CARTOGRAPHY OF COASTAL DYNAMICS: (CASE STUDY: COASTAL FRINGE FROM HAMMAM-LIF TO SOLYMAR BEACH -TUNISIA)

Samir MEDHIOUB[1], Chokri YAICH[2]

[1]Technologist, Dept. of Civil Eng., ISET of Sfax
(PTT CHIHIA, BP 46, 3041 Sfax, Tunisia)
E-mail:samir.medhioub@gmail.com
[2]Professor, Head of DSE Laboratory, University of Sfax
(ENIS BP W3038, Sfax, Tunisia)
E-mail:chokri.yaich@enis.rnu.tn

This study deals with the use of the multi-temporal teledetection data for the survey of the morphology of the coastline and its surrounding region. Aerial photos (1962, 1988 et 1996) are used in order to retrace the spatio-temporal dynamics of the coastal active fringe from Hammam-lif to Solymar (Tunisia). This analysis is a continuity of previous studies performed on the same site. The results of this temporal evolution showed the existence of three sectors: the first is characterized by relatively moderate erosion (2,2 m/year) compared to the average speed of erosion (5m/year) observed in previous studies (1890- 1974). This erosion is notably observed on either side of coast protection structures implemented in this zone. The second, escaped from the anthropogenic action, is favoured by some accumulations (0,9 m/an). The last sector appears by a precarious stability. The cartography of the coastal dynamics of the study area was elaborated on the basis of historical and recent data listed as well as the results obtained from this work.

Key Words : *coastal, dynamic, erosion, aerial photos, cartography*

1. CONTEXT AND OBJECTIVES

The shore fringe from Hammam-lif to Solymar (Figure 1), object of this study, does not escape the phenomenon of erosion. It is subjected to a progressive degradation involving in certain points, an important retreat of the line of coast, with harmful environmental consequences (Paskoff, 1985; Oueslati, 2004; Zeggaf, 1996). It corresponds to a dynamic balance which changes unceasingly under the influence of the natural factors and the upstream and the downstream of the implemented coastal structures (Figure 2) whose characteristics are given in Table 1. This is the goal of this diachronic study, based on the numerical technique of the geometrical correction and the assembling of the aerial photos. It not only aims to apprehending the kinematics of evolution of the coast but also to draw up the cartography of dynamics coastal which would be an interesting tool, extremely useful for the developers and the decision makers to make decision.

This study is in fact an extension to former research works related to the measurement of the dynamics and the evolution of this coastal fringe from 1890 to 1974. These studies showed that in the period from 1890 to 1962 the speed of erosion was approximately 0,1m/year but from 1962 to 1974, an increasing speed of erosion which varies from 6,4 to 4,2 m/year is detected (L.C .H. F, 1981; SOGREAH, 1992).

Fig.1 Location plan from Hammam-lif to solymar beach (Tunisia).

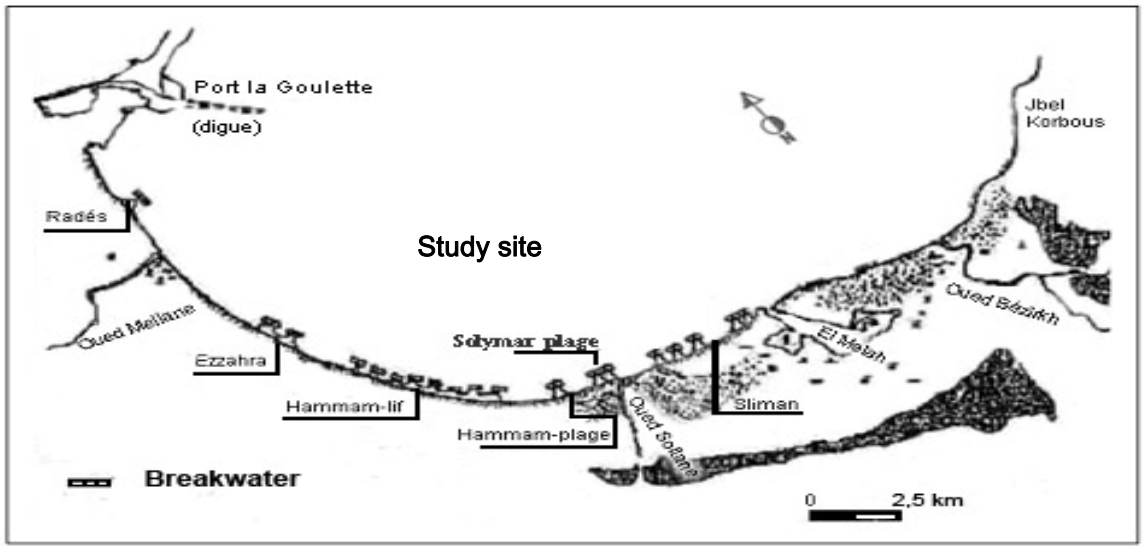

Fig.2 Emergent breakwaters implemented at the Gulf of Tunis.

