ON THE MECHANISM OF SEDIMENT TRANSPORT ON THE WESTERN PART OF THE MEDITERRANEAN SHELF OFF THE NILE DELTA

Makram A. Gerges and Mounir S. Salama
Mediterranean Sea Branch   Coastal Research Branch

Institute of Oceanography and Fisheries, Alexandria, Egypt

ABSTRACT

Considerable bathymetric changes have been recently observed on the Mediterranean shelf off the Nile Delta, indicating areas of erosion and accretion. Accordingly, the mechanism of sediment transport is described and an attempt is made to correlate these changes to the prevailing current system, wave action, and bottom slope gradients in the region.

INTRODUCTION

Significant environmental changes have been observed along the Egyptian Mediterranean coast after the construction of the High Dam at Aswan in 1964. The regulation of the fresh water outflow from the Nile River prevented more than 90% of the usual discharge with its suspended load from reaching the Mediterranean basin. This has deleteriously affected the continental shelf environment and the coastal zone stability. Now that solid material is no longer being supplied by the river to the coastal zone, current and wave actions are causing serious erosional problems, particularly near the two mouths of the Nile, e.g., at Rosetta promontary the present rate of erosion has been estimated as 200 m/year.

In a separate study, Salama and Toma (1978) showed that bottom changes have taken place revealing erosion in some areas and accretion in others, depending on the magnitude and direction of forces applied, type of sediment transported and the bottom topography. The aim of this study is to discuss the relationship between the observed bathymetric changes and the revealed sediment distribution pattern, on one hand, and the prevailing dynamical forces on the other. An attempt is made to describe the mechanism of the sediment transport. Such study is evidently essential and important for effective coastal management.

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AREA OF INVESTIGATION AND MATERIAL

The investigated area extends for about 150 km along the Nile Delta coast between Alexandria in the west and the outlet of Lake Burullus in the east, and seaward to an average water depth of about 70m.

Results of the old bathymetric surveys conducted by the British Admiralty in 1919-22, and of the recent surveys carried out by the R/V Chain in 1975 and by the UNESCO-sponcered Coastal Protection Project in Egypt during 1976-77, were analysed. The present pattern of sediment distribution given by Summerhayes et al (1978) has been considered. In addition, data obtained from current and wave measurements carried out in the inner shelf region of the Nile Delta were used to confirm the proposed mechanism of sediment transport as described below

RESULTS AND CONCLUSIONS

The comparison of the old and recent bathymetric surveys showed that considerable isobath shifts have taken place in the last 75 years (Fig. 1). These shifts indicated severe erosion in Abu Qir Bay and moderate erosion in the inner shelf off Rosetta mouth. Meanwhile, accretion is observed in Burullus shelf beyond 20 m depth.

According to Moussa (1973) and Summerhayes et al (1978), the sediment distribution of the area shows great variation from calcarious sand on Alexandria shelf to silty sand in Abu Qir Bay. Mud deposits are concentrated off Rosetta mouth, while relict sand covers Burullus shelf.

The bottom slope gradients (Fig. 2) indicate that in Abu Qir Bay area, gentle slopes (1:2500) are observed nearshore, followed by steeper slopes (1:500 - 1:1000) offshore, while in Burullus area the reverse occurs. This striking feature generally favors the sediment transport to be seaward in the first area and landward in the second.

The above results and discussions, supported by some wave and bottom current measurements, assume that the sediment transport should occur, as proposed in Fig. (3), by a mechanism which could be discribed as follows:

I. <u>In Abu Qir Bay</u>: In the western half of the Bay, away from Rosetta fan area, the transport in shallow water (of depth less than 20m) tends to have a direction ranging between NE and SE. In deeper water, the transport takes a Northeastern direction until it reaches the outer boundary of the Bay, where it turns to N and NNW direction. Finally the general eastward flow circulating the Eastern Mediterranean which, according to Gerges (1976), is unidirectional from surface to bottom influences the transport beyond the 50m-depth contour to attain an eastward direction.

Results from current measurements carried out in the shallow water region of this part of the Bay (Tebelius, 1977) indicated an almost absolute prevalence of NE and SE currents with percentage of occurance reaching about 75% of the time in some cases. This strongly supports the mechanism suggested in this study as discribed above.

