

# Protection of Ecosystems in Tourist Areas

Sousse Scale, Tunisia





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

### Protection of ecosystems in tourist areas Sousse scale, Tunisia



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## OVERVIEW

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## REVIEW

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## List of abbreviations

<b>AAO:</b> Bird Friends Association
<b>APAL:</b> Coastal Protection and Planning Agency
<b>BNG:</b> National Bank of Genes
<b>BPEH:</b> Bureau of Planning and Hydraulic Balances
<b>CBD:</b> Convention on Biological Diversity
<b>CNLCD:</b> National Council to Combat Desertification
<b>CRDA :</b> Regional Agricultural Development Commissions
<b>DGF:</b> General Directorate of Forestry
<b>DGPAq:</b> General Directorate for Fisheries and Aquaculture
<b>DGRE:</b> General Directorate of Water Resources
<b>GDAs:</b> Agricultural Development Groups
<b>IPBES:</b> Science-Policy Platform on Biodiversity and Ecosystem Services
<b>LCD:</b> Convention to Combat Desertification
<b>NDC:</b> Nationally Determined Contribution
<b>SDGs:</b> Sustainable Development Goals
<b>SONEDE:</b> National Company of Water Exploitation and Distribution

## Abstract

Tunisia has diverse ecosystems, including coastal, deep and wide waters. However, these ecosystems face increasing pressures from urbanization, marine erosion, sea waste, pollution, climate change, over- and illegal fishing. To protect these ecosystems; Tunisia has implemented voluntary policies to protect natural resources and environment without jeopardizing development goals. The Sousse Governorate, a significant agricultural and tourism region, is particularly affected by ecosystem change. This report focuses on monitoring the marine and coastal ecosystem in Sousse, identifying risks and threats to tourism, and developing management and protection approaches. The present document is developed through the review of existing data at national and regional scale. The report highlights the morphological characteristics of coastal ecosystems in the region of Sousse, the coastal and maritime tourism and its effects on coastal ecosystems in the island, focuses on reporting the trend of evolution of Sousse coastal ecosystem and present some policies and strategies for coastal ecosystem protection and management to improve tourism in this zone.



## I. Introduction

Tunisia contains 64 islands and islets along nearly 1300 Km of coastline; it is home to varied ecosystems, both coastal (with numerous biocenoses of the upper, middle, infra and approximately coastal floors such as those of fine sands partially humidified by sea water, posidonia herbs, coralligen, etc.), deep and/or wide (shore waters with its pelagic species, deep white corals, high bottom and banks, etc.). Some ecosystems are very particular by marine and aquatic flora and fauna. To date, in Tunisia, more than 600 marine and aquatic plant species have been identified along the Tunisian coastline and more than 3400 marine or aquatic animal species, unevenly distributed along the coast and depending on depth, are identified. This biological diversity is subject to numerous and increasing pressures: urbanization, marine erosion, sea waste and diverse pollution, sea level rise due to climate change, over-and illegal fishing, etc.

To achieve this, Tunisia tried to involve itself very early in a voluntary policy of protecting its natural resources and environment without jeopardizing its development goals. The risks will be both environmental and socioeconomic in nature and will highlight the extreme interdependence between them.

One of the most significant agricultural and tourism regions in Tunisia is the Tunisian Sahel, particularly the Sousse Governorate. We must at all costs protect the water and the soil

since the effects of climate change have been severe. It was necessary to implement laws and preventative measures to defend against soil erosion and degradation in the Sousse region.

This is part of this deliverable, which reports the effects of ecosystem change on a key sector of human activity; tourism. This sector, at the intersection of two central themes, the economy and the environment, represents an interesting subject of study; it is all the more interesting that its dependence on the climate is very strong.

The subject of this report is then the monitoring of the state of the marine and coastal ecosystem in Sousse in an approach based on the identification and assessment of coastal ecosystem risks and threats to tourism as well as the development of approaches used for the management and the protection of the coastal ecosystem in the tourist areas of Sousse.

The document is structured as follows.

- Characteristics and dynamics of Coastal Ecosystem in Sousse (Evolution, dynamics, threats and risks ...).
- Coastal and Maritime Tourism and its effects on coastal ecosystem in Sousse.

- Ecosystems changes and Coastal/Maritime Tourism in Sousse.
- Policies, plans and programs and recommendations for Coastal Ecosystem protection and management (Main policy initiatives and directives in Sousse, Relationship and gaps among policy measures and links with Coastal/Maritime tourism ...).
- Protected ecosystem services for Coastal/Maritime tourism in Sousse.
- Blue Economy and Ecosystem protection and management in relation to coastal and Maritime Tourism in Sousse.

## II. Characteristics and dynamics of Coastal Ecosystems in Sousse

### II.1. Geographical location of the studied area

The commune of Sousse covers an area of 45 km<sup>2</sup>. It is located at the southern end of Hammamet Golf along a coastline that runs between the ports of Hergla and Monastir (Figure 1). It is part of a larger geomorphological unit called the Tunisian Sahel. It is marked by a monotonous relief, consisting of vast plains and hilly hills, which do not exceed the 75 m of altitude. From the west to the south, the geomorphology progressively moves from low steppes to flat steppes plunging into the sea.



**Figure 1.** Geographical location of the governorate of Sousse.

### II.2. Biological evolution Traits

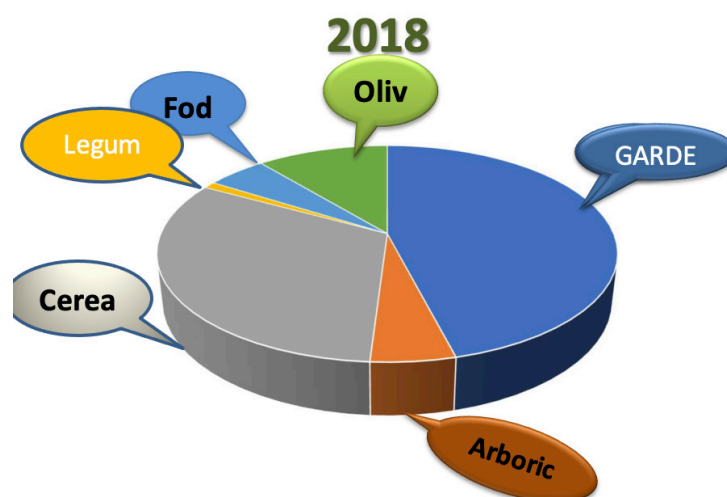
#### II.2.1. Terrestrial environment

Sousse is characterized by a rich and diversified ecological heritage; this region has a low sandy coast where the beautiful beaches are abundant and the climate is mild, which explains its high traffic.

