COASTAL PROCESSES ALONG ROSETTA PROMONTORY OF THE NILE DELTA , EGYPT.

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ABSTRACT

The Rosetta promontory is located about 60 km east of Alexandria on the western side of the Nile delta. This promontory prograded into the Mediterranean by about 3.5 km during the 19th century as a result of large quantities of sediments brought by the Rosetta branch during flood periods. This trend was reversed at the beginning of the 20th century and the rate of erosion has accelerated since 1964 due to the absence of the sediments which was trapped in the Lake Nasser behind the High Aswan Dam. This paper discusses the dynamic processes and environmental factors affecting the coastal changes of the Rosetta promontory and the response of the shoreline induced by of the protective structures that have been erected to control erosion .

Keywords: Coastal processes, dam effects, Egypt, Rosetta promontory, sediment transport, shoreline erosion.

INTRODUCTION

The Nile Delta coast consists of approximately 240 km of sandy beaches, Figure (1). This coast is the product of the sedimentary processes which had occurred between the upper Miocene period some 10 million years ago (Nielson 1977). Prior to the year 1900, the annual quantity of sediments brought by the river Nile through the Rosetta and Damietta branches into the sea as estimated to be more than 100 million tons per year (Hammad et al 1979). Old maps showed that between 1800 to 1900 the Rosetta promontory advanced by some 3.5 km (35 m/y) while the Damietta promontory advanced about 3km (30 m/y) (Sestini,1976). From 1900 to the present, the river sediment discharge had been decreased due to the control works constructed on the river itself and/or due to human interference with the shoreline. The erosion rate had accelerated since the construction of the High Aswan dam in 1964 which trapped all the sediments transported by the river (Orlova and Zenkowitch 1974, Frihy et al 1991).

This paper concentrates on the Rosetta promontory to show the dynamic processes and environmental factors affecting the coastal changes that have been monitored for the last 20 years . A concentrated program of field data collection started in 1982 comprising: survey of about 50 profiles covering the area, directional wave measurements, current measurements and collection of bottom sediment samples. These data were used in planing and designing protective structures executed during the period from 1986 to the beginning of 1991.

The aim of this paper is to:

(1) gives brief description of the data collected and the results of the analysis.
(2) illustrates the factors used in the design of the protective structures and
(3) monitoring the response of the shoreline due to the execution of the protective structures.

NEARSHORE PROFILES

Nearshore morphology of Rosetta promontory has been studied by analysing the nearshore profile data. Examining 50 profiles starting in 1982 to 1989, two types of profiles were apparent:

(i) Undernourished profiles are found at Rosetta promontory Figure (2a).
(ii) Overnourished profiles exist a few kilometers east and west of Rosetta promontory which acts as a sink for the eroded material from the tip of the promontory Figure (2b).

The short term changes of each type of the profile are given in Figures (2c) and (2d).

