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Environmental changes and vulnerability in the Gharbi Island (Kerkennah, Tunisia)

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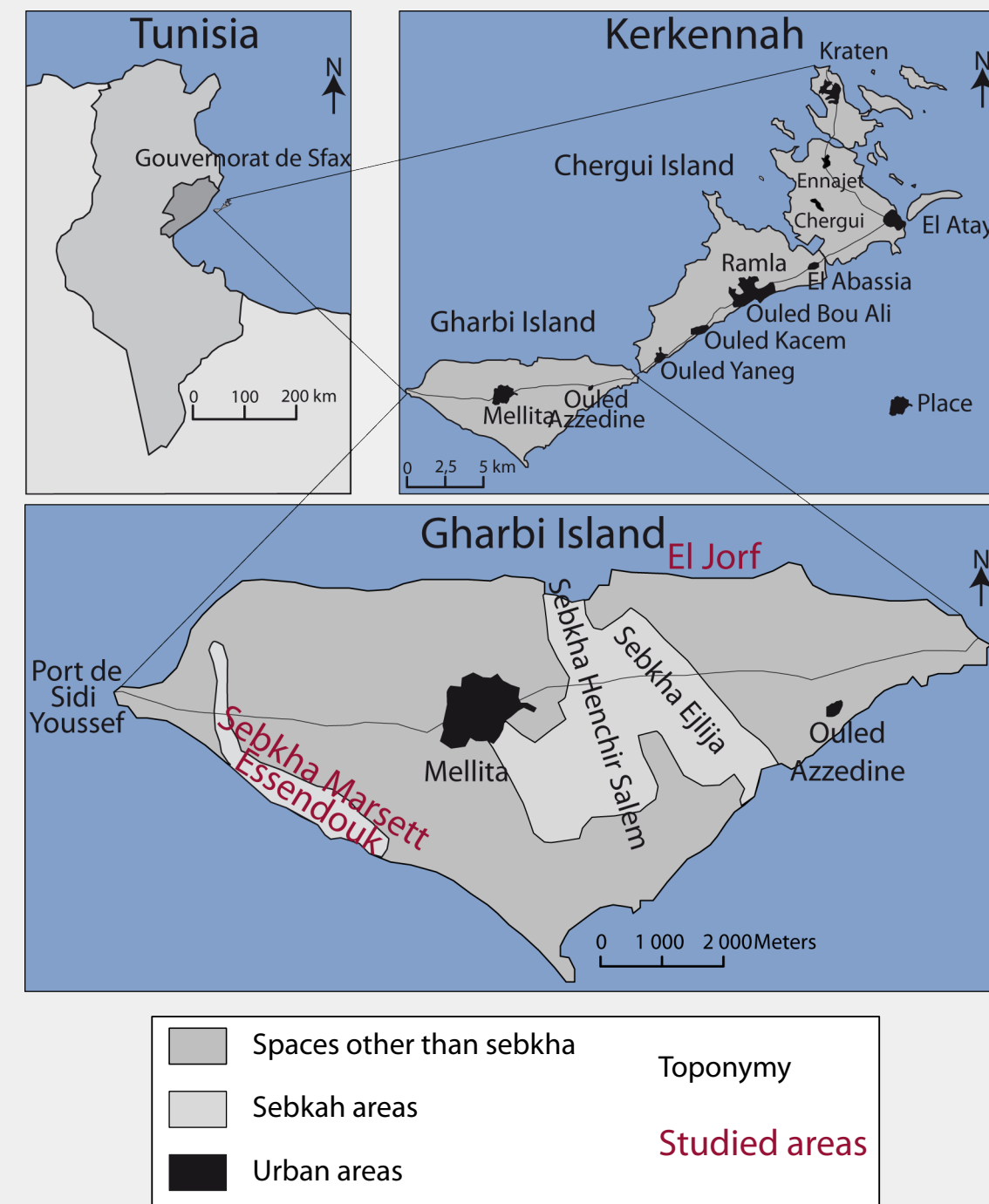
Context