The landscape of Grand Sousse is essentially formed by the olive groves. In addition, the vast plains and high hills with their natural corridors (wadis, streams ...) are containing a wide biodiversity of plant and animal species (Figure 2 and Figure 3) (Jlassi et al., 2020). In addition to olives, palm and various fruit trees are cultivated on agricultural land of Sousse.



**Figure 2.** The predominance of olive growing in the agricultural areas bordering “Sebkhat of Sousse”



**Figure3.** Distribution of plant production quantities by type in the Governorate of Sousse in 2018 (Source: Governorates in figures 2018).

In another hand, more than 126 species of trees and ornamental shrubs are cultivated in Tunisia. Many of these species have become common in Sousse (*Araucaria*, *Bougainvillea*, *Ficus nitida*, *Ficus australis*, *Ficus rebuginosa*, *Jacaranda*, *Phoenix*, *Schinus*, *Phoenix canariensis*, *Phoenix dactylifera*, *Washingtonia filifera*, *Chamoerops humilis*, *Pritchardia*, etc) (Figure 4 and Figure 5) (Jlassi et al., 2020). The majority of the ornamental flora of the municipality of Sousse has been developed for decoration purposes of the city.



**Figure 4.** *Ficus rebuginosa*



**Figure 5.** *Phoenix dactylifera*

## II.2.2. Marine ecosystem

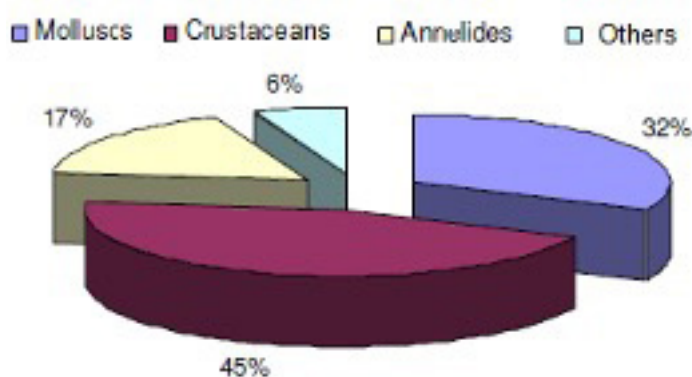
- **Flora**

The study of the plant populations collected during our visits to Sousse reveals that this area is characterized by a very rich and varied flora, consisting mainly of *Zizifus lotus*; *Stipa tenacissima*; *Edysarum carnosum*; *Oleae europea*, *salicornia arabica*, *Sueda Frutecosa*, *Arthrocnemum indicum*, *Atrocneum glocum*, *Atriplex Halimus*, *Atriplex glauca*, as well as *Tamarix aphylla*, *Cirpes*, *Typha* and *Phragmites* (Elouardani, 2020).. The Sebkha El Kalbyya and its surroundings also has introduced species, such as *Pinus halepensis*, *Eucalyptus camaldulensis*, *Acacia cyclopes*, *Opuntia ficus indica* and *Eucalyptus gonfocephala* (Mejri et al., 2009).



### • Fauna

The macrofaunistic community is essentially dominated by 3 Phylums: the Molluscs, the Crustaceans (*Zenobiana prismatica* and *Idotea balthica basteri*) and the Annelides (*Cirriiformia tentaculata*, *Cirratulus cirratus*, *Capitella capitata* and *Nematonereis unicornis*). These Phylums contribute with almost 94% to the composition of the overall wildlife with a predominance of Crustaceans. Other groups are poorly represented (Figure 6) (Mejri et al., 2009).



**Figure 6.** Total percentages of the various taxons recorded in 2020.

The Sebkhia Sidi El Hani in Sousse, attracts also some ornithological species, such as the pink flamant, the interrupted collar Gravelot and the stem duck. Therefore, the Sebkhia serves as a natural refuge for several species, especially during the rainy years that allow some to nest there. In addition, this site is a favorable habitat for the development of *Artemia salina*, a crustacean species of great interest for the feeding of birds and aquaculture species.

Given this importance, the Sebkhia has been classified as an Area of Importance for the Conservation of Waterbirds ('Important Bird Area') by the World Bird Friends Association (AAO) since 2001. The site is also classified as a wetland of national importance (Elouardani, 2020).

## II.3. Pressions and threats on Coastal Ecosystems in Sousse

### II.3.1. Climate change

According to the results of the "National Adaptation Strategy for Tunisian Agriculture and Ecosystems to Climate Change" in 2005-2006, which made it possible to explore the possible impacts of climate change on natural resources by 2030, the effects of climate change would directly impact water resources, ecosystems, agrosystems and biodiversity in general.

### II.3.2. The artificialization of natural environments

Since the twentieth century, the city of Sousse underwent a rapid urban expansion to the dupe of its fertile agricultural land (Jlassi et al., 2020) . Thus, pollution, in various forms (solid, liquid, aerial ...), constitutes an increasingly restrictive obstacle to the conservation of biodiversity. The use of sebkha of Sousse as an uncontrolled landfill decreasing their productivity, thus causing the disappearance of the populations which live there (Belghith D., 2012).

### II.3.3. Limited forestry potential

For years, Madfoun's forest has been undergoing degradation and is in sharp decline. Similarly, the border range has been narrowed (nearly half was lost between 2002 and 2019).

The conservation of this forest is crucial in the protection of local and passing wildlife and plays a role of wind breeze that reduces the mechanical erosive effect. It is also useful in the nutrition and preservation of the plate (Figure 7) (Elouardani, 2020).



**Figure 7.** Evolution of the perimeter of the “Madfoun Forest” between 2002 and 2019.

### II.3.4. Air pollution

Concentrations of microscopic particulates are threatening urban biodiversity. The sources of air pollutants in the city of Sousse arise mainly from the transport sector and certain polluting industrial activities located in the town or in the periurban area (Jlassi et al., 2020).

