



**Tunisia-Italy Power Interconnector Project**  
**Environmental and Social Impact Assessment (ESIA)**  
**Section 4 - Environmental baseline – Terrestrial domain –**  
**Tunisian side**  
*Draft for Consultations*

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## 1. INTRODUCTION

This section of the ESIA contains a description of the baseline physical and biological characteristics of the environment at the proposed project areas for the Tunisian side.

The present environmental baseline characterization for the terrestrial domain analysed the following environmental components:

- Air and Climate;
- Geology and geomorphology;
- Hydrogeology and hydrology;
- Biodiversity;
- Noise;
- Electromagnetic fields; and
- Landscape.

## 2. PROJECT AREA OF INFLUENCE

According to the World Bank Group (WBG) Standards on Environmental and Social Sustainability, the Area of Influence encompasses, as appropriate:

- The area likely to be affected by: (i) the project and the client's activities and facilities that are directly owned, operated or managed (including by contractors) and that are a component of the project; (ii) impacts from unplanned but predictable developments caused by the project that may occur later or at a different location; or (iii) indirect project impacts on biodiversity or on ecosystem services upon which Affected Communities' livelihoods are dependent.
- Associated facilities, which are facilities that are not funded as part of the project and that would not have been constructed or expanded if the project did not exist and without which the project would not be viable.
- Cumulative impacts that result from the incremental impact, on areas or resources used or directly impacted by the project, from other existing, planned or reasonably defined developments at the time the risks and impacts identification process is conducted.

The width of the Area of Influence (AoI) considered for this project is:

- 2 km on either side of the marine section line
- 6 km on either side of the overhead line.

The OHL Mlaabi - Mornaguia line by a corridor of 113 km length and 12 km width, as a core area where direct effects are likely to occur will cover 145 600 ha, as well as the wider area of influence where indirect, combined and cumulative effects are geographically spread on the surrounding areas and communities throw four (4) administrative zones concerned by the OHL lines (Nabeul, Ben Arous, Zaghouan, and Manouba Governorates).

The identification and the analysis of existing natural habitats in the Project's Area of Influence (AoI) was carried out based on detailed site visits and by application of the Integrated Biodiversity Assessment Tool (IBAT), completed with bibliographic resources.

This leads to identify in the larger Aol of 14 Protected and Key Biodiversity Areas (KBA) from which 5 KBA are located inside the Aol (buffer of 6 km each side of the line): Barrage (Dam) Oued El Hjar; Barrage Mlâabi; Barrage Sidi Abdelmoneem; Barrage Lebna; Barrage Chiba; and Aqueduc de Zaghouan. The 4 first dams (barrage) cited above are Artificial Wetland classified internationally as Ramsar Areas (Table below and Figure 23).

The other KBA are located at between 0.5 km (Jbel Boukornine) and 14 km (Jbel Zaghouan) of the Aol.

**Table 1: List of the Key Biodiversity Areas (KBA) identified in the extended Aol**

N°	Key Biodiversity Area (KBA)	Distance from Aol (km)	Typology	International Status
1	Barrage Oued El Hjar	0 km (inside Aol)	Artificial Wetland	Ramsar Area
2	Barrage Mlâabi	0 km (inside Aol)	Artificial Wetland	Ramsar Area
3	Barrage Abdelmoneem Sidi	0 km (inside Aol)	Artificial Wetland	Ramsar Area
4	Barrage Lebna	0 km (inside Aol)	Artificial Wetland	Ramsar Area
5	Barrage Chiba	0 km (inside Aol)	Artificial Wetland	
6	Barrage Bezikh	3 km	Artificial Wetland	
7	Barrage Masri	3 km	Artificial Wetland	
8	Barrage Mornaguia	7 km	Artificial Wetland	Ramsar Area
9	Lagune de Korba	6 km	Natural Wetland	Ramsar Area
10	Lagune de Soliman	5 km	Artificial Wetland	Ramsar Area
11	Jbel Boukornine	0.5 km	Mountain	
12	Jbel Zaghouan	14 km	Mountain	
13	Dunes de Ras El Melan	2 km	Coastal dunes	
14	Aqueduc de Zaghouan	0 km (inside Aol)	Archeological site	

The impact area may extends through varied agricultural and urban land, likely to affect eleven (11) wadis (rivers) as well as six (6) natural wetlands and at least thirteen (13) reservoirs or dams (artificial wetlands).

**Table 2: Wetlands around the project area**

Wetlands	Reservoirs	Wadis (Rivers)
<i>Sijoumi*</i>	<i>Ghdir El Golla*</i>	<i>Oued El Hjar</i>
<i>Sebkha Soliman*</i>	<i>Mornaguia*</i>	<i>Oued Tafekhst</i>
<i>Sebkha Farjouna</i>	<i>Dam El Hma</i>	<i>Oued El Mida</i>
<i>Sebkha Maamoura*</i>	<i>Bekbaeka</i>	<i>Oued Chiba</i>
<i>Sebkha Tazerka*</i>	<i>Chiba</i>	<i>Oued Bouliden</i>
<i>Sebkha Korba*</i>	<i>Lebna*</i>	<i>Oued El Manzah</i>
	<i>Malaabi*</i>	<i>Oued El Masri</i>
	<i>El Lahjar*</i>	<i>Oued El Melah</i>
	<i>Elwediane</i>	<i>Oued El Hma</i>
	<i>Sidi Abdelmoneem*</i>	<i>Oued Meliane</i>

<b>Wetlands</b>	<b>Reservoirs</b>	<b>Wadis (Rivers)</b>
	<i>ElMasri</i>	<i>Canal Mejerdah Cap Bon</i>
	<i>Bezirkh</i>	
	<i>Gasroun</i>	

\*Ramsar sites

### 3. AIR AND CLIMATE

#### 3.1 Climate

##### 3.1.1 National level

Tunisia's climate is temperate with mild winters and hot summers in general. The north of the country is mountainous, with a Mediterranean climatic effect and the south regions are semi-arid and arid desert closer to the Sahara.

The northern areas, dominated by the Atlas Mountains, are characterized by a typical Mediterranean climate with hot temperature in summer season of up to 22°C (between June to September) and precipitation during winter (between November to February), which does not exceed 500 mm of rainfall per year. The western and central regions, are marked by an arid steppe climate with an annual mean temperature of 18°C. Southern regions, drought can be frequent with high temperatures, more than 32°C in the summer.

Average annual precipitation is around 200 mm and the country is marked by a spatiotemporally disparity regarding rainfall, varying from 1,500 mm in the north to less than 100 mm in the south. In the last few years, Tunisia reported a 3% decrease in annual precipitation making the country more affected by drought periods and dry spells and as a result the need to reduce water availability in several areas. Stronger precipitation causing flash floods in recent years has also been reported in the country (GERICS, 2019).

Annual average temperatures range between 16°C to 20°C, with an average monthly high of 30.5°C in the summer season, between July and August and with a lowest average monthly of only 10°C in winter period (January).

Studies on the evolution of temperature during the last decades, conducted by Vernier et al, state that the average annual temperatures increased by about 1.4°C during the 20th century with a most rapid warming occurring in the summer (1.8°C) and a lowest in spring (1.4°C). Other studies mention that the mean annual temperatures will increase by 0.38°C, 1.03°C and 1.86°C for the 10th, 50th, and 90th percentiles for the RCP4.5 (Representative Concentration Pathway<sup>1</sup>) model.

These climate conditions makes Tunisia a highly arid country with lowest annual precipitation and the majority of rain falls along humid and coastal zones (high altitude and coastal areas).

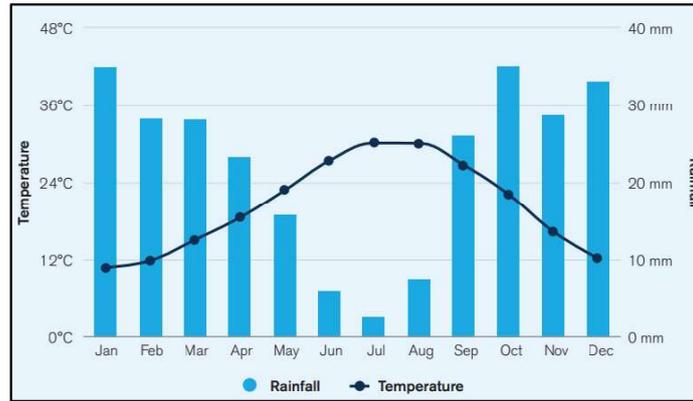
The following table shows historical climate parameters for the 1901-2019 period, based on the analysis of data issued from the World Group's Climate Change Knowledge Portal (CCKP).

<sup>1</sup> The Representative Concentration Pathway (RCP) is a model adopted by the Intergovernmental Panel on Climate Change (IPCC) used for climate modeling and to estimate the trajectory of greenhouse concentration.

**Table 3: Summary of climate statistics of Tunisia during 1901-2019 period (source Climate Change Knowledge Portal)**

<i>Climate parameters</i>	<i>Period 1901-2019</i>
Mean annual temperature (°C)	19.4
Mean annual precipitation (mm)	263.5
Mean maximum annual temperature (°C)	25.4
Mean minimum annual temperature (°C)	13.5

The figure below shows the variation of the average monthly temperature and rainfall in Tunisia for the same period stated above (1901-2019).



**Figure 1 : Average monthly temperature and rainfall of Tunisia between 1901-2019 (source Climate Risk Country Profile, World Bank)**

The country is subdivided into 5 agro-ecological zones according to the climatic characteristics and the provinces are grouped as follows:

- ❖ Sub-humid: Ariana, Ben Arous, Bizerte, Beja, Jendouba, Manouba, Nabeul, Tunis
- ❖ Semi-arid: Kef, Monastir, Siliana, Sousse, Zaghouan
- ❖ Arid higher altitude: Kairouan, Kasserine, Mahdia, Sfax, Sidi Bouz
- ❖ Arid lower altitude: Gabes, Gafsa, Medenine
- ❖ Arid: Kebili, Tataouine, Tozeur

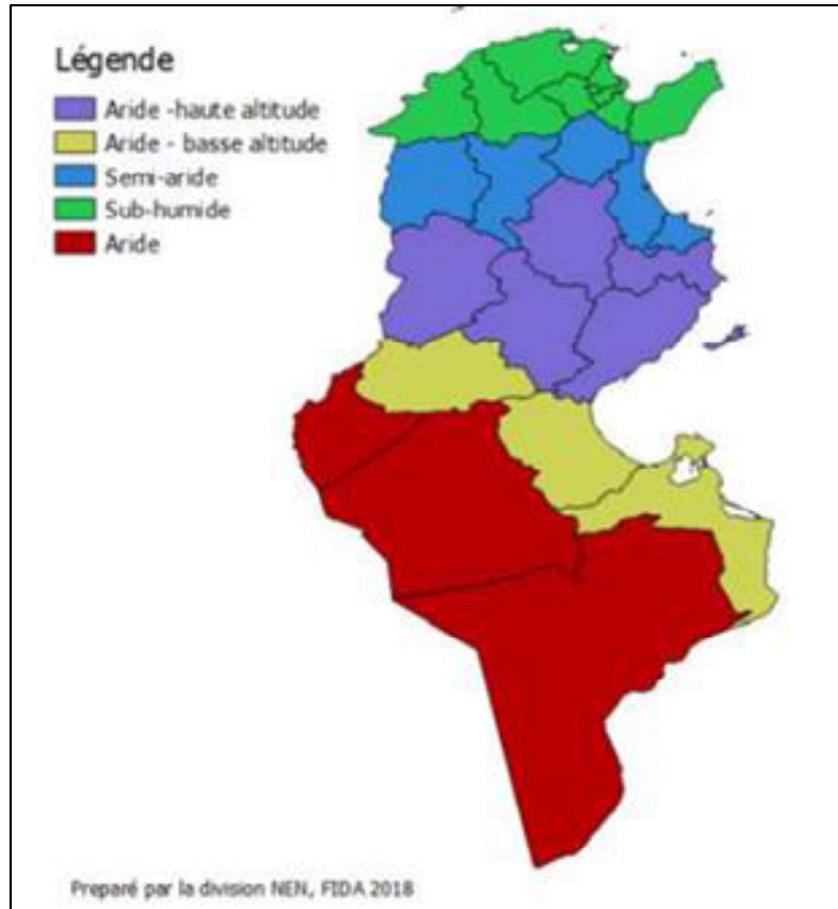


Figure 2 : Agroecological zones of Tunisia (IFAD, 2018)

### 3.1.2 Extended study area

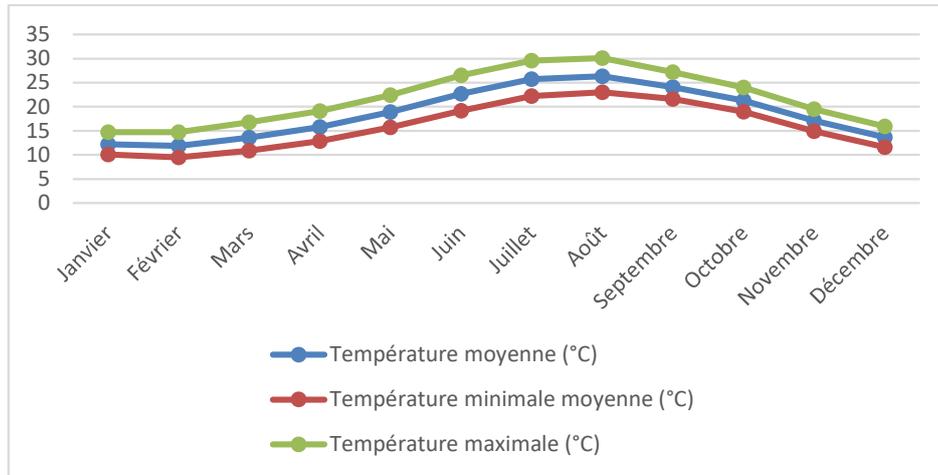
#### 3.1.2.1 Nabeul Governorate

Cap Bon, a peninsula of 2788 km<sup>2</sup> in northeastern Tunisia, the climate of Nabeul is characterized by hot and dry summers as well as mild and wet winters. In January, daily mean temperature in Cap Bon is on average 12 °C, whereas in August it rises to 27 °C. Average annual precipitation totals 425 mm, with considerable variations from year to year, from 144 mm (1981) to 772 mm (2003). Nevertheless, variability is also high during the course of the year and dry periods occur frequently. During July and August, there is often no precipitation at all (Köberl and al, 2015)<sup>2</sup>.

#### ❖ Temperature

The observed temperatures are typical of a peninsular Mediterranean climate. Cap Bon region is characterized by an average annual temperature of around 18.6°C. February is the coldest month with an average of 11.5°C. August is the warmest month with an average of 23°C, as shown in the following Figure. In summer, temperatures can reach excessive figures. In July 2022, the temperature reached 39°C.

<sup>2</sup> Modelling climate change impacts on tourism demand: A comparative study from Sardinia (Italy) and Cap Bon (Tunisia), 2015

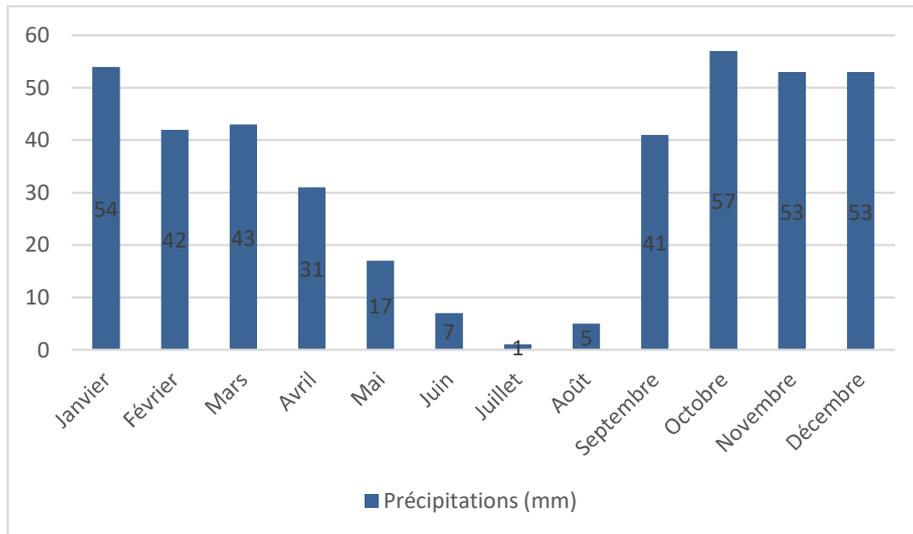


Source : <https://fr.climate-data.org/> (1991 -2021)

**Figure 3 : Annual temperature in Nabeul**

❖ **Rainfall**

The Cap Bon's climate is characterised by high precipitation, compared to the other regions of Tunisia, annual rainfall in Nabeul governorate is around 404 mm. The figure below gives the average monthly rainfall, according to INM data for Nabeul station:



Source : <https://fr.climate-data.org/> (1991 -2021)

**Figure 4 : Average monthly rainfall data in Nabeul**

The distribution of rainfall in the governorate of Nabeul is characterised by:

- An autumnal rainy period (from September to November) which cumulates about 37.4% of the annual rainfall. These rains are often in the form of thunderstorms with high intensity.
- A rainy winter period (December to February) which cumulates about 36% of the annual rainfall.
- A spring period with moderate rainfall, which accumulates about 14.4% of the annual rainfall.

A dry summer period of three months (June, July and August) which accumulates less than 12.2% of the annual rainfall.

Heavy rainfall with torrential nature (stormy precipitation of more than 30 mm in 24 h) is not negligible and represents between 25 to 30% of the annual precipitation recorded. These rains are often recorded in autumn

and cause flooding and because of their erosive character, they play an important role in the morphogenesis of the region of Cap Bon<sup>3</sup>.

❖ **Wind**

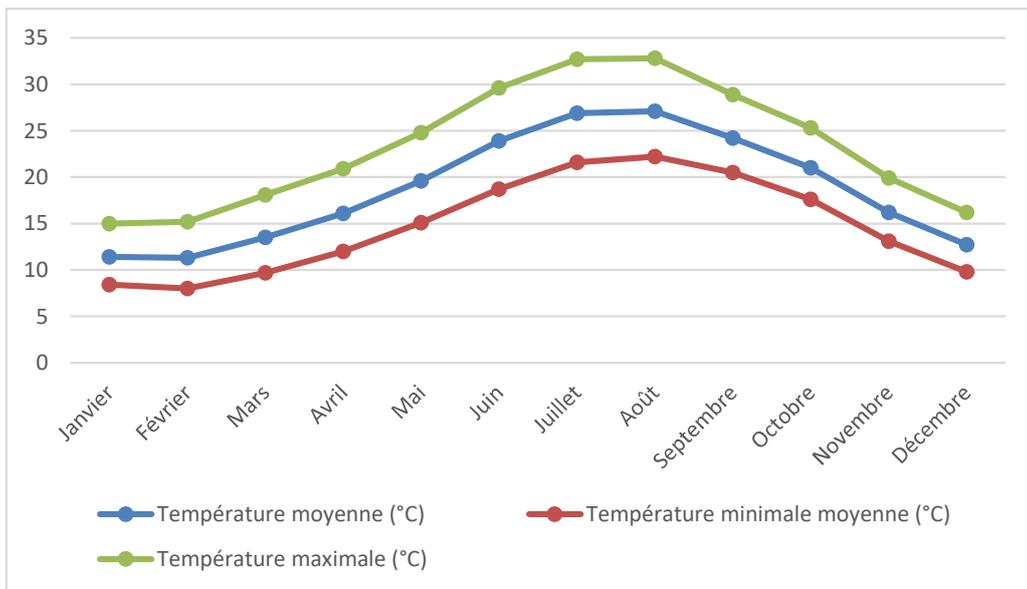
Nabeul's climate is strongly subject to the maritime influence, the region is characterised by about 356 windy days, and only 9 calm days. The dominant directions are 110 days northwest, 65 days west, 45 days north, and 40 days southwest. Southeast winds are predominantly summer winds.

The average annual wind speed is 16.66 km/h but it can reach 30 m/s in some period during the year, especially in the cold season.

**3.1.2.2 Ben Arous Governorate**

❖ **Temperature**

The observed temperatures are typical of a hot Mediterranean climate with dry summers. The average recorded is around 18.6°C. February is the coldest month with an average of 11.3°C. August is the warmest month with an average of 27.1°C. In summer, temperatures can reach excessive figures. In July 2022, the temperature reached 40°C.



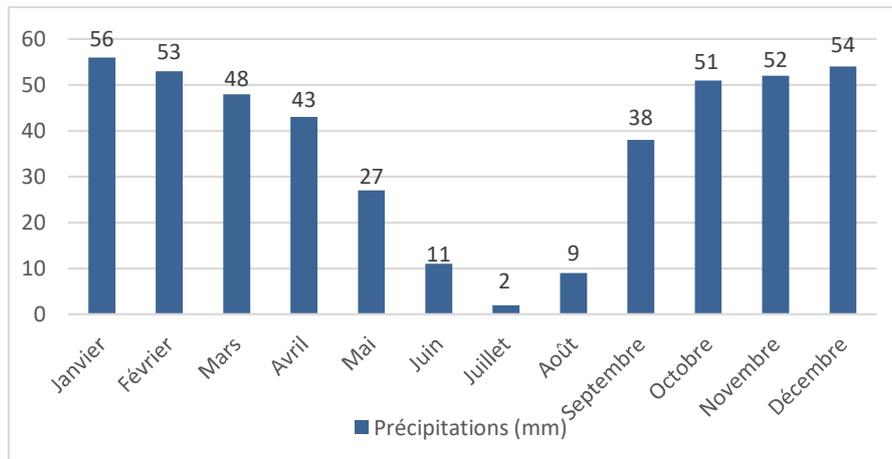
Source : <https://fr.climate-data.org/> (1991 -2021)

**Figure 5 : Average monthly temperature in Ben Arous**

❖ **Rainfall**

In Ben Arous, annual rainfall is around 444 mm. The figure below shows the average monthly rainfall:

<sup>3</sup> Atlas du gouvernorat de Nabeul



Source : <https://fr.climate-data.org/> (1991 -2021)

**Figure 6 : Average monthly rainfall data in Ben Arous**

Rainfall distribution in Ben Arous is characterised by:

- ❖ An autumnal rainy period (from September to November) which accumulates about 31.75% of the annual rainfall.
- ❖ A rainy winter period (December to February) which accounts for about 36.65% of the annual rainfall.
- ❖ A spring period with moderate rainfall, which accounts for approximately 26.6% of the annual rainfall.
- ❖ A dry summer period lasting three months (June, July and August) which accounts for less than 5% of the annual rainfall.
- ❖ **Wind**

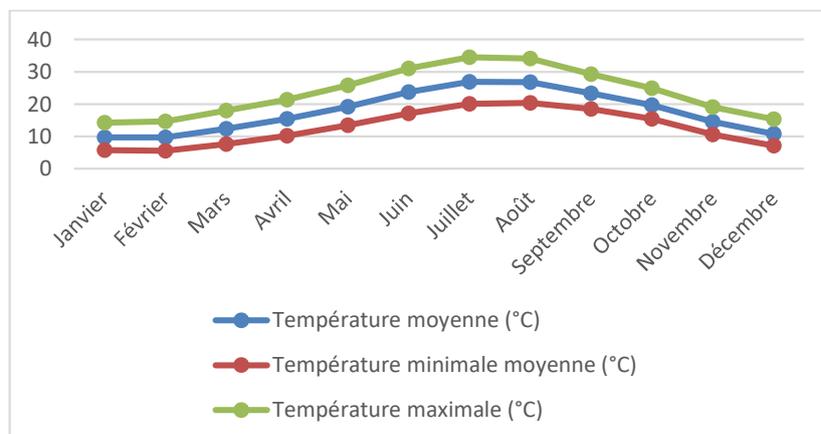
West and northwest winds are the most dominant and the average annual wind speed is 16.66 km/h with gusts up to 52 km/h.

### 3.1.2.3 Zaghouan Governorate

#### ❖ Temperature

The observed temperatures are typical of a hot Mediterranean climate with dry summers. The average recorded is around 18.6°C.

February is the coldest month with an average of 11.3°C. August is the warmest month with an average of 27.1°C. In summer, temperatures can reach excessive figures. In July 2022, the temperature reached 40°C.

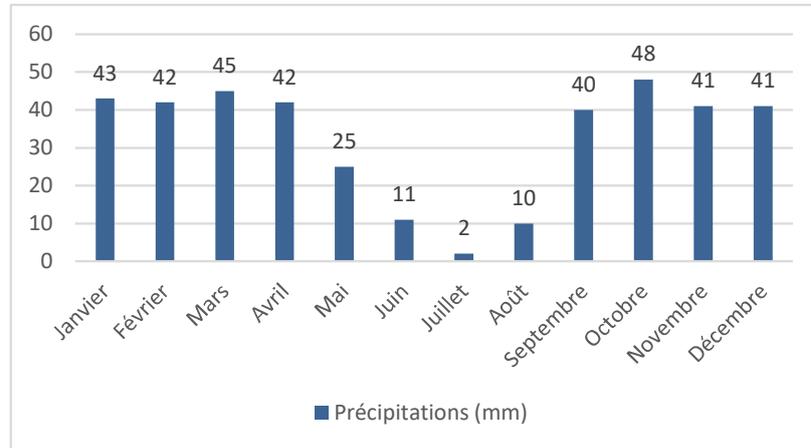


Source : <https://fr.climate-data.org/> (1991 -2021)

**Figure 7 : Average monthly temperature in Zaghouan**

❖ **Rainfall**

Annual rainfall in Zaghouan reach 444 mm, the following Figure shows the average monthly rainfall in the region.