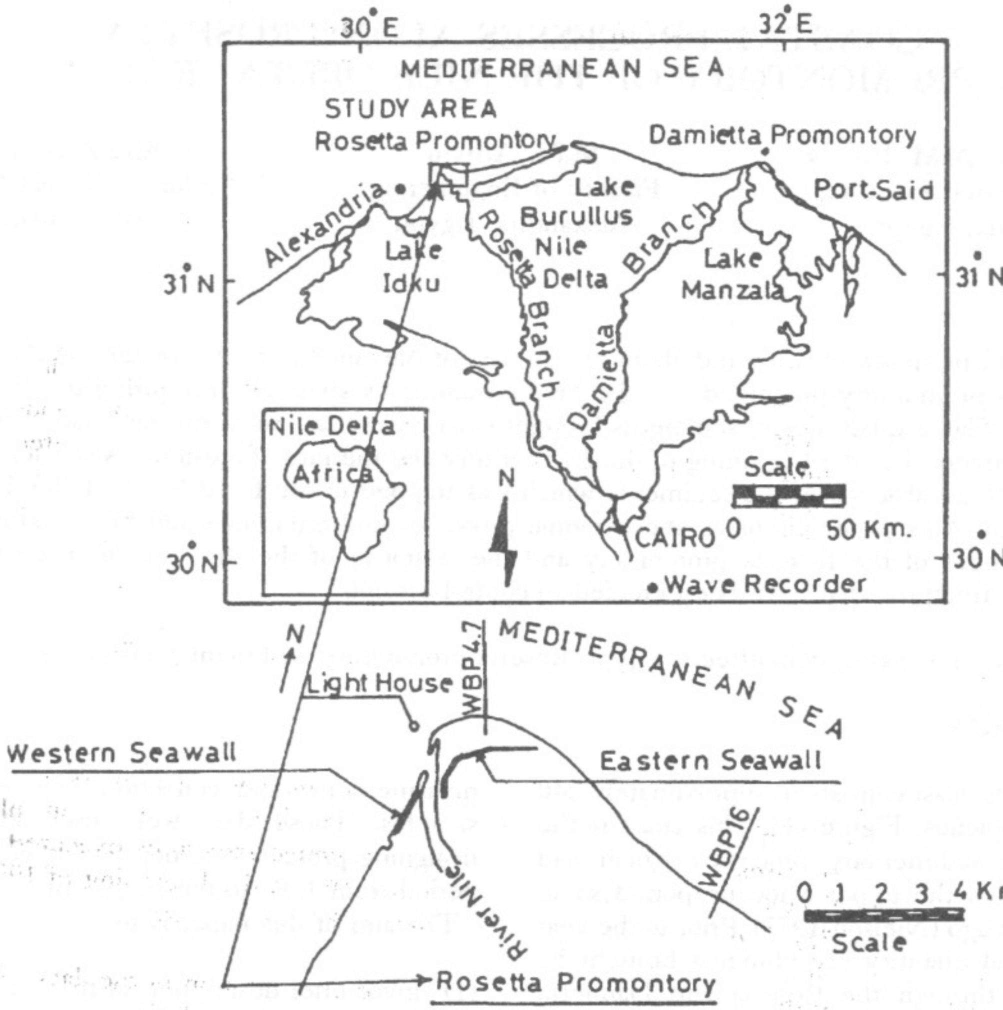

Figure 1. Nile Delta and Rosetta Promontory Study Area.

PATTERNS OF SHORELINE CHANGES

Figure (3) shows the prograding of the promontory during the 19th century as well as the remarkable erosion on the tip of the promontory at the beginning of the 20th century. The erosion rates for the western part of the promontory for the period 1900/1941, 1941/1964, 1964/1971, 1971/1982 and 1982/1989 were 18, 33, 93, 230 and 40 m/year respectively. They were 16, 26, 115, 130 and 100 m/year for the eastern part of the promontory during the same periods (Fanos et al 1989). The old Rosetta lighthouse which was 950m inland from the tip of the western part in 1898, became isolated in the sea and was destroyed in 1942. The second light house which was 1 km inland in 1970, became an offshore island in 1976 and by 1984, severe erosion at the tip of the promontory left this structure isolated in the mediterranean and nearly 1.5 km from land (Frihy,1988).

PROCESSES AFFECTING THE ROSETTA PROMONTORY

The major forces influencing the coastal processes along the Nile delta are induced by winds and waves. A directional wave recording system termed the Cassette Acquisition System (CAS) was installed in 1981 at Abu Quir bay Figure (1). The system is a portable, self-contained remote recording system for