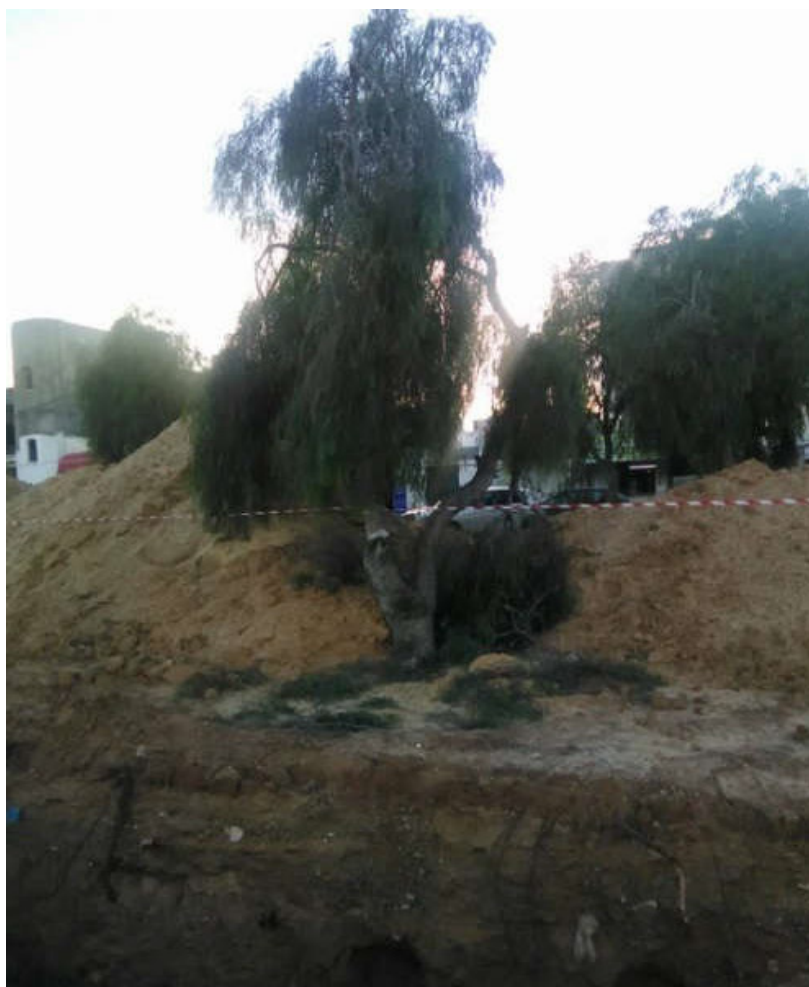
### II.3.5. Destruction and fragmentation of ecosystems

The theory of “metapopulations” is based on the assumption that the isolation of urban green spaces causes dispersal of species and presents a risk, at least for species with low dispersal capacity. Indeed, connectivity between green spaces can be improved by creating corridors. The rarefaction, fragmentation and isolation of habitats on the territory, therefore constitute real threats to biodiversity. Thus, the degradation and fragmentation of ecosystems is one of the most formidable causes of the degradation of urban biodiversity in Sousse (Figure 8 and Figure 9). Various works in the city threaten biodiversity (Jlassi et al., 2020) (Hanski I.A. et al., 2018).



**Figure 8.** Ecological degradation of the Sebkha of Sousse.





**Figure 9.** Various works in the city threaten biodiversity.

### II.3.6. The overfishing

Unsustainable fishing practices can exhaust fish populations, disrupt food chains and alter the dynamics of ecosystems (Figure 10).



**Figure 10.** Fishing Port of Sousse.

### II.3.7. The introduction of invasive alien species

Yellow *lamorella* “*solanumelaeagnifolium*”, is a small plant characterized by its purple flowers and thorny stems and leaves. This species is invasive and causes a decrease in the productivity of the land. It is present in the public garden of Erayhan (Figure 11). However, Article 6 of the *Convention on Biological Diversity*, ratified by Tunisia, in May 1993, incitates the requirement to control or *eradicate alien* species that threaten ecosystems, habitats or species (Jlassi et al., 2020).



**Figure 11.** The yellow nightshade “*Solanum eleagnifolium*” occupies the public garden of Erayhan.

### III. Approaches/tools to estimate the cumulative impact of threats on ecosystems

*Environmental Impact Assessment* it assess the potential impacts of development projects and identify mitigation measures to reduce negative impacts on ecosystems.

*Cumulative Impact Assessment (EIC)* The EIC assesses the combined impacts of multiple stressors on ecosystems over time, providing a holistic understanding of the cumulative effects.

*Ecological Modeling* Computer models simulate ecosystem dynamics and help predict how multiple stressors interact and affect ecosystems.

*Indicator Species Analysis* The study of species sensitive to environmental change can provide information on the overall health of ecosystems.

*Remote Detection and Geographic Information Systems* Remote detection technologies and Geographical Information Systems (GIS) are used to monitor land-use change, coastal erosion and habitat loss.

*Ecosystem Services Value Assessment* Assigning economic values to ecosystem services helps policymakers understand the importance of preserving these services for human well-being.

*Scenario Planning* The creation of different development and climate change scenarios explores various potential impacts and outcomes, facilitating decision-making.

*Stakeholder Engagement* Involving local communities, scientists, policy makers and industry stakeholders fosters collaboration and leads to more comprehensive impact assessments.

By combining these approaches and tools, decision makers can gain a comprehensive understanding of the cumulative impacts of threats on ecosystems in Sousse. This information supports informed decision-making for sustainable development and conservation efforts.

## IV. Coastal Tourism and its effects on coastal ecosystems in Sousse

While a century ago only 15% of the Earth's surface was modified by the direct effects of human activities, this proportion has now grown to 87% of the ocean and 77% of the land. According to a recent report from the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), human activities threaten around 1 million species with extinction (IPBES 2019), many others being extinct already (Garnivet E., 2020).

The tourism industry does not escape this rule. In fact, tourism has become an increasingly accessible activity and has thus developed over time to become a mass activity. This activity then becomes a threat to fragile environments as it presents too much pressure in relation to the environment's capacity to host. The repeated passage of visitors to host lands, the use of natural resources without concern for the sustainability of this consumer good, the increase of waste generated by consumption, are all negative impacts on ecosystems and can affect local communities in different ways. In fact, tourism is a growing source of disruption to fragile ecosystems. Its social, economic and environmental impacts are considerable and complex, especially because tourism focuses on vulnerable natural and cultural sites. Thus, these sites are weakening from year to year by mass tourism favouring the overconsumption of natural resources, and by the development of tourist infrastructures responding to an ever-growing demand. Furthermore, short-term gains from tourism may take up long-term environmental considerations, in particular with regard to the conservation and sustainable use of biodiversity. This is important in coastal maritime regions, where tourism is constantly increasing and where biodiversity is the greatest.

