

# Coastal Protection Measures in Tourist Areas

Sousse Scale, Tunisia





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

### Coastal protection measures in tourist areas

Sousse scale, Tunisia



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## OVERVIEW

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## REVIEW

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## List of abbreviations

**ANPE:** National Agency for Environment Protection

**APAL:** Coastal Protection and Planning Agency

**CCC:** Convention on Climate Change

**GIZ:** German Technical Cooperation

**GODEM:** Green Waste Management and Construction Waste

**IEVP:** European Neighbourhood and Partnership Instrument

**KfW :** Kreditanstalt für Wiederaufbau

**NSCC:** National Strategy on Climate Change

**NW-SE:** North West South East

**ONTT:** Tunisian National Tourist Office

**OTEDD:** Tunisian Observatory of Environment and Sustainable Development

**PNUD:** United Nations Development Program

**RN:** National Road

**SONEDE:** National Company of Water Exploitation and Distribution

**STEG:** Tunisian Company of Electricity and Gas

## Abstract

The Tunisian coastline, including the Grand Sousse region, faces severe pressures that threaten its natural resources and sustainability. The geomorphological potential of the region has been a source of economic growth, but in the same time is often imposing anthropogenic constraints and threats on region. The tourism sector has significantly impacted the environment, the economy, and the society in the Grand Sousse region. Massive urbanization and the intense occupation of tourist facilities has caused the almost complete destruction of the coastline, with a restriction of the width of the beaches to less than 10 meters in some places (compared to 20 to 100 meters further north of the Grand Sousse region). Therefore, good environmental governance is essential, and the implementation of environmental protection measures is a priority for the Grand Sousse region. The main objectives of this report are to monitor the marine and coastal environment in Sousse, identify environmental risks and threats, and report the approaches and measures used for managing and protecting the coastline in tourist areas. The report covers coastal morpho-dynamics, development impacts on coastal stability, coastal protection measures, and sustainable Coastal/Maritime Tourism in Sousse.



## I. Introduction

The Tunisian coastline, which is home to 76% of the population, 87% of the industrial activity and 80% of the tourist activity, is subjected to severe pressures that jeopardize the rational management of its natural resources and consequently its sustainability. The Tunisian coastline is also subjected to risks associated with climate change, in particular, the accelerated sea level rise.

One of the most significant agricultural and tourism regions in the Tunisian coastline is the Tunisian Sahel, particularly the Grand Sousse region. The environmental context of the region of Sousse is paradoxical. The multiple geological and geomorphological climate potentials have fostered the development of the region and have been the source of a concentration of people, activities and wealth for a long history. These potentialities, so beneficial for the socio-economic development of the region, are in contrary; impose anthropogenic constraints on the region. These human constraints weigh on an already vulnerable environment, with respect to modes of exploitation that do not always respect the limits of tolerance. Indeed, the geomorphological environment manifests a particular vulnerability to erosion, especially coastal.

With the excessive development of tourism infrastructure over the past decade in Sousse region, it is recommended to adopt a proactive strategy that allows to optimize the exploitation of natural resources, to promote sustainable economic and social development without damaging the environment, having already experienced a high level of vulnerability. Faced with the complexity and transversality of these current and projected issues, good environmental governance is imperative. The implementation of a strategy of environmental protection measures is therefore an absolute priority for the Grand Sousse region.

This is the aim of this work which is to release the effects of climate change on 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 main objectives of this report are then; the monitoring of the state of the marine and coastal environment in Sousse, in an approach based on the identification and assessment of environmental risks and threats to tourism, as well as the report of approaches and measures used for the management and the protection of the coastline in the tourist areas of Sousse.

This report will cover the following parts:

- Coastal morpho-dynamics in Sousse (General description, trend and factors).
- Coastal and Maritime Tourism development impacts on coastal stability.
- Coastal protection measures and their effects on coastal and Maritime Tourism in Sousse.
- Blue Economy and Coastal protection measures and sustainable Coastal/ Maritime Tourism in Sousse.

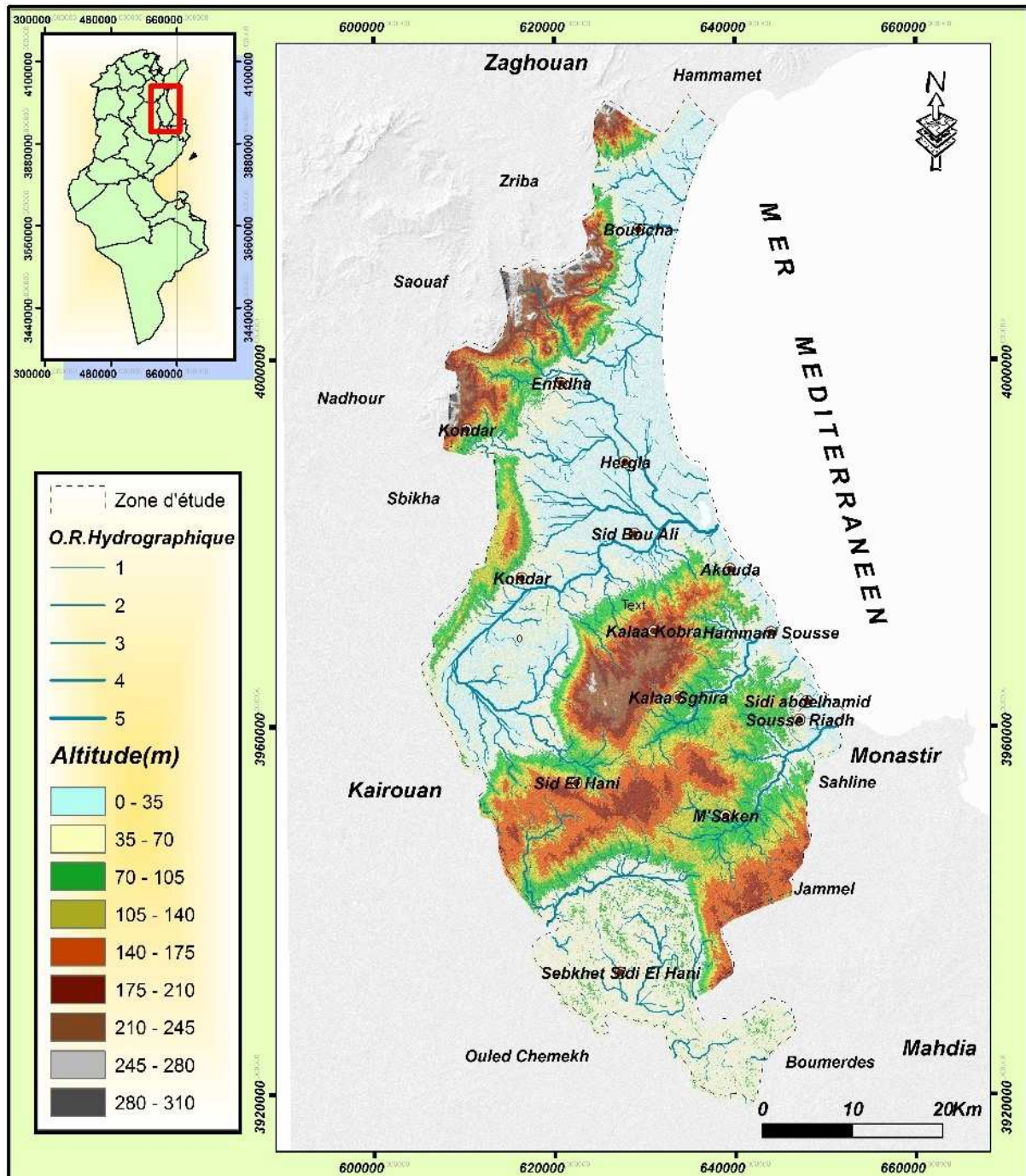
## II. Coastal morpho-dynamics in Sousse