Source : <https://fr.climate-data.org/> (1991 -2021)

**Figure 8 : Average monthly rainfall data in Zaghouan**

The distribution of rainfall in the governorate of Zaghouan is characterised by:

- An autumnal rainy period (from September to November) which accumulates about 33% of the annual rainfall.
- A rainy winter period (December to February) which accounts for about 32% of the annual rainfall.
- A spring period with moderate rainfall, which accounts for about 29% of the annual rainfall.
- A dry summer period lasting three months (June, July and August) which accounts for less than 6% of the annual rainfall..

❖ **Wind**

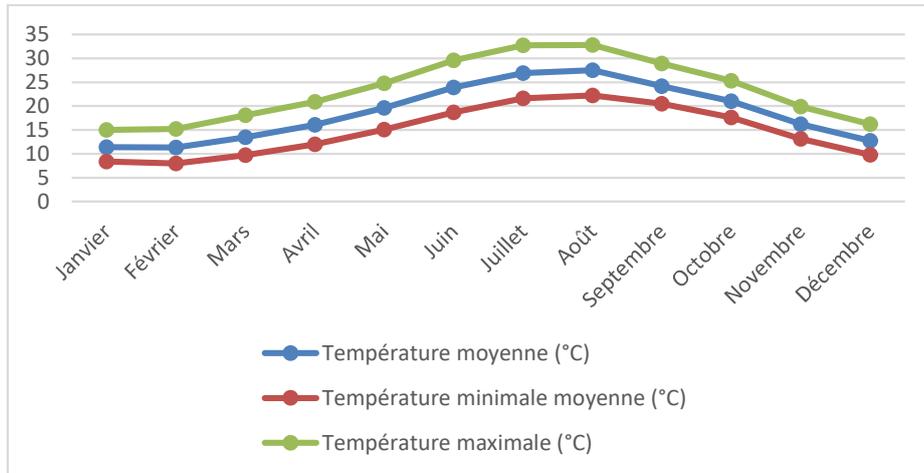
North and North-West winds are the most dominant and the average annual wind speed is 16.66 km/h.

**3.1.2.4 Manouba Governorate**

The climate of the governorate of Manouba is Mediterranean, belonging to the upper semi-arid bioclimatic stage, with mild and humid winters and dry and hot summers.

❖ **Temperature**

The observed temperatures are typical of a hot Mediterranean climate with dry summers. The average recorded is around 18.6°C. February is the coldest month with an average of 11.3°C. August is the warmest month with an average of 27.1°C.

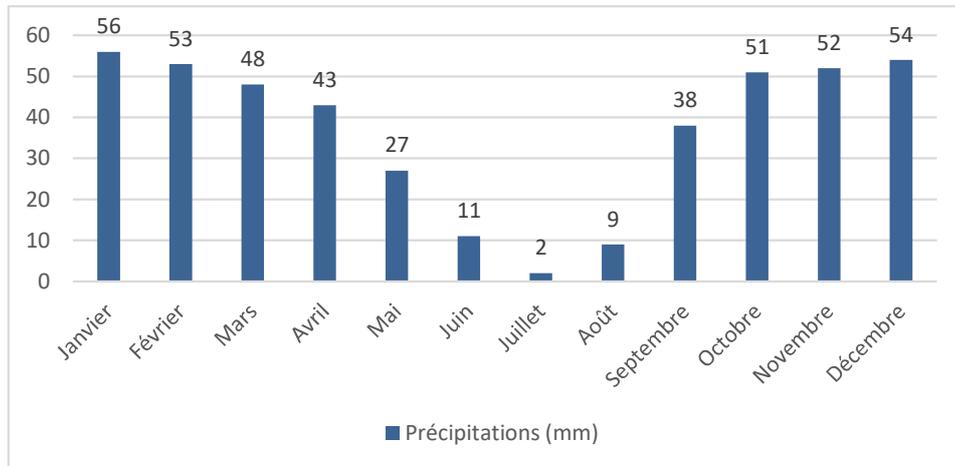


Source : <https://fr.climate-data.org/> (1991 -2021)

**Figure 9 : Average monthly temperature in Manouba**

❖ **Rainfall**

The annual rainfall in the governorate of Manouba is 450 mm. The figure below gives the average monthly rainfall:



Source : <https://fr.climate-data.org/> (1991 -2021)

**Figure 10 : Average monthly rainfall data in Manouba**

The distribution of rainfall in the governorate of Manouba is characterised by:

- An autumnal rainy period (from September to November) which accounts for about 32% of the annual rainfall.
- A rainy winter period (December to February) which accounts for about 37% of the annual rainfall.
- A spring period with moderate rainfall, which accounts for about 27% of the annual rainfall.
- A dry summer period lasting three months (June, July and August) which accounts for less than 5% of the annual rainfall.

❖ **Wind**

West and northwest winds are the most dominant and the average annual wind speed is 16.66 km/h with gusts up to 52 km/h.

### 3.2 Air quality

At the national level, the legislation regarding air quality is regulated by the Law N°2007-34 (4 June 2007) and the limit values of air pollutants, from stationary sources, are set by the Decree N°2010-2519 of 28 September 2010. In addition to that, the Decree N°2018-447 of May 18, 2018 and the NT 106-04 standard sets the limit values and alert threshold for ambient air quality.

At the international level, the Environmental Health and Safety Guidelines define air quality standards: General EHS Guidelines: Environmental Air Emissions and Ambient Air Quality; the latter refers to Air Quality Guidelines published by WHO (World Health Organization).

To date, no specific air quality data are available. The surroundings of the area concerned by the project's components (TUNITA and OHL line) are mostly rural with presence of some industrial areas, in particular towards the landfall area of Kélibia and near the Mornaguia converter station. These activities are not expected to generate pollutants such as NO<sub>x</sub>, CO<sub>x</sub> and PM<sub>2.5</sub> and PM<sub>10</sub>.

Without accurate field measurements, we believe that the air quality appears to be below the thresholds set by WHO and World Bank EHS standards.

#### 3.2.1 WHO standards

The WHO standards have been updated to 2021. The WHO has set intermediate values to reach the recommended levels:

**Table 4: Recommended and target air quality levels set by WHO organization**

Pollutant	Time selected	Intermediate target				Recommended level
		1	2	3	4	
PM <sub>2.5</sub> , µg/m <sup>3</sup>	Annual	35	25	15	10	5
	24 hours <sup>a</sup>	75	50	37,5	25	15
PM <sub>10</sub> , µg/m <sup>3</sup>	Annual	70	50	30	20	15
	24 hours <sup>a</sup>	150	100	75	50	45
O <sub>3</sub> , µg/m <sup>3</sup>	Peak season <sup>b</sup>	100	70	–	–	60
	8 hours <sup>a</sup>	160	120	–	–	100
NO <sub>2</sub> , µg/m <sup>3</sup>	Annual	40	30	20	–	10
	24 hours <sup>a</sup>	120	50	–	–	25
SO <sub>2</sub> , µg/m <sup>3</sup>	24 hours <sup>a</sup>	125	50	–	–	40
CO, mg/m <sup>3</sup>	24 hours <sup>a</sup>	7	–	–	–	4

a/ 99th percentile (i.e. 3 to 4 surplus days per year)

b/ Average of the maximum 8-hour average O<sub>3</sub> concentration over six consecutive months, with the highest O<sub>3</sub> concentration of the six-month rolling averages.

### 3.2.2 Tunisian standards

National emission thresholds set at National level by the Decree N°2018-447 of May 18, 2018, as shown by the following table.

**Table 5: Limit values and Alert threshold for PM10 and PM2.5 (Decree N°2018-447 of May 18, 2018)**

	Limit values		Alert threshold
	Daily average over the year ( $\mu\text{g}/\text{m}^3$ )	Annual average ( $\mu\text{g}/\text{m}^3$ )	
PM10	50	40	150*
PM2.5	35	20	-

*\*as a daily average exceeded during three (3) consecutive days (applied as of January 1, 2021).*

The following table presents the air quality index of the four governorates concerned by the Project, as reported by the IQAIR website.

**Table 6: Air pollution index in the study area (source: IQAIR)**

	Nabeul	Ben Arous	Zaghouan	Manouba
Air pollution index (IQA in french)	17	25	29	29
Major pollutants	PM2.5	PM2.5	PM2.5	PM2.5
Concentration PM2.5 ( $\mu\text{g}/\text{m}^3$ )	4,1	6,1	7,1	7,1

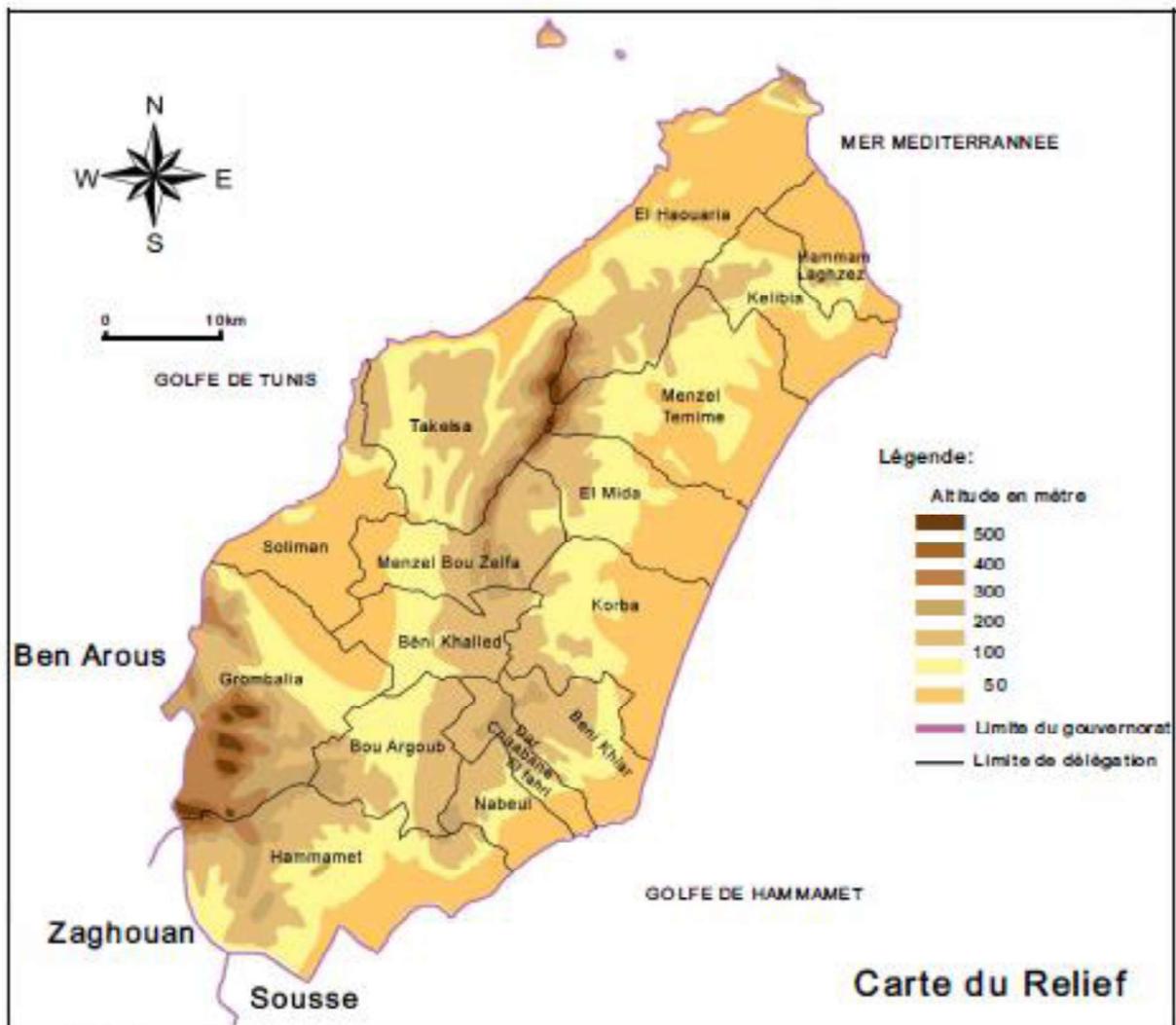
<https://www.iqair.com/fr/>

## 4. GEOLOGY AND GEOMORPHOLOGY

### 4.1 Nabeul Governorate

#### 4.1.1 Relief

The Cap Bon peninsula, oriented South-West / North-East, appears as a vast folded zone of which the Djebel Sidi Abderrahmene (Tunisian part of the Atlas mountain chain) anticline constitutes the backbone. The eccentric position towards the West of this mountainous ridge, limited by the plains of Grombalia to the South, El Haouaria to the North, Takelsa to the West and Dakhla to the East, gives Cap Bon a dissymmetrical appearance.



Source CRDA de Nabeul

Source Atlas Nabeul

**Figure 11 : Topographic map of Nabeul**

The western slope is steep and the coasts are rugged, rocky or overgrown with dunes. This steep western ridge contrasts with small, fragmented and much effaced ridges, almost flattened on the eastern flank. To the east, in fact, the foothills gradually descend to the sea; ancient beach formations, dunes and elongated lagoons border the coastline.

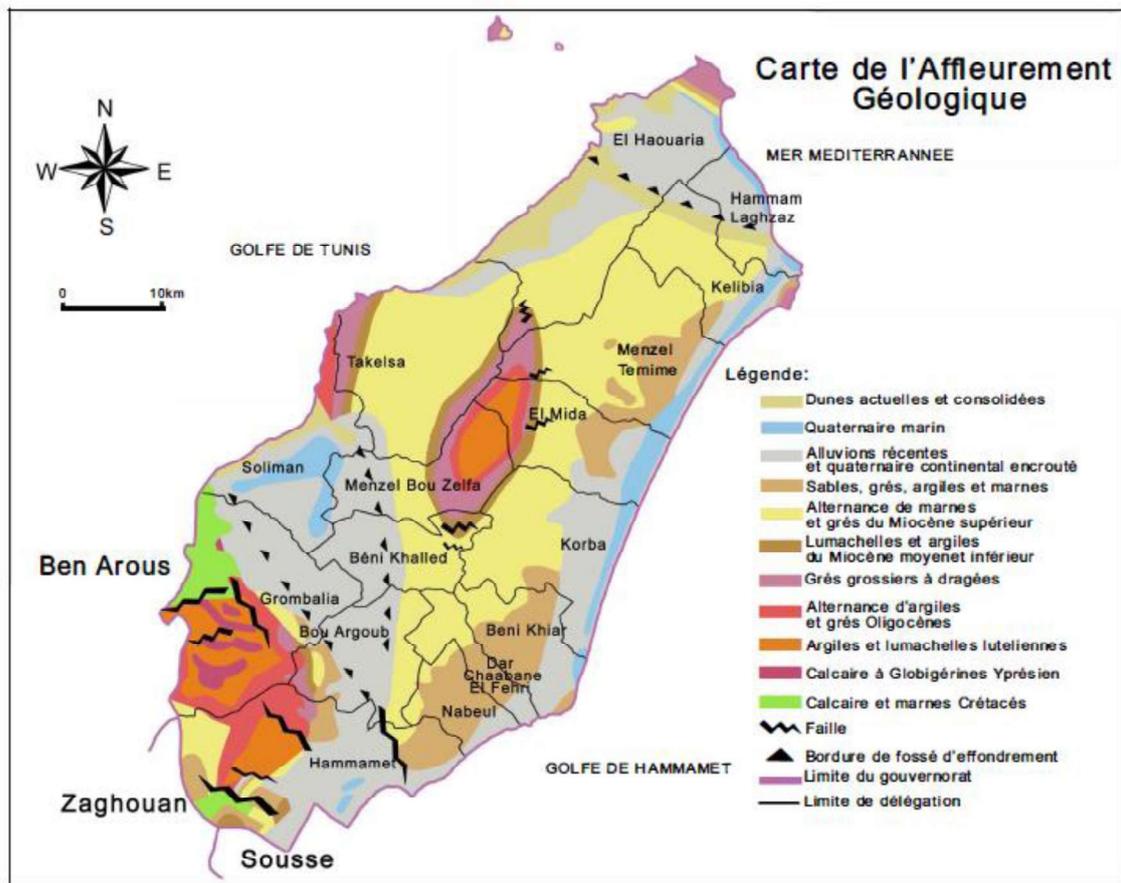
Seen from the sky, the relief of Cap Bon is quite rugged. One third of its territory is made up of low djebels, of which Djebel Abderrahmane is the highest. Extreme point of the Tunisian Dorsal, it is a set of asymmetrical

ridges (Djebel Diss, Djebel El Hofra, Djebel Hannous, Kef Bougaoula and Kef Errand which culminates at 637 m), with steep slopes on one side, gentle on the other, which divides the peninsula in a south-west/north-east direction, and from which starts the main part of the hydrological network of the region. Other jebels are in front of the sea, with steep slopes and peaks: Djebel Korbus (419 m), Djebel Labiadh (393 m) in Haouaria, Mount Farcouni (435 m) on the island of Zembra.

A series of djebels more to the west separates the Cap Bon from the rest of the territory. Culminating sometimes at 500 m, it extends from Hammam-Lif to Hammamet (djebels Bazine, Ashagshag, Bouchoucha, El Mekki, Ezzit, Latrach).

#### 4.1.2 Geology

Cap Bon region is mainly an anticlinal structure under the Mount of jbel Abderrahmen or Oued Chiba, the stratigraphic series is essentially of Miocene age and is presented by a succession of marly and sandy or sandy banks. The anticline of jbel Abderrahmen is bordered on its east-west flanks by two synclines formed essentially of marly layers; the synclines of Takelsa in the west and Dakhla in the east.



**Figure 12 : Geological map of Nabeul (source Atlas of Nabeul)**

Jbel Abderrahmen anticline constitutes, in fact, a set of mountains that culminate at more than 600m. These different reliefs are subject to a pronounced erosion. Indeed, the center of the anticline which should present the maximum bulge, was eroded by the wadi Chiba to form an ovoid anticlinal combe of 15 km long and 7 km wide, notched in the Eocene marls.

## 4.2 Ben Arous Governorate

### 4.2.1 Relief

Grand-Tunis region is structured around three wetlands and a double crown of hills and mountains of the North-Eastern Tell. This system consists of the following:

- In the West, the plains of Mornaguia and Manouba extend around Sebkhath Séjourni and Djebel Ammar.
- In the North, the plains of Soukra and Ariana spread out between Jebel Ennahli (175 m), Sebkhath of Ariana and the lake of Tunis.
- In the south, in the governorate of Ben Arous, the plains of Mornag and Fouchana, drained by the Méliane wadi and the El Hammam wadi, spread out from the heights of Jebel Boukornine (507 m) and Jebel Ressay (805 m).

### 4.2.2 Geology

Located at the northeastern end of the Tunisian Dorsale, the region of Grand-Tunis is characterised by several slumps caused by a network of faults at the end of the Tertiary era. These slumps are identified with the large sedimentation basins:

- Medjerdah valley,
- Lake Tunis,
- Sebkhath Séjourni
- The plain of the oued Méliane

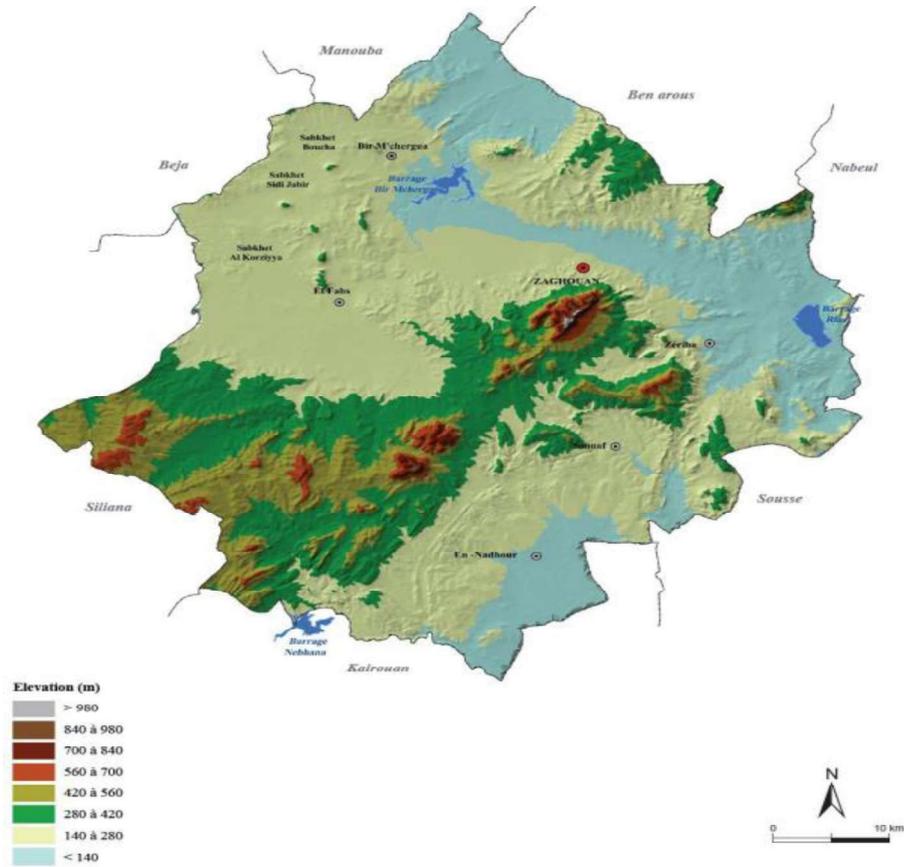
In addition, these slumps have generated the summits of Jbel Ressay and Boukornine, composed of Jurassic and Cretaceous limestone.

Thus, the relief of the region, formed by subsident pressures and small hills of structural origin, is marked by a system of major faults and numerous accidents. Mornague, the main plain of the governorate of Ben Arous, consists of deposits of continental quaternary.

## 4.3 Zaghuan Governorate

### 4.3.1 Relief

The governorate of Zaghuan is located between the Haut Tell and the Tunisian ridge and is characterised by varied and uneven relief. The morphological landscape is rather open with alternations of several topographical units, namely the mountainous massifs and the plains punctuated by isolated hills. The Djbel Zaghuan massif: It constitutes one of the most important orographic units of the Dorsale. It is located in the western axis of the northern half of the mountainous ensemble. The other mountainous units of the region are : Jbel Fkirine, Jbel Sidi Zit, Jbel Ben Saïdane and Jbel Oust.



**Figure 13 : Topographic map of Zaghouan (source SAD Zaghouan 2030)**

The northern sector of the governorate (Bir Mchergua), crossed by the present project, is characterised by an abundance of alluvial plains (crossed by the main wadis of the governorate) and hills.

#### 4.3.2 Geology

North and North Eastern sector, mainly dominated by alluvial plains and hills. This sector covers the localities of Sminja, Le Fahs and Bir Mcherga. It consists of alluvial plains crossed by the main wadis of the region, namely the wadi Kébir-Miliane and the wadi Erremel. The southern and southern eastern sector includes the territorial spaces around the localities of Zriba, Saouaf and Nadhour.

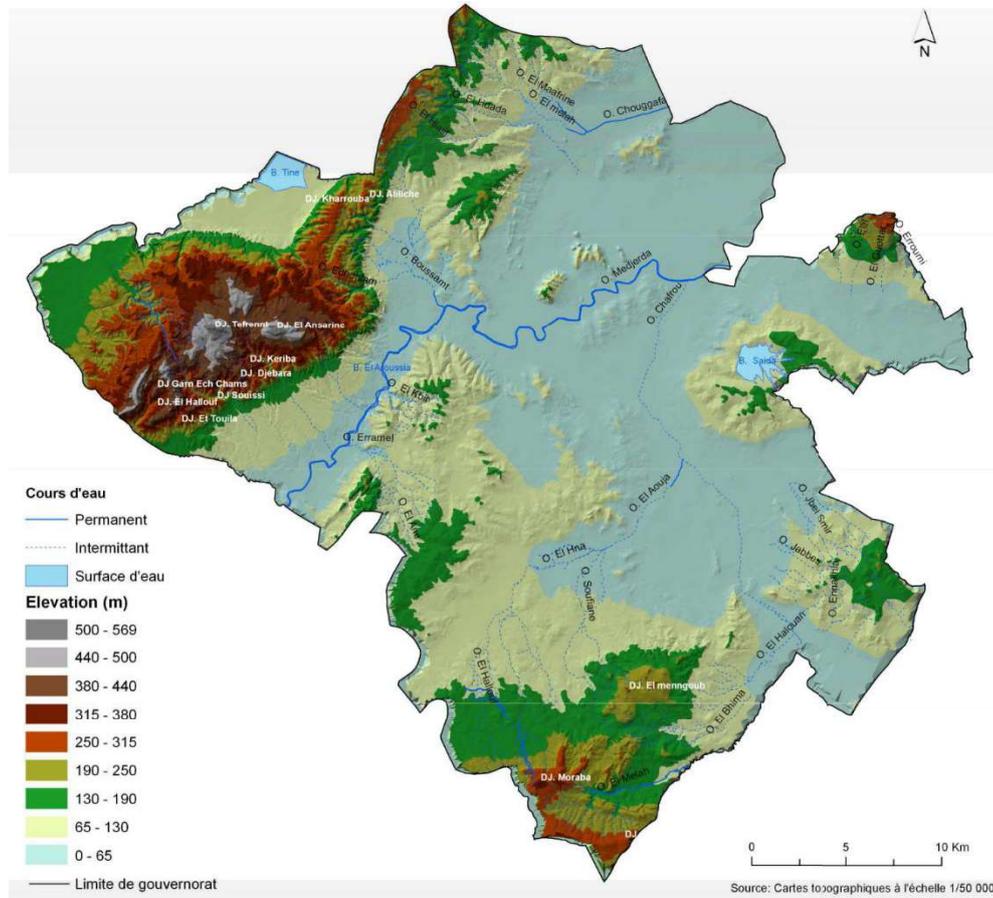
Limestone outcrops occupy the whole anticline of Jbel Zaghouan, Jbel Oust and the Mount of Hammam Zriba. The geological structure of the governorate of Zaghouan is composed of rocks with limestone dominance, rocks with limestone-marl alternations and rocks with sandstone-clay alternations.