In such context, the tourism in the region of Sousse is the first activity, after the fishing industry, benefiting from the sea. More than 80% of the hotels are lying along 13 Km of coastline. It is expected to be the most environmentally friendly, but like any human activity it becomes the biggest environmental problem.

Beach occupation and sand extraction are the first negative results of hotel building in Sousse. The increasing number of pleasure boats, ports and other pleasure structures; fully occupied during summer time and located in many cases in the coastal areas, is becoming one more source of marine pollution by the amount of wastes they discharge deliberately into the sea (oily water, garbage, sewage) and particularly by the difficulties in handling them.

The impact on ecosystems is really serious through the bacteriological pollution of the sea, and therefore the disturbance caused to marine organisms by the propulsion engines of thousands of pleasure boats having their exhaust pipes under water, releasing a considerable amount of thermal energy and toxic gases into the sea water. These boats represent a real threat to the coral and sea grass.

In the same context, a report was published in 2003 by the Centre of Regional Activities for Specially Protected Areas CAR/ASP under the title: Impact of tourism on the marine and coastal biodiversity of the Mediterranean. The report revealed that the coasts between the Sousse and the Monastir regions constitute a migratory stop for an avifauna of international importance, such as the railleur goeland, classified as a vulnerable species. These coasts constitute one of the most western nesting sites of the *Caouanne* turtle, this species is unfortunately very threatened by tourism and coastal fishing in the Mediterranean (CAR/ASP, 2003).

To conclude what was discussed previously, the Maritime Tourism constitutes a serious damage to the maritime and coastal ecosystem and environmental quality in Sousse, by:

- Wasting generation and marine littering.
- Overconsumption of scarce natural resources as water.
- Environmental and land degradation and hazards to biodiversity: destruction of ecosystems as a result of complex construction and urbanization in fragile natural spaces.
- Biodiversity losses and decrease of the aesthetic value of landscapes.
- Pollution of soil and water.
- Overconsumption of water.
- Disruption of flora and fauna.
- Emissions of greenhouse gases at a rate of 20% from tourist travel.



## V. Ecosystems changes in Sousse

### V.1. Ecosystems change, a threat to tourist destinations

Changes in ecosystems are defined as the rapid reorganization of an ecosystem whose previously stable state becomes very different, permanently. Rapid changes in ocean conditions can result in changes in species abundance, community composition, and tropical reorganization.

There are two main causes of changes in the ecosystem:

- Climate factors, including climate change.
- Anthropogenic factors such as fishing, introduced species and habitat changes.

Ecosystems changes impacts have started to shift maritime and coastal tourism patterns, with several consequences for local communities. According to the United Nations Framework Convention, this is a change in the climate caused directly or indirectly by any human activity. It changes the composition of the Earth's atmosphere. The environmental impact of this global warming and the intensification of human activity threaten certain tourist destinations.

### V.2. Ecosystems changes and Coastal Tourism in Sousse ; a threat to the sustainability of Tourism.

The erosion of the beaches and the pollution of the coastal waters are notable barriers to the development of beach tourism in Sousse. The degraded coastal line, which extends from the fishing and trade port to the left bank of the Hamdoun ocean, accounts for 39% of the city's total coastline. This accentuates the frequentation of the tourist beach and the over-exploitation of the beach of Boujâafar. With forecasts of sea level rise by 2100; the "coastal erosion" wave increasingly threatens the stability and extent of the beaches, which will further reduce the tourist accommodation capacity for swimming. With the pollution of bathing waters and the health risks that arise, the future of beach tourism is at risk. The spread of urbanization on the coasts combined with the DPM invasion created an imbalance between proportions in protected sites and artificialized territories. This significantly reduces the attractiveness of the city. Residents and tourists are lacking places to relax. Finally, the algal explosion at the level of some seaside sites creates more and more healthy bathing conditions and helps to reduce the attractiveness of the beaches.

## VI. Strategies and measures applied in Sousse against threats affecting ecosystems

### VI.1. Organizational structure

The coastline and coastal ecosystems are a major issue for three major Ministries: the Ministry of the Environment, the Ministry of Equipment, Housing and Spatial Planning, and the Ministry of Agriculture, Hydraulic Resources and Fisheries.

Ministry of Tourism and the Ministry of Industry, in addition to public bodies and several other actors, are involved in the coastal zone, including the private sector, academic and research institutions and civil society (table 1).

**Table 1.** Tunisian agencies, institutions and organizations involved in the coastal ecosystems protection

Title	Details and mission
<b>National Agency for Environment Protection (ANPE)</b>	The ANPE is a public establishment created under law 88-91 of 1988, revised by law 92-115 of 1992, and a Ministry responsible for environment and sustainable development. It is responsible for elaborating government policies on pollution control and environmental protection, implementing them through specific and sectoral actions, and proposing measures to prevent risks and natural disasters. The ANPE ensures pollution discharge control, monitoring, and treatment plants, collaborates with stakeholders on environmental research, and supervises national monitoring networks.
<b>Tunisian Observatory of Environment and Sustainable Development (OTEDD)</b>	The OTEDD, under ANPE supervision, assesses Tunisia's environment and sustainable development indicators, collecting data from ministries, producing statistics, and developing information systems for environmental and sustainable development.
<b>National Waste Management Agency (ANGED)</b>	Created with the aim of contributing to the improvement of the citizen's living environment through the protection of the environment and the safeguarding of its resources by controlling and managing waste. It encourages waste recycling, waste energy recovery and waste material valuation.
<b>National Sanitation Office (ONAS)</b>	Its mission is to ensure the management of the sanitation sector and the protection of the environment against sources of water pollution. It is in charge of the construction and operation of the sanitation network. It ensures operation, maintenance, renewal of all facilities dealing with sanitation services in cities. It is also in charge of elaborating and realizing integrated projects dealing with waste water treatment and rain water disposal.