The Sousse's coastal is part of the eastern coast of Tunisia. It is located at the junction between the Gulf of Hammamet and the mega promontory of the Sahel. From a configuration point of view, it shows a more or less regular NW-SE direction to the north of Sousse and then it curves to the south, where one recognizes successively the bay of Dkhila and the peninsula of Monastir.

### II.1. Nearly uniform geomorphological characteristics

#### II.1.1. A near flat territory surrounded by hills

The Grand Sousse is part of the region of the Sahel and the Tunisian Low Steppes. The natural region is bordered to the north by the southeastern fortresses of the eastern dorsale which it connects further north to the Highlands of Zaghouanais as well as through the Peninsula of Cape Bon. From the west coast, it is delimited by the meridian chain M'nara-Touila also known as it is called the "North-South axis" and opens on the Mediterranean of the eastern coast (Figure 1).



**Figure 1.** Hypsometric map of the Grand Sousse region(Elouardani, 2020).

### II.1.2. A land “sunk” by detritious deposits

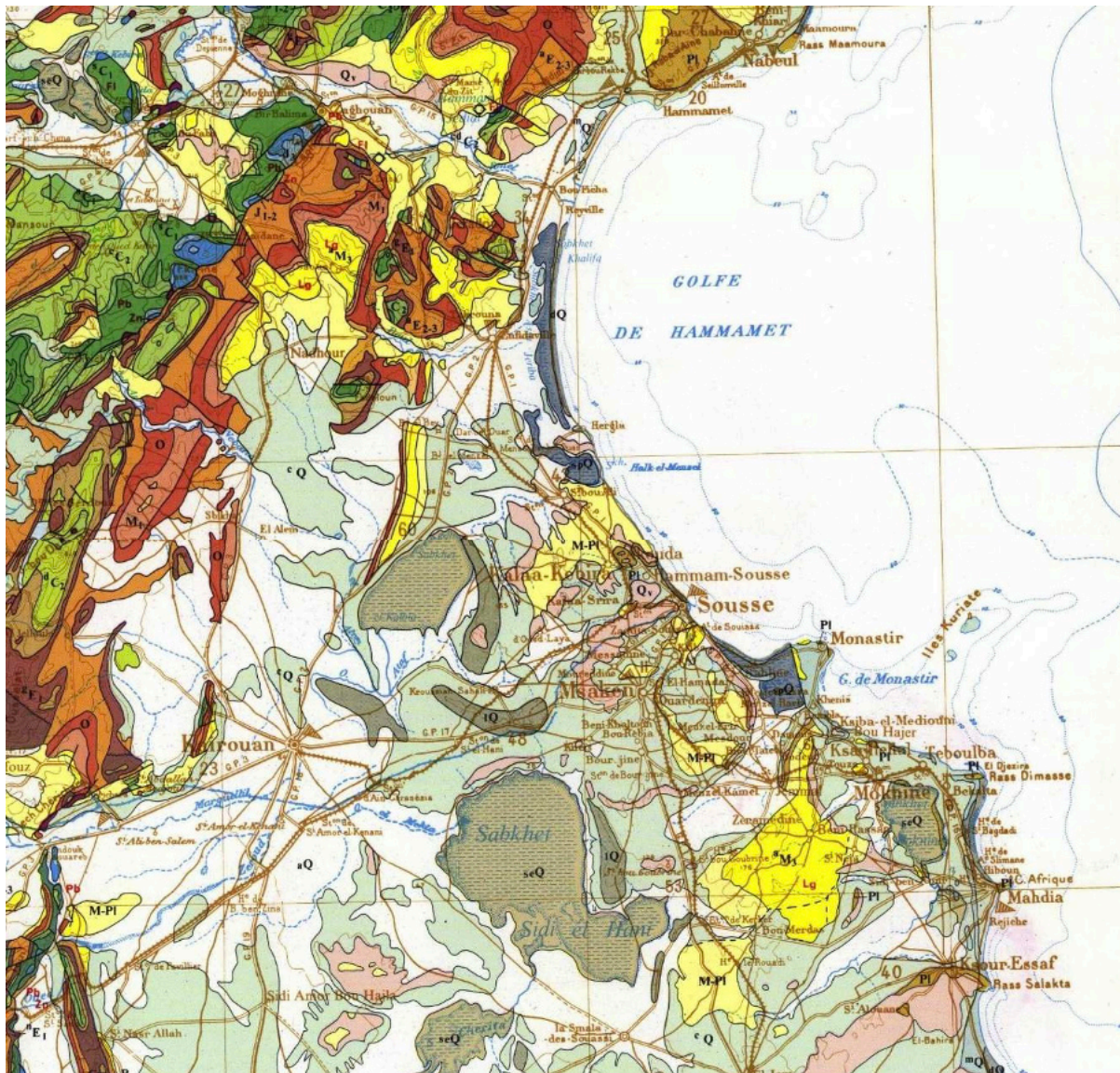
The entire Sahel region, correspond to a vast area. It has been in existence since the Miocene. This is what explains the enormous mass of detritious deposits that have accumulated there accelerating this renewal movement (Figure 2).

Despite the absence of resistant rocks, the main reliefs are in accordance with the structure. This correspondence is explained by the recent three tectonic movements that have the conflict in the Sahel region continued until the post-Tyrrhenian period (Elouardani, 2020).