With a variety of soils, three main types of soil can be reported in the governorate namely: calcimorphic soils, halomorphic soils and recent hydromorphic soils of alluvial contribution. The composition of these types depends essentially on the lithological and topographical context of the region.

### 4.4 Manouba Governorate

#### 4.4.1 Relief

Manouba is characterised by a heterogeneous and very varied topographic surface: plains and hills between the Jebel chains that dominate them towards the North, the South-West and part of the East of the governorate. However, the plains and hills represent the dominant topographical aspect in the area (nearly 75%).



**Figure 14 : Topography and hydrography of Manouba (source Atlas of Manouba)**

With the exception of Jebel Lansarine, which rises to 583 m, the governorate of Manouba is characterised by a modest but very marked relief in the landscape. This relief is essentially represented by a series of hills delimiting the governorate in its northwestern and southeastern parts, the altitudes of which do not exceed 300m.

Due to its location in the lower valley of the Medjerda, the Manouba plain is considered the most important in the region of Grand Tunis due to its geographical extent (53Km<sup>2</sup>) and its fertility.

The plain of Manouba is a subsident depression, limited by Djebel Ammar in the North-West, the Pliocene hills of Ariana in the Northeast, the Djebels Aïn El Krima and Sidi Salah in the South-West. It is also characterised by low altitude, which not exceed 40 m in general.

#### 4.4.2 Geology

From Jedaida and Tebourba, the Lansarine, Djebara and Keriba Djebels constitute the terminal branches of the North-Western Saherian Atlas.

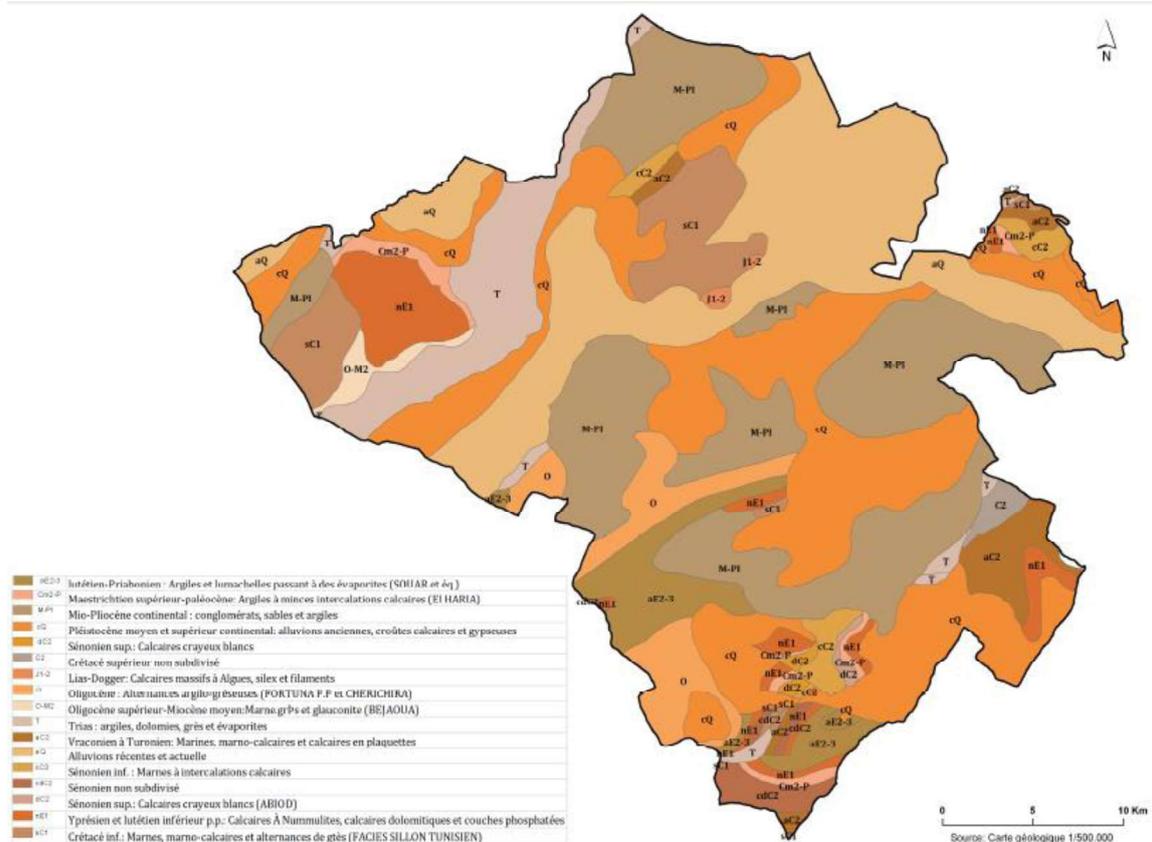


Figure 15 : Manouba geological map (source Atlas of Manouba)

Within the southern part of the region, Mornaguia (area concerned by the OHL line), Atlas ranges of southwestern and northeastern orientation (Djebels Moraba and Djerifete) dominate Borj El Amri.

In the center, the flat part is a recent alluvial plain which was formed on the site of a marine gulf deeply cut by the geological accidents inside a strongly folded region. This plain corresponds to a subsident and collapsed synclinal structure. It is occupied by quaternary alluvial deposits, most often sandy-clay to sandy-clay-silt.



- surface: that of the Quaternary,
- deep: housed in the Pliocene deposit.

These two aquifers are overlapped hydraulically and lithologically, since no impermeable layer has been identified that allows their piezometric individualization and the surface wells generally intersect both horizons.

## 5.2 Ben Arous Governorate

The region of Tunis with its physical components (gulf and reliefs) is structured by three basins that capture rainwater from the plains and surrounding mountains, namely the lake of Tunis, the sebkhas of Ariana and Séjoumi.

Two large wadis flow in the plains, in the North, the Medjerda wadi, and in the South the Méliane wadi and its tributary the El Hammam wadi. Main river of the governorate of Ben Arous, the wadi Méliane flows into the sea at the height of the town of Rades near the Olympic City.

The wadi which takes its source in Jebel Bargou and Mansour drains a watershed of about 2000 km<sup>2</sup> and extends over a hundred kilometers.

The waters of the wadi once devastating have been controlled by the construction of a dam at Bir M'chergua allowing the protection of the downstream basin of the wadi against flooding and floods generated by heavy rainfall episodic.

The hydrographic system of the southern zone, structured around the wadi Melian is composed of many small wadis and tributaries: wadi El Hammam, wadi Ben Aissa, wadi El Bakbaka, wadi Skhira, wadi El Gsab and wadi El Boul. These wadis flow between the Boukornine and Djebel Ressay mountains in the Mornag plain to flow into the Méliane wadi through its tributary the El Hammam wadi.

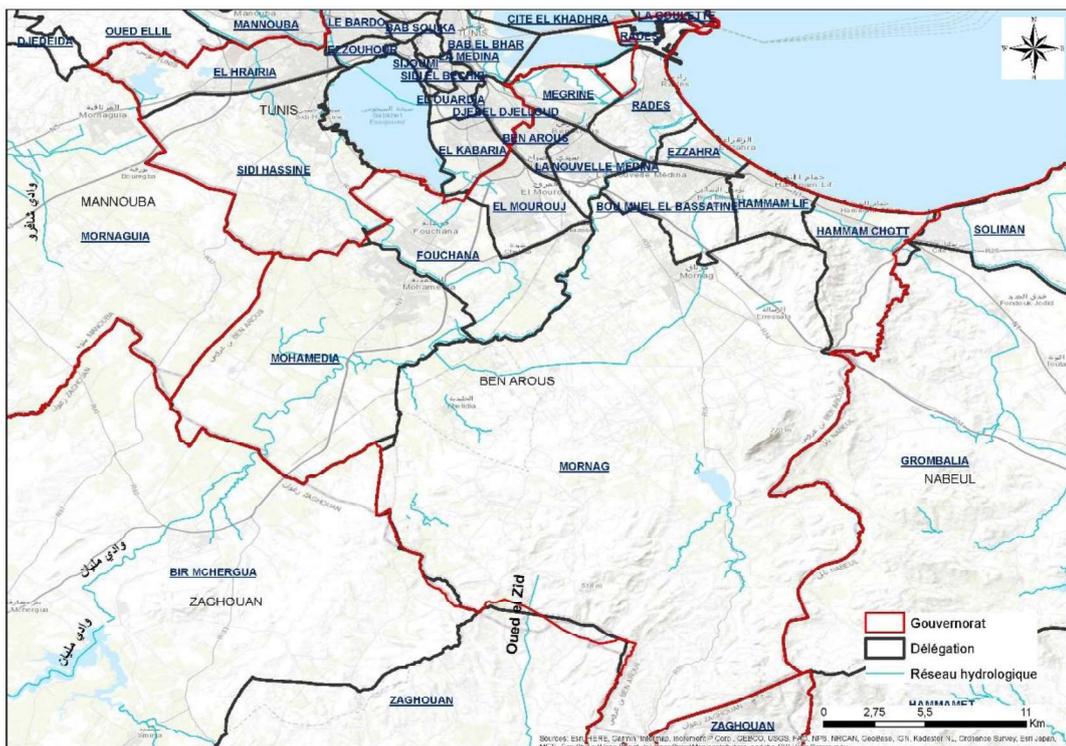


Figure 17 : Hydrographic network of Ben Arous





## 6. BIODIVERSITY AND ECOSYSTEM SERVICES

Located on the western Mediterranean between Algeria (western border) and Libya (southeastern border) with a total area of 163 610 square kilometres, Tunisia is a rich respiratory of various natural resources due to its varied topography and bioclimatic zones. The northwestern border includes an extension of the Atlas mountains, characteristic of the Maghreb region, and these mountains are called "La Dorsale Tunisienne". The Dorsale mountains includes various mountain areas in Zaghouane (Jebel Zaghouane) and in the Cap Bon region (Nabeul), not far from the area concerned by the OHL line.

There are around 22 500 species of vascular plants in the Mediterranean area, as reported by Myers and al (2000), with 11 700 species in the "hotspot region" including Tunisia (Thompson and al, 2005).

Considered as a small country regarding its territory, Tunisia is characterized by climatic diversity as shown in the Figure below. The humid region is located in the northwestern forest and it represent 3.6% of the total area of the country. The annual average rainfall in the northern zone is 1,500 mm and this area presents a typical Mediterranean climate. In central Tunisia, the semi-arid zone has a steppe climate and represents 20% of the total area of the country. The southern zone is divided into two climatic regions (Tarhouni et al 2007), namely the arid and desert zones. The average total annual rainfall in the arid and desert zones is 200 mm and 50 mm. There are about 1 million hectares of forest in Tunisia, and the forest represents only 6% of the total area of the nation. Moreover, due to deforestation and desertification, land degradation has accelerated in arid and semi-arid regions (Korea Rural Economic Institute 2014).

Natural environment in Tunisia includes seven major groups or types of natural ecosystems: coastal ecosystems, island, mountain, steppe, desert, oasis and wetlands. To them is added agrosystems that represent an important group in the current land use.

Desert regions comprises between 30% and 40% of the total area of the area and protected areas cover around 6 % of the total land area. Currently, there are 44 sites considered as protected sites including 17 national parks and 27 natural reserves. Tunisia has also 4 animal reserves and 41 RAMSAR sites. These area helps protecting species and genetic diversity, maintain ecosystem services (carbon storage and sequestration, fight against erosion and landslides, conservation of soil and water resources, etc.) and to support livelihoods of local communities. The majority of protected areas and parks are directly managed by the forest services (Direction Générale des Forêts DGF).

The specific natural wealth is found its 69 sets of natural ecosystems and 12 sets of agrosystems (Sixième Rapport National sur la Biodiversité), which include:

- ❖ 7 212 species including 3 749 species of terrestrial plants and animals and 3 463 species of marine flora and fauna.
- ❖ 32 collections of microorganisms with 22 650 strains in total.

### 6.1 Habitats and biodiversity threat

The OHL Mlaabi - Mornaguia line by a corridor of 113km length and 12 km width, as a core area where direct effects are likely to occur will cover 145600 ha, as well as the wider area of influence where indirect, combined and cumulative effects are geographically spread on the surrounding areas and communities throw 4 administrative zones concerned by the OHL lines (Nabeul, Ben Arous, Zaghouan, and Manouba Governorates).

#### 6.1.1 Critical Habitat

According to the definition, of the WBG's Policy and Standards on Environmental and Social Sustainability (WBG, 2012), the habitat crossed by the OHL, are mainly **modified habitat** made up of agricultural land (83% of the buffer zone) and urban area (4%); the **natural habitat** are limited to forest (13%) and bare ground (less than 1%). as for the **critical habitats**, part of natural habitats, and according to the criteria of the WBG, they are absent in the project area.

In fact, **Critical Habitats** are defined by the WBG as areas with a high biodiversity value. This includes areas that meet at least one or more of the following five main criteria:

1. Habitat of significant importance to Critically Endangered and/or Endangered species as listed on the International Union for the Conservation of Nature (IUCN) Red List of Threatened Species;
2. Habitat of significant importance to endemic and/or restricted-range species;
3. Habitat supporting globally significant concentrations of migratory species and/or congregatory species;
4. Highly threatened and/or unique ecosystems; and/or
5. Areas associated with key evolutionary processes.

### 6.1.2 **Natural Habitat**

Natural habitats are areas composed of viable assemblages of plant and/or animal species of largely native origin, and/or where human activity has not essentially modified an area's primary ecological functions and species composition.

Through the OHL, the natural habitats are represented by the 19270 ha of forest and less than 1ha of bare ground.

Forest areas in the study area host natural forest, scrub and plantations.

Forest plantation areas, especially in Dar Chichou and Rtiba, are mainly occupied by eucalyptus, pines, acacia and offer a suitable environment for many passerine species such as Fringillidae. Other forest areas with potential high biodiversity value are mainly mountainous lands, around Beni Ayech, the area between Grombalia and Jebel Ressas and some areas located in Zaghouan. These areas are occupied by forest and scrubland with some olive trees, which provide a favourable habitat for several nesting and migratory species of birds.

Ecological forms are represented in the area by forest, scrub, halophytes, chasmophytes, etc. *Cistus* species (*Cistus monspeliensis*, *Cistus libanotus*, *Cistus salviifolius vulgaris* and *Cistus villosus*), which are a sign of ecosystem degradation due to the effect of human pressure, in particular grazing activities. Three oak species can be observed, such as *Quercus coccifera L.*, *Quercus ilex L.* and *Quercus suber L.*

### 6.1.3 **Modified Habitat**

Modified habitats are areas that may contain a large proportion of plant and/or animal species of non-native origin, and/or where human activity has substantially modified an area's primary ecological functions and species composition. Modified habitats may include areas managed for agriculture, forest plantations, reclaimed coastal zones, and reclaimed wetlands.

The main component of the terrestrial part of the OHL project, will cross different types of modified habitats. This includes agricultural land (irrigated perimeters, farmland, Pastureland, olive, citrus, cereal, vineyard), grassland and some fragmented forest areas are common. The OHL corridor is located near many wetlands sites of ecological interest for flora and fauna (RAMSAR/IBA/KBA sites, etc.).

Variable damage on crops and vegetation can be expected during this activity. Outside forest areas with very dense cover, it is possible to pass the cable between trees and avoid/reduce any possible damage to them. This is the case for the project's area, where the OHL will pass through relatively open and rural landscape, except areas occupied by citrus orchards between Menzel Bouzelfa and Grombalia and forest areas and scrubland near Jebel Ressas (between Ben Arous-Nabeul and Zaghouan).

Corridors of 12km wide along the routes of the OHL line over 113 km between Mlaabi and Mornaguia, will be affected both in the terrestrial part and in the aerial part in relation to the heights and types of pylons. Added to this are the 5.7 km of HVDC underground cables and the junction box.

In the underground part, the burying of the cables displaces the sediments, however its effect is localized because the majority of the displaced sediments will be deposited less than tens of meters from the route of

the cable. In addition, the small-scale impacts will concern agricultural soils and road structures or infrastructure (roads, tracks, roads).

Otherwise for the high voltage lines, more specifically, the areas where the pylons are installed are subject to temporary damage and disturbances linked to excavations and the displacement of sediments over approximately 20,608 m<sup>2</sup> (322 pylons x 64 m<sup>2</sup>). Flora and endogenous fauna species will have occasional impacts and their recovery will be relatively quick due to their adaptation to the environment. As for the vagile fauna, the species are capable of fleeing outside the work area. The overall environmental footprint on the terrestrial environment is generally low and most habitats will only be partially disturbed. The avifauna may suffers the highest impact and disturbance.

## 6.2 Key Biodiversity Areas and Sensitive Areas

### 6.2.1 Protected areas

Natural habitats and protected areas constitute a real source for biodiversity protection. Actually, Tunisia has a network of protected areas, mainly composed by the following:

#### ❖ 17 national parks

- Zembra and Zembretta
- El Feija
- Sidi Touil
- Zaghouan
- Orbata
- Jebel Chitana – Cap N gro
- Boukornine
- Chaambi
- Jbil
- Mghilla
- Dghoumes
- OuedZen
- Ichkeul
- Bouhedma
- Serj
- Zaghdoud
- Seghar-Jabbes

#### ❖ 27 natural reserves

- Galite Galiton
- Mejen Chitane
- Tourbi re de Dar Fatma
- Saddine
- Jebel Rihana Jebel Goul be
- Jebel Serj
- Ile de Chikly
- Jardin Botanique de Tunis
- El Gonna
- Ettella
- Sebkhata Kelbia
- Grottes de Chauves souris
- Jebel Hammamet
- Jebel Ghorra
- Iles Kneiss
- Jebel Touati
- Jebel Bent Ahmed
- Kef Errai
- Jebel Bouramli
- Ain Chrichira
- Thelja
- BV Oued Gabes
- Khchem El Kelb
- Jebel Khroufa
- Ain Zana
- Oued Dkouk
- Mell gue Jebel Essif

#### ❖ 4 wildlife reserves

- Ain Baccouche
- Dar Chichou
- Orbata
- M'Hibeus

#### ❖ 33 sites of arboreta and seed populations and seed reserve for natural forest

The Project's area of influence includes several areas of importance for biodiversity, such as:

- **Mlaâbi reservoir (IBA site TN006)**

Located at around 500 m from the CS and OHL line, the dam is covering 200 ha in total is a man-made water body built for irrigation of local agriculture (cereal and olive tree plantations) present in Menzel Temime Delegation.

Flora within the site is characterized by the presence of little permanent vegetation such as *Typha angustifolia*, *Tamarix* and *Juncus* species.

Is an important area for many waterbirds species and considered also an important stop-over area for migrating birds crossing the Cap region before joining Garaet El Haouaria and after Europe.

Birds species: an important site for *Oxyura leucocephala* (VU) (around 12 to 80 pairs according to AAO and BirdLife statistics) and *Marmaronetta angustirostris* (VU), where the two species breed.



Figure 20 : Mlaâbi reservoir with the presence of some waterbird species

- **Lebna reservoir (TN012)**

Considered as the biggest artificial reservoir of the northern Cap Bon region and it covers 1 000 ha. Flora species present in the area include *Phragmites communis*, *Typha angustifolia* and *Juncus* spp., which provide nesting habitat and cover for many waterbirds.

Birds species observed within the area include, as the case of Mlaâbi and Oued Hjar, the two species with global conservation concern *Oxyura leucocephala* (20–50 birds also winter) and *Marmaronetta angustirostris* (50–100 birds winter). It also attracts other breeding species, such as *Porphyrio porphyrio*, *Tachybaptus ruficollis*, *Podiceps cristatus*, *Fulica atra*. and *Elaeetus caeruleus*.

It is an important site for waterbirds species as *Plegadis falcinellus*, *Platalea leucorodia*, storks, waders and terns.

The site receives more than 20,000 individuals of waterbirds species such as *Anas platyrhynchos*, *A. acuta*, *A. penelope*, *A. clypeata*, *A. strepera*, *Aythya fuligula*, *A. ferina* and *Fulica atra*.



Figure 21 : Lebna reservoir with agricultural land (cereal farming)

- **Oued El Hjar reservoir (RAMSAR site NO2013)**

One of the biggest freshwater reservoir in Cap Bon region covering 254 ha and constructed to provide water for agricultural purposes (cereal farming, animal rearing, vegetable and tobacco cultivation).

Flora species present in the area include *Typha angustifolia*, *Tamarix* and *Juncus* species, which offers a suitable for nesting for many waterbird species.

The site is an important for migratory, nesting and wintering species, such as species classified as endangered and/or vulnerable like *Oxyura leucocephala* (up to a hundred in winter season, 20 individuals recorded in January 2009<sup>4</sup>) and *Marmaronetta angustirostris* (more than 4 000 in October 1999 according to Isenmann (2005)). This site is a favorite site for *Arythya nyroca*, *Oxyura leucocephala* and *Phoenicopterus roseus* and it provides a resting place for several migratory species during spring migration.

- **Sidi Abdelmoneem (IBA site TN008)**

A smallest man-made reservoir covering 250 ha, the natural vegetation present near the reservoir include *Phragmites australis*, *Typha angustifolia* and some *Juncus* species.

Considered as an important site in Cap Bon for nesting species, such as *Oxyura leucocephala* (VU) (around 15 to 80 pairs according to AAO and BirdLife statistics). *Marmaronetta angustirostris* (VU) also frequents and breeds in the area.

According AAO data, the reservoir is a favorite site for many other species of waterbirds such as *Anas platyrhynchos*, *A. querquedula*, *A. clypeata*, *A. acuta*, *Aythya ferina*, *Fulica atra* and *Porphyrio porphyrio*.

- **El Masri reservoir (TN015)**

The dam cover 150 ha and used for water-supply to the national grid, located in the Dorsale mountain of Tunisia near Grombalia town.

Flora species present include *Phragmites communis*, *Typha angustifolia* and *Juncus* species. The mountain slopes are clothed in a forest of *Tetraclinis articulata*.

*Oxyura leucocephala* (around 10 to 50 pairs) has been observed in the site. Other breeding species such as *Podiceps cristatus* and *Tachybaptus ruficollis* are likely to be observed in the area and also wintering species *Aythya ferina* and *Fulica atra*.

<sup>4</sup> Recensement des oiseaux d'eau Tunisia Janvier 2009, Association Les Amis des Oiseaux et Programme des Nations Unies pour l'Environnement Plan d'Action pour la Méditerranée

- **Aqueduct of Zaghouan (TN013)**

Considered as an historical roman aqueduct, as part of the water-supply system used in the past to supply water from Zaghouan to Carthage and composed of a 20 m high pillars and arches series. Many cavities and hole are present in the system and used by many bird and bat species.

Cavities and holes present in the aqueduct are used as nesting and roosting sites for *Falco naumanni* (30 pairs), *F. biarmicus*, *F. tinnunculus*, *Coracias garrulus*, *Petronia petronia*, *Sturnus unicolor* and *Corvus corax*.

- **Lagunes du Cap Bon Oriental – Korba (TN 014)**

A coastal lagoon located between Korba and Menzel Temime with over 12 km long. Is a lagoon chain with some part are dried up due to agriculture activities very present in the surrounding areas. Korba lagoon is a permanent waterbody and remain wet even in summer period through water recharge actions with treated waste-water from the waste plant of Korba.

Vegetation present include the following species *Ammophila arenaria*, *Erygium maritimum* and *Euphorbia paralias* and other halophytic vegetation such as *Arthrophytum* and *Salicornia species*.

Korba lagoon is an important stop-over site for migratory species during spring and autumn periods. Several waterbird species occur frequently and it include *Ardea cinerea*, *Egretta garzetta*, *Phoenicopterus ruber*, *Tadorna tadorna*, *Marmaronetta angustirostris* (around 40 to 100 birds), *Anas platyrhynchos*, *A. clypeata*, *A. acuta*, *Calidris minuta*, *Himantopus himantopus* (up to 250 pairs breed), *Charadrius dubius*, *C. alexandrinus* and *Recurvirostra avosetta*.

- **Sebkha of Soliman (TN011)**

A saltpan located between the town of Soliman and the sea. The vegetation is mainly halophytic and it includes *Arthrocnemum* and *Salicornia* and is considered as the first North African wetland coast for many migratory species during autumn period.