Table 1 Summary of implemented breakwaters at study site.

Coastal area	Number of segments	Date of construction	Medium segment length (m)	Medium gap length (m)	Water depth (m)	Offshore Distance (m)	Type
Hammam-lif	8	1985	150	55	2,5	100	Dike
Hammam-plage	1	1987	100	-	1,75	80	Dike
Solymar beach	2	1989	130	65	2,5	185	Dike

2. MATERIAL AND METHOD

(1) Basis data

The available data was:

- The aerial photos of 1962, 1988 and 1996 missions with scales of 1/12500, 1/10000 respectively;
- A set of topographic maps of the study area, scale of 1/25000, dated in 1974.

These data are provided by the Office of Topography and the Cartography of Tunisia.

(2) Data processing

Four principal phases are followed in the data processing:

a) Phase 1: Digitalization of the aerial photos:

Each aerial photo has been scanned to create an image with 300 dpi resolution. The resulting image undergoes improvements of contrast, luminosity, and clearness.

b) Phase 2: Geometrical correction:

The aerial photos had to be projected in the same geographical reference system. To make it, a geometrical distortions correction due to the relief, and the errors of scale, as well as the errors due to the conditions of sight catch, remain necessary to obtain finally a homogeneous image.

The geometrical correction of the aerial photos was carried out by ERDAS IMAGINES software which integrates mathematical models or transformations functions of a punctual coordinates of a brute image into new coordinates reference to the geographical system used (ERDAS, 1999). The correction is more precise as the average quadratic error (Root Mean Square) is weak. In the whole corrections carried out, the average quadratic errors didn't exceed one meter which judged acceptable.

c) Phase 3: Assembling of the corrected aerial photos:

The corrected images have been assembled in order to cover the whole study Area. The mean difficulty of this phase is to determine the jointure line, which delimits the covering share zone of each selected close image.

d) Phase 4: Selection and digitalization of the feature of coast:

As coastline, we adopted the instantaneous limit (or water line) of the beach (ROBIN, 2002). The digitalization of the coastline for the assembled and corrected aerial photos of the different mission (1962, 1988 and 1996) was done using the Arcview software.

3. RESULTS AND DISCUSSIONS

The result of the superposition of the three coastlines relative to the three missions (Figure 3) allowed the identification of three entities for this coastal fringe: the first characterizing a coastal entity with erosive tendency, second entity representing a quasi-stable behaviour of the coast and a accumulative tendency representing the third entity. This result was integrated in the establishment of the cartography of the coastal dynamics of the study area.

a) Fraction of the coast with tendency to the stability

This entity of the coast is marked by a dense urbanization and coastal structures (breakwaters, dike,…). This typical landscape is observed in three portions of the littoral corresponding to the localities of Hammam-lif (zone A), Hammam-plage (zone B) and Solymar-beach (zone D). After a pronounced erosion period from 1962 to 1974, these three portions seem to have reached a certain precarious stability due to the formation of the tombolos behind the implemented breakwaters.

b) Fraction of the coast with tendency to accumulation

The coastal fringe from Hammam-plage to Solymar-beach (zone C), has escaped from the anthropogenic pressure and therefore, it could preserve its natural state and it presents a speed of accumulation of sediments of 0,9m/year.

c) Fraction of the coast with tendency to erosion

The coastal protection structures constructed in the study area partly fulfilled their function because they generate a clear increase of the speed of erosion on either sides of their location (a mean speed of erosion equal to 2,2 m/year).

d) Cartography of coastal dynamics

The cartography of coastal dynamics is an invaluable tool for those engaged in the management of the coastal areas. It provides information on the natural, anthropogenic activities and sedimentary and hydrological dynamics as well as the critical sites. This information will be easily accessible to private and public users and will help to overcome the difficulties encountered to have them separately.

The cartography of the coastal dynamics of the study area (Figure 4) was elaborated on the basis of historical and recent data listed as well as the results (diachronic of the littoral, longshore transport, onshore-offshore transport,…) obtained from this work. This information includes the inherent characteristics, the anthropogenic activities and the hydrological and sedimentary dynamics of the site.

The reading of the maps makes it possible to observe for example the spatial and the fast development of the urbanization (from West to East) as well as the coastal protection structures.