In short, the following succession is distinguished from the north to the south:

- The Synclinal of El Kalbyya Sebkha.
- The Anticlinal of Kalaa Kebira.
- The synclinal valley of the Leya. Oued.
- The anticlinal dome of Ouerdanine.
- The synclinal pit of Menzel Kamel-Jammel.
- The anticlinal dome of Zermdine.
- The synchrony of El-Jem and Rejiche.





**Figure 2:** Geological map of northeastern Tunisia and the Grand Sousse (Source: Geological Service of Tunisia (Map 1/500000)) (Elouardani, 2020).

## II.2. Geomorphological dynamics

### II.2.1. Dynamics of the Monastir cliff

The Monastir cliff is undergoing a rapid and complex evolution. There are three types of processes involved in the natural dynamics of this cliff (Figure 3).

Eruptions affect the upper part of the cliff formed in the Tyrrhenian grass; they are functional there or fissures run through the top of the rock. They manifest themselves by the detachment of a few blocks of Tyrrhenian grass and their training at the foot of the cliff. Slides affect the cliff wall favored by a strong immersion of clay into water after

major and time-spread rainy episodes. They manifest themselves by the existence of niches and scratch scars as well as small packs of clay dragged down the cliff. Raining is favored by the predominance of tender clay rocks and rainfall that falls in the form of averse. They manifest themselves by the existence of many fairly deep ravines that affect the wall and top of the cliff. This work and deforestation action, were carried out during the 1960's to stabilize these ravines. In order to stabilize the wall of the cliff, large clogging work was carried out in two phases. The first operation dates back to the 1990's. It focused on the encroachment of a section about 900 m long located on the side of the Marina. The second was undertaken in 2014. It focused on the encroachment of a section of about 1 km long located in the extension of the first to the Ouest (APAL, 2018).



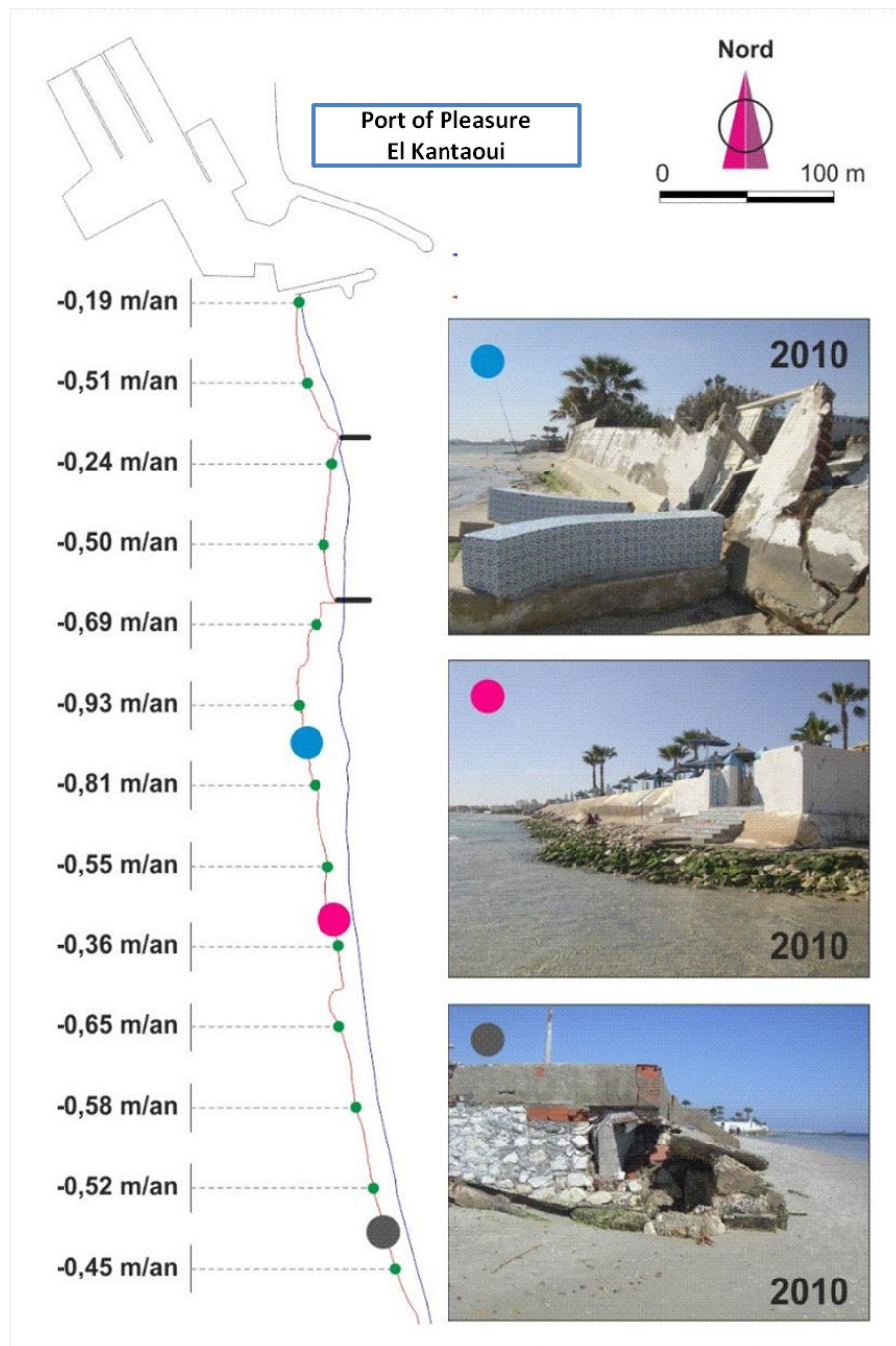
**Figure 3.** The cliff of Monastir carved in layers of clay and Miocene sand (Brahim, 2017).