Many breeding species occurs in the region, such as *Marmaronetta angustirostris*, *Himantopus himantopus* and *Glareola pratincola*. Other species have been recorded also, among of them *Plegadis falcinellus*, *Tringa stagnatilis*, *Charadrius hiaticula*, *Pluvialis apricaria*, *Vanellus vanellus*, *Limosa limosa* and *Numenius arquata* and other wintering birds as *Phoenicopterus ruber* and several ducks.

- **Ghedir El Golla and Mornaguia reservoirs (TN007)**

A man-made reservoir, the dam cover an area of 300 ha surrounding by agricultural land. Constructed to supply water to the national water grid, the site is considered an important area for many bird species. The vegetation present is composed of *Phragmites australis*, *Typha angustifolia*, *Inula viscosa* and *Juncus species*. According to the AAO observations and surveys, *Oxyura leucocephala* is present throughout the year and may breed, although numbers are often highest in late summer and autumn. *Marmaronetta angustirostris* is regularly present in summer and probably breeds, as do *Tachybaptus ruficollis*, *Podiceps cristatus* and *Fulica atra*. The site also receives several species of birds in late summer, such as waders, *Glareola pratincola*, *Chlidonias niger*, *Sterna nilotica*; *S. Nilotica*, *Aythya nyroca* and *G. Pratincola*.

## Other sites

- **National Park of Boukornine**

Created in 1987 (Decree N°240 of February 17, 1987), the national park cover 1 939 ha with a high diversity of flora with 525 species including its two emblematic species *Cyclamen persicum* and *Tetraclinis articulata* (Thuya de Berbérie).

Wildlife richness includes more than 25 species of mammals, 50 species of birds, 16 species of reptiles and a significant number of invertebrates. Some bird species can be observed, such as diurnal raptors (Bonelli's eagle, golden eagle, Jean Le Blanc circaet, ferocious buzzard, European sparrowhawk and black kite) and nocturnal raptors (little owl, barn owl, great horned owl). Some sedentary and migratory species frequent the

park, such as the hoopoe, the rock pigeon, the turtle dove, the great cordon, the corn quail, the black-headed warbler, the robin, the skylark (Direction Générale de l'Environnement, 2006).

- **Jbel Zaghouan (National Park)**

Created in 2010 (Decree of March 29, 2010), the park cover 2 010 ha. Several types and ecological forms are represented in the area : forest, scrub, maquis, halophytes, chasmophytes, ect. Different types of cistus (*Cistus monspeliensis* L., *Cistus libanotus* L., *Cistus salviifolius* L. var. *vulgaris* Willk. et *Cistus villosus* L.), which are a sign of ecosystem degradation due to the effect of human pressure, in particular grazing activities. Three oak species can be observed, such as *Quercus coccifera* L., *Quercus ilex* L. and *Quercus suber* L.

Regarding fauna species, the most significant group present in the park is birds (PAG, 2007):

- Diurnal raptors: Golden eagle, Bonelli's eagle, Peregrine falcon, Ferocious hawk.
- Nocturnal raptors: Little owl, Barn owl, Tawny owl, Great horned owl.
- Wintering migrants: Sardinian warbler, European starling, Ruffed Blackbird.
- Some breeding species that occur in summer period: White stork, Black kite and White kite, Egyptian vulture, Alpine swift and Turtle dove.

- **Forest of Dar Chichou**

Dar chichou forest is an attractive site for the transit of migratory species, in particular during the spring migration. The site also provides a resting place for several bird species before passing through El Haouaria to continue the trip to Europe.

Scrubland "maquis" areas, which harbour a more significant floristic richness compared to that observed in forest plantations (Dar Chichou and Oued Abid) are important for some birds species, such as warblers, blackbirds, grassland species (larks, quail).

- **Chiba Reservoir**

An artificial dam constructed to ensure water supply for the national grid system and for agricultural purposes. It is not an IBA site but some waterbirds species have been reported often, such as the White-headed duck (*Oxyura leucocephala*)<sup>5</sup> and the Red crested Pochard (*Netta rufina*) observed in 2015 and reported by the AAO (Association les Amis des Oiseaux) association<sup>6</sup>.



Figure 22 : Oued Chiba reservoir

## 6.2.2 Key Biodiversity Areas (KBA)

Direct impact may affect five (5) from the fourteen (14) Key Biodiversity Area (KBA) sites identified in the large Aol. Other KBA sites still outside the buffer zone and likely to be less concerned. (Table).

<sup>5</sup> Cited in the "Elaboration du Registre National des Espèces Sauvages REGNES 2010" Study

<sup>6</sup> <https://northafricanbirds.wordpress.com/page/10/>

**Table 7: List of the Key Biodiversity Areas (KBA) identified in the extended Aol**

N°	Key Biodiversity Area (KBA)	Distance from Aol (km)	Typology	International Status
1	Barrage Oued El Hjar	0 km (inside Aol)	Artificial Wetland	Ramsar Area
2	Barrage Mlâabi	0 km (inside Aol)	Artificial Wetland	Ramsar Area
3	Barrage Abdelmoneem Sidi	0 km (inside Aol)	Artificial Wetland	Ramsar Area
4	Barrage Lebna	0 km (inside Aol)	Artificial Wetland	Ramsar Area
5	Barrage Chiba	0 km (inside Aol)	Artificial Wetland	
6	Barrage Bezikh	3 km	Artificial Wetland	
7	Barrage Masri	3 km	Artificial Wetland	
8	Barrage Mornaguia	7 km	Artificial Wetland	Ramsar Area
9	Lagune de Korba	6 km	Natural Wetland	Ramsar Area
10	Lagune de Soliman	5 km	Artificial Wetland	Ramsar Area
11	Jbel Boukornine	0.5 km	Mountain	
12	Jbel Zaghouan	14 km	Mountain	
13	Dunes de Ras El Melan	2 km	Coastal dunes	
14	Aqueduc de Zaghouan	0 km (inside Aol)	Archeological site	

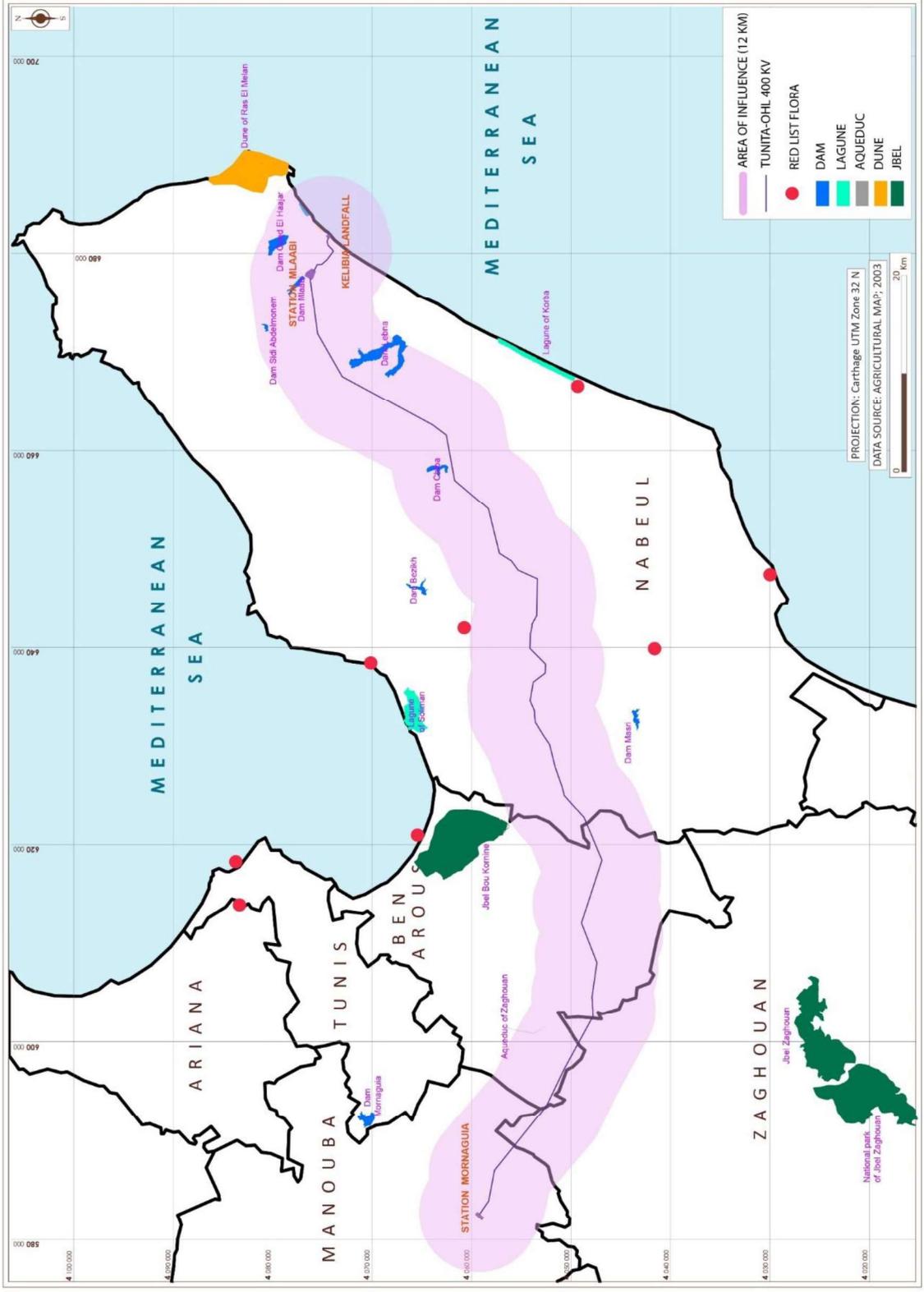


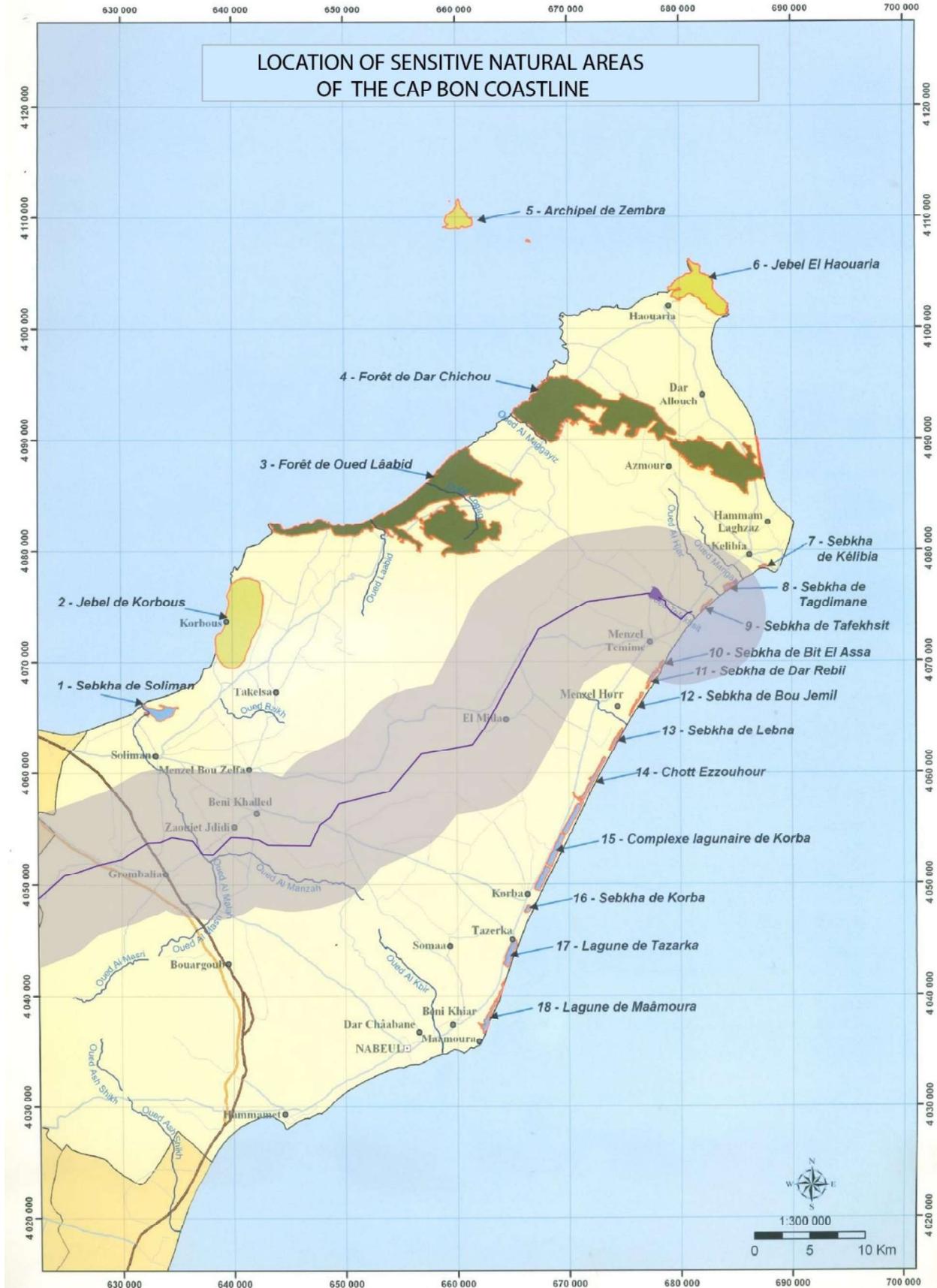
Figure 23 : Key Biodiversity Areas (KBA) and Red List Flora identified by the IBAT tool in the extended Aol

### 6.2.3 *Classified Sensitive Natural Areas*

From the classified sensitive natural areas of Cap Bon (APAL), four (4) coastal sebkha are included in the extended Aol: Sebkha de Tagdimane, Sebkha de Tafekhsit, Sebkha de Bit El Assa, Sebkha de Dar Rebi. No impact is foreseen for the five (5) other sites where the perimeter remains outside the project buffer zone.

**Table 8: Classified Sensitive Natural Areas**

Sensitive Natural Areas		Distance from Aol (km)
1	Archipel de Zembra	66 km
2	Korbous Mountain	18 km
3	Dar Chichou – Oued Laabid Forest	2 – 12 km
4	El Haouria Moutain	48 km
5	Coastal wetalands (Lagunes du Cap Bon Oriental (3 lagoons, 4 sebkhas)	5 – 36 km
	Coastal wetalands (Lagunes du Cap Bon Oriental (4 sebkhas)	0 km

**Figure 24 : Sensitive Natural areas of Cap-Bon**

### 6.3 Flora

Several plant species in Tunisia are threatened with extinction and are covered by national regulations to ensure their protection against existing threats. The following table presents a list of plant species threatened with extinction and covered by the Ordre of the Minister of Agriculture of July 19, 2006 (which represent only 3% of the total flora present in Tunisia).

**Table 9: Flora species threatened with extinction in Tunisia**

<b>Flora species threatened with extinction set by the Order of the Minister of Agriculture of July 19, 2006</b>		
<i>Castanea sativa</i>	<i>Periploca angustifolia</i>	<i>Henophyton deserti</i>
<i>Quercus afares</i>	<i>Poterium spinosum</i>	<i>Prosopis farcta</i>
<i>Cedrus atlantica</i>	<i>Prunus syriaca</i>	<i>Ziziphus spinachristi</i>
<i>Cupressus sempervirens</i>	<i>Sorbus aria</i>	<i>Rhus tripartitum</i>
<i>Acer monspessulanum</i>	<i>Withania frutescens</i>	<i>Stipagrostis pulmosa</i>
<i>Prunus avium</i>	<i>Anthyllis barba jovis</i>	<i>Stipagrostis ciliata</i>
<i>Celtis australis</i>	<i>Anthyllis henoniana</i>	<i>Stipagrostis obtuse</i>
<i>Ulmus compestris</i>	<i>Atriplex mollis</i>	<i>Cymbopogon schoenanthus</i>
<i>Pistacia atlantica</i>	<i>Rhamnus frangula</i>	<i>Dactylis glomerata</i>
<i>Acacia tortilis sp raddiana</i>	<i>Cenchrus ciliaris</i>	<i>Digitaria nodosa</i>
<i>Calligonum azel</i>	<i>Tricholaena teneriffae</i>	<i>Pennisetum dichotomum</i>
<i>Calligonum arich</i>	<i>Panicum turgidum</i>	<i>Pennisetum elatum</i>
<i>Calligonum polygonoides</i>	<i>Stipa fontasii</i>	<i>Pennisetum sotaceum</i>
<i>Cotoneaster racemiflora</i>	<i>Asphodelus acaulis</i>	<i>Colchicum autonnale</i>
<i>Spartidium saharae</i>	<i>Anarrhinum brevifolium</i>	<i>Ephedra alata alenda</i>
<i>Marrubium deserti</i>	<i>Rosa ssp</i>	<i>Helianthemum confertum</i>
<i>Orchis ssp</i>	<i>Viola ssp</i>	<i>Sporobolus marginatus</i>
<i>Tulipa ssp</i>	<i>Iris ssp</i>	<i>Cyclamen ssp</i>

The Study area falls within the sub-humid and semi-arid with mild winter, the terrestrial habitat is subject to human pressures and characterised by predominantly agricultural land (cereal, citrus orchards, vineyard, olive tree plantations, etc.) and some forest and scrubland areas (natural forest and plantations).

Inventory and identification efforts have shown that the vascular terrestrial flora comprises 2,163 species to which should be added all exotic species that have been introduced. Amongst this flora are found endemic Tunisian species, Tuniso-Algerian, Tuniso-Libyan and Saharan species. There are 20 Tunisian species, 13 sub-species and 9 varieties, 72 Tuniso-Algerian species, 8 sub species and 3 varieties, 6 Tuniso-Libyan species and 3 varieties.

In Tunisia, forest formations occupy 1.3 million hectares according to the statistics of the last National Forest Program (PFN, 2010) including all forest plantations done by the forest services. Naturel forest represent 368000 ha and they are essentially compose of the following species: Aleppo pine (200 000 ha); Cork oak (70 113 ha), Cedar "Thuya" (30 438 ha), Zeen oak (8 332 ha), Mixed oak species (14 220 ha), Maritime pine (5 153 ha), Holm oak (2 369 ha), Acacia tortillis radianna (7 574 ha), Afares oak (around 45 ha) and other overs an area of 29 756 ha (cypress, oleaster, kermes oak, caronb, etc.).

Forest formations affected by anthropic pressure, agriculture, pollution, deforestation, etc. are essentially composed of maquis and scrubland vegetation with or without tree covers. They cover 314 070 ha according to the PFN statistics of 2010.

Forest plantations cover an area of 311 080 ha, species most used in reforestation program in the country include the following: Aleppo pine, Ecalyptus, Acacia, Pinus pinastern Cypress, mixture of Eucalyptus and Acacia and other.

The management of forest sector is governed by the forestry code established in 1966 and revised in 1988 and some of its articles were subsequently amended several times between 2011, 2005 and 2009.

The Cap Bon peninsula is part of the semi-arid and sub-humid areas with abundant rainfall regime in general. This region is characterised by a fertile coastal plains that contrast with the hilly hinterland, in particular near the Jbel Abderrahmane region (around Beni Ayech where the OHL line exist). The plains are highly populated and intensively farmed, which is one of the causes of the aquifer's salinization phenomena observed in Cap Bon region.

Jebel Abderrahmane englobe a set of agro-sylvo-pastoral ecosystems and its farmed fields are succeeded by natural vegetation "maquis" occupied by Kermes oaks and other species, such as *Coridothymus Capitatus*, *Coris monspelliensis*, *Lavandula Stochas* and *Rosmarinus officinalis* facies. The scrubland with *Quercus coccifera* and *Erica Arborea* starts at an altitude of 300 m.

The area in which the project is located is characterized for the most part by agricultural land, urban area especially for the HDD and HVDC parts and some areas of the OHL line are occupied by natural vegetation (forest and scrubland).

The vegetation cover in the Cap Bon peninsula is adapted to the topography of the region where two major groups exist: forest and lagoon environments. The forest occupies 60 000 hectares and includes different types of trees, shrubs and other plant formations: oak, olive tree lentisks, carob trees and introduced species such as pine pignon (between Sidi Daoud and Dar chichou).

The maquis and scrubland occupy an important part of forest areas in Nabeul, characteristic of areas under human influence and whose forest has been disturbed by human activities. Areas affected by the passage of the OHL line are occupied by this type of natural vegetation and are home to species such as myrtle, oleaster, cedar berber, oak kermes, rosemary and geranium. The cedar of berberia "Thuya de Berbérie" and the oak kermes form the scrub and scrubland of Jbel Abderrahmane.

The forests of Dar Chichou, Oued Abid and Oued Ksab were created entirely by man as part of reforestation programs launched by the forestry services in the colonial era to ensure the fixation of the dunes and fight against silting. The forest of Dar Chichou is composed of different species: pines, eucalyptus, acacias, thyme, rosemary, lavender, oak kermes, oxycèdre, retam, juniper *Phoenicia* with some rare species such as broom and astragalus.

The lagoon environments the plant cover is dominated by a herbaceous stratum composed mainly of rush and clumps of chenopodiaceae (*Atriplex* and *Retam*) and *Tamarix*.

Zaghouan governorates is characterized by a diversity of natural habitats and rich vegetation cover with a mix between forest and grazing land used for extensive livestock. As for the Cap Bon, the topography contributes to the diversity of the natural vegetation of the region, where three sub-sets can be distinguished:

- Center of the governorate, where the Dorsale mountain is located with steep slopes and with several Jebels: Zaghouane mountain containing the national park of Zaghouane, Jbel Fkirine, Jbel Ben Saidane and Errouagueb. Jbel Zaghouane (1 295 m) is a national park, created in March 29, 2010 and it is a part of the tunisian Dorsale Mountain. Located at Zriba and Zaf=ghouane Delegations, the national park cover more than 2 010 ha. Occupied and exploited by human since antiquity, the park is a remarkable site for the richness of its flora and fauna, but also due to the presence of the "Temple des Eaux" site and the Aqueduct. Flora present in the area is dominated by species of scrubland and maquis with the presence of indicator species of declining of natural habitats due to various anthropic activities (overgrazing, forest fires, etc.), such as *Cistus monspeliensis*, *Cistus libanotus*, *Cistus salviifolius* var. *vulgaris* Willk. et *Cistus villosus*. Some oak species can be found in Zaghouane as *Quercus coccifera* and *Quercus ilex*.
- In the West: the valley of Kébir-Méliane with the plains of EL Fahs and Smindja.
- In the East: a mixed landscape with the plains of Jradou, Oued Errmel and the small hills of Jbel Mdeker and Jbel Khazal.

In zaghouan, the OHL will pass through the northern boundary of the governorate by the two delegations of Jbel El oust and Ain Asker. In the first delegation, the area crossed is characterized by the presence of scrubland and macquis with: myrtle, oleaster, rosemary and geranium.

Based on field visits made by the Consultant between Octobre and Decembre 2021, three types of habitats exist in the Project area:

- Farming land
- Forest and scrubland areas
- Wetland and water reserve



**Agricultural land (cereal, annual crop) on flat land near Menzel Temime (Nabeul)**



**Agricultural land (olive tree plantations) between Beni Ayache et Bir Drassen (Nabeul)**



**A tower (OHL 90 kV) installed in a vineyard near Menzel Bouzelfa Nord (Nabeul)**



**Two existing power transmission lines installed on agricultural land between El Mida et Menzel Temime**



**Forest area with pine and olive tree, and scrubland in the upper areas (Khanguet EL Hojjej, Nabeul)**



**Scrubland with Pistacia lentiscus (Between Kabouti and Jebel Ressay)**



**Wetland- Barrage Mlaâbi (RAMSAR and IBA site) near the CS and OHL**



**Wetland-Barrage Chiba (a key biodiversity area) located at 500 m from the OHL corridor**

The spontaneous flora of the Aol has more than 929 species, it is marked by the series of kermes oak (*Quercus coccifera*), juniper scrubland (*Juniperus phoenicea*) at the mounts, the bottoms of the valleys are covered by lentisks and oleasters.

The only specified vulnerable flora taxa *Leopoldia maritima* (VU) is largely extent in Tunisia (Ben Haj Jilani et al. 2020). The IBAT Tool allows identifying eight point of this red list specie in the extended Aol.

The agricultural land is divided between arboriculture (olive trees, vines and citrus fruits), followed by cereal and market garden crops.

#### 6.4 Fauna

Concerning fauna, invertebrates are not well known. Only 27 species of gastropods and 10 species of scorpionides are the most studied. Several hundred insects are known following detailed studies relating to their impacts on agricultural production (110 nematodes identified). In the case of vertebrates, 63 species of

reptiles and 362 species of birds are important players in biological diversity. Wild mammals are characterised by an original biogeography and a specific diversity (78 species).

The marine fauna is also little known, especially zooplankton and invertebrate populations (sponges, molluscs, crustaceans, echinoderms, etc.). The population of vertebrates is composed of marine mammals such as monk seals --which seem to have totally disappeared--, quite numerous marine birds especially in the Gulf of Gabes, sea tortoises which are protected, cartilaginous fish (59 species), bony fish (227 species in Tunisia out of a total of 532 in the Mediterranean).