2. <u>In the Rosetta fan area</u>: In the western sector of the fan northwesterly transport is prevailing affected to a great extent by the bottom topography as the bottom slope gradient and the existance of Rosetta canyon both help the sediment to escape in that direction. Meanwhile, in the eastern sector of the fan, a northeasterly transport is indicated. However, in deeper water of this sector, near the 50 m-depth contour, the transport tends to be eastward.

   Bottom currents were measured at two stations 4.5 and 9.5 km to the northwest of Rosetta mouth, at depths of 11.5 and 15.8 m respectively. Results obtained from the first station showed that variability of velocity and direction was an outstanding feature of the bottom currents. At this locality, the current was southwesterly 35% of the time, whereas the northern components of the currents prevailed for only 24% of the time but with higher velocities, sometimes exceeding 30 cm/sec. At the second station, the main directions of current were between N and NNE with velocities ranging from $\leqslant$ 3 to 10 cm/sec. This confirms the proposed mode of transport in the Rosetta fan area.

3. <u>In Burullus shelf area</u>: Completely different mechanism of sediment transport is observed in this area, resulting obvious accretion. This part of the shelf, being rather an open area of the Nile Delta coast, is more exposed to the driving forces coming from the open sea in the form of winds, waves and associated currents. The prev-

ailing northwesterly winds generate waves, the most predominant directions of which are the NW (30%) and the NNW (30%) and the N (13%) (Rahal, 1977). As these waves transmit their energy and momentum toward the coast, bottom-boundary currents are produced flowing over the shelf in the direction of wave propagation, and these currents play the significant role in the sediment transport over the shelf. The resulting currents stir up the sediments and transport them toward the coast. Proceeding coastwards, These currents would dissipate energy and thus the transported sediments are accumulated over Burullus banks resulting accretion.

In conclusion, it should be mentioned that the above discribed mechanisms are restricted only to the coastal areas beyond the littoral zone which exihibits its own dynamics.

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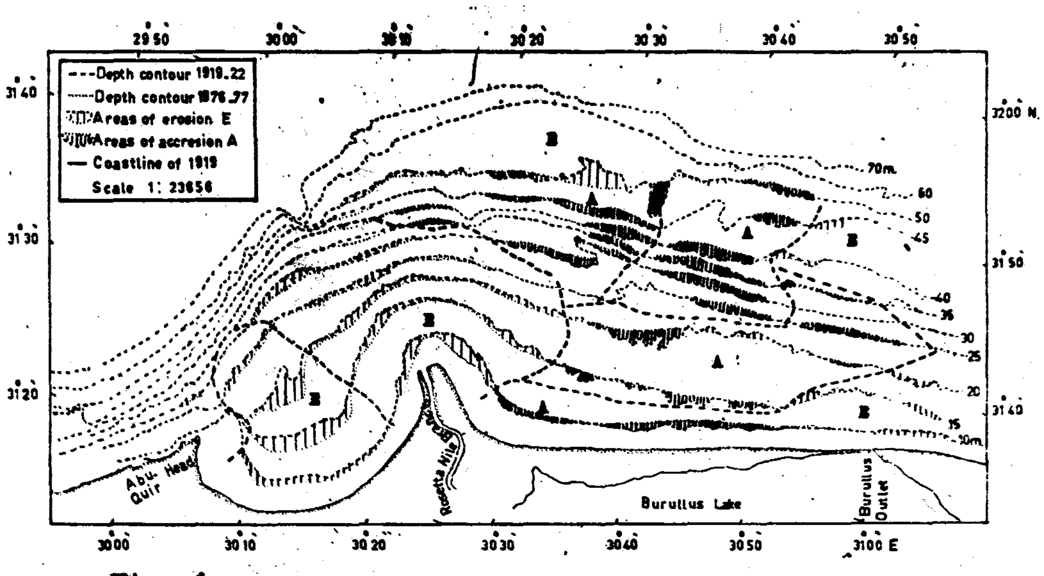

Fig. 1 Map showing the shefts of the contours.