Gharbi is one of the two biggest islands in the Kerkennah archipelago located in the Gabes Gulf (Tunisia). It shows several specificities including:

- Very low topography (13 meters max)
- Numerous sebkhas areas that represent 39.2% of the total surface of the island (i.e. 1884 ha)
- Loose and erodable materials
- Semi-arid climate
- Numerous agricultural parcels (especially on the borders of the sebkhas)

Since the 1950's, climate change in the Mediterranean Sea has been highlighted by several observations:

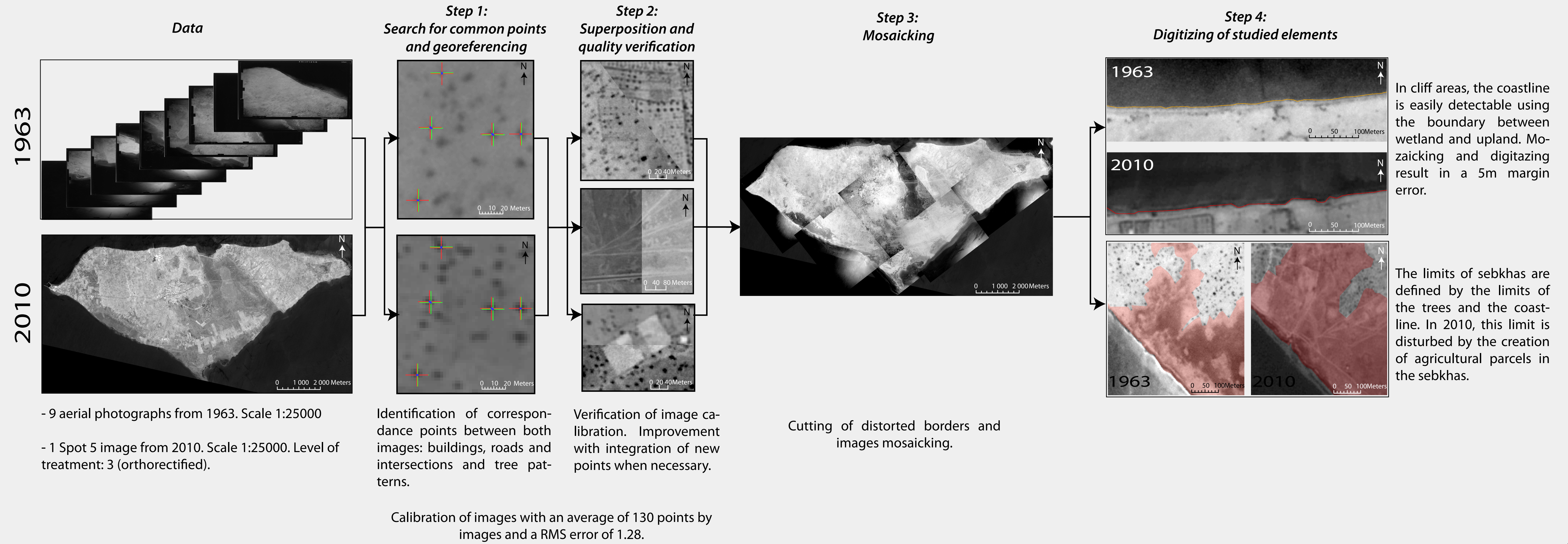
- Changes in the variability of precipitations
- Sea level rise (absolute and relative, with evidences of subsidence since the end of antiquity)
- Increase of temperatures and relative evapotranspiration especially in summer
- Changes in the direction of the strongest winds