In Tunisia, fauna group is exposed to anthropic activities (hunting, agriculture, urban expansion, etc.) since the end of the 19th century. Many species have disappeared and others are increasingly exposed to human pressures that cause the fragmentation of their habitats. Among these species, the following:

- *Hyaena hyaena* a large predator present in mountainous areas of the Tunisian Dorsale, especially in Chaambi National Park (Center of Tunisia).
- *Hystrix cristata* a large rodent and a nocturnal herbivore present also in mountainous habitats and forest areas in the north and center of the Country.
- *Leptailurus serval* present in the National park of El Feija.
- *Lutra lutra* a small carnivorous and semi-aquatic mammal, it can be founded in the permanent watercourses in the north of the Country, in particular in Oued Abid at around 16 km from the OHL corridor.
- *Genetta genetta* a carnivorous mammal of small size and it can be founded in various forest and mountainous areas of the Country, including Jebel Abderrahmen in Nabeul.

Protected fauna species in Tunisia, considered as rare and endangered, are presented in the following table:

**Table 10: Fauna species considered as rare and/or endangered by Tunisian legislation**

mammals	Avifauna	Reptiles
Bubalus bubalis	Anas Strepera	Emys orbicularis etmauremis leprosa
Cervus elaplus barbarous	Tadorna tadorna	Geckos (all species)
Addax nasomaculatus	Anas platyrhynchos	Agamas (all species)
Oryx dammah	Cygnus	Chamaeleo chamaeleo
Gazelle Dorcas	Porzana marginalis	Lizards (all species)
Gazella dama mhor	Larus (Géolands)	Skinks (all species)
Gazella leptoceros	Larus (Grèbes)	Snakes (all species)
Gazella cuvieri	Mergus	Naja haje
Ammotragus lervia	Porzana marginalis	Eryx jaculus
Acynonyx jubatus	Larus (Mouette)	Mantada ssp
Lutra lutra	Rallus	Phasma ssp
Monachus monachus	Sterna	Papillio ssp
Fennecus zerda	Pelecanus	Amphibians
Hyaena hyaena	Hydrobates pelagicus	Salamandra
Mustela nivalis	Puffinus puffinus	Bufo ssp
Leptailurus serval	Sula bassana	Hyla meridionalis
Lynx caracal caracal	Egretta garzetta	Ranucula
Cocidurra russula	Coconia ciconia	
Hystrix cristata	Phoenicopterus ruber	
Ctenodactylus goundi	Grus grus	

mammals
Toutes les espèces
Felis lybica
Recurvirostra avosetta
Calidris
Tringa
Cursorius
Glareola
Charadrius
Himantopus

Avifauna
Platalea leucorodia
Camelus camelus
Outarde houbara

Reptiles
----------

In the north-eastern region of the country, the most significant and emblematic group of fauna is birds (migratory and nesting) and it includes: raptors (golden eagle, bonelli's eagle, peregrine falcon, hawk, etc.) and nocturnal raptors (little owl, barn owl, great horned owl), wintering migratory birds (Sardinian warbler, European starling, ruffed blackbird and other), summer breeding migrants (white stork, buzzard, griffon vulture, falcons, sparrowhawk and limicoles and anatides. For mammals, various species are living in the park such as jackal, fox, striped hyena, mongoose, weasel and zorilla, lynx, etc. Jebel Zaghouan is also considered as a favorable zone for some bat species.

#### 6.4.1 Mammals, amphibians and reptiles

IBAT assessment identified some **mammals**, indicators of the ecological state of natural environments of the area: the weasel (*Mustela nivalis*), the otter (*Lutra lutra*) (NT), the porcupine (*Hystrix cristata*); other common species, are **amphibians**, among which the painted discus (*Discoglossus pictus*) and **reptiles**, including the tortoise (*Testudo graeca*), the snake (*Natrix natrix*) and the lizards (*Lacerta pater*) endemic to North Africa.

The **water plan** and rivers host the freshwater turtle (*Emys orbicularis*) and the freshwater crab (*Potamon algeriensis*), both endemic to North Africa.

#### 6.4.2 Bats

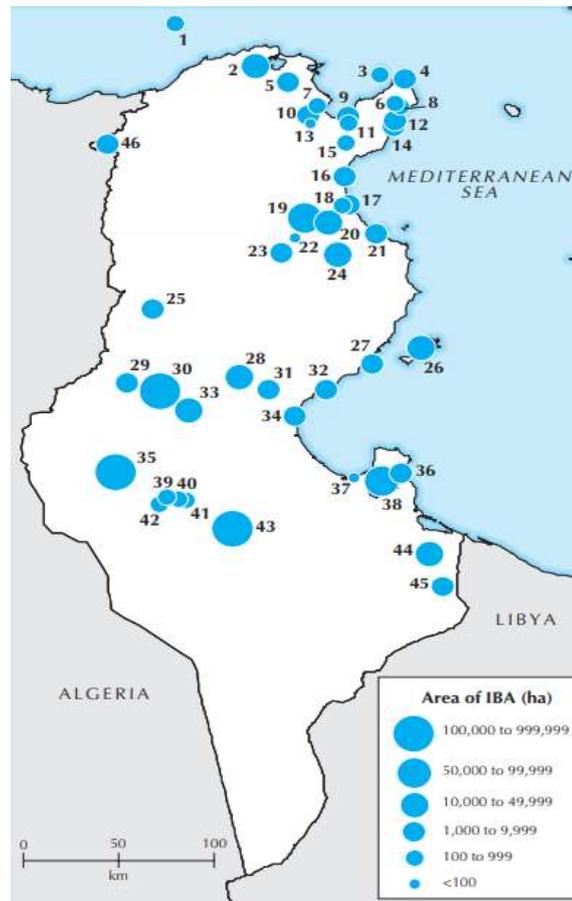
IBAT assessment also identified Bats fauna considered as poorly known among North African faunas with only 19 species recorded to date, as reported by Dalhoumi and al (2011 and 2014). Some of these species are identified, only a few individuals, in the study area in particular in mountain forest areas between Jebel Ressas (Ben Arous), Jebel Sidi Abderrahman (Nabeul) and Zaghouan (near the aqueduct and the national park).

Some bat species can be observed in the area crossed by the OHL line, especially in mountain and forest areas, (*Myotis capaccinii* (VU), *Miniopterus schreibersii* (VU), *Rhinolophus blasii* (LC)), etc. (in particular near mountain areas Beni Aych, Djebel Ressas and Zaghouan).

#### 6.4.3 Avifauna

With a large variety of wetlands and several of which are considered important sites or Important Bird Areas (IBA) for migratory and breeding birds. Wetlands include freshwater lakes, artificial dams, sebkhas and chotts (permanent or seasonal salt-lakes) and coastal lagoons.

Currently Tunisia has 46 Important Bird Areas (IBA), representing 7.6% of the total area of the country (around 12 529 km<sup>2</sup>). The following map shows the location of IBA sites in Tunisia, and as indicated on the map the study area (North East) is home to several sites of importance for birds:



**Figure 25 : Location and size of IBA areas in Tunisia (Amari and Azafzaf)**

According to AMARI and AZAFZAF, Tunisia has a varied avifauna of about 360 species including 160 breed among them nine species of global conservation concern have been recorded: Breeding species : *Oxyura leucocephala* (VU), *Marmaronetta angustirostris* (VU), *Falco naumanni* (VU) and *Larus audouinii* (CD) ; *Crex crex* (VU) recorder in small numbers during spring migration ; *Circus macrourus* (NT) ; *Aythya nyroca* (VU) a regular migrant and winter visitor but in small number ; *Numenius tenuirostris* (CR) and *Tetrax tetrax* (NT).

The Cap-Bon peninsula, including part from Ben Arous and Zaghouane governorates, is considered as an important feeding area and essential stopover for many migratory birds (birds-of-prey and large soaring birds, e.g. White Stork *Ciconia ciconia*) on their seasonal journeys between Europe and Africa across the Strait of Sicily . Based on AAO surveys, annually between March and May, 20 000 to 40 000 individuals of around 24 species of raptors fly over the peninsula.

In Cap-Bon region, the avifauna is one of the richest one in the country, according to the data collected by the AAO association (NGO that works for the protection of birds in Tunisia). The Cap Bon region contains several coastal lagoons and sebkhas with temporary water bodies, which fill up during the winter and dry up during the summer, except the sebkha of Soliman and the lagoon of Korba, which are characterized by a permanent water body throughout the year. These water bodies shelter a high biological wealth, including algae and microalgae, fish and birds (Amari and al).

Forest areas in the study area (scrub, natural forest, plantations) and wetlands provide a favourable habitat for several nesting and migratory species of birds. Forest plantation areas, especially in Dar Chichou and Rtiba, are mainly occupied by eucalyptus, pines, acacia and these offer a suitable environment for many Fringillidae species.

Important sites for bird species near the study area, in particular close to the CS and OHL line, are as follows:

Species classified as vulnerable or endangered, according to the red list of IUCN, and may be affected by the Project, in particular the OHL component, are as follow:

- **White-headed Duck (*Oxyura leucocephala*) (EN)**

Considered as a sedentary and wintering breeder, the species was regularly recorded in winter period in many wetlands (1 550 birds recorded in 1969 in Lac Sud de Tunis by M. Smart (Smart, 1992)). Since 1970, the oxyura has been reported in small numbers throughout the year on waterbodies reservoir, especially in Cap Bon region, with nesting evidence from Kairouan and Nord Est regions in the Country.

Species was regularly observed in great number in winter season and in different places along the Cap Bon region (Mlaâbi, Oued El Hajar, Sidi Abdelmonem, Lebna, Chiba, Mornaguia, etc.).

- **Marbled Teal (*Marmaronetta angustirostris*) (VU)**

The Marbled Teal is classified as vulnerable species according to the IUCN Red List. It is a species with a fragmented habitat, it can be found in Mediterranean and West Africa (3000-3500 individuals), in the Eastern Mediterranean (1000 individuals) (1000 individuals), SW Asia (5000-15000) and South Asia (5000 individuals). Population coming from the western Mediterranean (Spain, Morocco, Algeria and Tunisia) winters in North African and in other West African countries.

It is a species with a nomadic behavior which tends to leave disturbed areas to seek other more favorable sites. Bos et al (2000), reports that the population of this species has experienced a development since the 1990s due to the multiplication of freshwater wetlands in Tunisia (construction of new dams in the region of Cap Bon) and the migration of part of the population from eastern Algeria to the Tunisian wetlands.



**White-headed Duck (source: Otgonbayar Tsend)**



**Marbled Teal (source: Francis C. Franklin)**

Both species (White-headed Duck and Marbled Teal) are very present in the study area, on the whole wetlands of the region of Cape Bon and Ben Arous the two species have been recorded. They are considered as the most sensitive birds to collisions with power lines (Justo Martin et al, 2019)<sup>7</sup>.

- **Egyptian Vulture (*Neophron percnopterus*) (EN)**

A migratory breeder, has been recorded in several places in Tunisia, such as in the Hight Tell, the mounts of Teboursouk, in Jbel Ichkeul, near the mountains of the Tunisian Dorsale, in Cap Bon region (Jbel Labiod El Haouaria) and in other areas in central and southern Tunisia. The breeding population was estimated by Gaultier to be 100-150 breeding pairs and seems to be stable during the period 1975-1990 (in Isenmann et al. 2005).

The Egyptian vulture winters in tropical Africa. It migrates from August to February-March. However, there are also a few passages through Cap Bon during post-nuptial (late August to September) and pre-nuptial (February to March) migration. Most of the European migratory population passes through Gibraltar or the Bosphorus.

<sup>7</sup> Les oiseaux et les réseaux électriques en Afrique du Nord Guide pratique pour l'identification et la prévention des lignes électriques dangereuses

The Egyptian vulture is very vulnerable to power transmission line and highly exposed to electrocution and entanglement with electrical component of power transmission lines. In September 2010, 17 Egyptian vulture carcasses have been found under 31 km segment of a power transmission line in Sudan (0.055 dead bird per tower) (Angelow and al, 2012)<sup>8</sup>.



**Egyptian Vulture (source: Íñigo Fajardo)**

- **Saker Falcon (*Falco cherrug*) (EN)**

The Saker Falcon is a migratory bird and wintering in small numbers. According to Isenmann et al (2005)<sup>9</sup>, these are birds from the Balkans and especially from the south of Russia that migrate to tropical Africa as far as Senegal and pass and/or winter in Tunisia.

This falcon frequents wooded areas, tree steppes, plains and mountain areas (mountains of Tunisian Dorsale and Haouaria area).

In Mongolia, high mortality rates in Saker Falcons (*Falco cherrug*) have been recorded due to electrocutions which could significantly affect their populations, as reported by IUCN.



**Saker Falcon electrocuted (source Andrw Dixon)**

- ***Falco naumanni***

In Tunisia, the species has three ecological statuses : migratory breeder, passing visitor and wintering. For breeders category, small colonies (between 5-10 couples) are present in the Tunisian Dorsale mountains and in the High Tell. A few couples nest in Ichkeul national park and some colonies (20-30 couples) were reported on the banks of Mejerda (Bizerte). However all these observations are old. More recently, colonies have been established in the Aqueducts of Mhamedia, Oued Ellil (20 and 30 pairs respectively) and the amphitheater of El Jem. In sum 100-150 pairs between 1975-1990 (estimate by Th. Gaultier in Isenman 2005). The Tunisian population of Kestrel winters in tropical Africa with probably a few individuals wintering in Tunisia. Nevertheless, winterers are observed in the north and the region of Kairouan. For the passage migration, it

<sup>8</sup> Persistent electrocution mortality of Egyptian Vultures *Neophron percnopterus* over 28 years in East Africa

<sup>9</sup> Oiseaux de Tunisie / Birds of Tunisia. Société d'études ornithologiques de France

is the For the passage migration, it is the pre-nuptial migration which is the most marked, in particular in Cap Bon from mid-April to the end of May (Isenman and all, 2005).

The species have been recorded (30 pairs) in the Zaghouan aqueduct IBA site (TN013), where Falco use the cavities and holes present in the aqueduct as nesting and roosting sites.

The Falco naumanni is very vulnerable to power transmission line and highly exposed to electrocution and entanglement with electrical component of power transmission lines.



#### **Hanging of a Falco naumanni with electrical conductor (source: Íñigo Fajardo)**

**The project area is well concerned by avifauna:** around 71 bird species were inventoried in the area (AAO, 2013). The Cap Bon has always represented a privileged way of passage for the migratory flow of water birds on a global scale due to its geographical location (Sicily-Tunisian channel). The migratory flows of these birds are spectacular during the spring prenuptial passages.

Indirect impact zone may extends through varied agricultural and urban lands, likely to affect wadis (rivers) as well as natural wetlands and at reservoirs or dams (artificial wetlands) around. These sites make a network suitable for different birds' activities, breeding, nesting, feeding, and resting.

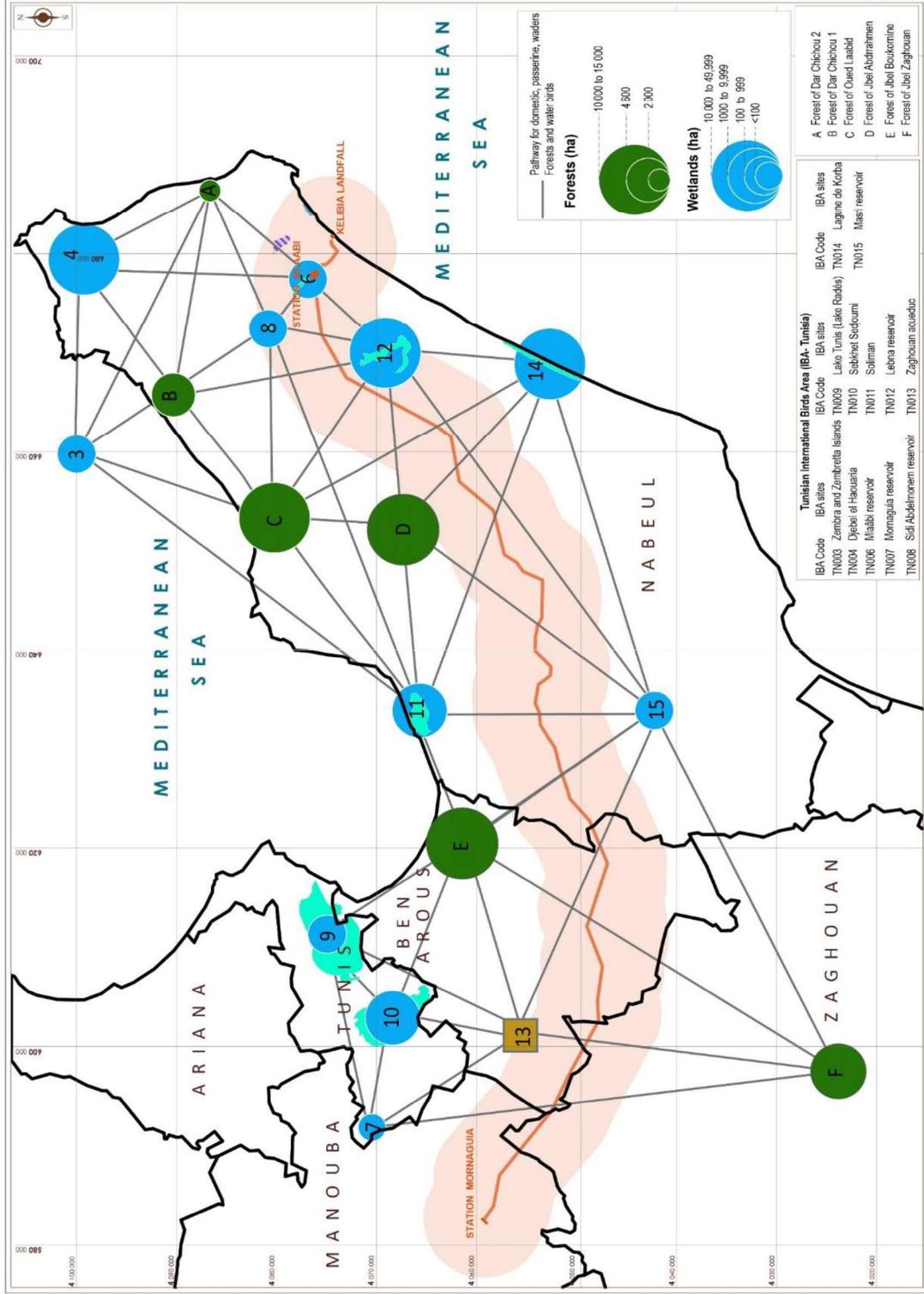
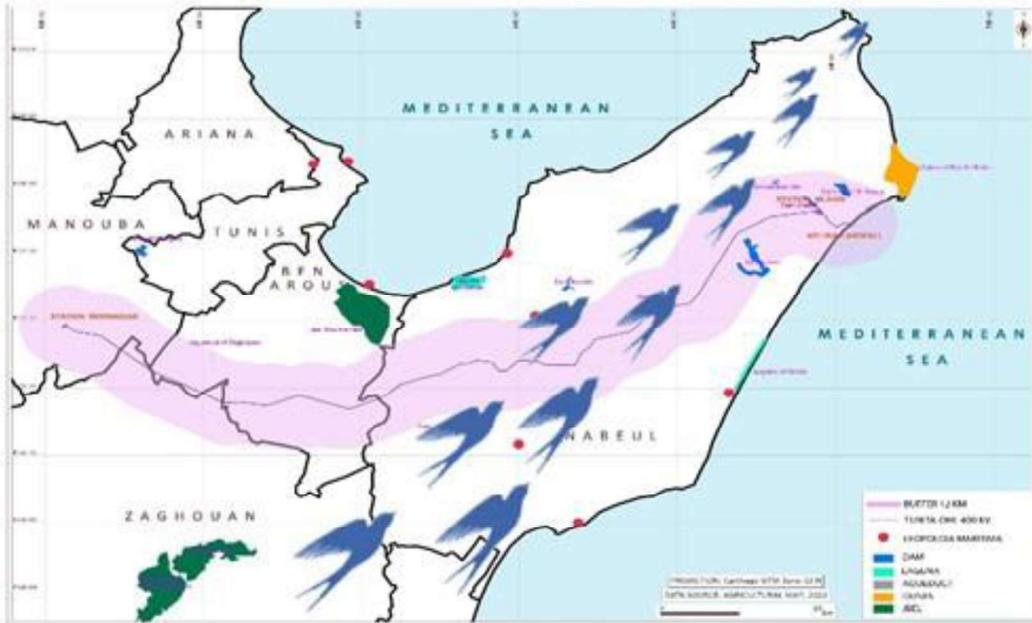


Figure 26 : Pathways for domestic, passerine, waders, forests and water birds

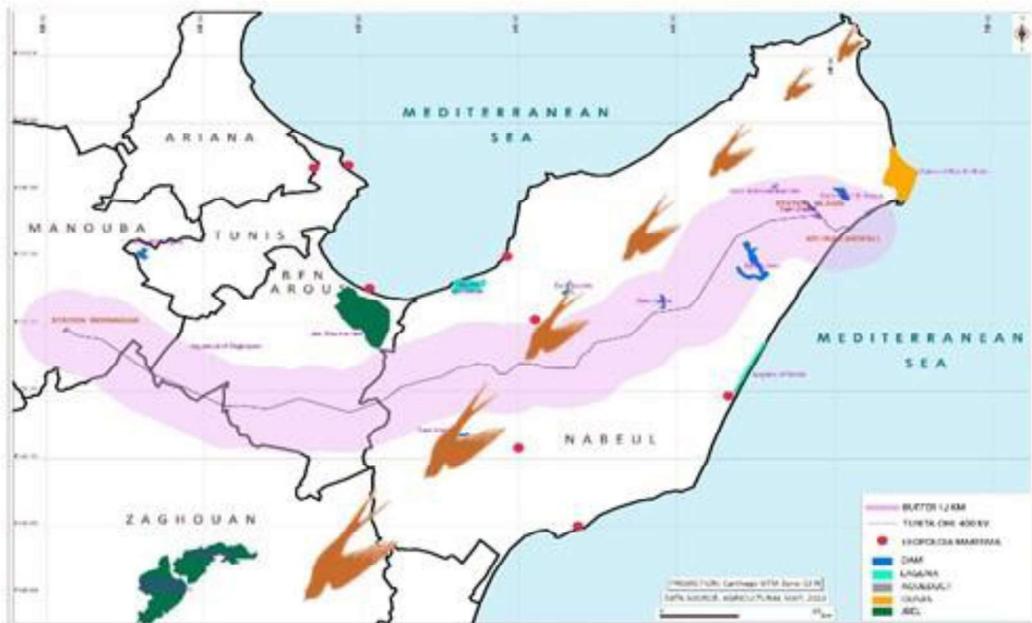
Usually, three (3) migratory flows can be identified:

- **The spring migration** which extends from March to June, with Africa-Europe direction. This migration is characterized by flights in flocks comprising a large number of individuals. Spring migration is rapid, and birds returning to their nesting grounds are therefore in a hurry to reproduce.



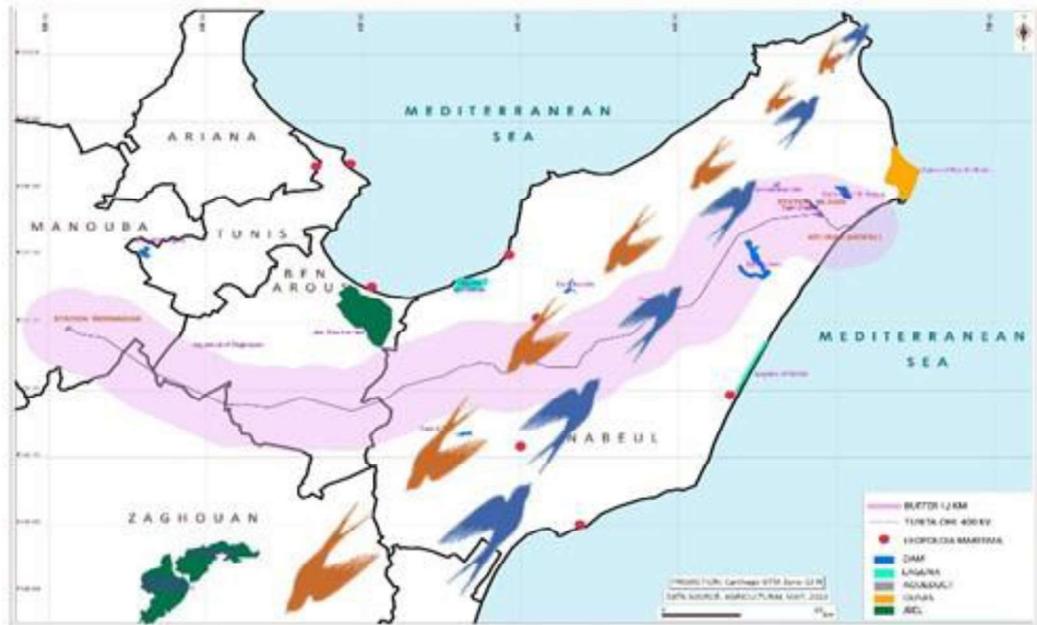
Spring migration

- **The autumn migration** which extends from September to November in the Europe-Africa direction. The birds that migrate during this period are much more dispersed with several stopovers along the way.



Autumn migration

- **The winter migration** of water birds (ducks, geese) starting by the end of November from Europe to Africa, and by the end of February for the comeback.



### Winter migration

**Figure 27 : Major migratory corridors across the project area**

**Many raptors** have been observed at this site: the booted eagle (*Hieraeetus pennatus*), the short-toed eagle (*Circaetus gallicus*), the honey buzzard (*Pernis apivorus*), the common kestrel (*Falco tinnunculus*), the black kite (*Milvus migrans*), marsh harrier (*Circus aeruginosus*), sparrowhawk (*Accipiter nisus*). Other sedentary nesting species such as white kite (*Elanus caeruleus*), ferocious buzzard (*Buteo rufinus*), are encountered.