<b>The General Directorate of Land Use Planning</b>	This department is also in charge, of carrying out studies and research in order to understand the natural and economic specificities of the different regions of the country as well as the elaboration and implementation of orientations in favour of a rational management of the territory and a sustainable development.
<b>General Directorate of Air and Maritime Services</b>	It is in charge of the realization of seaports, in particular the new commercial, fishing and yachting harbours, the monitoring of the operations of the delimitation and revision of the delimitation of the maritime public domain as well as its protection, the management of the maritime public domain and the protection of the coastline against marine erosion.
<b>The Bureau of Planning and Hydraulic Balances (BPEH)</b>	The BPEH is responsible for determining conventional and non-conventional water resources, setting the water needs of the various socio-economic sectors and proposing plans and programs for the allocation of water resources to the various users, taking into account supply and demand.
<b>General Directorate of Water Resources (DGRE)</b>	This General Directorate is in charge of setting up and managing networks for measuring and observing the country's water resources, assessing and establishing general water resource balances, 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.
<b>National Company for the Exploitation and Distribution of Water (SONEDE)</b>	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.
<b>General Directorate of Forestry (DGF)</b>	The General Directorate of Forestry is the focal point for Tunisia for the RAMSAR Convention and is in charge of the management of wetlands and national parks in Tunisia.
<b>General Directorate for Fisheries and Aquaculture (DGPAq)</b>	It has many tasks, in particular 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 in 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 to ensure their sustainable management.
<b>Regional Agricultural Development Commissions (CRDA)</b>	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.
<b>Agricultural Development Groups (GDAs)</b>	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.

## VI.2.The legal system

The management of coastal ecosystems and various aspects of environmental protection, including those related to the phenomenon of climate change, are covered by a significant regulatory and legislative arsenal in Tunisia; however, the regulatory framework has some gaps that require updating and the strengthening of tools for the implementation of regulations. The table 2 lists the key legal documents (decrees, laws and others) that govern environmental policy in general and coastal ecosystem management in particular.

**Table 2.** Decrees, laws and codes that govern environmental policy and coastal ecosystem management

Type	Number	Date	Details
<b>Decrees</b>	85-56	January 2, 1985	Regulation of discharges into the receiving environment
	2005-1991	July 11, 2005	Environmental impact study fixing the categories subject to the impact study and the specifications;
<b>Laws</b>	88-91	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
	. 94-122	November 28, 1994	Amended by Law No. 2003-78 of December 29, 2003: on the code of land use and urban planning
	95-73	July 24, 1995	Maritime public domain (DPM);
	95-72	July 24, 1995	Creation of an agency for the protection and development of the coast (APAL);
	96-29	April 3, 1996	National emergency response plan to combat marine pollution incidents
	2009-49	July 20, 2009	Marine and coastal protected areas
<b>The Water Code</b>	-	1975 (A draft new water code is submitted to the Prime Ministry in 2023)	Use of water in the public domain
<b>Code of Urban and Territorial Planning</b>	-	November 28, 1994	Prevention of environmental degradation
<b>Order of the Minister for Local Affairs and the Environment and the Minister for Industry and Small and Medium Enterprises</b>	2018-315	march 26, 2018	Fixing the limit values for discharges of effluents into the receiving medium

### VI.3. National biodiversity policy

Tunisia ratified the Convention on Biological Diversity in May 1993. The protection of biodiversity in Tunisia is provided by a fairly large legal arsenal, which includes provisions at different scales of the legal standard: Laws such as those relating to the protection of agricultural land, fishing, water and soil conservation, marine and coastal protected areas and Organic Law No. 2018-29 of 9 May 2018, relating to the Code of Local Government, which stipulates in its Article 253: The president of the commune is in charge of the municipal regulation, the environmental police, the execution of the decisions of the municipal council

and the protection of the environment, within the whole communal perimeter , including the public domain of the state. Legislation of an institutional nature that specifically targets the protection of biodiversity, such as the laws on the establishment of the National Agency for the Protection of the Environment and the law on the creation of the Agency for the Protection and Development of the Environment. Littoral ; Decrees such as those concerning the creation of the National Bank of Genes (BNG) and that relating to the creation of the National Council to Combat Desertification (CNLCD) (Jlassi et al., 2020).

### VI.4. International conventions

Tunisia has signed and ratified, including the Convention on Biological Diversity (CBD), the Cartagena Protocol, the Nagoya Protocol, the Convention on International Trade in Endangered Species of Wild Fauna and Flora, the Convention for the Protection of the World Cultural and Natural Heritage, the Ramsar Convention, the Bonn Convention, on the Conservation of Migratory Species, Wildlife Species, the United Nations Convention to Combat Desertification (LCD), the Framework Convention Climate Change (UNFCCC) and the Paris Agreement, ratified by Tunisia in October 2016, including the objectives of the Nationally Determined Contribution (NDC) on Climate Change Adaptation, the International Treaty, on plant genetic resources for food and agriculture; The 2030 Development Agenda and the 17 Sustainable Development Goals (SDGs); The Sendai framework for disaster risk reduction; Agenda 21.

### VI.5. Coastal Ecosystem initiatives protection measures in Sousse

#### VI.5.1. Launch of TouMaLi project in the Hammam-Sousse pilot tourist area ( Mars 2023 )

The TouMaLi, “Contribution of sustainable waste management systems in the tourism sector to the protection of marine ecosystems” has just been launched in the Hammam-Sousse tourism pilot area, said regional tourism commissioner in Sousse, Taoufik Gaied.

Implemented under the coordination of the German University of Rostock with the International Centre for Environmental Technologies of Tunis (CITET), the TouMaLi project aims to reduce plastic waste in coastal areas, Gaied explains, adding that the project is also being implemented in Egypt and Morocco.

The pilot area of Hammam-Sousse, which can accommodate about forty hotels, has been selected for the implementation of this project that will reduce plastic pollution of the beaches and its surroundings in the selected tourist area, according to the same source.

Financed by the German Federal Ministry of Environment, Nature Protection and Nuclear Safety (BMU), as part of the Marine Waste Financing Programme and run by the University of Rostock, the TouMaLi project was launched in Tunisia on November 13, 2021.

Implemented by CITET, it aims to reduce the abundance of marine waste. It is a regional project to transfer innovative technologies at the level of 4 partner countries, namely Tunisia, Algeria, Egypt and Morocco.