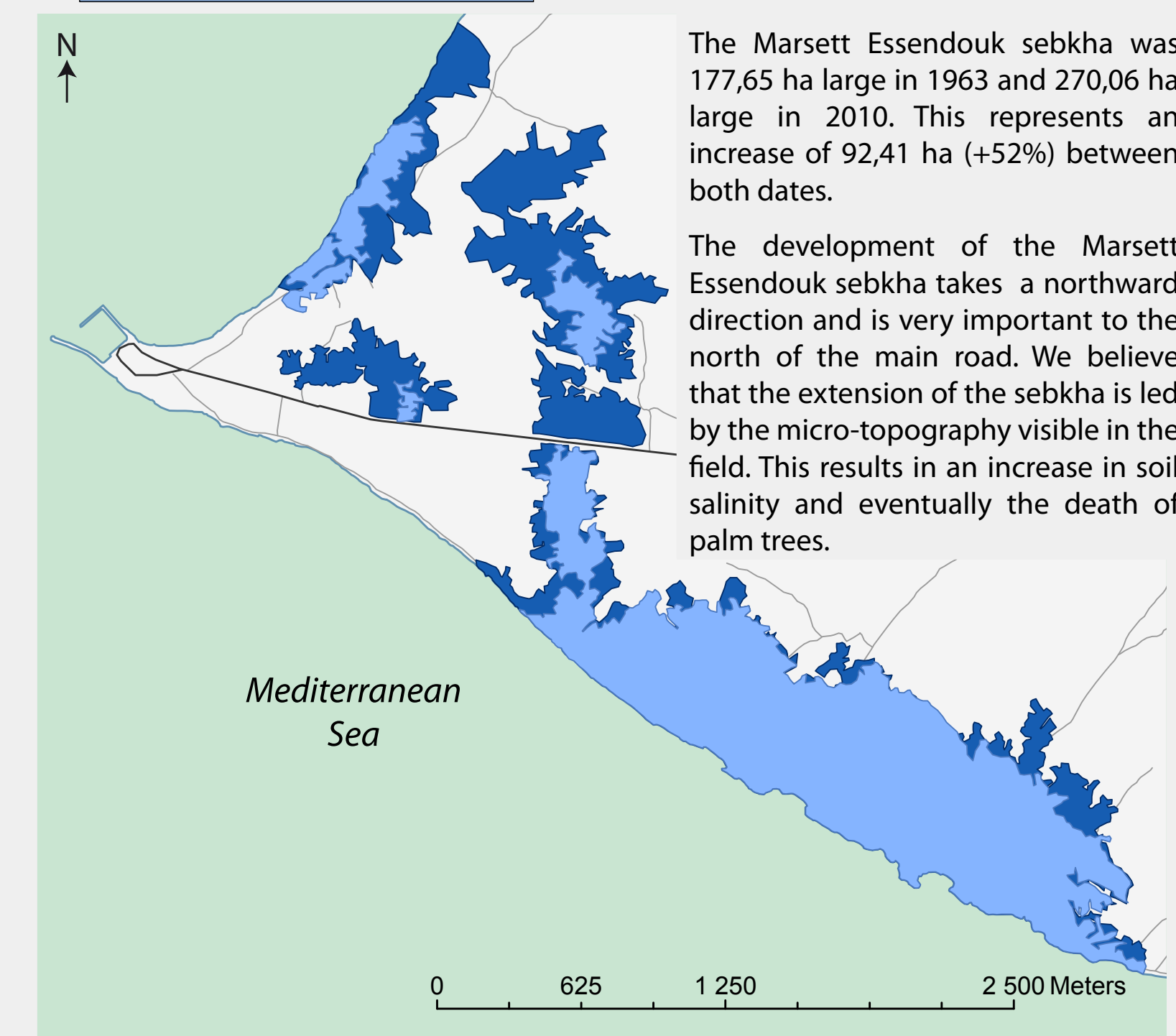
The fragility of the Gharbi Island therefore appears through several clues including marine erosion and soil salinization. It is due to multiple factors of geologic, geomorphologic, climatic and anthropic nature.