Among the birds that frequent the wetlands four species requiring special attention:

- The slender-billed curlew (*Numenius tenuirostris*);
- The Audouin's gull (*Larus audouini*);
- The white-headed duck (*Oxyra leucocephala*);
- The marbled teal (*Marmaronetta angustirostris*).

Further to the eleven (11) wetlands designed Ramsar sites adjoin the project area, the closest IBAs are eight (8) sites, between 0.5 and 33 km from the project route: Zembra and Zembretta (TN003) Mlaabi dam (TN006), Sidi Abdelmoneem dam (TN008), Lobna dam (TN012) , El Masri dam (TN015), Korba lagoon (TN 014) Sebkhia Soliman (TN011), Sebkhia Sijoumi (TN010).

The flight altitude is highly variable depending on the species, ranging from tens to hundreds of meters above the ground. Some species fly very high, including geese and cranes which have been seen between 3000 and 5000 meters above sea level.

The raptors evolve at a few hundred meters in height when the wind is moderate, but they approach the ground in strong winds.

Migrations are diurnal in raptors, storks, cranes, swallows, swifts and grain-eating birds, nocturnal for several waterbirds.

The birds likely to be observed along the OHL reach thirty (30) species, with a flight height ranging from 10m to 300m. According to sizes and taxonomic status, two major groups can be considered: Raptor and Passerine, waders, water and domestic birds. The first group evolves more or less beyond the height of the OHL, while the second evolves rather below the lines with multiple movements between the different habitats of the area.

Considering the flight height, the collision risks for the first group are mainly moderate for the first group at mainly low or neglected for the second groups (See tables below)

**Table 11: Ecological status, risks and flight height ranges common birds on the area**

Species	Ecological status: M: Migratory, N: Nesting, S: Sedentary	Flight height (m)	Collision risk for flights in flocks
<b>Raptors</b>			
Sparrowhawk <i>Accipiter nisus</i>	M : Raptor	20- 30	moderate
Short-toed Eagle <i>Circaetus gallicus</i>	N : Raptor, rare and protected species	20- 50	moderate
Milan black <i>Milvus migran</i>	M : Raptor, protected species	20-40	moderate
Long-legged buzzard <i>Buteo rufinus</i>	S : Raptor, vulnerable and protected species	20- 40	moderate
Common Buzzard <i>Buteo buteo</i>	M : Raptor		
Western marsh harrier <i>Circus aeruginosus</i>	SN : Raptor	40	Neglected
Montagu's Harrier <i>Circus pygargus</i>	M : Raptor	50	neglected
Honey buzzard <i>Pernis apivorus</i>	M : Raptor, protected species	30-100	moderate
Black-winged kite <i>Elanus caeruleus</i>	N : Small raptor	15- 40	moderate
Booted eagle <i>Hieraaetus pennatus</i>	M : Raptor	200	neglected
Egyptian vulture <i>Neophron percnopterus</i>	M : Raptor	100	neglected
Peregrine Falcon <i>Falco peregrinus</i>	S: diurnal raptor threatened, rare and protected	30- 50	moderate
Common kestrel <i>Falco tinnunculus</i>	S: diurnal Raptor, expanding and protected	30 - 40	moderate
Raven <i>Corvus corax</i>	N : Raptor	20- 40	moderate
<b>Passerine, waders, water and domestic birds</b>			
Cattle Egret <i>Bulbucus ibis</i>	S : Wader, endemic species	15- 20	neglected
Little Egret <i>Egretta garzetta</i>	S ; Wader, vulnerable and protected species	15- 30	moderate
Gray Heron <i>Ardea cinerea</i>	NM : Wader	20- 25	low
Turtle Dove <i>Streptopelia turtur</i>	N : passerine	15- 30	moderate
Mesh Dove <i>Spilopelia senegalensis</i>	NS : passerine	50- 300	neglected
European bee-eater <i>Merops apiaster</i>	M : Passerine	30-150	low
Hoopoe <i>Upupa epops</i>	NS : Passerine	30	moderate
Starling <i>Sturnus sp</i>	NS : Passerine	30	moderate
BlueBird <i>Monticola solitarius</i>	NS : Passerine	10	neglected

Species	Ecological status: M: Migratory, N: Nesting, S: Sedentary	Flight height (m)	Collision risk for flights in flocks
Window swallow <i>Delichon urbicum</i>	M : passerine	20	neglected
Crested Lark <i>Galerida cristata</i>	NS : passerine	15- 20	neglected
Rock Pigeon <i>Columba livia</i>	NS : Domestic	20- 30	moderate
White Stork <i>Ciconia ciconia</i>	M : Grand voilier	30	
Black Stork <i>Ciconia nigra</i>	M : Grand voilier	100-150	Neglected
Blossy ibis <i>Plegadis falcinellus</i>	M : Water bird	30-150	low

**For large migration**, we can consider a major collision risk zone that extends over 23 km through the OHL where the migratory flow is channeled between the Tunisian dorsal and the Gulf of Hammamet.

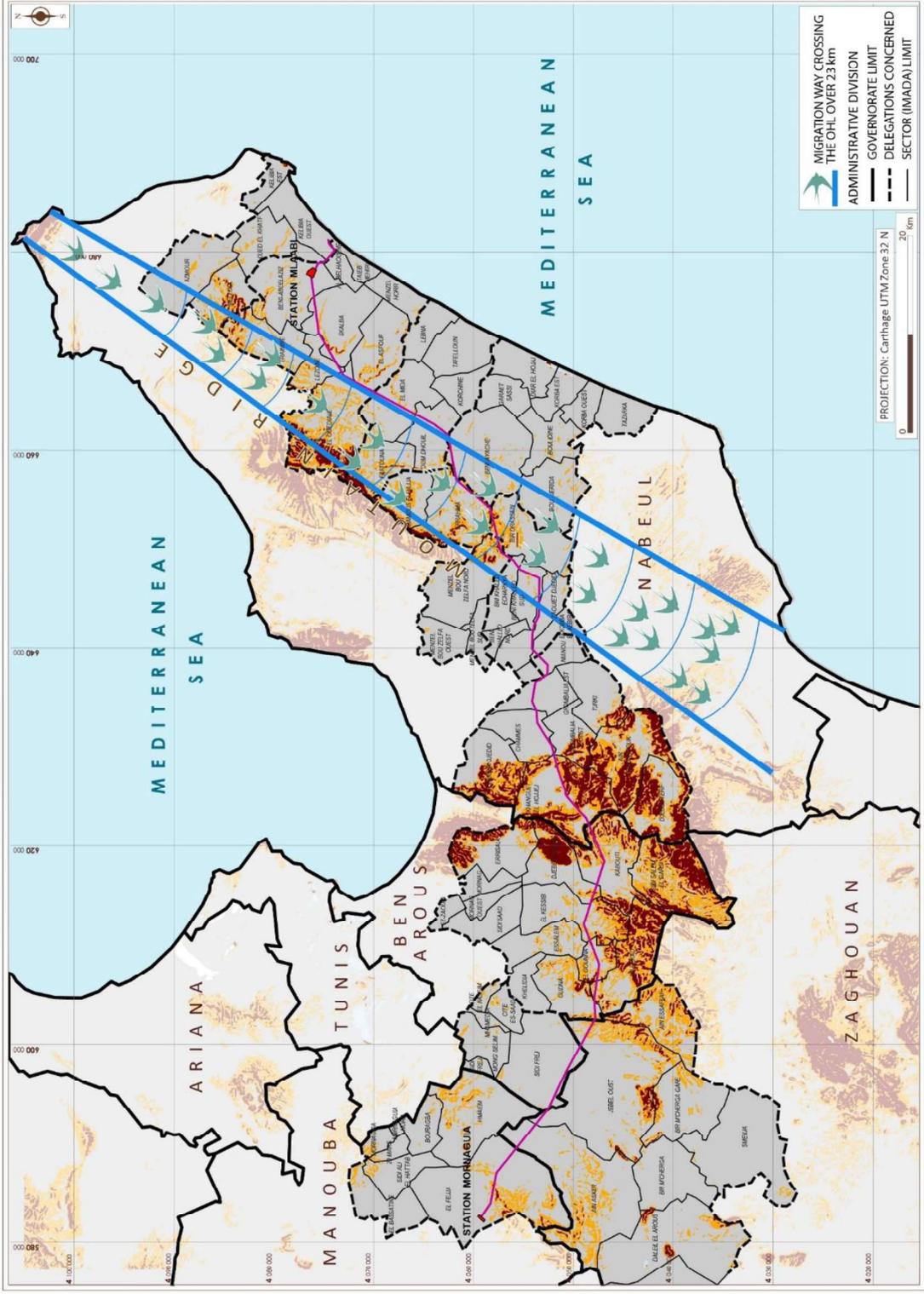


Figure 28 : Migration corridor and Major collision risk zone

#### 6.4.4 Other species

IBAT assessment also identified some reptile, fish (freshwater category) and fungi species that may be affected by the Project (CS and OHL), as presented in the following table.

**Table 12: Other fauna species identified by IBAT Tool**

Species	IUCN status	Distribution	Presence in Project area	Risk of significant impacts from the Project
Punican Bleak ( <i>Anaocypris punica</i> )	CR	This fish is endemic to the upper Medjerda River catchment in Tunisia and Algeria (only two small highly fragmented subpopulations remaining where they inhabit small-to-medium-sized intermittent hill streams in forested areas) but its extant distribution is poorly understood (Freyhof & Ford, 2022a). Major threats include pollution and excessive abstraction of ground and surface water, as well as the construction of dams.	Not reported	Low
Tunisian Bleak ( <i>Tropidophoxinellus chaignoni</i> )	EN	This fish is known from five locations in northeastern Tunisia only (Freyhof & Ford, 2022b), between the Meliane River south of Tunis to tributaries of the Sebkhia lake in Souss Governorate, including the Abid and Lebna rivers on the Cape Bon Peninsula. It prefers low altitude, slow-moving stretches of rivers and tributaries. It is unclear whether it has successfully colonised the numerous artificial reservoirs created by dam construction within its range. Major threats include pollution, excessive abstraction of ground and surface water, and dam construction	Not reported	Low
<i>Thorectes puncticollis</i>	EN	This insect has a distribution restricted to sandy soils with xerothermic scrublands at low altitudes in Algeria, Tunisia and Libya. In Tunisia, it has been recently reported from new localities in Sousse, Sfax, Kairouan and Tataouine. Historical records from Tunis correspond to a subpopulation which have probably disappeared, due to the expansion of the city (IUCN)	Not reported	Low
Blanc's Fringe-toed Lizard ( <i>Acanthodactylus blanci</i> )	EN	This lizard is known from coastal, and some inland, regions of northwestern and northeastern Tunisia, and northern Algeria, between sea level up to 900 m asl. It is found in semi-arid habitats with open vegetation, at	Not reported	Low

Species	IUCN status	Distribution	Presence in Project area	Risk of significant impacts from the Project
		coastal sites, in dunes with plant growth, and in areas of clay substrate with shrubs or sparse Eucalyptus plantations. It has also been recorded from pine forests.		
North African Shad ( <i>Alosa algeriensis</i> )	EN	This fish is anadromous <sup>10</sup> fish is endemic to Northern Africa and Western Sardinia costs, including coastal lagoons and rivers. Some unconfirmed subpopulations might be landlocked residents of artificial freshwater lakes (Freyhof & Ford, 2022b).	Not reported	Low
Collybie méditerranéenne ( <i>Laccariopsis mediterranea</i> )	EN	Rare fungus growing in coastal dune habitats in the western Mediterranean, including Sicily (usually their habitats are Natura 2000 sites 'Coastal dunes with Juniperus spp')	Unknown	Low

## 6.5 Flag species

The red list extract from IBAT assessment covers largely the country, with 59 species represented by 5 terrestrial and 5 marines groups (Table below).

<sup>10</sup> A fish migrating up rivers from the sea to spawn. The opposite of catadromous.

**Table 13: Flag list species identified by IBAT in the Aol**

Group	Number of species	List of species	Status in Aol	Reference
<b>Mammalians</b>	<b>2</b>	<i>Ammotragus lervia</i>	Ammotragus lervia (Bovidae, Caprini): still present by few populations remain, especially in protected areas, those of Bougarnine and Zaghouan park are considered outside the buffer zone	Mimoun, J., Cassinello, J. & Nouira, S. 2016. Update of the distribution and status of the aoudad <i>Ammotragus lervia</i> (Bovidae, Caprini) in Tunisia. V - 81 Mammalia DO - 10.1515/mammalia-2015-0069
		<i>Panthera pardus</i>	<i>Panthera pardus</i> : the last individual in Tunisia would have disappeared in 1930	Burhan M. Gharaibeh 1997 : Systematics, distribution, and zoogeography of mammals of Tunisia, Lubbock, <a href="#">Université Texas Tech</a> , 1997, 354 p
<b>Reptiles</b>	<b>3</b>	<i>Chelonia mydas</i>	The <i>Acanthodactylus blanci</i> , is lizard specie of the semi-arid bioclimatic stage present in the sandy biotopes of the coastal dunes including those of Kelibia.	Saïd Nouira S. and Ch. Blanc. 2003 : Distribution spatiale des Lacertidés (Sauria, Reptilia) en Tunisie ; caractéristiques des biotopes et rôle des facteurs écologiques <a href="#">Ecologia Mediterranea (29-1)</a> pp. 71-86.
		<i>Dermochelys coriacea</i> <i>Acanthodactylus blanci</i>	Gomphus lucasii (VU), the clubtail classified as vulnerable species who needs permanent or temporary pond to be protected as much as possible	Jödöcke, Reinhard J., Arlt, J., Kunz, B., Lopau, W., Seidenbusch, R. 2000: The Odonata of Tunisia JO - International Journal of Odonatology. VL - 3. DO - 10.1080/13887890.2000.9748135.
<b>Insects</b>	<b>4</b>	<i>Neomarius gandolphii</i> <i>Thorectes puncticolis</i> <i>Thanasimodes dorsalis</i>	Three beetles signalised are more or less present in the area <i>Neomarius gandolphii</i> (EN) and <i>Thorectes puncticolis</i> and <i>Thorectes puncticolis</i> . The fourth specie <i>Thanasimodes dorsalis</i> ( VU) is not reported in the area.	ONAS 2019: Stations d'épuration des eaux usées en Tunisie: Evaluation de la biodiversité selon la norme de performance. Rapport principal Volume I. 90p.

Group	Number of species	List of species	Status in Aoi	Reference
<b>Bats</b>	<b>2</b>	<p><i>Rhinolophus mehelyi</i></p> <p><i>Miniopterus schreibersii</i></p>	<p>Bats list are signalized in area especially in mountain and forest areas. Species are <i>Rhinolophus mehelyi</i> (VU) (<i>Myotis capaccinii</i> (VU), <i>Miniopterus schreibersii</i> (VU), <i>Rhinolophus blasii</i> (LC)).</p>	<p>Ridha Dalhoumi, Patricia Aissa, Stephane Aulagnier. Taxonomic status and distribution of Tunisian bats. <i>Revue Suisse de Zoologie</i>, 2011, 118 (2), pp.265 - 292. (hal-02642620)</p>
<b>Flora</b>	<b>12</b>	<p><i>Rumex algeriensis</i> (plantae)</p> <p><i>Serapias stenopetala</i></p> <p><i>Juncus sorrentinii</i></p> <p><i>Pilularia minuta</i></p> <p><i>Epilobium numidicum</i></p> <p><i>Rhynchospora modesti-lucennoi</i></p> <p><i>Rumex tunetanus</i></p> <p><i>Damasonium polyspermum</i></p> <p><i>Lepidium violaceum</i></p> <p><i>Stipa tenacissima</i></p> <p><i>Leopoldia maritima</i></p> <p><i>Tettigonia savignyi</i></p>	<p>The flora list, 12 species are mainly common in Tunisia, with two classified vulnerable species <i>Stipa tenacissima</i> and <i>Leopoldia maritima</i>.</p>	<p>Ben Haj Jilani, I., Domina, G. &amp; Véla, E. 2020. <i>Leopoldia maritima</i>. The IUCN Red List of Threatened Species 2020: 91974011A91974139. <a href="https://dx.doi.org/10.2305/IUCN.UK.2020-2">https://dx.doi.org/10.2305/IUCN.UK.2020-2</a>.</p>
<b>Fungus</b>	<b>1</b>	<p><i>Laccariopsis mediterranea</i></p>	<p><i>Laccariopsis mediterranea</i> saprotrophic rate fungus growing in coastal dune habitats, with <i>Juniperus</i> spp." and "Shifting dunes along the shoreline with <i>Ammophila</i>. These habitats are subject to severe threats from climate change, urbanization and other human activities</p>	<p>Gisotti, D. 2019. <i>Laccariopsis mediterranea</i>. The IUCN Red List of Threatened Species 2019: e.T157150127A157150208. <a href="https://dx.doi.org/10.2305/IUCN.UK.2019-3">https://dx.doi.org/10.2305/IUCN.UK.2019-3</a></p>

Group	Number of species	List of species	Status in Aol	Reference
<b>Birds</b>	<b>11</b>	<i>Oxyura leucocephala</i> <i>Marmaronetta angustirostris</i> <i>Aythya ferina</i> <i>Streptopelia turtur</i> <i>Numenius tenuirostris</i> <i>Larus audouinii</i> <i>Falco vespertinus</i> <i>Falco cherrug</i> <i>Puffinus yelkouan</i> <i>Puffinus mauretanicus</i>	Among 11 birds listed, 5 species may occur in the considered area of influence (Aol): <i>Oxyura leucocephala</i> , <i>Marmaronetta angustirostris</i> , <i>Streptopelia turtur</i> , <i>Numenius tenuirostris</i> , <i>Larus audouinii</i> the population of <i>Puffinus yelkouan</i> in Zembra islands.	STEG 2013 : <i>Etude de suivi de l'avifaune de la centrale éolienne de Sidi Daoud. Rapport final. Juillet 2013. 89p.</i>

## 6.6 Ecosystem services

Ecosystem Services (ES) are the direct and indirect contributions of ecosystems to human well-being. They are the benefits that people, as well as businesses, derive from ecosystems. These are: (1) provisioning services; (2) regulating services; (3) supporting services; and (4) cultural services.

Ecosystem Services valued by humans are often enabled through biodiversity and therefore impacts on biodiversity can often impair the provision of these services.

Ecosystem Services are linked to the key components of the ecosystem along the 113 km of the OHL route, which are:

- ✓ Forest areas;
- ✓ Wetlands;
- ✓ Agricultural areas (irrigated perimeters, farmland, Pastureland);
- ✓ Natural areas (bare ground);
- ✓ Urban areas.

Considering the ecologically appropriate area of analysis, the areas relating to these zones are estimated as follows.

**Table 14: Ecosystemic services in the Project Aol**

Land Occupations	Land uses activities	Surface Area (ha)	Percentage
Urban area	Human activities	5 899	4.1%
Forest	Biodiversity, forestry	19 271	13.2%
Bare ground	Biodiversity	631	0.4%
Irrigated perimeters	Agriculture	4 325	3.0%
Wetlands	Biodiversity, Irrigation, Fisheries	1 042	0.7%
Farmland	Agriculture	113 097	77.7%
Pastureland	Agriculture pastoralism	1 310	0.9%
<b>TOTAL</b>		<b>145 575</b>	<b>100%</b>

The inventory of the ecosystem services output from the area affected by the OHL project reveal the relatively low importance of forest, wetlands and natural zone that represent successively 13%; 0.7% and 0.4 %. The major OHL buffer still over modified areas (agricultural or urban which represent 82.3% and 4.1%).

According to this, the ecosystems services still not vulnerable. Mitigation measures must focus on the minimization of the duration of field works and the work seasons which should less interfere with these services such as: birds migration, pollination or recreational and tourism services. Secondly, the mitigation may be reinforced by the reforestation of all modified zones taking into account the original vegetation cover.

The table below gives an analysis of the Ecosystem Services output from the project area, risks and mitigation measures.

**Table 15: Ecosystem services output from the project area, threat and mitigation measures**

	<b>Services</b>	<b>Areas</b>	<b>Risks</b>	<b>Mitigation measures</b>
<b>Regulating services</b>	Local climate regulation	W F	L	Rr Rf
	Air purification	F A	L	Rr Rf
	Water purification	W F	L	Rr Rf
	Absorption of releases	W	L	Rr Rf
	Flood and drought mitigation	W F	L	Rr Rf
	Soil fertility	F	L	Rr Rf
	Degradation of organic matter	W	L	Rr Rf
	Soil decontamination	W	L	Rr Rf
	Erosion control	F A	L	Rr Rf
	Pollination	F A	L	Rr Rf
	Seed dispersal	F	L	Rr Rf
	carbon storage and sequestration	F W A	L	Rr Rf
	Barrier effect	F	L	Rr Rf Rn
	noise reduction	F	M	Rr Rf Rn
<b>Provisioning services</b>	food supply	W A	L	Rr Rf
	Fresh water supply	W	L	Rr Rf
	Fuel supply	F	L	Rr Rf
	Material supply	F N	L	Rr Rf
	Useful animals	W A F	L	Rr Rf
	Supply of medicinal species	F N	L	Rr Rf
	Source of genetic resources	F	L	Rr Rf
<b>Cultural services</b>	Calming factor	F W N		Rr Rf
	Way of travel	F A		Rr Rf
	Recreational and tourism potential	F W N		Rr Rf Rn
	Landscape aesthetics	F W N		Rr Rf
	Source of artistic inspiration	F W N		Rr Rf
	Scientific interest	F W N		Rr Rf
	Educational potential	F W N		Rr Rf
	Cultural Heritage	F W N		Rr Rf
	Existence value	F W N		Rr Rf



Services		Areas	Risks	Mitigation measures
	Bequest value	F W N		Rr Rf
<i>Supportin</i>	Biodiversity: species and habitats	F W N		Rr Rf
	Nutrient cycling	F W N		Rr Rf
	Resistance to biotic and abiotic stresses	F W N		Rr Rf

**Areas:** W = Wetland; F= Forest; A = Agriculture; N = Natural

**Risks due to OHL:** L = low; M = Moderate, H = High

**Measure:** Rr = Reduce works duration; Rf = Reforestation; Rn = Respect for norms

## 7. NOISE

### 7.1 Applicable standards

Noise legislation in Tunisia include the following:

- The Decree N°84-1556 of December 29, 1984 related to noise generated by industrial activities, it regulate noise level for industrial areas and units. Its article 26 sets the level of 50 dB as a limit value to not exceed during daytime by an industrial activity. This decree is applicable for the present project, in particular for the HDD landfall activities in Kélibia and for the construction and operation of the Mlaâbi CS. The first one will be located in the existing industrial zone of Menzel Yahia and the second component will be developed within the proposed industrial zone of Mlaâbi.
- The Highway Code in relation with noise emission from vehicles, which prohibiting the use of multiple or high-pitched sound generators and the free exhaust of gas and pollutants and it sets limit values of noise for each type of vehicle. This Code is applicable for the present project as the construction and operation activities will use several types of vehicle.
- The Order of the Ministry of Public Health and Social Affairs of January 10, 1995 related to noise in workplace. The Order sets the daily noise exposure level at 85 dB.
- The Order of the Municipality of Tunis of August 22, 2000 which sets the limit values of noise within the area covered by the communal space. It is important to note that Tunis is the only council in Tunisia that has a specific regulation on noise.

The interconnector project will cross four governorates: Nabeul, Ben Arous, Zaghouan and Manouba. None of these governorates has a regulatory framework applied at local level. Consequently, at National level the noise limits applicable to the Project are those set by the Order of the Municipality of Tunis.

The following table shows the noise limit values as per the municipal decree of the Municipality of Tunis setting the regulation of noise pollution control.

**Table 16: Noise level set by the Order of the Municipality of Tunis**

Zone	Limit values (dB)		
	Night	Period between day-night (6-7 am and 8-10 pm)	Day
Medical centre, recreation area and natural protected areas	35	40	45
Residential areas (sub-urban) with low traffic flow	40	45	50
Urban residential areas urban	45	50	55
Residential areas (urban or sub-urban) with commercial, business centre and workshops and with high traffic flow	50	55	60
Zone dominated by commercial, industrial or agricultural areas	55	60	65
Zone dominated by heavy industry	60	65	70

In addition to the national legislation, The World Bank Group (WBG) General EHS Guidelines (WBG, 2007) provide guidance on acceptable noise levels to residential and other sensitive receptors, as shown in the following table:

**Table 17: WBG's General EHS Guidelines guidance on acceptable noise levels to residential and other sensitive receptors (WBG, 2007)**

Receptor	One Hour Laeq Db	
	Daytime (07:00 To 22:00)	Night-Time (22:00 To 07:00)
Residential, Institutional, Educational	55	45
Industrial, Commercial	70	70

## 7.2 Baseline conditions

### ❖ HDD work site (Kelibia landing point)

The HDD work site is located inside an existing industrial zone of Menzel Yahia, where only two sardine industrial units are in operation) and its surrounding is rural. The chosen area is close to the sea, which influences the noise environment of the area. The area is located at only 700 m from the residential areas along the MC27 regional road linking Menzel Temime to Kelibia municipalities.