### **VI.5.2. Project of depollution and planning of Hamdoun Oued and «Sebkha» of Sousse (Elouardani, 2020) (Secretariat of the Convention on Biological Diversity, 2004)**

- ***Depollution and planning of Hamdoun Oued***

The river's assainissement can benefit biodiversity and restore ecological balance in the river and rivers, minimizing the impact of pollution on socio-economic activities. Rehabilitation and enhancement of the riverine zone can improve the overall quality of life in limited-income neighborhoods. The transformation of the river into a place of pleasure could disenclave the southern zone, offering quality leisure infrastructure and opportunities for interaction and exchanges. The project's globality encourages participation and concertation at every stage, establishing an innovative management model that could be applied to other rivers in the country.

This part of the is funded by each stakeholder for the activities that are assigned to it and that fall within its competence (local communities, ANGEd, ONAS, industrial, STEG, etc.)

- ***Planning of the “Sebkha” of Sousse in a multi-thematic park***

The integrated project aims to protect and enhance wetlands through purification, biodiversity reconstruction, and urban and economic development. It will improve living conditions, reduce hygiene risks, and improve air quality. Urban parks will also enhance air quality and reduce leakage. The ambitious rehabilitation and planning program will redesign the southern area of the city, revitalizing the city's natural environment.

This part of the project is funded by APAL and/or ANGEd by supporting all or part of the

Sebkha rehabilitation study in addition to private investors, mainly in the planning and installation of the facilities.

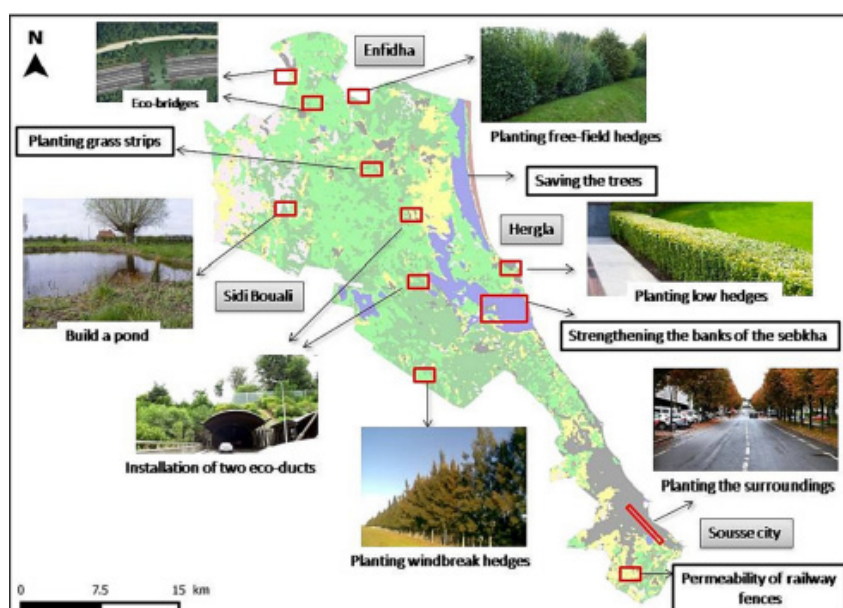
The Project of depollution and Planning of Hamdoun Oued and the “Sebkha” of Sousse lasted 5 years, in the period between 2010 and 2015.

- *Explore the Sebkha and oed Hamdoun wetlands to develop leisure activities.*

It is about exploring the opportunities of tourism enhancement that the Sebkha of Sousse and the Hamdoun Oude can offer for the diversification and support of the sector. The objective is to build on the attractiveness and functionality of the City of Sousse Strategic Development Plan 2014 wetlands to diversify and enrich the current tourist offer. This goes through the development of new eco-tourism products, or through the establishment of leisure activities in the natural surroundings (recreation and walking airs...). The importance of this approach is triple. It enables, on the one hand, to diversify and strengthen the infrastructure and leisure offerings in the city. On the other hand, it responds to a growing demand from tourists to devote themselves to green tourism; visit natural sites or they can enjoy biodiversity, relax and move away from standardized concrete and artificial landscapes.

### VI.5.3. Proposal for actions in favor of biodiversity in Sousse

Proposal for actions in favor of biodiversity in the Sousse region are proposed to enhance biodiversity and make the study area susceptible to more fauna and flora species (Boussema et al., 2023). These proposals from north to south are presented in Figure 12.



**Figure 12.** Development plan for biodiversity conservation in the Sousse region

- a) Installation of two eco-bridges; can be constructed allowing the passage of small and medium fauna at the level of the regional road, with 2 m in width and 8 m in length.
- b) Planting free-field hedges; in the rural environment northeast of Enfifidha, having a height of 2 m and a width of 0.8 m. It will have an ecological and anti-erosive role. The composition of the selected species may include *Quercus coccifera*; *Quercus ilex*; *Juniperus*; and *Tamarix*.
- c) Saving the trees of El Madfoun forest; is a challenge in terms of maintaining biodiversity and local landscape identities.
- d) Planting grass strips; with 5 m wide, sown or spontaneous, on the edge of cultivated plots in the agricultural area in the central eastern part of the Enfifidha region. Legumes such as Clover and Lucerne; can be usefully combined with Ray-grass. And which are interesting for insects (honey bees) and birds (areas of refuge, rest, food and reproduction).
- e) Building a pond; northwest of Enfifidha, near the forest of Ain Garci; 1.2 m deep allowing plants to take root with amphibious vegetation such as: *Juncetia bufonii*, *Bidentetia tripartita*; and *Nasturtium officinale*.
- f) Installation of two eco-ducts; at Enfifidha at the level of the Highway (A1) and the national road (RN1). These passages will combine a fluvial flow and a transition zone for terrestrial fauna.
- g) Planting low hedges; around the subdivisions created from the Land Housing Agency at the southern entrance of Hergla city.
- h) Strengthening of the banks of Halq El Mingel's sebkha; by the planting of *Acacia cyanophylla* associated with *Pins maritime* to protect it against erosion and mitigate the phenomenon of sea spray.
- i) Planting windbreak hedges; in the crop fields of Sidi Bouali city which comprise a deciduous species; *Populus*, and a persistent species; the *Cupressus* to break the power of the wind and protect crops.
- j) Planting of the edges of the Boulevard of Environment; located at the southern entrance of Sousse city. Evergreen trees are chosen as alignment trees to shade the passage in this boulevard, especially in summer, composed of *Brachychiton populneus*.  
The latter is altered with a shrub-type plant such as *Euphorbia pulcherrima* to favor the installation of small fauna.
- k) Permeability of railway fences; located south of the city of Sousse which allow most species to pass under and the larger animals to walk on it.