In this context, we attempt to quantify the evolution of a cliff portion and the surface of the Marsett Essendouk sebkha between 1963 and 2010, using a photo-interpretation approach.

Data and methods

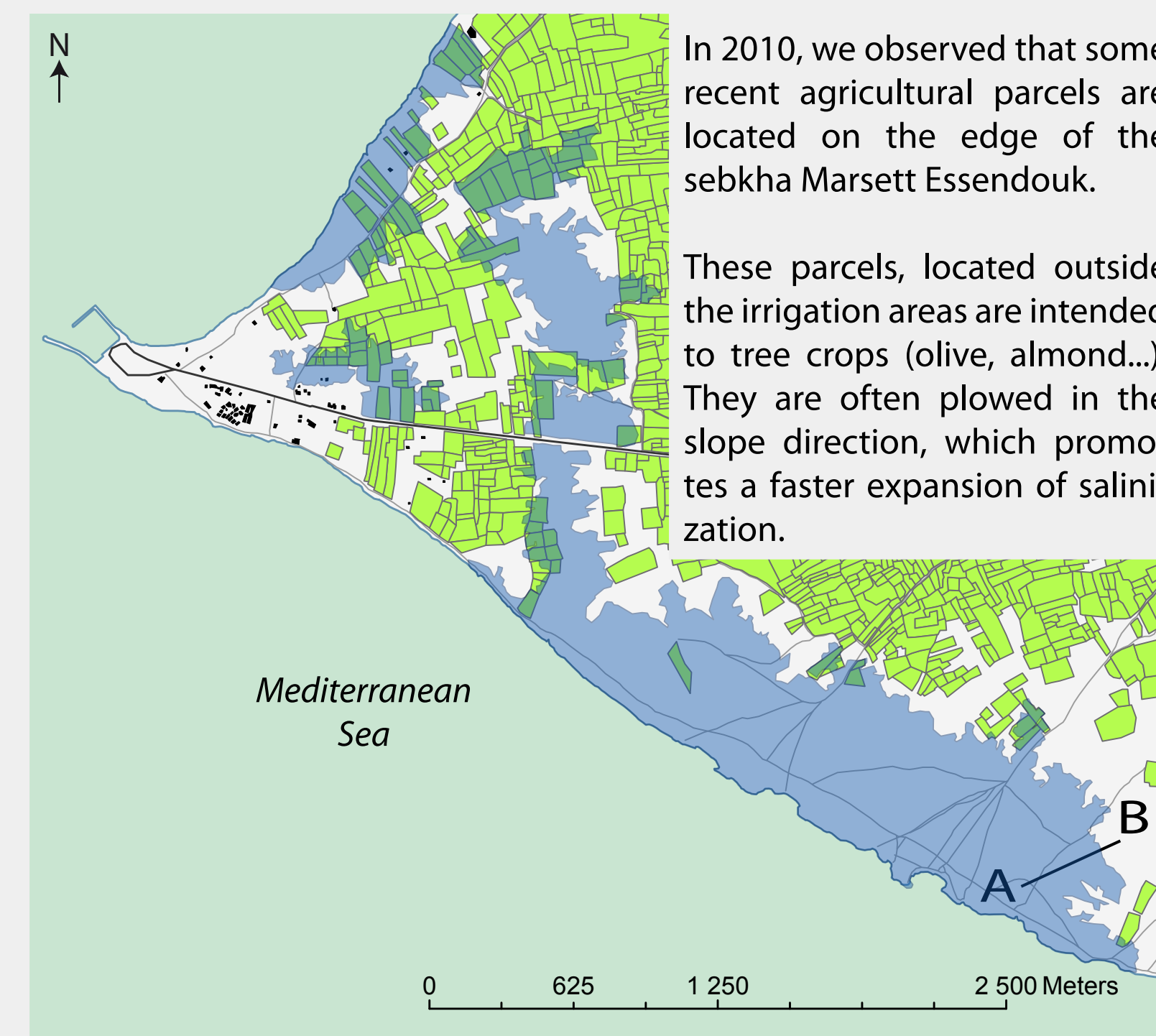


Sebkha evolution



The Marsett Essendouk sebkha was 177,65 ha large in 1963 and 270,06 ha large in 2010. This represents an increase of 92,41 ha (+52%) between both dates.