The prevailing noise climate is dominated by man-made sources. Day-time noise sources are predominately characterise by workers of the two fish factories present in the area and delivery trucks and vehicles. Night-time noise sources are predominately characterised by the sea waves and low traffic that can be observed on the MC27 road and houses located there.

Between October 31 and November 2, 2022, a noise survey was performed for the area surrounding the HDD site of Kelibia. Three receptors was selected around the HDD site as shown in the following figure:

**Table 18: Description and location of the chosen receptors for noise monitoring**

Receptor ID	Coordinates		Description
	Latitude	Longitude	
R1	36° 47' 59.75" N	11° 2' 10.78" E	Near the industrial zone of Menzel Yahia Considered a Zone dominated by commercial, industrial or agricultural areas (National standard) and as an industrial and commercial area (WBG)
R2	36°48'14.01"N	11° 2'32.36"E	An isolated settlement used during summer time Considered a Zone dominated by commercial, industrial or agricultural areas (National standard) and as an industrial and commercial area (WBG)
R3	36°48'18.69"N	11° 1'51.43"E	Residential area located at 700 m from the HDD site (along the MC27 road) Considered as a Residential areas (urban or sub-urban) with commercial, business centre

Receptor ID	Coordinates		Description
	Latitude	Longitude	
			and workshops and with high traffic flow (National standard) and as a Residential, Institutional, Educational (WBG)



**Figure 29 : HDD site of Kelibia and the three selected receptors for noise monitoring**

The results of noise monitoring are as follows:

**Table 19: Results of the noise monitoring**

Receptor ID	Measurements		National limits (Order of the Municipality of Tunis)		WBG Noise Level Guidelines	
	Day Time (dB(A))	Night Time (dB(A))	Day Time (dB(A))	Night Time (dB(A))	Day Time (dB(A))	Night Time (dB(A))
R1	30	34.7	65	55	70	70
R2	36	38.2	65	55	70	70
R3	48.7	44.8	60	50	55	45

❖ **HVDC underground cable**

The HVDC cable will link the junction box (HDD site) to the Mlaâbi CS and will have an overall length of 5.67 km. The cable route is located on existing roadways, it will follow the MC27 road passing through residential areas (part of the agglomeration of Sidi Jamel Eddine) to continue along unpaved roads (agricultural and rural environment) before reaching the CS.

The prevailing noise climate is dominated by man-made sources. Day-time noise sources are predominately characterised by local persons present along the MC27 road, the existing vehicles movement within this road and any other equipment used for farming activities in rural areas crossed by the cable.

					
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Local persons living along the MC27 road and the users of this road may be affected by the project activities (construction phase).

❖ **Mlaâbi CS**

The Mlaâbi CS is located inside another industrial zone (planned one) and the surrounding is mostly rural with some isolated houses which may be affected by the project activities.

The prevailing noise climate is dominated by man-made sources, in particular noise generated by vehicles and equipment for agricultural purposes and noise generated by traffic on the MC45 road. Day-time noise sources are predominately characterised by traffic within the MC45 road and farming activities.

❖ **OHL 400 kV Mlaâbi Mornaguia (113 km)**

The area affected by the OHL line is mostly rural with some isolated habitations, in particular between beni Khalled-Grombalia in Nabeul Governorate.

Some Key Biodiversity Areas are located near the OHL line, among these natural areas some water reservoirs classified as RAMSAR or IBA sites, thus sites of interest for various fauna species (migratory and nesting avifauna).

## 8. ELECTROMAGNETIC FIELDS

Electric and magnetic fields (EMF) are invisible lines of force emitted by and surrounding any electrical device (e.g. power lines and electrical equipment).

**Electric fields** exist whenever a positive or negative electrical charge is present. They exert forces on other charges within the field. The strength of the electric field is measured in volts per metre (V/m). Any electrical wire that is charged will produce an associated electric field. This field exists even when there is no current flowing. The higher the voltage, the stronger the electric field at a given distance from the wire.

Electric fields are strongest close to a charge or charged conductor, and their strength rapidly diminishes with distance from it. Conductors such as metal shield them very effectively. Other materials, such as building materials and trees, provide some shielding capability. When power lines are buried in the ground, the electric fields at the surface are hardly detectable.

**Magnetic fields** arise from the motion of electric charges. The strength of the magnetic field is measured in amperes per meter (A/m); however, the magnetic flux density, measured in Tesla (or microtesla  $\mu\text{T}$ ), is accepted as the most relevant quantity for relating to magnetic field effects. In contrast to electric fields, a magnetic field is only produced once a device is switched on and current flows.

The higher the current, the greater the strength of the magnetic field. Like electric fields, magnetic fields are strongest close to their origin and rapidly decrease at greater distances from the source. Magnetic fields pass through most materials and are difficult to shield.

Electromagnetic fields can be static or time-varying:

- A **static field** does not vary over time. A **direct current (DC)** is an electric current flowing in one direction only. In any battery-powered appliance, the current flows from the battery to the appliance and then back to the battery. It will create a static magnetic field. The earth's magnetic field is also a static field (The natural static magnetic field of the Earth is  $\sim 50 \mu\text{T}$  and, depending on the geographic location, varies from  $\sim 30$  to  $70 \mu\text{T}$ ).
- In contrast, **time-varying** electromagnetic fields are produced by **alternating currents (AC)**. Alternating currents reverse their direction at regular intervals. In most European countries electricity changes direction with a frequency of 50 cycles per second or 50 Hertz. North American electricity has a frequency of 60 Hertz. Power frequency EMF are considered Extremely Low Frequency (ELF)<sup>18</sup>.

With regard to the power transmission and distribution sector, there is public and scientific concern primarily over the potential health effects associated with exposure to time-varying EMF, although there is no empirical data demonstrating adverse health effects from exposure to typical EMF levels from power transmissions lines and equipment.

### 8.1 Applicable standards

A number of guidelines/standards have been set both at national and international level to limit public exposure to EMF; international reference standards are those published by the International Commission on Non-Ionizing Radiation Protection (ICNIRP). The latter is a non-governmental organization formally recognized by the World Health Organization (WHO).

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<sup>18</sup> National Institute of Environmental Health Sciences (2002)

ICNIRP published the following guidelines for limiting exposure to both time-varying and static EMF, following reviews of all the peer-reviewed scientific literature, including thermal and non-thermal effects:

- “ICNIRP Guidelines for Limiting Exposure to Time-varying Electric, Magnetic, and Electromagnetic Fields, 1998;
- “ICNIRP Guidelines on limits of exposure to static magnetic fields “, 2009.

**8.1.1 International limits of exposure to time-varying EMF**

ICNIRP standards on time-varying EMF are based on evaluations of biological effects that have been established to have health consequences. The main conclusion from the WHO reviews is that exposures below the limits recommended by the ICNIRP international guidelines do not appear to have any known consequence on health.

The following table lists general public exposure limits to time-varying electric and magnetic fields at 50 Hz frequency (power grid) published by the ICNIRP and transposed into the WBG EHS guidelines for Electric Power Transmission and Distribution.

**Table 20: ICNIRP limits of exposure to time-varying electric and magnetic fields applicable to general public**

Frequency	Electric Field (V/m)	Magnetic Field (µT)
50 Hz	5000	100
<i>Source: ICNIRP (1998): “Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz)</i>		

**8.1.2 International limits of exposure to static EMF**

ICNIRP latest limits of exposure to static magnetic fields have been released in 2009, following the World Health Organization (WHO) health criteria document on static electric and magnetic fields developed within the Environmental Health Criteria Program (WHO 2006). This WHO document contains a review of biological effects reported from exposure to static fields and, together with other relevant publications served as the scientific database for the development of the rationale for the ICNIRP 2009 guidelines, which supersede those published by ICNIRP in 1994 (ICNIRP 1994).

It is noted that there are no exposure limits set on electric static field.

**Table 21: ICNIRP limits of exposure to static magnetic field applicable to general public**

Exposure characteristics	Magnetic Field (µT)
Exposure of any part of the body (b)	400.000
<i>a) ICNIRP recommends that these limits should be viewed operationally as spatial peak exposure limits</i>	
<i>b) Because of potential indirect adverse effects, ICNIRP recognizes that practical policies need to be implemented to prevent inadvertent harmful exposure of persons with implanted electronic medical devices and implants containing ferromagnetic material, and dangers from flying objects, which can lead to much lower restriction levels such as 0.5 mT.</i>	

At the national level, Tunisia does not have a specific regulation for electromagnetic fields. STEG only has requirements for the distance of power transmission projects (OHL and cables) to potential sensitive receptors present in the neighbourhood of the OHL line, as indicated in the following table.

**Table 22: STEG's requirements for distance from power transmission lines**

Description	Required distance			
	Immediate vicinity of conductors	90 KV	150 KV	225 KV
	12 m	13 m	14m	16 m
Immediate vicinity of conductors	La hauteur du pylône			

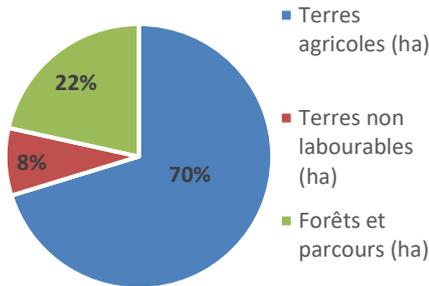
**8.2 Baseline conditions**

The HVDC cable crosses mostly agricultural areas, with the exception of the portion near the city of Sidi Jamel Eddine and near the industrial zone of Menzel Yahia, which are urban areas. However, direct current generates static magnetic fields and negligible adverse impacts are anticipated at this stage.

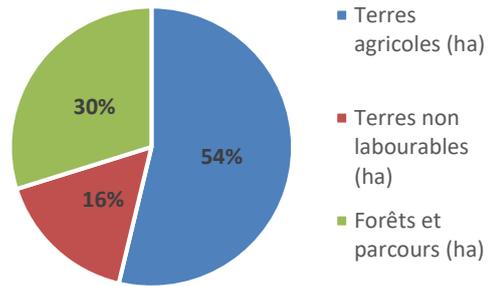
The proposed OHL transmission line would pass away from settlement except for a few isolated cases, located over 100 m from the line route. Most of the people living in the Aol of the project are involved in agriculture (cereal, olive tree, citrus orchards, etc.) and the generated EMF would cause inconvenience to them in case of high exposure to this field. The project contains several existing HV lines, in particular the part located in Mlaabi and Grombalia where the proposed OHL line follows an existing 90 KV line. The risk of interference contains several existing HV lines, in particular the part located in Mlaabi and Grombalia where the proposed OHL line follows an existing 90 KV line. The risk of interference between the two lines and cumulative between the two lines remain possible.

## 9. LAND USE

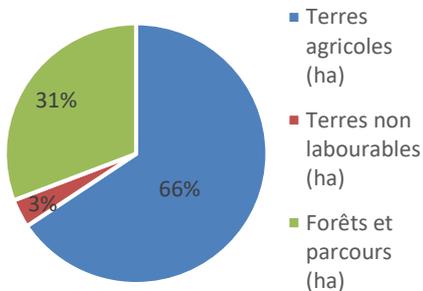
The governorates concerned cover a total area of 746 508 ha. Agricultural land represents 68 %, forest and grazing land represents 24 % and 8 % for other lands not suitable for agricultural use. Details about the types of land are given by the following Figures.



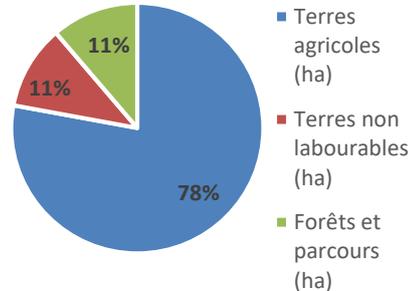
**Figure 30 : Distribution by land use category Nabeul**



**Figure 31 : Distribution by land use category Ben Arous**

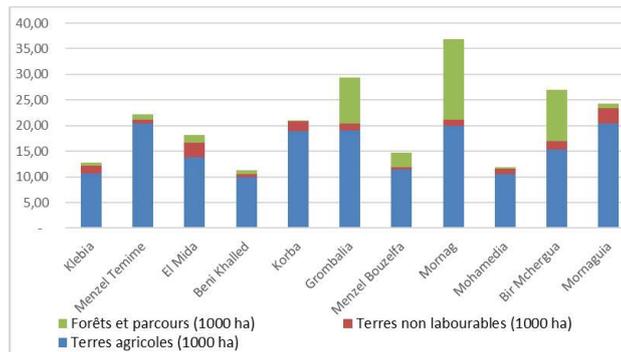


**Figure 32 : Distribution by land use category Zaghouan**



**Figure 33 : Distribution by land use category Manouba**

The following figure shows that the delegations crossed by the Project have all a common point, the agriculture remains the main activity exercised and that almost 3/4 of their surface is occupied by agricultural exploitations: cereal, arboriculture (olive trees, citrus orchards, vineyards, etc.).



**Figure 34 : Distribution by land use category**

The following map illustrates different land uses in the study area, with agriculture (irrigated and rainfed) remaining the main land use in the region.

The flatlands between Menzel Temime and El Mida are used mainly for cereal growing and some areas of arboriculture (olive and citrus). This area contains irrigated perimeters.

Areas around Menzel Bouzelfa, Beni Khaled and Grombalia is mainly used for arboriculture with citrus plantations and some areas of olive trees.

The areas between Bir Mchergua and (Zaghouan) and Mornaguia (Manouba), are used for cereal growing.

The hilly areas are occupied by forest formations and scrub, it is mainly the areas between Bni Ayach and Bir Drassen (Jbel Abderrahman) and the parts located between Jbel Ressay and the hilly areas of Zaghouan.

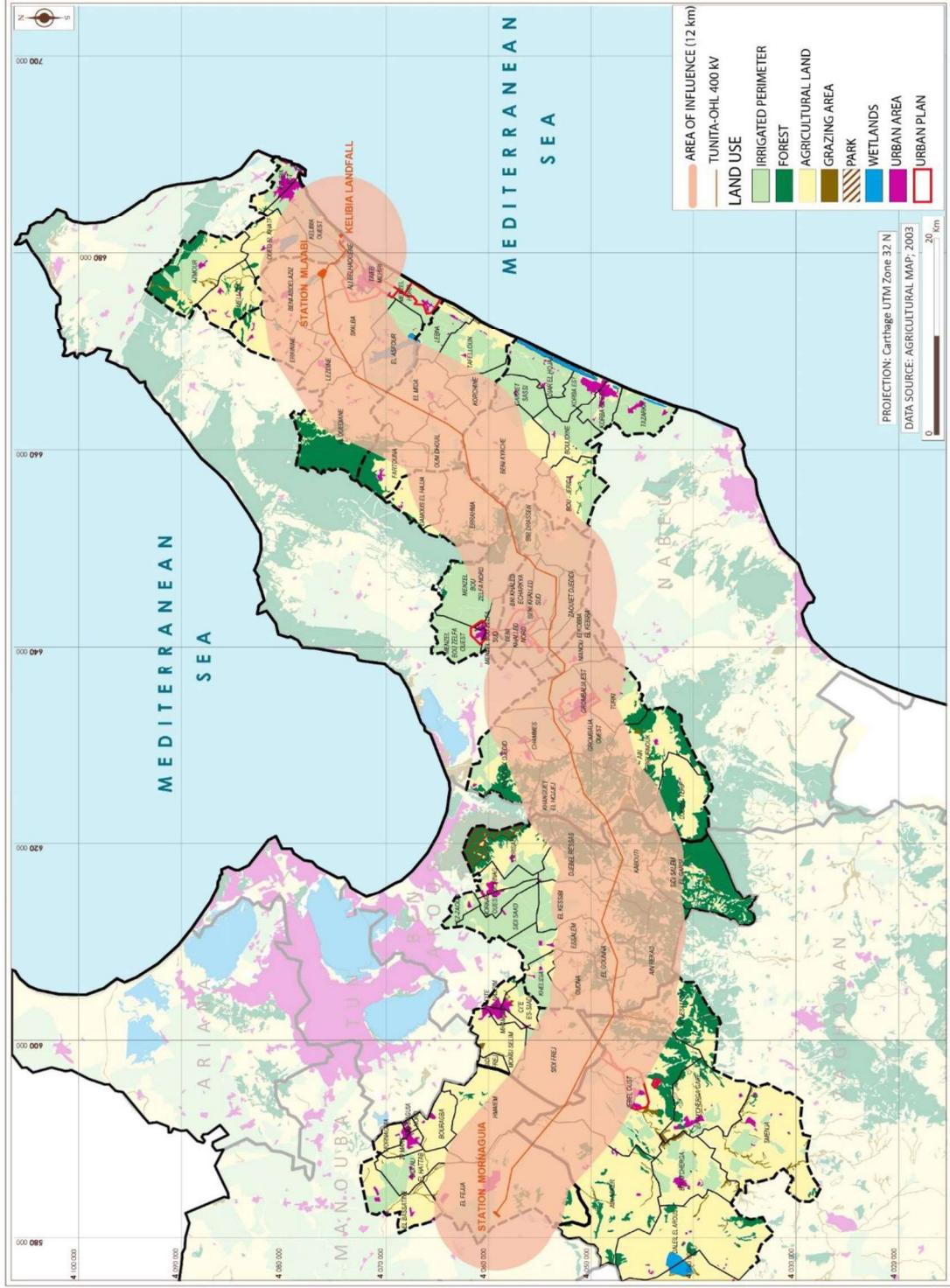


Figure 35 : Land use map

## 10.LANDSCAPE

The area is characterised by a predominantly flat morphology for the whole area concerned by the HVDC cable and the Mlaâbi CS. In the other hand for the OHL component, the latter crosses flat land between Menzel Temime and El Mida, between Beni Khalled and Grombalia and towards Mornaguia, It also passes by relatively uneven grounds (towards Beni Aych, Khanguel El Hojjej and over a large part located in Ben Arous).

There is an agricultural use of the soil, with the presence of tree crops, mainly olive groves and, to a lesser extent, vineyards and orchards (citrus groves especially in Menzel Bouzelfa and Beni Khalled delegations) and annual crops (cereal) very present in the delegations of Menzel Bouzelfa and El Mida (Nabeul) and in the sections located in Zaghouan, Ben Arous and Manouba.

Although most of the study area is heavily influenced by agricultural activities, the OHL line will also cross natural areas occupied by forest species, especially for the part located on the administrative boundary between Nabeul and Ben Arous (Khanguel El Hojjej and Kabouti).

Based on the observations made in field, the following landscapes have been identified:

Landscape	Key characteristics
Residential and commercial (including industrial areas)	landscape dominated by human activities housing, commercial, roads and traffic and industrial activities 
Agriculture/annual crop	Areas of agriculture Medium to large scale farming land Annual crop (cereal) within an open landscape

Landscape	Key characteristics
	
<p>Agriculture/ arboriculture</p>	<p>Areas of agriculture: citrus orchards around Menzel Bouzelfa, Beni Khalled and Grombalia Small to medium scale land An area for citrus safeguarding</p> 
<p>Forest and scrubland areas</p>	<p>Areas occupied by forest and scrub cover on the mountains between Nabeul, Zaghouan and Ben Arous</p> 
<p>Wetlands</p>	<p>Natural and artificial wetlands (constructed for drinking water supply and agriculture) in the Cap Bon region</p> 

## 11.DETAILED DESCRIPTION OF EACH SECTION CROSSED BY THE LINE ROUTE

The following map illustrates different land uses in the study area, with agriculture (irrigated and rainfed) remaining the main land use in the region.

The flatlands between Menzel Temime and El Mida are used mainly for cereal growing and some areas of arboriculture (olive and citrus). This area contains irrigated perimeters.

Areas around Menzel Bouzelfa, Beni Khalled and Grombalia is mainly used for arboriculture with citrus plantations and some areas of olive trees.

The areas between Bir Mchergua and (Zaghouan) and Mornaguia (Manouba), are used for cereal growing.

The hilly areas are occupied by forest formations and scrub, it is mainly the areas between Beni Ayach and Bir Drassen (Jbel Abderrahman) and the parts located between Jbel Ressas and the hilly areas of Zaghouan.

The area is characterised by a predominantly flat morphology for the whole area concerned by the HVDC cable and the Mlaâbi CS. In the other hand, for the OHL component, the latter crosses flat land between Menzel Temime and El Mida, between Beni Khalled and Grombalia and towards Mornaguia, It also passes by relatively uneven grounds (towards Beni Aych, Khanguel El Hojje and over a large part located in Ben Arous).

There is an agricultural use of the soil, with the presence of tree crops, mainly olive groves and, to a lesser extent, vineyards and orchards (citrus groves especially in Menzel Bouzelfa and Beni Khalled delegations) and annual crops (cereal) very present in the delegations of Menzel Bouzelfa and El Mida (Nabeul) and in the sections located in Zaghouan, Ben Arous and Manouba.

Although most of the study area is heavily influenced by agricultural activities, the OHL line will also cross natural areas occupied by forest species, especially for the part located on the administrative boundary between Nabeul and Ben Arous (Khanguel El Hojje and Kabouti).

The OHL route can, then, be divided into four sections:

- ✓ The first part of the line route (section between S1 and S8): land is relatively flat and the main activity is agriculture (annual crops rainfed or irrigated by the waters from Lebna and Mlaâbi dams). This presents no major constraints except the presence of the two RAMSAR and IBA sites (Mlaâbi and Lebna dams) that will be subject to further analysis during the elaboration of ESIA study in order to propose necessary mitigation measures.
- ✓ The second part between S8 and S17: an arboricultural area with lands mainly occupied by citrus plantations and it concerns especially Menzel Bouzelfa and Beni Khalled (considered as citrus safeguard areas in Tunisia). The main constraint is due to these private plantations (citrus orchards) and to the damage potentially caused during the construction phase of the project.
- ✓ The third part located between S17 and S32 includes agricultural (Nabeul side) and forest areas (especially in Ben Arous). In this section the line will pass through flat lands occupied by agriculture (olive tree plantations and vineyards) and areas with hilly relief covered by scrublands and forests.
- ✓ The last part of the line route: a flat lands with some hilly zones where the principal activity is annual agriculture (cereal crops). This section has no significant constraints for the proposed project especially with the presence of several existing HV power lines.

In order to facilitate the description of the line route, a number is assigned to each summit, starting from the Mlaâbi site and going in the direction of Mornaguia.

Section	Description of the crossed areas
<p><b>S1-S2</b></p>	<ul style="list-style-type: none"> <li>✓ Section located in the Imada of Beni Abdelaziz (Menzel Temime Delegation, Nabeul Governorate);</li> <li>✓ S1 is located inside the site proposed for the converter station of Mlaabi</li> <li>✓ S2 is located inside an olive tree plantation (a new one). The installation of a pylon at S2 will probably require the uprooting of one or more olive trees in this plantation (see image below);</li> <li>✓ Houses identified in the Mlaâbi area are located at a distance of approx. 270 m from S2.</li> </ul> <div data-bbox="512 598 1233 987" data-label="Image"> </div> <p data-bbox="536 1010 1209 1039" style="text-align: center;"><b>Figure 36 : Olive tree plantation near the Mlaâbi zone</b></p>
<p><b>S2-S3</b></p>	<ul style="list-style-type: none"> <li>✓ Section located between two Imadas (Beni Abdelaziz and Skalba);</li> <li>✓ Rural zone between the two points, large plain;</li> <li>✓ Open territory with easy access and presence of several routes that can facilitate works during the construction phase of the project;</li> <li>✓ The principal activity in this area is agriculture: mainly cereal farming (wheat, barley, fodder, etc.);</li> </ul> <div data-bbox="263 1292 1430 1780" data-label="Image"> </div> <p data-bbox="443 1803 1302 1832" style="text-align: center;"><b>Figure 37 : Cereal cultivations in the area proposed for the OHL line</b></p> <ul style="list-style-type: none"> <li>✓ The line will cross a dry wetland (probably dried by human actions as we can see on the picture below the presence of several artificial drainage channels);</li> </ul>



**Figure 38 : Dry wetland crossed by the OHL line**

- ✓ S3 is near two small villages: 750 m from El Gobaa and about 300 m from Ghriss;
- ✓ The line will cross agricultural lands.

**S3-S4**

- ✓ Section situated between Skalba and Lezdine Imadas (Menzel Temim Delegation, Nabeul Governorate);
- ✓ Same landscape as the one observed before (from S2 to S3), a rural area and lands occupied by cereal crops;
- ✓ Presence of sheep and cattle breeding in this area;
- ✓ No environmental constraints to report for this section. The most relevant issue is the passage through private lands (farmers), with consequent need to propose compensatory measures for PAPs (populations affected by the project);



**Figure 39 : Existing road between El Gobaa et Ghriss (presence of an MV line power) and the relief in the area concerned by the project (mostly agricultural use)**

**S4-S5**

- ✓ Section located between two delegations (Menzel Temime and EL Mida) and concerns 4 Imadas (El Ouediane, El Asfour, EL Mida and Oum Dhouil);
- ✓ The line route follows the regional road RR43 with intersection (36°46'55.91"N, 10°52'16.03"E);
- ✓ Same relief as the other sections described above with the same land use (cereal farms, vast plain, etc.);
- ❖ **Nearby OHL lines in the same area**
- ✓ At 300 m from the proposed line route (in the north), we identified the presence of two HV power lines,: the 90 kv line Sidi Abdelmonaam Menzel Temime-Grombalia and the 90 KV line Sidi Abdelmonaam Menzel Temime-Korba (see photo below);
- ✓ The presence of these two lines confirms the possibility to install the OHL line of Mlaâbi-Mornaguia in this area (if no other constraints exist). Normally STEG should not have problems with PAPs (farmers) to install the pylons in their lands in this section;



**Figure 40 : The two 90 KV power lines between Menzel Temime, Korba and Grombalia**



**Figure 41 : Pylon inside an agricultural area with its covered surface,**

As we see the owner (farmer) can still use his land even in the area directly under the pylon (but only for annual crops but not for arboriculture)

❖ **Presence of a gas pipeline**

- ✓ At a short distance or directly in correspondence with the proposed route of the 400 kv OHL line (represented in green color in the image below), we observed the presence of some markers that signal the existence of a gas pipeline (SERGAZ Company) : these markers are located at points P16 (36°46'55.91"N, 10°52'16.03"E) and P17 (36°46'35.81"N, 10°52'1.26"E) (see image below);



**Figure 42 : Presence of a gas pipeline near the area proposed for the OHL line at P16 and P17**



**Figure 43 : Markers for the gas pipeline Algeria- Italy (SERGAZ Company)**

- ✓ At 2 km from point P17, presence of a station for the same gas pipeline located at 50 m from the line route proposed for OHL Mlaâbi-Mornaguia.