## VI.6. Recommendations to ensure the protection management and sustainability of the coastal ecosystem in Tunisia

Tunisia has not exploited its entire natural coastal environment and has acknowledged the need to design and protect its coastline with a view to sustainable development. This strategy for the protection of the marine and coastal environment has addressed various relevant aspects such as planning and management (integration and enhancement of the coastal area, protection and management of its natural and cultural heritage; development of guiding schemes for the planning of sensitive coastal areas), protection against marine erosion and conservation of natural resources, protection against various forms of pollution, measures in favor of marine resources. In addition, a national strategy for sustainable coastal tourism has been implemented. It is about promoting environmentally friendly tourism as a guarantee of product quality. Legal and regulatory structures have been created, including planning plans for tourist areas, the implementation of which has enabled integrated tourism development based on the diversification of the offer and the development of new tourism niches: Saharan, sports, cultural, ecological, etc. The implementation of the strategy for the protection of the marine and coastal environment has led to the strengthening of the legislative and institutional framework in these areas.

The objectives of the strategy are:

- i. ensuring the protection of marine environments and species in order to ensure ecological balance; in particular by establishing the legal and institutional framework for the creation of protected marine areas in Tunisia (Framework Law “Marine Protected Areas”).
- ii. Contribute to the sustainable development of coastal areas, in particular through the controlled development of ecotourism.
- iii. Contribute to raising public awareness of the protection of biodiversity.
- iv. Ensuring ecological continuity between waterways and restoring broken connections.
- v. Reduce pressures that threaten biodiversity and ecosystem sustainability, including coastal water pollution and over-exploitation of fisheries resources.
- vi. Requalify and preserve wetlands.

## **VI.7.Recommendations and Guidelines for Involving Tourists in citizen Science Activities in Sousse**

By implementing recommendations and guidelines, Sousse can successfully involve tourists in citizen science activities, fostering a sense of environmental stewardship and contributing to the sustainable management of its coastal ecosystems.

### **VI.7.1.Awareness Campaigns:**

Launch educational campaigns highlighting the importance of coastal ecosystem conservation and the role of citizen science. Create informative brochures, posters, and digital content that explain how tourists can actively contribute to scientific initiatives.

### **VI.7.2. User-Friendly Mobile Applications**

Develop user-friendly mobile applications that enable tourists to easily report observations of coastal flora, fauna, and environmental changes.

Provide step-by-step instructions for data collection and submission.

### **VI.7.3. Guided Tours with a Purpose**

Offer guided eco-tours led by trained guides who educate tourists about the local ecosystem and involve them in data collection efforts.

Integrate citizen science tasks within guided tours, making the experience both educational and participatory.

### **VI.7.4.Citizen Science Stations**

Set up designated areas at tourist information centers or key sites where tourists can access information about ongoing citizen science projects.

Provide materials like binoculars, field guides, and data sheets for tourists to contribute to data collection.

### **VI.7.5.Collaborative Partnerships**

Collaborate with local schools, universities, and research institutions to design citizen science programs that involve tourists, researchers, and students.

### **VI.7.6.Collaborative Partnerships**

Create an online platform or social media group where tourists can share their observations, photographs, and experiences, fostering a sense of community and collaboration.



## VII. Protected ecosystem services for coastal tourism in Sousse

### VII.1. Protected ecosystem services for coastal tourism in Sousse

Paradoxically, natural ecosystems and biological resources that can be threatened by the development of tourism, provide the same goods and services that are at the origin of this industry (Plan stratégique de développement de la ville de Sousse, 2014).

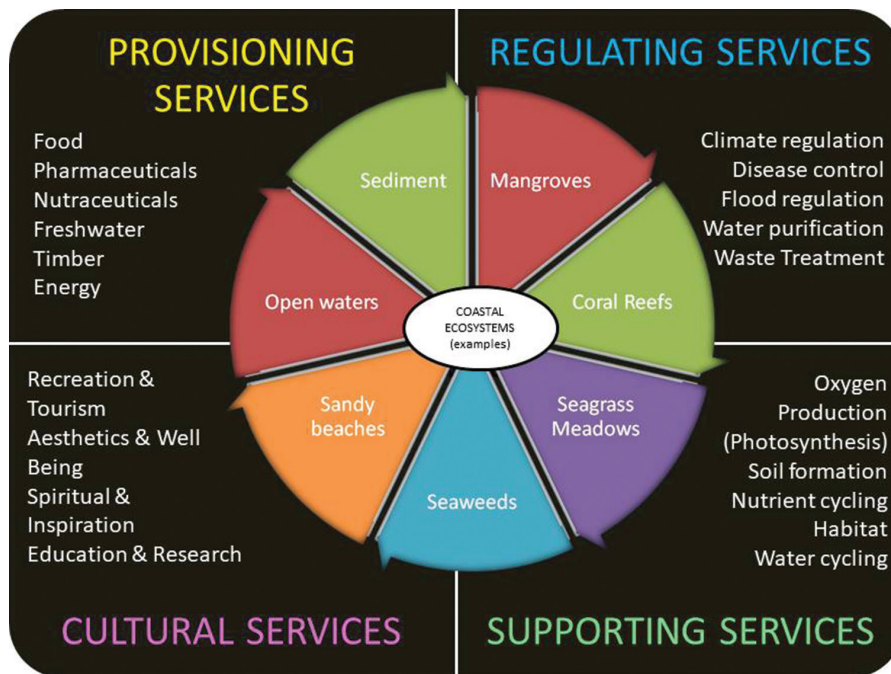
Ecosystems are defined as dynamic complexes of plant, animal and micro-organism communities and the nonliving environment, interacting as a functional unit.

A large number of goods and services are provided by ecosystems. Some of these goods are easily recognized while the recognition for many others which are relatively less apparent has come over time. The former include food, timber and freshwater while the latter include varied services ranging from pollination to disease control and climate regulation.

The list of services that ecosystems provide can be long and confusing and hence, for meaningful understanding, they need to be classified (Figure 13).

The Millennium Ecosystem Assessment (MEA) describes ecosystem services as the benefits people obtain from ecosystems and categorized the various services from ecosystems into four major groups (Secrétariat de la Convention sur la Diversité Biologique, 2004). provisioning services: fisheries, building materials.