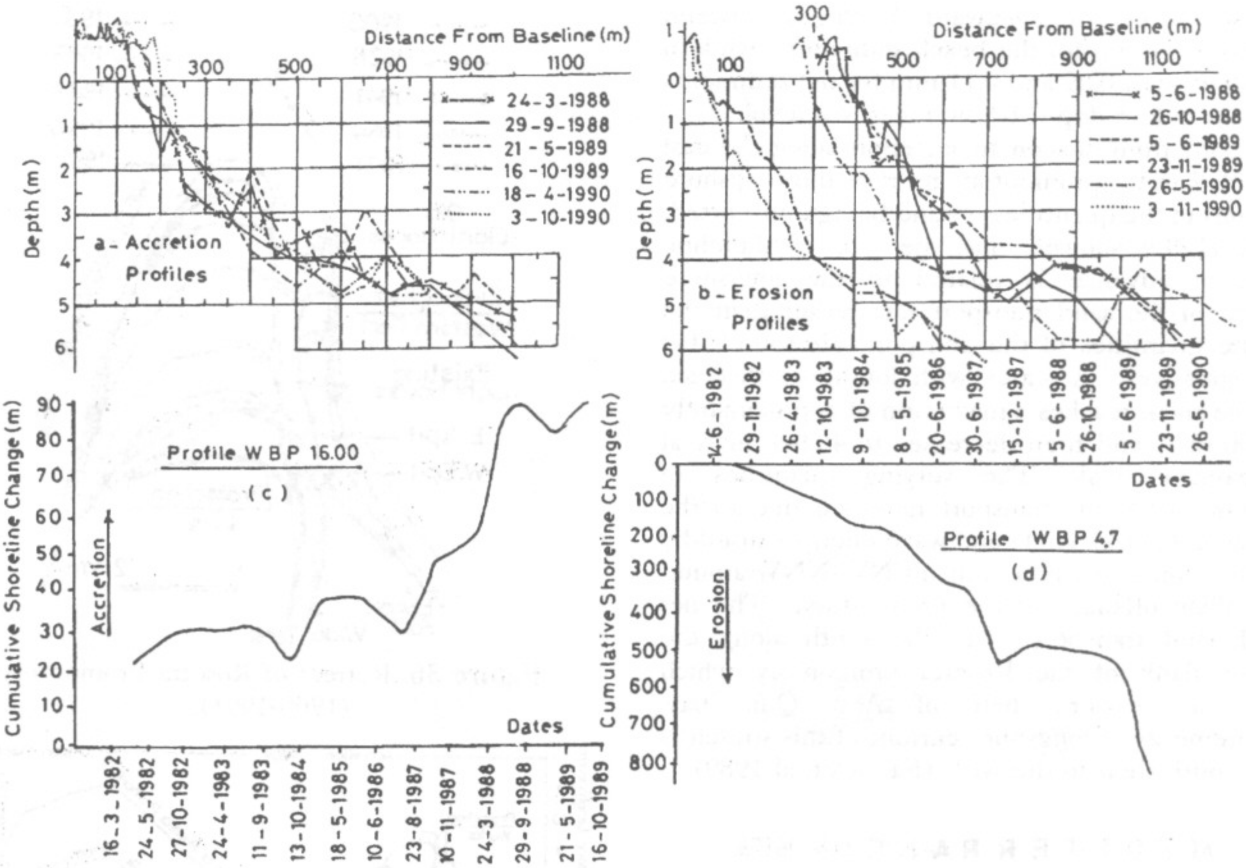

Figure 2. Profile Surveys of Rosetta Promontory.

sensing nearshore environmental parameters such as wave energy, wave direction and currents (Boyd et al, 1985). It was installed at about 18 km from the shore at 6m below mean water level and 11.5 m above the sea bed at Abu Quir bay.

The wave data are recorded every 6 hours for 34 minutes each record. The data are recorded on cassettes and are computer analysed to yield spectra, significant wave heights, periods and wave directions (Lowe and Inman 1984, Naffaa et al 1991).

The wave directions are predominantly from the WNW, NNW, N and W with a small portion of waves arrived from the NNE and NE especially in March through April (Figure (4)). The maximum significant wave height recorded at Abu Quir was 5.5m and the maximum significant wave period was 13 sec during 1985 to 1990.

The intensity of wave action is highly seasonal causing changes in wave energy flux which are responsible for the nearshore coastal changes. Construction of wave refraction diagrams illustrates the concentration of wave energy at the promontory and in part explains the severe erosion that took place (Naffaa 1990).

