitation Office (ONAS):**

Its mission is to ensure sanitation sector management and the protection of the environment against water pollution. In fact, it oversees the construction and operation of the sanitation network. It ensures operation, maintenance, renewal of all facilities dealing with sanitation services in cities as well as elaborating and realizing integrated projects dealing with wastewater treatment and rain water disposal.

Ministry of Equipment, Housing and Spatial Planning:

This Ministry intervenes in various fields including that of land use planning and maritime infrastructure directly related to the coastal areas management. For this purpose, it has two General Directorates:

- The General Directorate of Land Use Planning. This department is also in charge of carrying out studies and research to understand the natural and economic specificities of the different regions of the country as well as the elaboration and implementation of orientations in favor of a rational management of the territory and a sustainable development.
- General Directorate of Air and Maritime Services. It oversees:
 - The realization of seaports, the new commercial, fishing, and yachting harbors,
 - Maritime public domain monitoring, the delimitation operations as well as the maritime management revision and finally the coastline protection against marine erosion.

Ministry of Agriculture, Hydraulic Resources and Fishing:

This Tunisian Ministry oversees formulating and implementing the country's agricultural, water resources and fisheries policies, as well as creating a favorable atmosphere for the public domain delimitation as well as its protection. The development of these sectors includes the following partners involved in the mission:

- The Bureau of Planning and Hydraulic Balances (BPEH):
The BPEH is responsible for determining conventional and non-conventional water resources, setting the water needs of the various socio-economic sectors. Then, proposing plans and programs for water resources allocation to the various users, considering supply and demand.
- General Directorate of Water Resources (DGRE):
This General Directorate oversees setting up and managing networks for measuring and observing the country's water resources, assessing and establishing general water resource balances, as well as developing the basis for water resource mobilization plans and their exploitation. The DGRE includes a Directorate of Groundwater in charge of programming and monitoring the exploitation of groundwater, including the coastal aquifers.
- National Company for the Exploitation and Distribution of Water (SONEDE):
It is a non-administrative public law company mainly in charge of the production and supply of drinking water throughout Tunisia. It is also responsible for all water collection, transport, treatment, and distribution facilities.
- General Directorate of Forestry (DGF):
The General Directorate of Forestry is the focal point for Tunisia for the RAMSAR Convention and oversees the management of wetlands and national parks in Tunisia.

- General Directorate for Fisheries and Aquaculture (DGPAq):

It has many tasks; it is responsible for collecting and processing statistical data on production and fishing effort. The DGPAq also issues fishing authorizations, controls, and monitors the fishing activity of all units, draws up and establishes fisheries development plans and ensures the application of the fishing regulations by force. In addition, the DGPAq draws up strategies and plans for the development of fisheries and aquaculture and specific programs aimed at the protection of fishery resources and ensures their sustainable management.

- Regional Agricultural Development Commissions (CRDA):

CRDAs are public administrative institutions with legal responsibility and financial autonomy present at the level of the 24 governorates including the coastal governorates. They are responsible for the implementation of national agricultural policy, water resources and fisheries at the local level.

- Agricultural Development Groups (GDAs):

GDAs are non-profit associations grouping users of water and natural resources with the aim of ensuring the protection and development of these natural resources.

Other Sectorial Ministries:

The other sectoral ministries involved in coastal ecosystems management are the Ministry of Tourism and the Ministry of Industry. In addition to public bodies, several other actors are involved in the coastal zone, including the private sector, academic and research institutions, and civil society.

V.2. Regulatory framework

Tunisia has an important regulatory and legislative arsenal that governs the management of coastal ecosystems and covers the various aspects of environmental protection, including those related to the climate change phenomenon. However, the regulatory framework has some gaps that require its updating and the strengthening of regulations implementation tools. In addition, it is worth highlighting an important advance in the field of the environment with the right of Tunisian citizens' declaration to a healthy and balanced environment and participation in climate security. In fact, in Article 45 of the Tunisian Constitution adopted on January 26, 2014, which states that "The State guarantees the right to a healthy and balanced environment and participation in climate security. The State must provide the necessary means to eliminate environmental pollution". In addition, the main regulatory texts relating to the environment in general, and the management of coastal ecosystems, are the following:

- Decree No. 85-56 of January 2, 1985: relating to the regulation of discharges into the receiving environment.
- Law No. 88-91 of August 2, 1988, amended by Law No. 92-115 of November 30, 1992, and Law No. 2001-14 of January 30, 2001: on the creation of the National Environmental Protection Agency.
- Law No. 94-122 of November 28, 1994, amended by Law No. 2003-78 of December 29, 2003: on the code of land use and urban planning.
- Law No. 95-73 of July 24, 1995: relating to the maritime public domain (DPM).
- Law n° 95-72 of July 24, 1995: relating to the creation of an agency for the protection and development of the coast (APAL).
- Law No. 96-29 of April 3, 1996: on the national emergency response plan to combat marine pollution incidents.
- Decree n° 2005-1991 published on July 11, 2005: relating to the environmental impact study fixing the categories subject to the impact study and the specifications.
- Law No. 2009-49 of July 20, 2009: on marine and coastal protected areas.
- The Water Code: relating to the use of water in the public domain.