The development of the Marsett Essendouk sebkha takes a northward direction and is very important to the north of the main road. We believe that the extension of the sebkha is led by the micro-topography visible in the field. This results in an increase in soil salinity and eventually the death of palm trees.



In 2010, we observed that some recent agricultural parcels are located on the edge of the sebkha Marsett Essendouk.

These parcels, located outside the irrigation areas are intended to tree crops (olive, almond...). They are often plowed in the slope direction, which promotes a faster expansion of salinization.



Visible gradient of tree health from the heart of the Sebkha (A, south-west) to the outside (B, North-east).

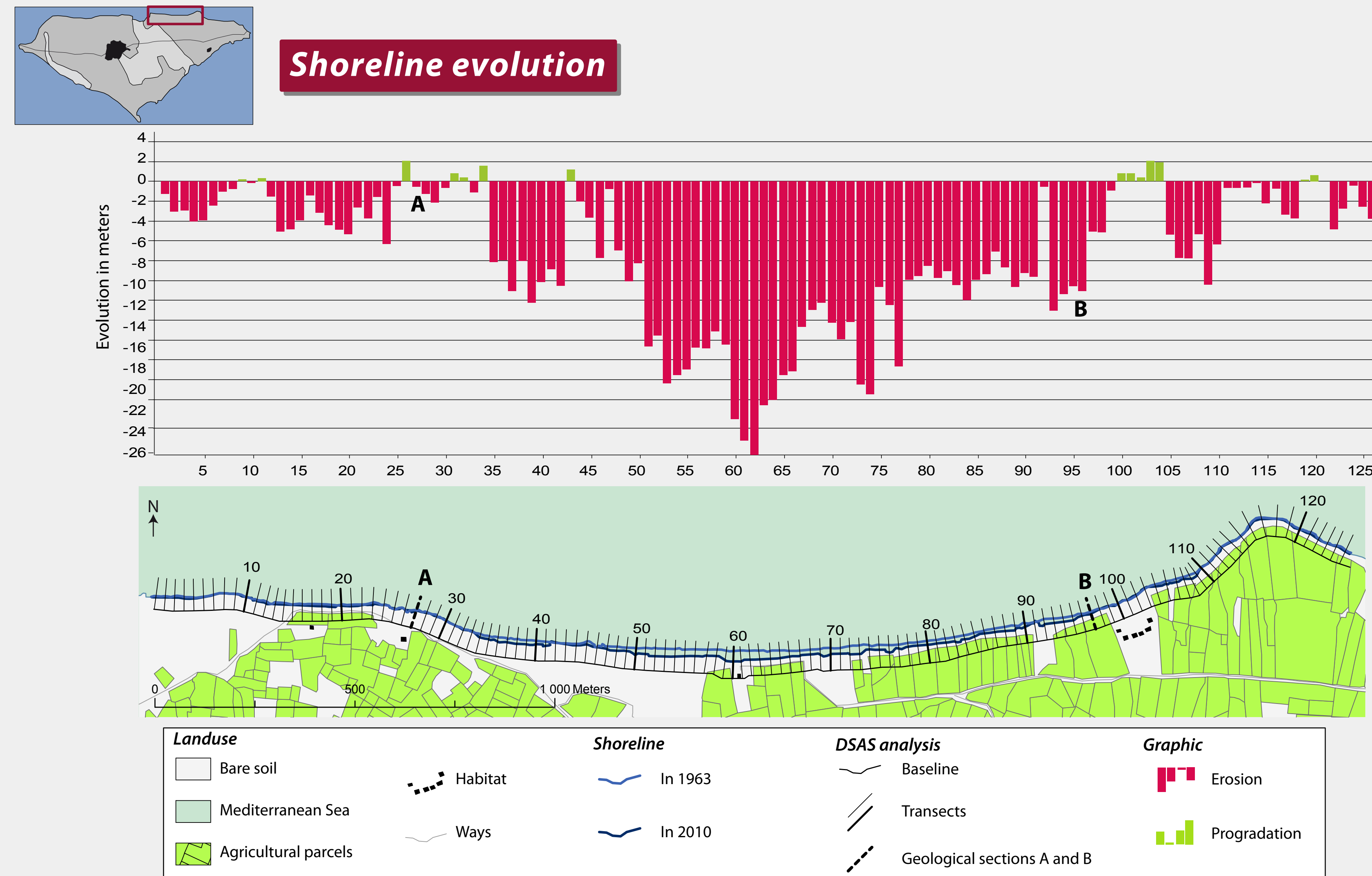
Conclusion

The Gharbi Island is vulnerable, especially regarding the extension of the sebkha and the retreat of the shoreline. Studied areas show an important erosion of the shoreline (with a maximum of $-26\text{ m} \pm 5\text{ m}$) and a major extension of the sebkha Marsett Essendouk (+52% in 47 years).

These two phenomena are related to both climate change and men who move into areas that are already vulnerable or will be in the near future.

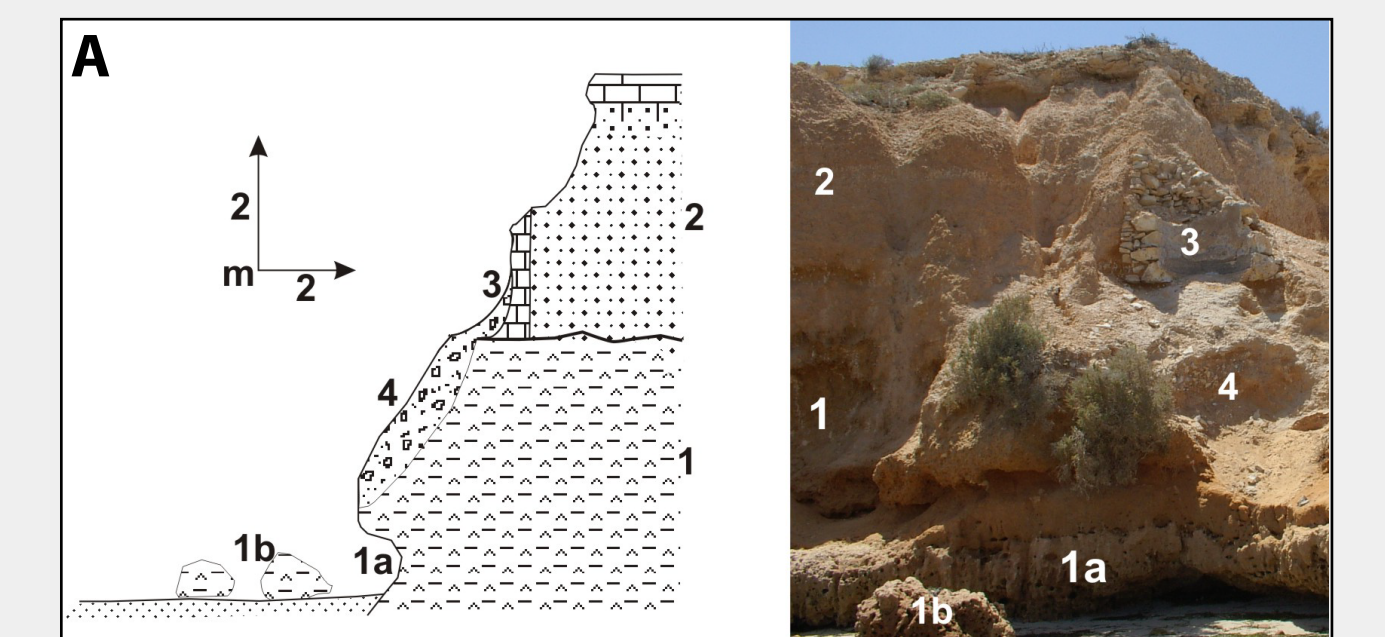
The extension of the sebkhas and the sea advancing in the land involves a reduction of arable land on the island and thus increases vulnerability to climate change and farming operations.