The longshore currents are measured within the surf zone twice daily at Rosetta promontory. Longshore current data are available from 1972 up to the present. The longshore current data have been subjected to monthly, seasonally and yearly statistical analysis to determine the probability distribution of currents. At Rosetta area the predominant direction on the eastern part of the promontory is from west to east while it is from north to south on the western part (Figure (5)). The maximum measured currents ranged from 80 to 90 cm/sec. (Fanos 1986 and Fanos et al. 1989).

The surface bottom sediment samples are taken along the profiles every 100 meters with a grab sampler. The samples are dried and subjected to mechanical analysis to determine the isocontour pattern of the mean grain size. At Rosetta area the mean grain size of the nearshore sediments shows a tendency to decrease seaward. It ranges between 0.13 and 0.23 mm for the beach sediments, while it ranges between 0.09 and 0.11 mm for the sediments taken up to 6 m depth below mean sea level.

The shift from erosion to accretion along the east flank of Rosetta promontory reflects the longshore variations in the quantities of sand being transported. Komar (1991) showed that the rate of shoreline retreat or advance is related to the longshore gradient of the sand transport rate rather than the absolute quantities of the transport. He found that Q_s progressively increases with longshore distance from the river, reaches a maximum of approximately 417,000 m^3/y and then decreases to 40,000 m^3/y at the eastern flank. The varying quantities of longshore sediment transport rates are due to the changes in breaker angle and wave energy caused by the refraction of the predominant NW-NNW around the shallow offshore of the promontory. The net littoral sand transport is to the south along the western flank of the Rosetta promontory which forms the eastern half of Abu Quir bay. Measurements of longshore current of this stretch is to the south then to the west (Fanos et. al 1989).

Figure 3a. Shore-line Advance at Rosetta Promontory (1500-1900).

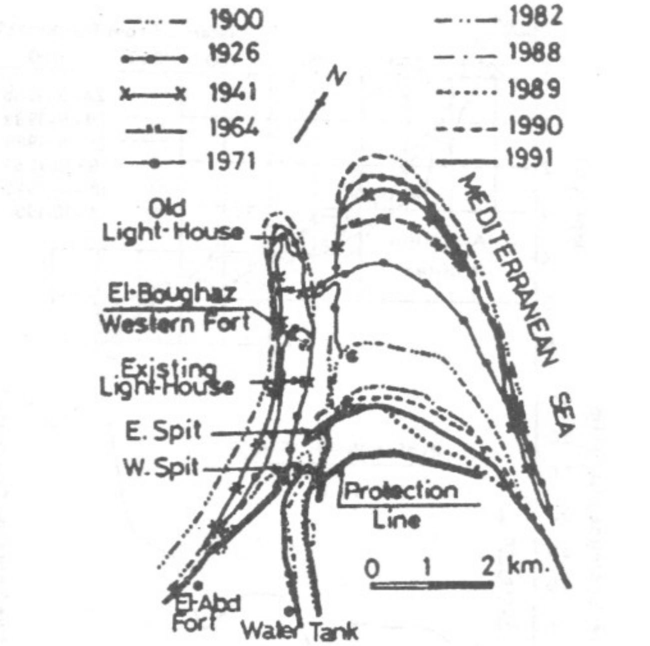

Figure 3b. Retreat of Rosetta Promontory (1900-1991).

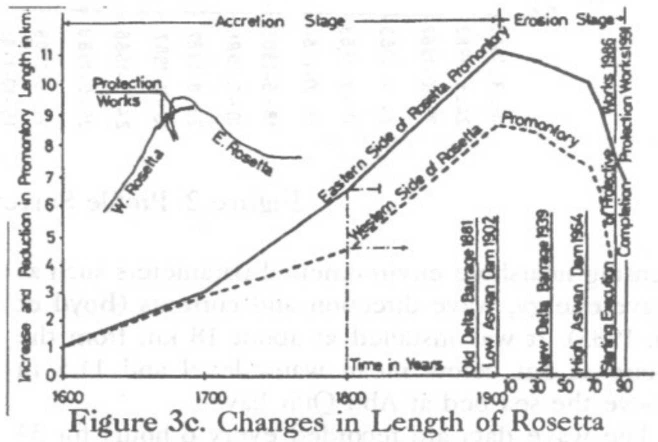

Figure 3c. Changes in Length of Rosetta Promontory (1600-1991).