- Supporting services: life-cycle maintenance for both fauna and local, element and nutrient cycling.
- Regulating services: carbon sequestration and storage, erosion prevention, waste-water treatment, moderation of extreme events.
- Cultural services: tourism, recreational, aesthetic, and spiritual benefits.



**Figure 13.** Ecosystem Services provided by Coastal Ecosystems.

## VII.2. Aspects related to the protection of ecosystems and the development of sustainable tourism in Sousse

### VII.2.1. Recommendations for ecosystem protection

- *Creation of Marine Reserves AND Sustainable Fisheries Regulations* Establish marine protected areas where human activities are limited to protect marine biodiversity and coastal habitats. Furthermore, fisheries quotas, minimum sizes and closure seasons must be established to preserve fish stocks.
- *Habitat Restoration* Engage coastal habitat restoration projects such as mangroves and sand dunes to enhance ecosystem resilience.
- *Sensitive Zones Management* Identify and protect important breeding and feeding areas for marine species in order to maintain food chains.
- *Pollution Reduction* Implement measures to minimize spills of waste, sewage and harmful chemicals into coastal areas.

## VII.2.2. Aspects related to the protection of ecosystems and the development of sustainable tourism in Sousse

In Sousse, the protection of coastal ecosystems is closely linked to the development of sustainable tourism. Efforts to preserve fragile ecosystems while promoting responsible tourism are at the heart of coastal integrated management strategies.

- *Eco-tourism*: Promote ecotourism activities that raise visitor awareness of environmental conservation and local culture.
- *Sustainable Infrastructure*: Encourage the construction of environmentally friendly tourist infrastructures, such as energy-efficient buildings and waste management systems.
- *Tourist Education*: Sensitizing tourists to good environmental practices, including waste reduction and ecosystem protection.
- *Tourist Flow Management*: Establish capacity limits for sensitive tourist sites to minimize the impact of overcrowding.
- *Community Participation*: Engage local communities in tourism planning and management to ensure that the benefits benefit residents.
- *Promoting Responsible Tourism*: Promote sustainable tourism initiatives and encourage visitors to choose environmentally friendly experiences.

## VII.2.3. Integration of Approches

The protection of coastal ecosystems and the development of sustainable tourism in Sousse are interdependent. Sustainable ecosystem management practices guarantee authentic tourist experiences and preserve the resources that attract visitors. By integrating ecosystem protection measures into tourism planning, Sousse can offer attractive destinations while ensuring the sustainability of its natural resources for future generations.

## VIII. Blue Economy and Ecosystem protection

Tourism is a vital economic source in the Mediterranean basin. The sun and beach tourists are of major social and economic importance for almost all Mediterranean countries. However, this industry's extensive and uncontrolled growth may negatively impact these fragile natural coastline areas.

### VIII.1. Blue Economy, Ecosystem protection and management in relation to coastal Tourism

The blue economy entails economic activities that create sustainable wealth from the ocean and coasts (MICBE, 2022), and encompasses three related but different meanings (Lakshmi, 2021):

- i) the need to address the environmental and ecological sustainability of the ocean
- ii) the overall contribution of the ocean to economies
- iii) The ocean economy as a growth opportunity for developed and developing nations.

The 2015 Ministerial Declaration on Blue Economy defines the blue economy as human activities involving sea-based interactions for sustainable development, including aquaculture, fisheries, blue biotechnologies, coastal and maritime tourism, shipping, ship-building, ports, ocean energy, and marine renewable energy. This broad term raises questions about which ocean-based industries can be considered “Blue” for producing socioeconomic benefits from sustainable marine ecosystem exploitation. The coastal tourism sector is also included in the blue economy. The UfM Ministerial Declaration on Sustainable Blue Economy emphasizes the importance of preserved marine ecosystems and marine cultural heritage in coastal areas. Eco-tourism market

Nature-based tourism, or eco-tourism, is a growing market located in or near Protected Areas (PAs). According to UNWTO's definition, ecotourism refers to forms of tourism such as nature-based forms of tourism in which the main motivation of the tourists is the observation and appreciation of nature as well as the traditional cultures prevailing in natural areas. It also contributes to minimising negative impacts on the natural and socio-cultural environment and supporting the preservation of natural areas which are used for ecotourism. It involves travelling to preserved destinations where the fauna, flora, and cultural heritage are the centre of attractions. The Mediterranean Sea, covered by 8.33% of Marine Protected Areas (MPAs), is a hotspot for Nature-based tourism. According to a recent European survey, 43% of the tourists' searches are for 'natural environment in the destination. Recent regional initiatives, such as the Mediterranean

Eco-tourism Network (MEET) and the DESTIMED PLUS project actively promotes high-quality ecotourism experiences that benefit conservation and local communities.

## VIII.2. Blue Economy and Ecosystem protection in Sousse

In Sousse 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 elaboration of a management plan. This management plan has, therefore, been developed as part of a consultation process according to the principles of the EAF approach. A second step is the creation of a Technical Monitoring and Consultation Committee (TMCC) of the MP of Sousse 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).

In addition, The **Project Eco-Blue Challenge 2021** in Sousse consists of innovative initiatives on the blue economy. The project aims to organize the traditional fishing (valorisation of this unique heritage in the Mediterranean) and determine the relationship between the Blue tourism and the Aquaculture: fish, crustaceans, sea cucumbers, algae, etc. (Plan Bleu, 2022).

## IX. Conclusions

The protection of biodiversity is a major issue at the national and international level. This paper highlights that continuing human activities growth and tourism in the first place, plays a substantial role in biodiversity loss and ecosystems change. Coastal and marine ecosystems deliver a wide range of goods and services, many of which provide material benefits such as food supply, regulation of water-quality processes, storm protection and carbon storage. The pressure of the population on the coastline in Sousse has changed the functioning of the coastal system. The establishment of recreational ports and tourist facilities damaged the quotas in Sousse. On the biological level, plant and animal life forms are regulated mainly by the seasonal evolution of tourist attendance. In fact, and during the summer season, the low hydrodynamics of the marine waters and the overcrowding of tourism generate a development of pollution sentinels. Thus, it seems that the demographic disturbances of the plant and animal populations of the Sousse area are correlated with organic pollution of the water mass which amplifies in the absence of major tide currents and to the disruption of ecosystems. The protection of Ecosystems in Tunisia in general and in Sousse in particular, is provided by a fairly large legal arsenal, which includes Laws, decrees and codes. This role urgently needs more attention in scientific, policy and public circles.

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