### II.2.2. Dynamics of beaches

The coastal anthropisation and the recent invasion of the seafront by the settlements have largely influenced the dynamics of the sandy coast. The beaches almost everywhere have undergone sensitive changes. In some segments, if the beach enjoys certain stability such as the bottom of the bay of Dkhila or in Boujafar or also north of the recreational port of El Kantaoui, the border dune has, on the contrary, been obliterated by the embroderment of the buildings and gardens of hotels or the arrangement of the seaside promenades. In other segments, the beach experienced a sensitive downturn and erosion that also affected the seafront arrangements. The most serious situations

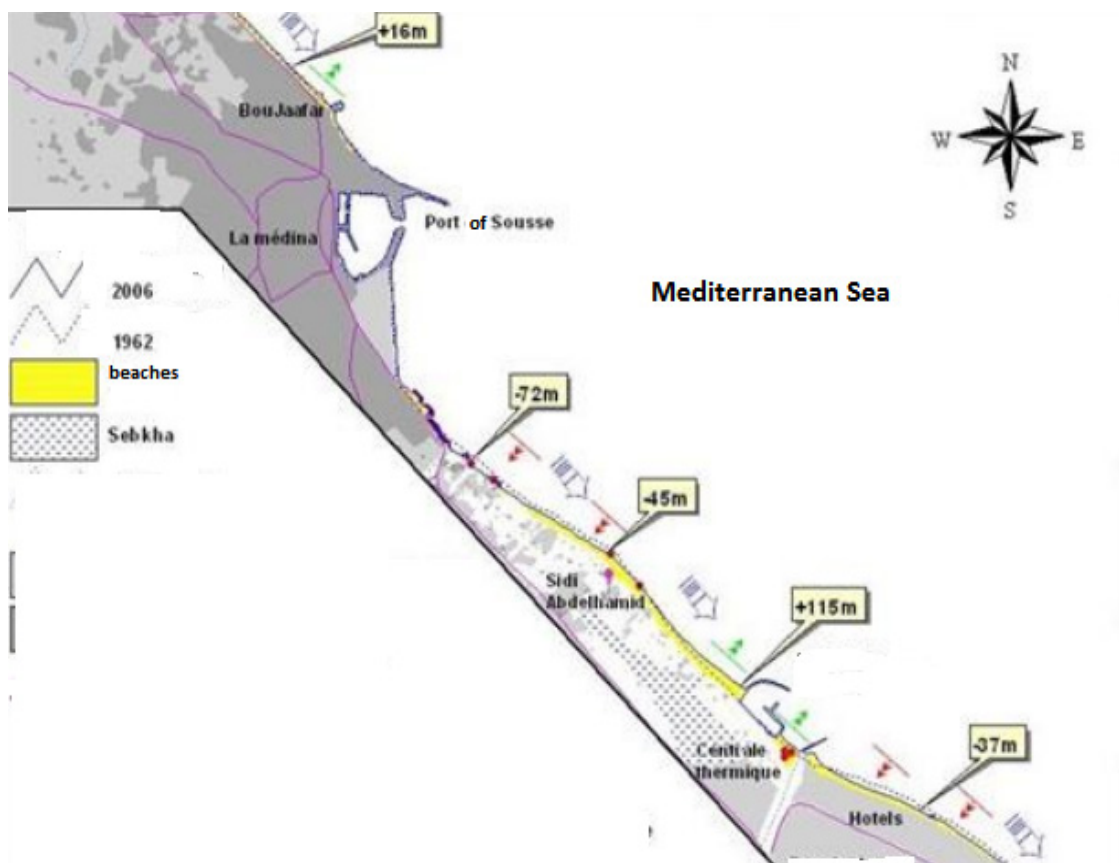


were caused by port arrangements due to the blockage of the longitudinal sedimentary transit by the jets, resulting in a significant erosion of the lower side of the coastal drift. In El Kantaoui, the erosion affects 1 km of coastal line south of the recreational port (Belhaj, 2004) and the annual downturn of the shoreline varies by place between 0.19 and 0.93 m/year (Figure 4) (Bada, 2016).



**Figure 4.** Evolution of the coastline south of the port of El Kantaoui (Bada, 2016).

This area is classified by the Coastal Protection and Planning Agency “APAL” as one of the areas requiring urgent protection intervention. South of the port of Sousse, precisely in the Gaïed Souassi district, the downturn reached locally 72m between 1962 and 2006 (Figure 5). To the south of the cooling basin of the STEG, it reached 37m. The erosion here affects the entire western part of the Dkhila tourist area (Figure 6 and Figure 7) (Elouardani, 2020).



**Figure 5.** Dynamics of the occupation of the coast and coastline in South Sousse between 1962 and 2006 (Brahim, 2017).





**Figure 6.** Erosion affecting beach and tourist facilities west of Dkhila Bay (Brahim, 2017).



**Figure 7.** Erosion affecting bungalows of a tourist unit in Dkhila (the situation in 2009) (Elouardani, 2020) .

Interventions by so-called heavy protection works were carried out in the 1990's and 2000's in several segments of the coast. (Figure 8) and . These works saved the arrangements but they denatured the sites of sandy beaches and sometimes aggravated the situation in the segments located more downstream; such is the case in the south of the commercial port of Sousse where the implantation of the breezes accelerated the erosion of the beach of the Gaïed Souassi neighborhood or also the case to the South of the port of El Kantaoui where the installation of spices accelerates the erosion further south.



**Figure 8.** Impact of ElKantaoui port planning on the southern sector (Brahim, 2017).

### III. Coastal and Maritime Tourism development impacts on coastal stability

Its geographical location, natural wealth and socio-cultural heritage give Tunisia certain assets in the field of tourism. Tourism development policy continued for more than three decades has allowed Tunisia to access a privileged place in the Mediterranean. In fact, Tunisia, with a capacity of 157,999 beds in 2021, makes revenue of the order of 2.286.1 million dinars, and receives 2,475,430 visitors for more than 8,077,345 nights in 2021 (ONTT,2022). These achievements have enabled tourism to become an important sector of the economy, due to the importance of tourism revenues in the balance sheet of payments, the direct and indirect employment created and the induced effects of tourist activity on the remaining economy. However, the development of tourism activity may be accompanied by environmental and social externalities that could affect the stability of coasts as well as the sustainability of the sector.

#### III-1- Coastal and Maritime Tourism in Sousse

Grand Sousse has a fairly large and developed hotel infrastructure with a large reception capacity and diversified leisure and entertainment facilities. The tourist area Sousse El Kantaoui represents 12.5% of the total number of establishments in the country with 67 hotel units in 2018.

The accommodation capacity of the Sousse El Kantaoui area has grown over time to be in second place, with the tourist area Nabeul-Hammamet (17% of the national total in 2018). In 2018, the tourist area of Sousse is also in second place after the touristic area of Djerba-Zarzis in terms of number of overnight stays with a growth rate of 19.6% compared to 2017. In 2019, the region of Sousse increased by 16.2% in terms of overnight stays but to a lesser extent compared to the most attractive regions, namely Yasmine-Hammamet, with an increase of 20.5% and Monastir-Skanes (+19.6%). The hotel units of the Grand Sousse are divided between the tourist areas of Sousse Medina (39 units in 2018 against 48 in 2010), Sousse El Kantaoui (25 units in 2018 and 2010) and Chott Mariem and Hergla (3 units in 2018 and 2010). The majority of these hotels are 5 and 4 stars categories, or 57% of the total hotels in the region.