4. SYNTHESIS AND CONCLUSION

The dynamic response of the natural and anthropogenic factors of the coastal fringe from

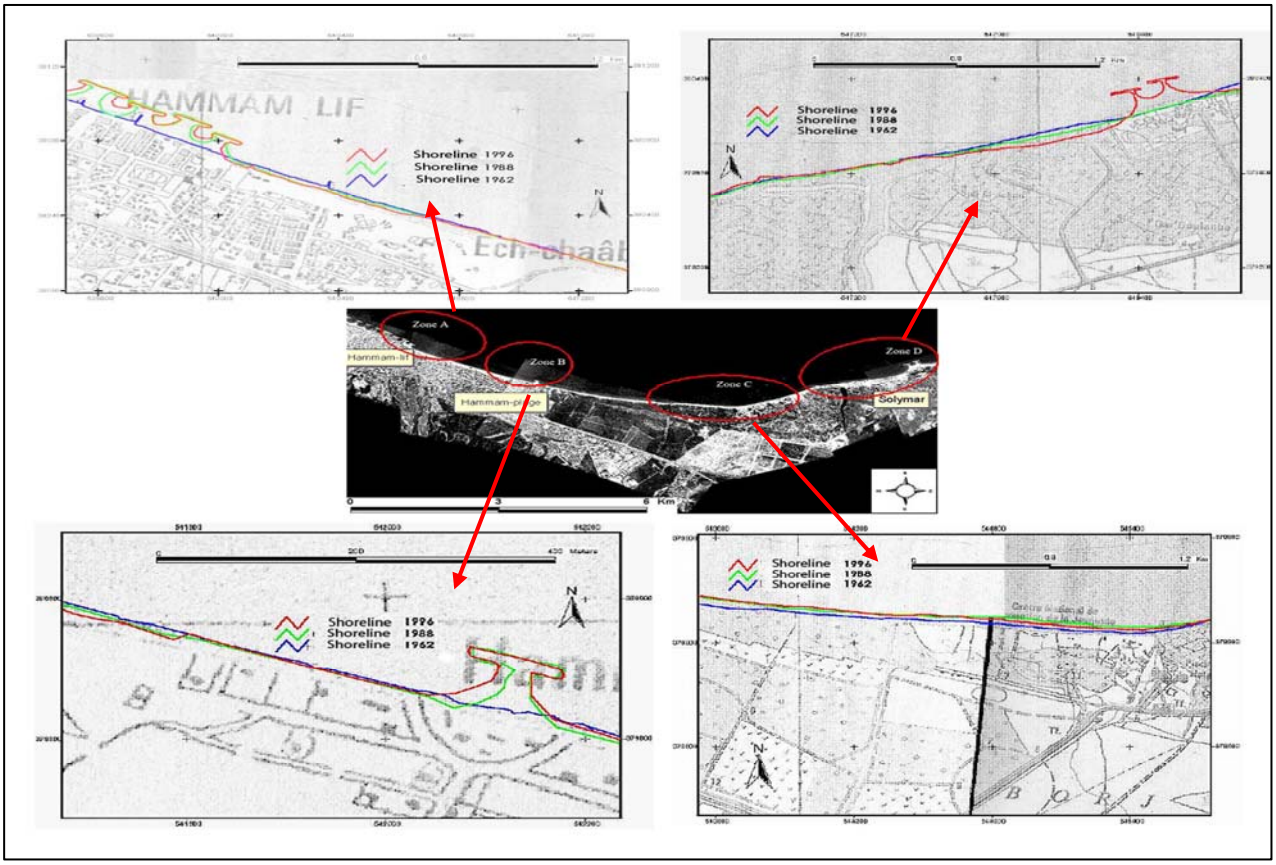

Fig.3 Diachronic of the coastal fringe from Hammam-lif and Solymar beach for the period 1962 to 1996.