**Figure 44 : The Gas station observed (36°45'17.83"N, 10°51'1.92"E)**

- ✓ More details related to this pipeline are needed (STEG should request from SERGAZ) in order to adjust the line route proposed for the Mlaâbi-Mornaguia project. After the review of this report by ELMED, STEG explained that its technical services have already studied all possible interference between the two projects without finding any problem, so this pipeline is not an issue anymore. In any case, the Consultant requests the pipeline route of SERGAZ (a kmz file) in order to validate this finding and to verify that the minimum distance between the two projects is respected.

❖ **RAMSAR site (Lebna Dam) N°1698**

- ✓ The biggest artificial dam built in Cap Bon in 1987;
- ✓ The dam provides water for irrigated crops in Lebna (cereal cultures, fodder, etc.);
- ✓ The RAMSAR site is close to the proposed line route (at approximately 1.5 to 2 km).
- ✓ The Lebna Dam is also classified as an IBA site (TN042) according to its importance for migratory and nesting waterbirds (number exceed 20.000 birds<sup>19</sup>);
- ✓ This dam is considered since then as a favorite destination for many waterbirds species, which migrate from Europe to North Africa. Some of these species are considered as endangered/vulnerable, especially the Marbled Teal (*Marmaronetta angustirostris*), the White-Headed Duck (*Oxyura leucocephala*), the Ferruginous Duck (*Aythya nyroca*), the Glossy Ibis (*Plegadis falcinellus*), the Eurasian Spoonbill (*Platalea leucorodia*), the Little Bittern (*Ixobrychus minutus*), the Western Swamphen (*Porphyrio porphyrio*), etc.;
- ✓ This site has a significant role in the protection and conservation of Palearctic migratory birds;
  - ➔ This site is a biodiversity hotspot, especially for waterbirds, and the construction of the 400 KV OHL line in this area may impact these birds (electrocution and collision, habitat changes caused by works and the installation of pylons).
  - ➔ Recommended to ensure mitigation measures to protect birds.

<sup>19</sup> [TN004 RIS 2007 F \(ramsar.org\)](https://www.ramsar.org)

For this section of the line, the landscape is still the same as the other parts observed above: an agricultural region dominated by cereal crops (rainfed in winter and irrigated in summer) with a good access using roads and routes.



**Figure 45 : The Lebna Dam: a RAMSAR site and an IBA area**



**Figure 46 : Protection markers on an MV line near the line route proposed for the Mlaâbi-Mornaguia project**

**S5-S6-  
S7**

- ✓ Section located in the Imada of Oum Dhouil (EL Mida Delegation) and in the Imada of Beni Ayache (Korba Delegation);
- ✓ Same landscape, without any constraints (open field with agricultural activity dominated by cereal crops and some olive tree plantations);
- ✓ A dam located at 500 m from the line route: the Chiba Dam;
- ✓ It is not an IBA site but some waterbirds species have been reported often, such as the White-headed duck (*Oxyura leucocephala*)<sup>20</sup> and the Red crested Pochard (*Netta rufina*) observed in 2015 and reported by the AAO (Association les Amis des Oiseaux) association<sup>21</sup>;



**Figure 47 : The Chiba Dam (36°41'41.99"N, 10°45'48.78"E)**

- ✓ At point (36°41'35.39"N, 10°46'27.33"E) the proposed line route crosses a water pipeline (see photo below);

<sup>20</sup> Cited in the "Elaboration du Registre National des Espèces Sauvages REGNES 2010" Study

<sup>21</sup> <https://northafricanbirds.wordpress.com/page/10/>



**Figure 48 : Water pipeline near the Chiba dam**

- ✓ From S6, we observe a change in the landscape, arboriculture is more present and dominates the area (many irrigated perimeters, olive tree plantations). The installation of pylons in this section will probably require uprooting some olive trees;



**Figure 49 : Olive tree plantations near the dam**

**S7-S8**

- ✓ Located inside the Imada of Errahma (Menzel Bouzelfa Delegation);
- ✓ This section passes through hills with difficult access;

- ✓ It is a rural area and the main activity observed is agriculture (olive tree plantations);
- ✓ The line route crosses some scrubland and maquis area, where we can observe species such as *Erica multiflora*, *Pistacia lentiscus*, *Phillyrea angustifolia* and other.
- ✓ To install pylons in these areas, STEG must request an authorization from the National Authority of Forest (Direction Générale des Forêts – DGF) in order to open access in the scrubland and maquis;
- ✓ No protected areas on this section, STEG must replace the uprooted trees and provide indemnities to farmers.



**Figure 50 : The section between S7 and S8, hilly land with natural vegetation (scrubland and maquis) and olive trees**

**S8-S9**

- ✓ A section located between two delegations: south part in the Imada of Bir Drassen (Beni Khalled Delegation) and north part in the Imada of Menzel Bouzelfa Nord (Menzel Bouzelfa Delegation);
- ✓ As the S7-S8 section, the line route will pass through a hilly area with the same land use (scrubland and maquis and some olive tree plantations);
- ✓ No specific environmental constraint in the area;
- ✓ The proposed line route crosses the existing 90 KV OHL line connecting Menzel Temime to Grombalia at point (36°39'12.48"N, 10°41'20.15"E);



**Figure 51 : Section S8-S9, land covered by natural vegetation (scrubland and maquis) and olive tree plantations**

**S9-S10**

- ✓ Located inside the Imada of Menzel Bouzelfa North (Delegation of Menzel Bouzelfa) and the Imada of Beni Khalled East (Delegation of Beni Khalled);

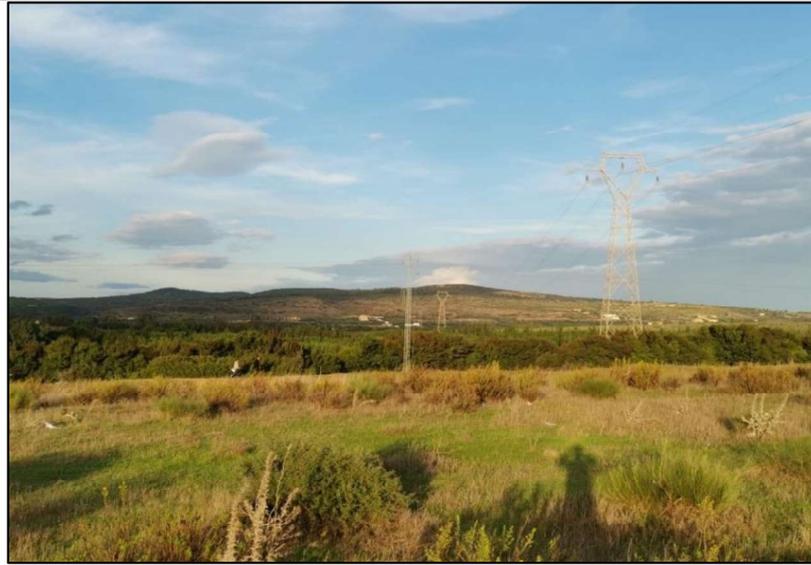
- ✓ From S9, we observe a change in the land use: citrus become the principal crop or culture in the area both in Menzel Bouzelfa and Menzel Beni Khaled. The line will pass through fenced orchards;
- ✓ In this section, some pylons will be placed inside citrus orchards (around 4 if we consider a distance of 450 m between each two pylons);
- ✓ The main constraints in this section are the irrigated perimeters and citrus plantations: the area covered by the pylons (and its access route) will cause the removal of citrus and olive trees. Consulting stakeholders, especially PAPs, the CRDA Agency (Commissariat Régional au Développement Agricole) and the AFA Agency (Agence Foncière Agricole) on this issue is essential in order to estimate damage compensation related to the installation of pylons.



Figure 52 : Line route between S9 to S10

**S10-  
S11**

- ✓ The section is located between two Imadas in Beni Khaled : East and South from the same Delegation;
- ✓ The proposed line route is located only 90 m from an existing OHL line (the Menzel Temime-Grombalia 90 KV line);
- ✓ The area is exclusively agricultural with a high density of citrus trees especially in the southern part of the section;
- ✓ The second part is occupied by natural vegetation with the presence of a waste management center at a distance of 10 m from the line route. This waste transfer center is not an issue for the OHL line
- ✓ The line route crosses the regional road RR42;
- ✓ Similar to the section S9-S10, in this section some pylons will be placed inside citrus orchards and consequently cause removal of several trees.



**Figure 53 : S10-S11 section: first plan open land with natural vegetation and second plan we can see the citrus plantations and presence of the 90 kV OHL line of Menzel Temime and Grombalia**

**S11-S12**

- ✓ Located inside the Imada of Beni Khalled South;
- ✓ The line passes through agricultural land (mostly for cereal crops) and it also crosses a river;
- ✓ It will also cross some and scrubland;
- ✓ The line route still follows the existing 90 KV OHL line of Menzel Temime and Grombalia (at a distance of approx. 85 m);
- ✓ No other constraints reported for this section, except the presence of an olive tree plantation near S12.



**Figure 54 : The 90 kV OHL line in the same area**

As we can see the owner/farmer still uses the area under the pylon installed in his vineyard

**S12-S13-S14**

- ✓ The section is located between the Imada of Beni Khalled South and the Imada of Zaouiet Djedidi (Beni Khalled Delegation);
- ✓ An agricultural zone with a large presence of citrus and some olive tree plantations;
- ✓ The nearest houses are situated at a distance of more than 150 m from the line;
- ✓ The main constraint in this section are the irrigated perimeters and citrus plantations;

- ✓ From the S12 point, the land is mostly occupied by citrus plantations with fenced orchards, either by windbreaks or by solid fences or barriers (metal or cement). The presence of such plantations and irrigated perimeters can limit the installation of pylons and other facilities for the project.
- ✓ No other environmental constraints are reported in the area, except the presence of a watercourse near the proposed line route.



**Figure 55 : Land use in the S12-S13 area: houses near the line, olive tree plantations close to the river and the fenced citrus plantations**

**S14-  
S15-  
S16**

- ✓ Located within Zaouiet Djedidi Imada (always in Beni Khalled Delegation);
- ✓ An area characterized by its high production of citrus fruits; the main land occupation is citrus orchards. Pylons will be installed inside these plantations and may need the removal of some trees;
- ✓ This section is characterized by the presence of a small river near the proposed line route (about 50m);
- ✓ The line route crosses the road connecting Beni Khalled to EL Gobba;
- ✓ The S15 is located in a fenced area (a citrus plantation surrounded by a brick wall) and is too close to the cited watercourse above (only 25 m). The position of this point (S15) must be revised because the line must not pass through a fenced private property as indicated by the Decree of May 30, 1992<sup>22</sup> concerning the installation, maintenance and exploitation of electrical transmission lines in Tunisia.

<sup>22</sup> [https://www.steg.com.tn/dwl/Textes\\_legislatifs\\_et\\_reglementaires\\_regissant\\_l\\_activite\\_de\\_la\\_STEG.pdf](https://www.steg.com.tn/dwl/Textes_legislatifs_et_reglementaires_regissant_l_activite_de_la_STEG.pdf)



**Figure 56 : Area crossed by the line route at S15: citrus plantations (with brick fence), a road and a MV line power near the watercourse**

- ✓ A few houses are located about 80 m from the proposed line route (at S16 side);



**Figure 57 : Area selected for S16: citrus plantations with fence**

**S16-  
S17**

- ✓ A portion located in the Imada of Zaouiet Djedidi;

✓ Same land occupation: a lot of citrus plantations and irrigated perimeters. No other constraints are observed in this section, except a building (house, villa or other) at 50 m from the line route (36°37'28.11"N, 10°33'53.55"E);

**S17-  
S18**

- ✓ A section located between two Delegations: Beni Khalled (Imada of El Gobba) and Grombalia (Imada of Niano);
- ✓ Same landscape is observed, with the same type of vegetation (high presence of citrus plantations);
- ✓ The line crosses the regional road RR42.



**Figure 58 : The road crossed by the line**

On the left we observed a fenced plot with a concrete wall and on the right a windbreaks plantations and a MV power line (36°37'13.92"N, 10°33'30.85"E)

**S18-  
S19**

- ✓ A section located in the Imada of Niano (Grombalia Delegation);
- ✓ Around 80% of this section is located in a new olive tree plantation;
- ✓ The line route crosses a watercourse (near the S219, at 70 m);
- ✓ Some buildings are located at about 150 m from the axis;
- ✓ The main constraints in this section still remain the agricultural lands and irrigated perimeters.



**Figure 59 : Position of S18 (on the left) and the olive tree plantation (on the right, presence of an existing HV power line)**

**S19-  
S20-  
S21-  
S22**

- ✓ Section located in the Imada of Grombalia East (Grombalia Delegation);
- ✓ The line route goes outside the agglomeration of Grombalia and the area's vocation remains agricultural with a lower presence of citrus plantations but with more vineyards in the area (a characteristic of Grombalia);

- ✓ In addition to vineyards, other species are also practiced such as olive trees and fodder crops;
- ✓ The line crosses the C42 road (between Grombalia and Beni Khalled);
- ✓ The proposed route finds again the 90 KV ohl line of Grombalia-Menzel Temime and crosses it at (36°37'27.87"N, 10°30'53.74"E);
- ✓ Some houses and buildings are located near the line route (approx. 50 to 100 m);
- ✓ The pylon S22 will be placed inside an open private plot occupied by fodder crops;
- ✓ Some houses are located at 100 m from the line route;
- ✓ Except the private lands (vineyards, olive trees, etc.), this section does not present any particular environmental constraints.



**Figure 60 : The area chosen for S22**



**Figure 61 : An OHL power line close to the proposed line route of Mlaâbi Mornaguia,**

As we can see a mitigation measure by adding perches to electricity pylons in order to reduce electrocution for birds (a nesting support for Storks) (36°36'44.09"N, 10°31'34.76"E)

**S22-  
S23-  
S24**

- ✓ The section is located inside the Imada of Chammes (Grombalia Delegation);
- ✓ The area crossed is agricultural: vineyards, olive trees and fodder plantations, with size of farms less than 3 ha;
- ✓ Some buildings are located near the line (S23 side);
- ✓ The line route crosses a railway line that connects Tunis to Nabeul at (36°37'1.01"N, 10°28'17.79"E);
- ✓ No other constraints to mention;



Figure 62 : Section S22-S23-S24: an agricultural area (vineyards, olive and almond trees)

S24-  
S25

- ✓ Section located between two Imadas: Chammes and Khanguet El Hojje;
- ✓ Same as the other sections, the area crossed by the line is agricultural and the main crops are olive trees, almond, etc.
- ✓ The line route will pass over the A1 highway (36°36'18.16"N, 10°26'17.11"E);
- ✓ The S25 is located on a hill (on the other side of the A1 highway) covered by natural végétation: Aleppo pine, *Tetraclinis articulata* (Thuya de Berberie), *Ceratonia Siliqua* (Caroubier) and other species (scrubland);



Figure 63 : Landscape showing the vegetation in the area between S24-S25 (olive trees at the bottom and natural species)

✓ The area is characterized by the presence of an HV line near the proposed line route of Mlaâbi Mornaguia (about 260 m, in parallel). This existing power line connects the station of Grombalia to the cement company of Carthage (located at Jebel Ressass, Ben Arous Governorate).

**S25-  
S26-  
S27**

- ✓ These summits are located in the sector/Imada of Khanguet El Hojje (Grombalia Delegation);
- ✓ It is a forest area with some agriculture activities (olive trees, annual crops, etc.);
- ✓ It is a mountainous area with a hilly relief. The flat areas are occupied by agriculture, especially olive trees and vineyards while the hills are covered by natural vegetation (thuya, pines, carob, scrubland and other species).
- ✓ According to the local authorities: Delegate of Grombalia, Omda of Khanguet El Hojje and the agent of the agriculture administration, lands in this area (Khanguet El Hojje) are mostly state owned lands unlike the Chammes Imada (section S22-S23-S24) where land is in majority privately owned;
- ✓ On this section, the proposed line route still follows the existing HV power line of Grombalia-Cement plan of Carthage. The distance between the two power lines is 150 m for the S25-S26 section but it becomes only 35 m for the S26-S27 → STEG should confirm the feasibility of this especially with the interference problems and mutual impacts);
- ✓ No other constraints to be reported for this section.



**Figure 64 : Landscape from S25 to S27 with the presence of an existing line power**

- ✓ At (36°34'54.35"N, 10°22'36.81"E) the line crosses the road that leads to Beni Ayech Village and an existing MV line power;
- ✓ No residential zones/habitations near the proposed route except the village of Beni Ayech located at 135 m from S27;



**Figure 65 : Left: the village of Beni Ayech, Right: the proposed area to install the S27**

S27-  
S28

- ✓ The most part of this section is located in the Imada of Kabouti (Mornag Delegation, Ben Arous Governorate);
- ✓ It is an agricultural area with olive tree plantations and annual crops (cereal);
- ✓ An area with hilly relief and the line route is close to Ressas montain (Djebel Ressas);
- ✓ The area is characterized by the presence of two dams: the first one Elhamma Dam (at 1 km) and the second one Bakbaka Dam (at 700 m); the Little Grebe (*Tachybatus ruficollis*) has been identified on this site<sup>23</sup>;
- ✓ Scrubland areas will be crossed by the line:



**Figure 66 : Landscape around S28 pylon: agricultural lands (cereal and some olive trees) and natural vegetation (scrubland, lentiscus, rosemary, thyme, etc.)**



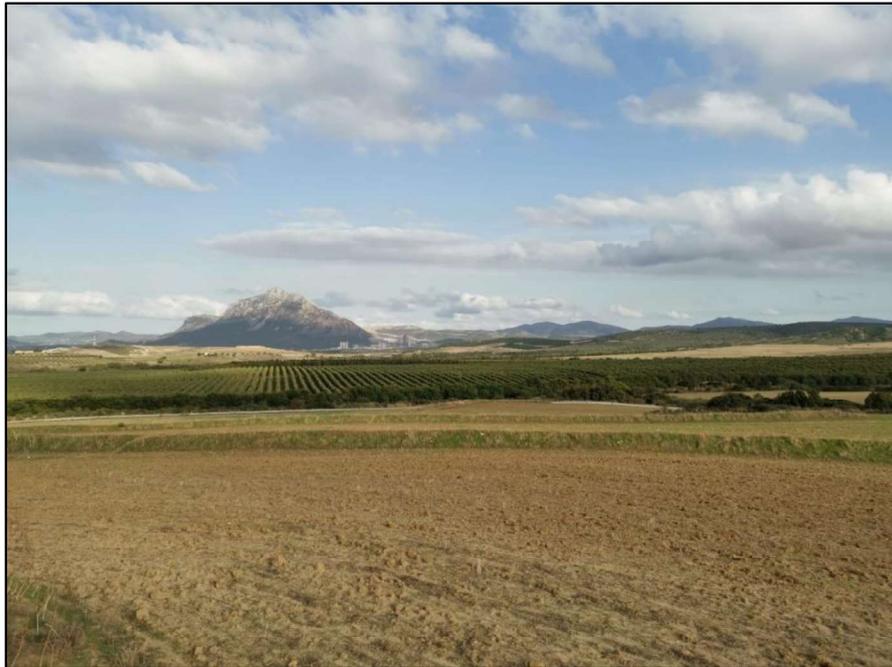
**Figure 67 : The ELHAMMA Dam (36°35'3.15"N, 10°18'11.20"E)**

<sup>23</sup> study of counting of waterbirds in Tunisia conducted by the AAO association in 2010 and cited in the a scientific paper "Importance Écologique Et Rôle Des Zones Humides Artificielles Du Nord De La Tunisie Dans La Conservation Des Oiseaux D'eau En Hivernage, 2008" : [https://www.researchgate.net/publication/282336873\\_Importance\\_ecologique\\_et\\_role\\_des\\_zones\\_humides\\_artificielles\\_du\\_nord\\_de\\_la\\_Tunisie\\_dans\\_la\\_conservation\\_des\\_oiseaux\\_d'eau\\_en\\_hivernage](https://www.researchgate.net/publication/282336873_Importance_ecologique_et_role_des_zones_humides_artificielles_du_nord_de_la_Tunisie_dans_la_conservation_des_oiseaux_d'eau_en_hivernage)

- ✓ Livestock sector is also present in this area;
- ✓ Some scattered houses around this section and the Merghna village near S28 (at 150 m from the line route);
- ✓ Access is ensured by a road that leads to the cement company of Carthage (located at 2 km from S28);

**S28-S29**

- ✓ This section goes through 3 Imadas (sectors) in the Delegation of Mornag: Kabouti, Djebel Ressas and Elkessibi;
- ✓ The section includes flat lands (agriculture) and hills (scrubland and natural vegetations);
- ✓ The main activity in this area is cereal crops with some olive tree plantations with the presence of a lake at 900 m from the line route;
- ✓ No habitation areas around the line route on this section except 3 or 4 houses located at 500 m from S29;
- ✓ The proposed line will cross an existing HV power line, the 225 KV line of Naasan-Sousse, at (36°34'10.73"N, 10°17'55.32"E), it will pass also a local road in 2 points (36°34'53.91"N, 10°15'16.83"E) and (36°34'55.31"N, 10°15'7.67"E) ;



**Figure 68 : Landscape around point S29: annual crops, olive tree plantations and Djebel Ressas (36°34'56.14"N, 10°15'9.67"E)**

**S29-S30**

- ✓ A section located between two Imadas: Elkessibi and Elgonna (Mornag Delegation);
- ✓ The area is mainly agricultural, with a mixture of cereal crops and olive tree plantations (especially on hills);
- ✓ The S30 will be located near the village of Borj Essougui: **the proposed line will pass in front of an elementary school at a distance of only 10 m.**



**Figure 69 : The area around S30: a school on the left; the line will cross an existing LV power line near the road**

**S30-  
S31-  
S32**

- ✓ This section will cross three Imadas in Mornag: Elgounna, Ain Rekad and Oudna;
- ✓ The area is mostly agricultural with some natural vegetation on hills;
- ✓ The line will pass near two small dams (at about 250 m);



**Figure 70 : The area between S30 to S32**

- ✓ No residential areas in this section.

**S32-  
S33**

- ✓ A section located between two Governorates: Zaghouan (Imada of Jebel Oust) and Ben Arous (Imada of Sidi Frej);
- ✓ The first part that crosses Jebel Oust is a hilly area occupied by agriculture (cereal crops) and scrubland;
- ✓ The line will cross the road leading to the Jebel Oust city and its industrial zone and railway line at (36°35'29.91"N, 10° 6'15.87"E);
- ✓ The area is also characterized by the presence of two HV power lines: the 225 kv of Naasan-Bir mcharga and the 225 kv of Mnihla-Bir Mcharga and the proposed line route will pass over these two lines at (36°34'57.92"N, 10° 7'26.90"E) and at (36°36'4.78"N, 10° 4'56.36"E);
- ✓ The line route will cross also Wad Meliane.



**Figure 71 : The area between S32 and S33: presence of a HV power line and a railway line and some buildings close to the line route of Mlaâbi**

- ✓ The line is located at 1100 m from the limit of the urban development plan PAU (Plan d'Aménagement Urbain) of Jebel Oust municipality;
- ✓ The principal activities in this area are agriculture (cereal crops and olive tree plantations) and industry, especially with the presence of the industrial zone in Jebel Oust.

**S33-S34**

- ✓ This section concerns two governorates: Zaghouan (two Imadas Jbel Oust and Ain Asker) and Manouba (Imada of El Fejja);
- ✓ The area is relatively flat and with good access and the main activity is annual agriculture (rainfed cereal) with some olive tree plantations;
- ✓ No residential areas near the proposed line route;



**Figure 72 : Lands near the S34: an open landscape with annual agriculture, the line route will pass through the road connecting El fejja to Jebel Oust**

**S34-S35-S36**

- ✓ The last part of the line route is entirely in Manouba Governorate (Imada of El Fejja) where the STEG station of Mornaguia is located;
- ✓ Many HV power lines exist in this area;

- ✓ An industrial zone is located 800 m from the line route;
- ✓ The line will cross agricultural lands (cereal crops);
- ✓ Two small lakes are located at 100 m from the line route.



**Figure 73 : The area around S35 and S36 (annual crops)**



**Figure 74 : Existing HV power lines in the area**



**Figure 75 : The Mornaguia station (36°40'41.57"N, 9°55'25.05"E)**

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