In 2019, the territory of the Grand Sousse welcomes 1,310,000 tourists who spend 5,810,000 nights. The development of the tourism sector in the Grand Sousse territory is contrasted between 2010 and 2019. In fact, while the number of tourists visiting the region has increased by more than 20% in 9 years, that of nights spent by these tourists has decreased by over 20% (Halioui et al.,2016).

## III.2. Coastal and Maritime Tourism development impacts on coastal stability

### III.2.1. Marine erosion and expansion of beaches

Mass tourism has caused an environmental crisis. The first hotels built on the DPM and port facilities were responsible for the erosion of several beaches, which form the basis for the development of beach tourism. This phenomenon occurs in many tourist areas (Brahim, 2020). Thus, in the absence of good environmental governance, mass tourism generates pollution that directly affects the places of tourist practices (Hellal, 2021).

In Sousse, there has been an accentuation of sand accumulation and an expansion of the beaches north of the harbor. On the other hand, south of the port slope and as a result of the sub-saturation of the coastal drift in sediments, marine erosion has become active, severe manifestations of depletion are recorded in front of the Hannibal Hotel. The rate of decline was estimated at -7m/year.

After the confection of two spices in front of the Hannibal Hotel, an aggravation of the manifestations of imbalance on the beaches of the southern sector was recorded (APAL, 2001). The close position of these spices to the southern stream of the port did not favor the natural recharge process. It has, on the contrary, accentuated the sedimentary deficit of the southern beaches. Their balance was once, thanks to the work of raising and biological fixation of the border dune, carried out by the peasantry to protect their Oulja lands from the intrusions of marine waters and saltwater. Now that balance is finally broken. The fencing of hotels and secondary residences that occupy the top of the beach disrupt sedimentary exchanges and accentuate the beach imbalance. From 1996 to the summer of 2004 and on a linear 833m south of the port of El Kantaoui, the lost beach area reached 45,000 m<sup>2</sup>. The rate of decline is estimated at -6m/year (APAL, 2018).

On the coastline of Sousse ElKantaoui, anthropological interventions and until the early 1970's had enabled the maintenance of the balance of the coastal system; but from 1975 date of the start of the construction of the tourist resort and the recreational port, the functioning of the morphogenic and biological processes has profoundly changed. Human activities have become decisive in the space-time evolution of this coastline. Indeed, the destruction of border dunes by port, hotel and urban arrangements and the protection work against the manifestations of flood risk significantly reduced the sedimentary budget and disrupted the dynamics of the beach and dunes on this coastline. The coastal linear of Sousse ElKantaoui, then evolved in response to hydrodynamic changes induced by expansions and arrangements related to tourism development. In addition to the recreational port, established in 1975 on an entirely sandy coast where an active and one-way coastal drift dominates, tourist units and private residences have taken place across the seafront in the form of a more or less continuous strip. These arrangements are accompanied by numerous public and private services activities. These changes led to the reduction in the supply of sand to the beach.



We have moved from a first generation of hotels, in a position on the seafront, to a second generation of second and third position hotels for which new hallways have been opened to access the shores. The analysis of the occupation map shows that the entire strip, between the tourist road and the coastal strip, has become an arranged and built space. This tourist enhancement of the coast has resulted in disruption of coastal transit and disturbance of sediment exchanges between the upper and lower beaches. The corollary effects of this dynamic were a modification of the active processes on this coastal linear; so the phenomena of ablation and retreat of the beaches took the place of those of transit and accumulation. The manifestations of precarious balance are by the preservation of the border dune by the work of the local peasantry aimed at both limiting the effects of winds loaded with sand and swamp and the penetration of marine waters are broken (APAL, 2001).

### III.2.2. Pollution of marine waters

In addition to the problems of severe and irreversible marine erosion, this coast has experienced for several years a pollution of marine waters directly related to human activity as emission of pollutants and poorly managed arrangements (APAL, 2001). By causing the degradation of grasslands, this pollution increases wave energy and makes coastal ecosystems even more fragile.

Few large hotel complexes have set up waste sorting systems. Pollution also affects the beaches that constitute the base of beach tourism. However, there are several actors involved in the cleaning of the beaches: the “APAL” (Littoral Protection and Planning Agency), the ONTT, municipalities and civil society during its major campaigns. An environmental policy was launched on June 13, 2017. Some of its agents are assigned to the surveillance of the beaches, and their mission is to verbalize those who throw waste on the public road. But until then, this police remains ineffective in combating pollution that affects all public spaces that are naturally places of tourist practices (APAL, 2018).

In recent years, APAL has become more dynamic and effective in verbalizing and punishing construction offenses on the coast. These efforts were accompanied by beach cleaning campaigns involving citizens and associations.

Finally, the crisis of the tourism system in Tunisia has multiple dimensions: economic, social, territorial and social. Thus, given its importance in the national economy, Tunisian tourism is forced to become more environmentally, socially and spatially sustainable. In the face of this challenge, sustainable tourism presents itself as an alternative to mass tourism.

## **IV. Coastal protection measures in Sousse and effects on coastal Tourism**

### **IV.1. National sectoral strategies**

Tunisia has developed several studies and national strategies related to the phenomenon of climate change (Touzi et al., 2015).

#### **IV.1.1. National Strategy for the Adaptation of the Tunisian Coast to the Effects of Climate Change (2012)**

The strategy was implemented by the Ministry of Environment and Sustainable Development with the support of the German Technical Cooperation GIZ as part of the Project on the Implementation of the United Nations Framework Convention on Climate Change (Project CCC/GIZ). The strategy aims the establishing of a common national vision on this phenomenon and a coherence of the multiple sectoral approaches undertaken in Tunisia. The final version was developed with the aim of strengthening national coastal protection strategies, creating a comprehensive strategic framework for interventions and defining a priority action plan.

#### **IV.1.2. Map of the vulnerability of the Tunisian coast to rising sea level due to climate change (2012)**

This study was developed as part of a partnership between APAL and UNDP under Africa's Global Programme for Adaptation to Climate Change. It helped to evaluate the impact of sea level rise on the Tunisian coasts and to develop a map of the vulnerability of Tunisia's coasts to sea levels rise.

#### **IV.1. 3. The Coastal Resilience Project (2015 - 2020)**

The project was created by APAL in collaboration with PNUD in order to promote the technology adaptation strategies and innovative financing options to address climate change-induced risks to populations and key socio-economic sectors in Tunisia's most vulnerable coastal areas.

#### **IV.1. 4. Tunisian Study of the environmental and socio-economic vulnerability to sea level rise**

This study was prepared by the Ministry of Environment and Sustainable Development in 2007. The results of this study focus on the analysis, classification and quantification of different types of natural forms based on their current vulnerability to sea level rise.