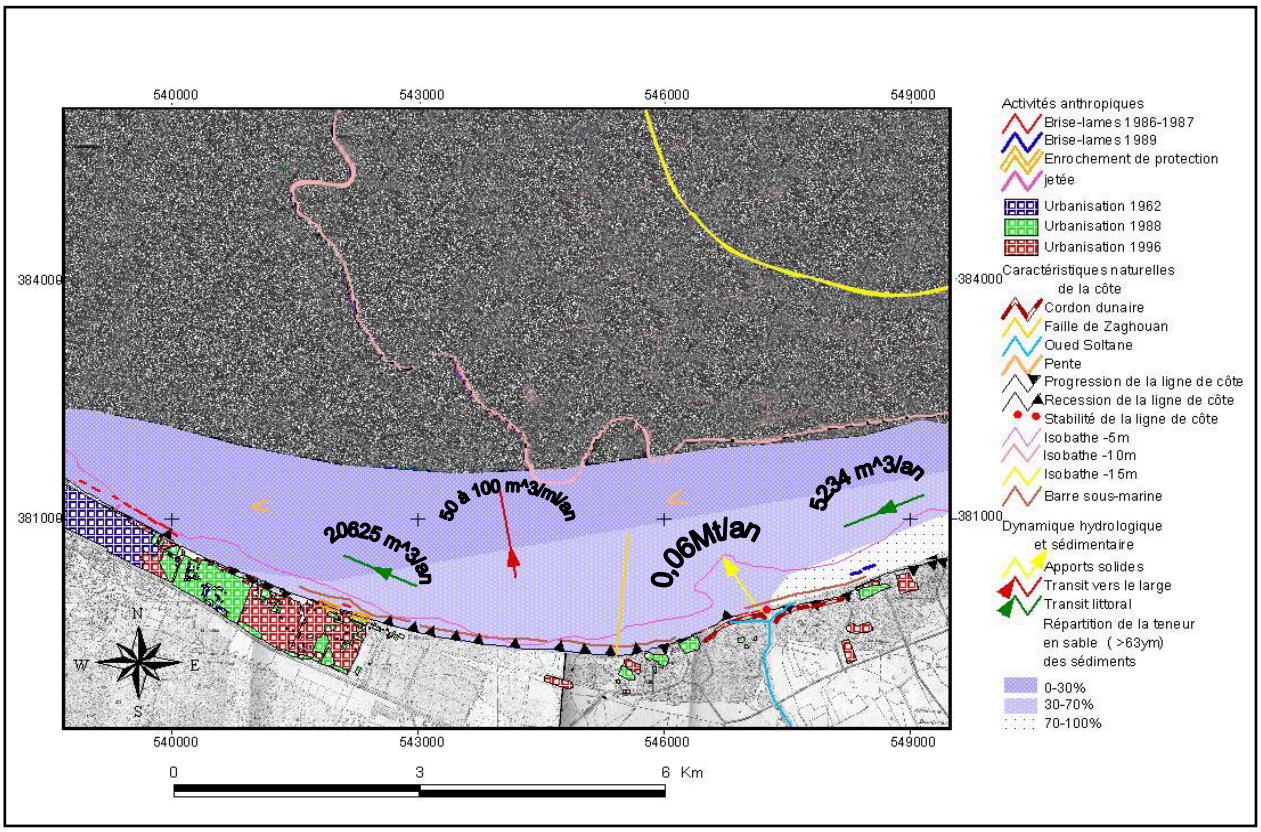

Fig.4 Cartography of coastal dynamics.

Hammam-lif to Solymar beach is approached by the treatment of aerial photos.

The study area is particularly interesting and remarkable for its geographical context (sheltered in a small Gulf) and for the anthropogenic pressure resulting in various implemented coastal protection structures.

The superposition of the three coastlines allowed not only to highlight the zones of regression, progression and stability of this coastal fringe but also to try to stress the need for an efficient and controlled management. This latter is based on a reliable, accessible and as complete as possible data. Therefore, there is a major interest in the establishment of a coastal dynamic map.

REFERENCES

1) ERDAS: 'Erdas field guide', *Erdas Imagine v 8.4*, 698pp., 1999.
2) Hidrotechnica Portuguesa H.P : 'General study of tunisien littoral protection against marine erosion', *Ministry of Equipment, Housing and Territory Management*, 11volumes. 1995.
3) Laboratoire Central d'Hydraulique de France L.C .H.F : 'Protection of the south beachs of Tunis ; First part : sedimentological diagnostic, *Ministry of Equipment, Housing and Territory Management*, 1981.
4) Oueslati A.: 'Littoral and Management in Tunisia' *Faculty of Sciences at Tunis*, 534pp., 2004.
5) Paskoff R.: 'Tunisia beachs', *Editec Caen*, 198pp., 1985
6) Robin M. : 'Télédétection et modélisation du trait de côte et de sa cinématique. In. Le littoral : regards, pratiques et savoirs', *ULM ed*., 95-115p., 2002.
7) SOGREAH. : 'Rehabilitation of the protection of the south beach of Tunis and Mahdia', *Ministry of Equipment, Housing and Territory Management*, 1992.
8) Zeggaf M. :' Impact study of structures protection on the littoral environment of the small bay of Tunis', Ph.D thesis in geology, *University of Tunis*, 139p., 1996