SHORELINE PROTECTION MEASURES

The protective works on the Rosetta promontory began in 1986 in order to stop erosion in this area. Two sea walls of 1.5 and 3.5 km length have been executed on the western and eastern parts of the promontory respectively, see Figure (1).

The sea has reached the western one and it is acting well while the eastern one is still in land. Four tons dolos blocks were used as an armor layer. The rate of erosion have been slowed down along both flanks. Continued monitoring will document effectiveness of the massive constructed sea walls.

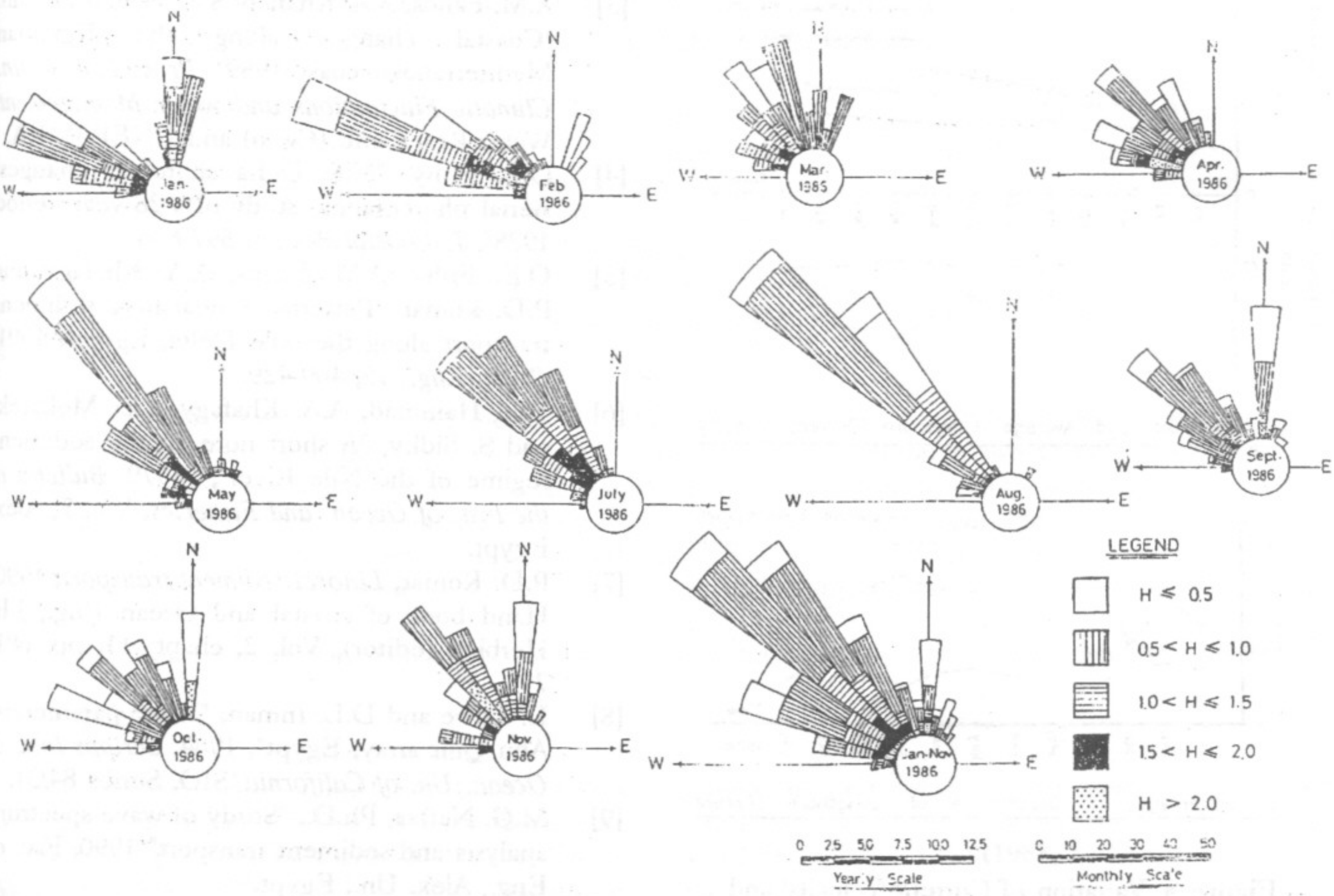

Figure 4. Wave Rose for Abu-Quir Station, for the Year 1986.

CONCLUSIONS

Erosion of Rosetta promontory has been accelerated since the beginning of the 20th century with very high rate of shoreline retreat. The reorientation of the shoreline is in response to the continued wave action and longshore sediment supply which was trapped in the upstream of the high Aswan Dam since 1964. The studies carried out showed that this erosion is closest to