## IV.1. 5. National Strategy for the Adaptation of the Agricultural Sector to climate change

This strategy was developed in response to the exceptional drought period in Tunisia between 1999 and 2001. It refers to agricultural areas located on the country's coastline.

### IV.1.6. Tunisian European study on the environmental profile in (2012)

The study highlighted the deficit of governance on climate change despite the inclusion of climate changes in the various work made possible by the recommendations of various international agreements and conventions on Climate Change and mainly the UNFCCC.

## IV.2. Coastal protection measures in Sousse

### IV.2.1. Coastal protection against erosion; El Kantaoui and Hergla section to Sousse port)

The first attempts to combat the erosion of the beaches in Sousse began in the 1980's through private initiatives. In front of the Hannibal Hotel, where the natural beach eventually disappeared (Mrabet et al., 1999), a spy system was installed and artificial recharges in rough sands were operated (Oueslati, 1993) (Figure 9 and Figure10).



**Figure 9.** Establishment of a clogging work to protect the arrangements affected by erosion (2015) (Brahim, 2017).



**Figure 10.** Spikes and crashes implanted south of ElKantaoui (Brahim, 2017).

These solutions enabled the provisional stabilization of the range without limiting the consequences due to the port's deployment and the interception of the sedimentary load by its protective jets. The extent of this erosion is also materialized by the flooding of the foundations of the walls of private properties located on the edge of the sea on the maritime public domain. This state of degradation has denatured the coastal landscape of the beach of Sousse el Kantaoui (Elouardani, 2020).

Recently, and in the face of the regressive evolution of the coastal dunes in the Grand Sousse region, praiseful efforts have been undertaken by the APAL to protect this so vulnerable coastline. In fact, a project was implemented within the framework of the Tunisian-German partnership, with a donation of 12.2 million dinars from the German bank for the development of KFW, covering 75% of the total cost of the project (Elouardani, 2020).

These works enabled, in the first phase, the creation of two rocky dugs in El Madfoun (delegation of Hergla) over a length of 430 meters and at the level of Montazah Hergla over a Length of 485 meters, as well as the establishment of a breaker on a distance of 150 meters.

The work also allowed the restoration of the beach in El Menchia and Khezama on 4 to 20 m, thanks to the installation of four diving breakers, 250 m long each, in Hammam Sousse and rocky dams on 100 m long at the beach of Hadrumet in Sousse-City. Wind breaks for the fixation of the dunes are also programmed at the level of the beach of El Madfoun over a length of 400 meters and 3 wind breaks at Chott Meriem, each of a longness of 200 meters (Elouardani, 2020).



### IV.2.2. Coastal protection against flooding in the Sousse-Nord area

A study on the protection of the northern subsoil city from flooding (Uni Conseil, 2006), was approved by the Directorate of Urban Hydraulics in 2006. This study suggests taking into account:

- A 50-year return period for the recalibration or bed covering of the important woods: oued Blibene, oued Kharroub and oued Chaabat Essandouk.
- A 50-year return period for the dimensioning of belt dugs and channels. This is the case with the proposed belt along the deviation of the national road RN1. This level of protection is necessary due to the risk that such works would present in the event of malfunction or breakdown.
- A return period of 20 years for collectors and purely urban works located in slopes or urbanization is already stabilized or called not much to evolve in the future.

### IV.2.3. Program for the Protection of the Tunisian Coast (PPTC) in North Sousse

This programme, which is under way, aims to protect 4.5 km of coastline in Sousse Nord from marine erosion and submersion for 4 locations by immersed blade winds and knives. The Tunisian coastal protection and planning agency (APAL) carried out the planning and protection work of the beaches of Sousse-Nord by carrying out four breakouts between 2017 and 2018. This is the second phase of a project launched in October 2016 with the realization, for the first phase, of a rock barrier of 100 meters long and three submerged wave breaks, of 200 meters each, to protect the coastline of the Chott Meriem area. At the same time, four wind winds are being constructed, over a length of 400 meters, for the fixation of sand dunes on the beach of El Medfoun where a 150-metre submerged wave wind is already operational, in addition to two other winds at the level of the southern beach of Hergla. This project, is financed by the German reconstruction bank of a value of 4 million euros.



**Figure 11.** Construction of breakwaters in North of Sousse.



**Figure 12.** Fixation of sand dunes on the beach of El Medfoun

#### **IV.2.4. Protection of the coastline and planning of the southern beach of the region of Sousse; IEVP Programme CT Mediterranean Basin 2007-2013**

The IEVP CT Mediterranean Basin Programme 2007-2013 is a multilateral cross-border cooperation initiative funded by the European Neighbourhood and Partnership Instrument. (IEVP). This programme aims to develop the city of Sousse through the protection of the coastline, the opening of the southern area to the sea and the development of leisure areas. The IEVP CT programme includes the development of a new beach occupation plan, the de-pollution of sea water and the construction of protection works, as well as the design of the seafront and the back beach located at the level of the southern zone of the region (Strategic Development Plan of the City of Sousse, 2014).

Table 1 summarizes all the Strategic Environmental Management Projects in Sousse.

**Table 1.** Strategic Environmental Management Projects.

Strategic Environmental Management Projects	
<b>Action plan 2015/2018</b>	<ul style="list-style-type: none"> <li>- Creation of a new beach occupation plan (POP)</li> <li>- Obtaining the Blue Flag</li> <li>- Dismantling and enhancement of the oed Hamdoun</li> <li>- Intervention Programme on the Blibene oed - Planning of the Sebkha of Sousse in a multi-thematic park</li> <li>- Rehabilitation of STEP Sousse Sud, STEP Hamdoun construction and mud management.</li> <li>- Pilot project for the collection and reuse of rainwater at the Olympic Stadium</li> <li>- Green Waste Management and Construction Waste (GODEM)</li> <li>- Establishment of a municipal waste management plan and organic waste management system (MED3R)</li> <li>- sorting, selective collection and recovery of organic and packaging waste.</li> <li>- Developing an Integrated Management Strategy for the Public Lighting Network</li> <li>- New criteria for building permits</li> <li>- Construction Project of the New Municipality (Better Service Organization / Zero CO<sub>2</sub> Building)</li> <li>- Pilot project for the establishment of an eco-school</li> <li>- Planning of the Hmedet Douik Park (Sahloul)</li> </ul>
<b>Current and Future Action Plan</b>	<ul style="list-style-type: none"> <li>- Protecting the Southern Coast</li> <li>- Northern Coast Protection Programme</li> <li>- Intervention program on the Sousse coast</li> <li>- Rainwater Management Programme</li> <li>- Development of a waste management monitoring and planning table</li> <li>- Establishment of Waste Exchange</li> <li>- Tri &amp; Valorisation of Building Waste</li> <li>- Support program for young entrepreneurs in the GDS sector</li> <li>- Telecommunication of the public lighting network - promotion of photovoltaics (Project CESMED) - Local Risk Management Policy</li> <li>- Preparation of an Environmental Code</li> <li>- Environmental Education Programme</li> <li>- Environmental management program for hotel and industrial units</li> <li>- Establishment of municipal environmental police.</li> </ul>



#### IV.2.5. Integrated Coastal Zone Management (GIZC)

This approach calls for coordinated management of the land, water, and natural resources along the coast. The (GIZC) seeks to strike a balance between economic growth, environmental protection, and social well-being. In order to ensure a long-term development, Sousse, the (GIZC) may involve cooperation between numerous parties, including local communities, government agencies, and the tourism industry.