Shoreline evolution



The comparison of the two dates shows a global retreat of the shoreline on the cliff area. Erosion areas are predominant and display important values (maximum $-26\text{ m} \pm 5\text{ m}$). Very few progradations are observed, and their values are all inferior to the error margin ($\pm 5\text{ m}$). These are likely due to the confusion between the inland and some rockfall and cannot be considered as a progress of the coastline.

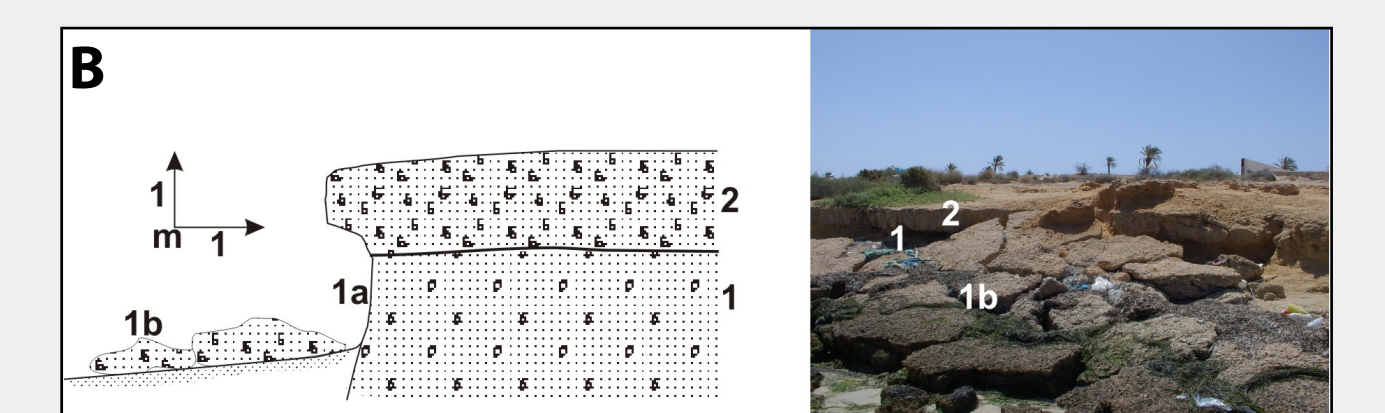
The erosion appears more or less rapid depending on the height and the geological composition of the cliffs (see the geological sections A and B).



1. Mio-Pliocene Gypsiferous clays forming the bedrock of the archipelago. Rapid retreat due to mechanical and chemical action of seawater. Manifestation of erosion: deep notch of 1 to 2 metres depth (1a) and rockfall (1b).

2. Sandy-silty deposits rich in calcareous nodules capped by a calcareous crust of Lower Pleistocene age. This crust often cracks in relation to infiltration of stormwater. It will be quickly blocked by contact with Mio-Pliocene clays. The formed aquifer was exploited since antiquity by wells (3).

4. Reddish silty colluvium and containing pebbles and potsherds.



1. Beige silty clay deposit rich in marine malacofauna and containing rare fragments of calcareous crust. Shaped into notches at the base (1a), which is sometimes 1 to 2 metres depth and favoring collapses and coast retreat.

2. Coarse and consolidated material, very rich in marine malacofauna and containing fragments of reworked limestone and sandstone crust. It experiences a severe erosion as evidenced by the numerous collapsed blocks (1b).