VI. Ecosystem services for Coastal/Maritime tourism

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

Marine Protected Areas (MPAs) can be useful tools for implementing ecosystem-based management, by regulating the different human uses in each area. They can correspond to small highly specialized areas (such as wilderness reserves protecting a fish species from overfishing) to large complex areas with multiple uses. Generally, MPAs are used to protect species or habitats, maintain livelihoods, facilitate restoration, or control access to the important areas for recreational, cultural, or historical reasons. Protected areas can enable managers to protect areas as well.

Moreover, Integrated Coastal Zone Management (ICZM) is an approach and a tool for coastal territories management aiming at sustainable development. It promises an integrated management with an ecosystem-based approach to space and resources that simultaneously considers terrestrial and marine, natural, economic and social systems of a coastal zone defined as a coherent territory for reflection and action. The ICZM concept was concretized at the Rio de Janeiro Convention in 1992. Chapter 17, one of the most consequential chapters of Agenda 21, makes the ICZM concept the approach that should be favored to move towards the sustainable development of coastal zones. The ICZM novelty lies precisely in the organization of a governance system that combines regulations, policies, incentives, support actions and consultation processes in a project that promotes the sustainable development of the coastal zone and its uses. It is important to note that Tunisia has regulated in its legislation the creation of these coastal zones. Thus, the national strategy, based on the analysis of the existing situation sets objectives, determines priorities, and justifies them. It also identifies coastal ecosystems requiring management and all the actors and processes involved. Moreover, it lists the measures that should be taken and their cost as well as the institutional instruments and legal and financial means available and sets a timetable for implementation”.

Finally, Marine Spatial Planning (MSP) could be considered as an effective tool towards sustainable tourism development. Indeed, MSP offers the chance to provide an overview and localization of the marine resources use and marine space, and to determine what can be done in different places with less impact and fewer use conflicts. Smaller-scale, spatially explicit management measures such as multiple-use areas zoning, MPA networks designation, or individual protected areas can also be derived from marine spatial planning. One of the advantages of such planning is that it allows planners and managers to integrate information on the ecosystem characteristics, the human activities impact on it (and vice versa), and its linkages with other ecosystems (or the impacts of other uses). This information can then be mapped to form the basis for (a)

spatialized sectoral regulations for specific uses, (b) plans for future research, monitoring, and assessment to fill information gaps, and/or (c) a comprehensive marine zoning plan. Coastal zone planners and marine resource managers have used a variety of marine spatial planning tools that differ in information content, scientific rigor and level of technology used.

Regarding the Djerba ecosystem, measures have been taken to limit construction near the coast as well as the protection of 'menzels' against silting up, the fight against the salinization of the water table by protecting the limestone ridge and rationalization of quarry exploitation.

VII. Blue Economy and Ecosystems

The concepts of “blue economy” and “blue growth” emerged before Rio + 20; The 2012 United Nations Conference on Sustainable Development (UNCSD). During formal negotiations and less formal UNCSD discussions, the concept of the blue economy has been used by different institutions with different meanings, often inconsistently (Silver *et al.* 2015).

Then there is no officially established definition of the blue economy. In fact, the eco-union definition was the one adopted in the current report. The blue economy is a non-polluting economy, circular and efficient in the use of resources, based on consumption practices and sustainable production, which promotes human well-being and social equality and creates economic value and employment, while significantly reducing environmental risks and resource shortages. The blue economy helps to preserve the health of the Mediterranean marine and coastal ecosystems, while ensuring a continuous supply of goods and services for present and future generations.

The Blue Economy gradual establishment is based on the sustainable development of several essential socio-economic activities.

In Djerba many works are in synergy with the concept of the blue economy and ecosystemic approaches. Regional and local stakeholders are very active and motivated comparing with other zones in Tunisia.

Associations are very active and treat some ecosystemic problems.

The implementation of EAF: Ecosystemic Approach in Fisheries in 2018 and the management plan elaboration. This management plan (MP) has, therefore, been developed as part of a consultation process according to the EAF approach principles. A second step is the Technical Monitoring and Consultation Committee creation (TMCC) of the MP of Djerba fisheries. In general, the Committee is made up of all the representatives at the regional level of direct stakeholders in the island fishery (Fishermen, UTAP, DGPAq, APAL, GIPP, APIP, National Marine Guard (NMG) and INSTM).

Moreover, the Blue Hope Project (DGPA, FAO) has an involvement in Djerba ecosystem preservation proposing an investment plan to realize strategic objectives in relation to ecological wellbeing.

Associations and citizens in Djerba Island have an important contribution in terms of sensibilization and cleaning activities but also inventories and studies related to the environment.

VIII. Conclusions

Djerba Island is one of the most coveted coastal areas of the country. The tourist occupation of picturesque sites on the various island beaches, the fishery resources exploitation through fishing, the maritime routes use, the seabed use for telecommunications connection establishment are concrete illustrations of the interrelation that exists between coastal and marine ecosystems and human activities.

The purpose of this report is to make environmental managers and policy makers aware of the existing diversity in sandy and low coasts of the Island, environments highly threatened by touristic development, and of the coastal diversity value in terms of sustainable development.

This first work of the coastal ecosystems' current situation synthesis and the sustainable development must be reinforced and supplemented by an important identification work of valid criteria to better judge this situation and to propose adequate measures to reconcile coastal ecosystems and the sustainable development of tourism in Tunisia.

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The present document has been produced with the financial assistance of the European Union under the ENI CBC Med Program. The contents of this document are the sole responsibility of *National Institute of Marine Sciences and Technologies* and can under no circumstances be regarded as reflecting the position of the European Union or the program management structures.

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