#### IV.2.6. The “Welja” a Coastal Conservation Agriculture Doomed To Disappearance

These lands were cultivated by small farmers from Hammam Sousse, behind the coastal dunes. These cultivated land (30 to 40m wide and a hundred meters long) is separated from the sea by a coastal strip of dunes fixed and maintained by the farmers, because the sea can undo them in the event of a storm. Sand is brought to raise them in order to isolate the back of the dunes from the salty sea water. The sand of the cultivated land is amended with organic fertilizers which ensure the growth of the crops. As the slope is towards the sea, the infiltrated rainwater seeps down towards the sea. The water table is then only less than two meters from the surface. Inside, the weljas are organized in contiguous rectangles lined with cut palm fronds (about 60cm long) and erected, probably to trap wind-blown sand and to act as a windbreak against sea spray. A central or side corridor separates the two rows of squares (Kalboussi, 2021).



**Figure 13.** Structure of a welja cultivated in sousse.

### IV.3. Actions related to the protection of coastal areas, for the benefit of the tourism sector

In addition to these protective measures directly related to the coastal areas in Sousse, several national programs and projects are underway, integrating climate change into coastal management for the benefit of the tourism sector (Table 2) (Le littoral, 2022).

**Table 2.** Ongoing National projects, integrating climate change into coastal areas management.

Title	Objectives	Project manager	Situation
<b>African Programme for Adaptation to Climate Change “APA” (2008-2012)</b>	Develop a strategic approach to creating an environment that is conducive to information, decision-making and implementation of climate change adaptation in Africa.	APAL in collaboration with UNDP, UNIDO, UNICEF, OMS and the Government of Japan	Finished
<b>ClimVar Project: Integration of variability and climate change into national strategies</b>	<p>Promote the use of Integrated Coastal Zone Management (GIZC) to address the impacts of variability and climate change in coastal areas by integrating them into the GIZC process.</p> <p>Increasing knowledge on variability and climate change at the regional Mediterranean level.</p> <p>Strengthening partnerships and capacity building.</p> <p>The collection of data and the creation of the platform for the exchange of climate information.</p> <p>Development of capabilities for an operational GIZC.</p>	FEM.	Inprogress
<b>The Coastal Resilience Project (2015 - 2020)</b>	promote technology adaptation strategies and innovative financing options to address climate change-induced risks to populations and key socio-economic sectors in Tunisia's most vulnerable coastal areas.	APAL in collaboration with UNDP.	Finished

## IV.4. Approaches used for coastal management and planning in tourist areas in Sousse

An overview of the approaches used for coastal management and planning in Sousse's tourism zones is provided below.

### IV.4.1. Integrated coastal zone management (GIZC)

The integrated management of the land, sea, and natural resources along the coast is known as integrated coastal zone management (GISC). GISC seeks to strike a balance between social progress, environmental preservation, and economic growth. To achieve sustainable development in Sousse, ICZM may entail cooperation between numerous stakeholders, including governmental organizations, regional communities, and the tourism sector.

### IV.4.2. Ecosystem-Based Approach

This approach focuses on maintaining the health and integrity of coastal ecosystems as a foundation for sustainable development. In Sousse, protecting and restoring natural habitats like dunes, wetlands, and coral reefs can enhance the resilience of the coast against climate change and contribute to the tourism industry's long-term viability.

### IV.4.3. Strategic Planning

Strategic planning involves setting clear goals, priorities, and guidelines for coastal development. In Sousse, strategic plans may identify areas for urban growth, tourism facilities, and conservation zones. This approach ensures that development aligns with long-term sustainability objectives.

### IV.4.4. Public Participation

Involving local communities, residents, and stakeholders in decision-making processes is essential. Public participation ensures that the interests and concerns of various groups are considered, leading to more effective and widely accepted management strategies.

### IV.4.5. Regulatory Frameworks

Clear regulations and laws are put in place to guide coastal development. These frameworks set standards for construction, waste management, pollution control, and access to sensitive areas. In Sousse, regulatory frameworks contribute to maintaining the quality of the coastal environment.

#### IV.4.6. Capacity Building

Capacity building initiatives provide training and resources to local authorities, communities, and businesses to effectively manage the coast. This can include training in environmental monitoring, sustainable tourism practices, and disaster preparedness.

#### IV.4.7. Tourism Sustainable Practices

Promoting sustainable tourism practices among businesses and tourists can help minimize the impact on coastal areas. This involves encouraging responsible waste disposal, eco-friendly transportation, and respect for local cultures and ecosystems.

#### IV.4.8. Climate Adaptation Strategies

Given the potential impacts of climate change, Sousse may adopt strategies to adapt to rising sea levels, increased storm events, and coastal erosion. These strategies could involve beach nourishment, building setbacks, and nature-based solutions.

In conclusion, Sousse employs a combination of integrated approaches to manage and plan its coastal areas in tourist zones. By considering ecological, economic, and social factors, Sousse aims to achieve sustainable development that benefits both its coastal ecosystems and its tourism industry.

### IV.5. Risks of coastal protection measures and impacts on coastal tourism in Sousse

Coastal erosion, caused by storm frequency and sea level rise, threatens coastal economies and tourism services. To address this, various tourism-oriented interventions and protection measures, such as marinas, docking areas, seawalls, and beach nourishment, have been implemented. Beach nourishment is a viable approach to mitigate erosion and support beach recreation and tourism. Sousse's coastal intervention projects involve building new marinas, beach nourishment, and coastal protection measures (Alexandrakis et al., 2019).

Climate change significantly impacts the tourism industry, affecting season length, natural resource availability, and service quality. It also increases heat waves, flood risks, and coastal degradation, affecting tourists and destination image (Halioui et al., 2016).