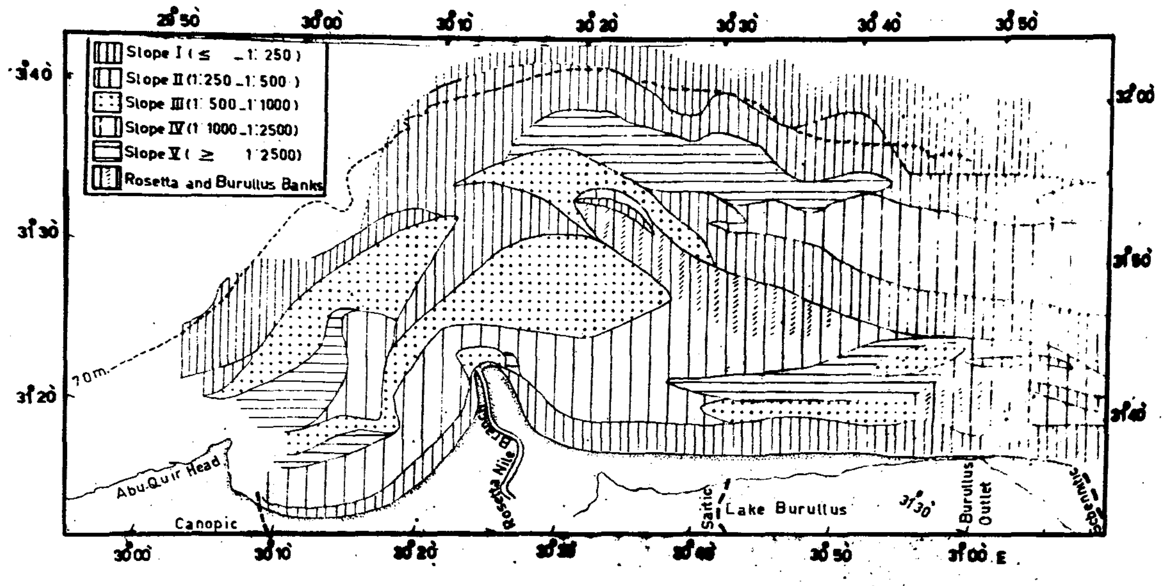

Fig. 2 - Slope gradient map

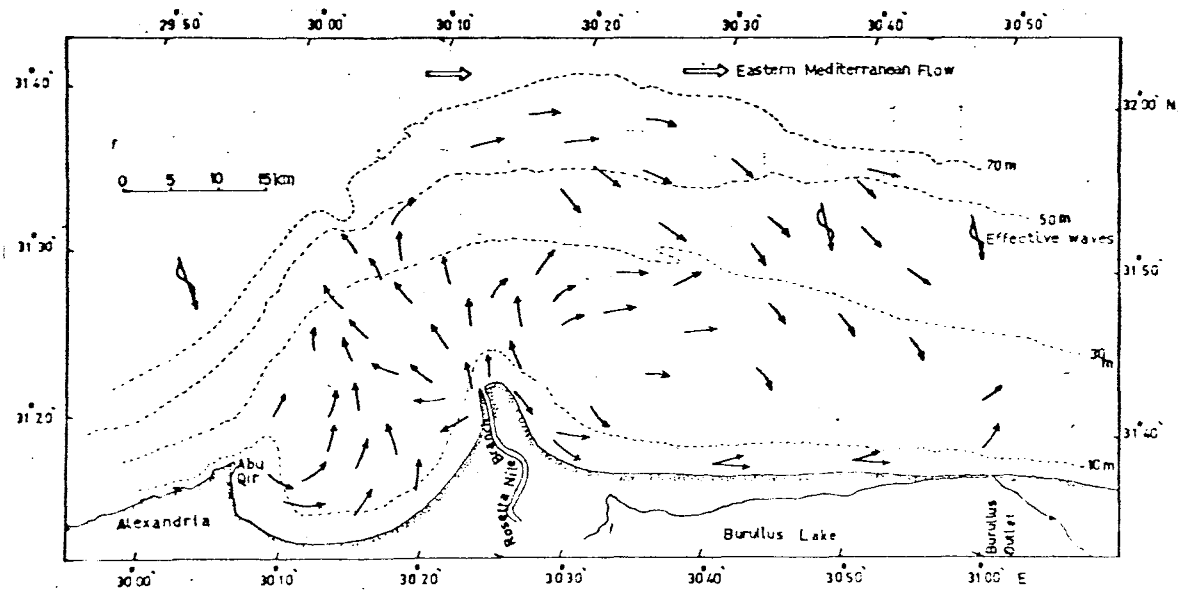

Fig. 3 - Net Bottom Transport