the tip of the eastern part of the promontory decreasing to the east and beyond a nodal area is converted to accretion and shoreline advance. At the western flank, the net littoral sand transport is to the south. This is due to the dominant direction of the longshore currents on both sides. Based on refraction diagrams, pronounced zones of wave convergence and divergence that result in strong longshore gradients of wave heights and breaker angles and therefore of sand transport rates.

In order to slow erosion in this area, two seawalls have been executed in 1986 at the eastern and western part of the promontory. The sea has reached the western one and is acting well while the eastern one is still in land. The rate of erosion slowed down along both flanks. Continued monitoring will document the effectiveness of the massive constructed seawalls.

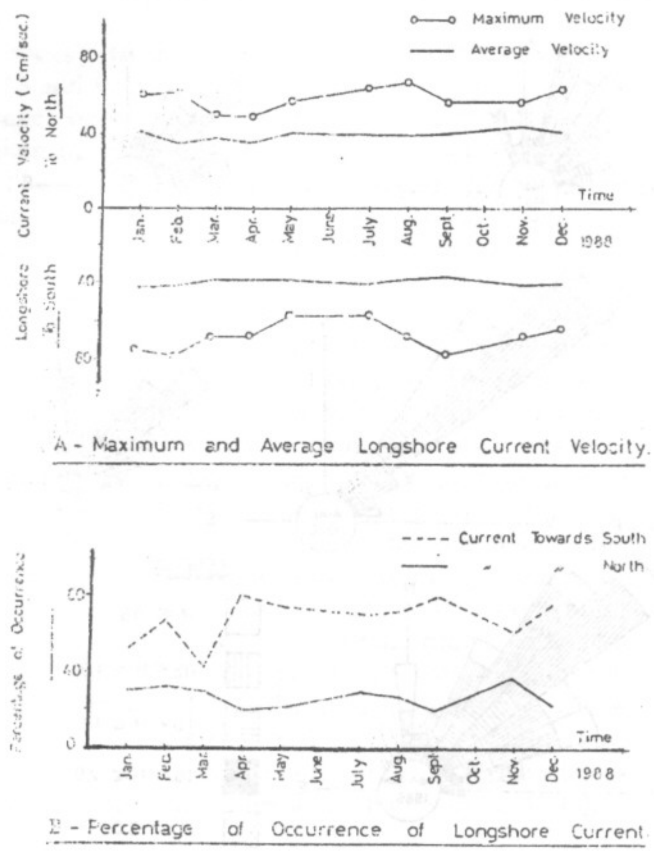

Figure 5. Variation of Current Velocity and Percentage of Occurrence West Rosetta Promontory for Year 1988.

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