Climate change has significant environmental and economic impacts, including heat waves, loss of sea ice, sea level rise, biodiversity, and water availability. The extent of climate change's effects varies across regions, and it significantly impacts the tourism industry. Tunisia's strategic geographical position, rich cultural heritage, and natural assets make it an attractive tourist destination. However, the country's vulnerability to climate change is also high, with global warming causing temperature increases and sea level rise. Tunisia is one of the most affected North African countries by global warming, with a high tourism potential but increased vulnerability to climate change.

The country's coastal infrastructure, mainly seaside tourism, increases its vulnerability to coastal erosion and sea level rise. The Vulnerability to Climate Change concept has been used in various areas to assess the vulnerability of the tourism sector to climate change (Halioui et al., 2016).

## IV.6. Risks of non-environmental sustainability

On the environmental level, certain risks of non-sustainability related to land use, and the use of resources (water and energy) are observed:

The concentration of tourist activity on the coast (85% of the hotel capacity and 92% of the nights) puts pressure on the shore in the form of erosion (Sousse, El kantaoui) and pollution of sea water. This poses a risk of non-sustainability of tourism activity and affects the long-term tourism competitiveness.

Climate change affects the beach tourism (rising sea levels and erosion of beaches) and the tourist activities carried out by visitors across the destination due to rising temperatures.

The beach nature of Tunisian tourism and its seasonal character exert pressure on natural resources, including water and energy. Water consumption, despite its decline in recent years as a result of the SONEDE pricing, remains far above Tunisia's strategic target of 300 liters per night.

Although it declined at the end of the period, energy consumption per night continued to rise over the period 1997-2006.

Within the framework of sustainable tourism development in Tunisia, the development of ecotourism remains at an embryonic stage. Despite the landscape and natural wealth of Tunisia and the establishment of several protected areas, ecotourism activity remains limited to researchers and assimilated to recreational activities by the national clientele (OTED, 2010)



## V. Blue Economy and Coastal protection measures

The Tunisian coast has a strong urban and tourist concentration: 65% of the urban agglomerations are located there (approximately 4.5 million inhabitants) and 95% of the hotel capacity (are for beaches. Almost all of Tunisia's industry is located in coastal areas. Heavy industries as well as most energy industries are concentrated on the coast. These industries are responsible for various pollution, especially on coastal sites in Sousse. The maritime economy brings together many sectors of activities related to the sea, mainly: fishing and aquaculture, maritime transport (including port activities), coastal tourism and oil and gas extraction at sea (World Bank, 2023).

In this context, it has become important for Tunisia to look at the concept of blue economy, which aims to promote economic growth, social inclusion and the preservation or improvement of livelihoods, while ensuring the sustainability of natural resources and ecosystem services, related to the sea and coast.

In fact, the blue economy refers to the disconnection between socio-economic development (through sectors and activities related to the sea and coastal areas) and the exploitation of natural resources and the degradation of the marine environment and ecosystems.

The blue economy would therefore be the decline of the concept of sustainable development at the level of maritime and coastal spaces. It is at the same time the declination of the concept of green economy in the seas and coastal areas, or to borrow the United Nations expression: "Green Economy in a Blue World" (a green economy within a blue world) (World Bank, 2022).

### V.1. Blue economy and environmental protection activities

These activities include: protection of posidonia herbs (which can contribute to carbon capture), conservation of biodiversity and protection of sensitive marine areas, protection and adaptation of the coastal area against erosion and sea level rise, depollution of contaminated marine and coastal sites, etc.

### V.2. Blue Economy Opportunities in Tunisia

In June 2022, and with support from the World Bank, Tunisia launched its first report on the status of the blue economy. The report, titled (*The Blue Economy in Tunisia: An Opportunity for Integrated and Sustainable Development of the Sea and Coastal Areas*), recommends initial guidelines for a national strategy in this area. Spearheaded by the Ministry of the Environment and the Secretariat General for Maritime Affairs, the report is the product of extensive consultation with stakeholders in the blue economy, including the public and private sectors, researchers, and various civil society organizations.

## V.3. Blue Economy in Sousse

### V.3.1. Project Eco-Blue Challenge 2021 in Sousse

The University of Sousse (USo), with the support of the Ministry of Higher Education and Scientific Research, is piloting a national project on innovation in the socially responsible blue economy. Within the framework of its PAQ DGSU UniSoR (Socially Responsible University), the USo through its Research and Innovation Support Unit (UDARI) the project consists of innovative initiatives on the blue economy: - Shipbuilding and maritime transport, - Marine energies: wind, tide, etc. - Marine biotechnology and human health, - Traditional fishing (valorisation of this unique heritage in the Mediterranean), - Blue tourism, - Aquaculture: fish, crustaceans, sea cucumbers, algae, etc.. These axes correspond to the potential that Tunisia has.

### V.3.2. Forum for the Mediterranean Blue Economy

**The first Mediterranean Forum for the Solidarity Blue Economy will take place at the Faculty of Medicine and the Socio-Scientific Complex of Sousse in Tunisia on 26-27 November 2021**

### V.3.3. Membership of the municipality of Sousse in the international program “Blue Flag” reserved for beaches.

To promote the image of the city as a tourist destination and to value the beaches, obtaining the Blue Flag label becomes a major challenge. The actors involved would be: the municipality of Sousse with the support of APAL.

## VI. Conclusions

The coasts of the Gulf of Hammamet and the Sahel of Sousse concentrate half of the country's tourist capacity. They suffer from places of serious damage to the environment and show signs of precarious balance of the coastline (process of erosion of beaches and decline of cliffs); Massive urbanization and intense occupation by tourist facilities has caused the almost complete destruction of the shoreline, with a restriction of the width of the beaches to less than 10 meters in some places (compared with 20 to 100 meters further north of the region of the Grand Sousse). Environmental problems obviously have repercussions on the quality of life of the inhabitants and on the region's most important sector, which is tourism. This to encourage regional governance as well as the national planned measures for the protection of the coastal coastline in Sousse. However, these new approaches to the planning and protection of coastal areas, which are driven by public institutions such as the APAL, are now shown to be insufficient and limited on the ground. and vice versa, they are even considered, as a great risk on the sea coasts as well as on the most important sector in the region of Sousse; we speak well of maritime tourism. Therefore, the spread and sharing of best practices in coastal climate change adaptation actions is essential in order to move rapidly towards integrated and sustainable coastal management.

Finally, there is no doubt that the blue economy represents for Tunisia in general and the region of Sousse in particular a sure opportunity, for the diversification of its maritime and coastal economy especially in the well-established sectors of tourism and fisheries, for this the creation of new innovative blue activities and the improvement of its food security and its energy balance while preserving its rich natural sea and coast capital is of great necessity.

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