Journal of Coastal Research	7	2	465-475	Fort Lauderdale, Florida	Spring 1991

Temporal Shoreline and Bottom Changes of the Inner Continental Shelf Off the Nile Delta, Egypt

O.E. Frihy[†], S. M. Nasr[‡], M.H. Ahmed[†], and M.El Raey[‡]

[†]Coastal Research Institute
Alexandria, Egypt

[‡]Institute of Graduate Studies
and Research
University of Alexandria
Alexandria, Egypt

ABSTRACT

FRIHY, O.E., NASR, S.M., AHMED, M.H., and RAEY, M., 1990. Temporal Shoreline and Bottom Changes of the Inner Continental Shelf Off the Nile Delta, Egypt. *Journal of Coastal Research*, 7(2), 465–475. Fort Lauderdale (Florida). ISSN 0749-0208.

Observations of long-term change in the shoreline and bathymetry on the inner continental shelf off the northern Nile delta are based on comparison of two bathymetric maps of closely-spaced soundings from 1919/22 and 1986. The changes are depicted after analyses of 40 bathymetric profiles in water depths as great as 30 m and extending about 30 km from the shore. Comparison among these profiles in terms of changes in water depth, shifting in bottom contours and volumetric changes in bottom sediments, identifies areas of erosion (Abu Quir Bay, Rosetta promontory, east of Burullus, and Damietta promontory) and accretion (Abu Khashaba coast, West Burullus inlet, Gamasa and the Damietta spit). These changes are generally due to long-term sediment movement in which most of the accreted sands come from eroded promontory tips as well as from offshore sources. Statistical correlation analysis indicates that areas of potential erosion and accretion are not related to sediment texture, slope gradient and water depth.

ADDITIONAL INDEX WORDS: *Nile delta, shoreline changes, inner shelf bathymetry, sediment transport, erosion, bathymetric survey.*

INTRODUCTION

The instability of the Nile delta coastal zone, in terms of erosion and accretion, has been observed since the beginning of the present century. Severe erosion of some coastal areas has destroyed roads and caused loss of buildings and resort beaches. On the other hand, shoaling due to accretion in lake inlets and estuaries has caused subsequent navigation hazards. Several general studies have been conducted in Nile delta coastal zone; including coastal geomorphology (SESTINI, 1976; FRIHY *et al.*, 1988); analysis of beach profiles normal to the shore up to 6 m depth (MANOHAR, 1976a&b); shoreline changes (SESTINI, 1976; MISDORP, 1977; KLEMAS and ABDEL KADER, 1982; FRIHY, 1988; SMITH and ABDEL KADER, 1988); surficial sediment distribution (SUMMERHAYES *et al.*, 1978); dynamic factors (KHAFAGY and MANOHAR, 1979; MANOHAR, 1981; FANOS, 1986; ELWANY *et al.*, 1988) and land subsidence or sea level rise (EMERY *et al.*, 1988; STANLEY, 1988). Earlier research on changes in the bottom morphology of the shelf of the Nile delta has been qualitatively investigated by MISDORP and SESTINI (1976) and TOMA and SALAMA (1980). Their bathymetric comparison was based on 1919/22 and 1975 maps.

The present study is based largely on quantitative comparison between the 1919/22 and the more recent 1986 bathymetric surveys. An attempt is also made to apply multiple correlation statistics between the erosion/accretion data and other profile parameters such as grain size distribution of bottom sediments, slope gradient and water depth. The overall pattern of sediment movement in the study area is also constructed on the basis of measured coastal changes between the two study maps.

Factors Controlling Shoreline and Bottom Changes

The erosion and accretion pattern along the coast of the Nile delta is generally a function of: (1) decrease of sediment supply to the coast, (2) subsidence and/or sea level rise and (3) hydrodynamic factors affecting the Nile delta coast.

A sufficient amount of sediments must be sup-

89065 received 25 October 1989: accepted in revision 5 February 1990.

plied to the sea by rivers to compensate for erosion. In fact, the decrease of sediment supply to the coast at the two Nile promontories is not only controlled by the impact of the man-made structures (dams and barrages) established across the Nile system, but also due to natural factors (FRIHY and KHAFAGY, 1989). These factors are mainly a response to climatic changes in the Nile's drainage basin due to a changed precipitation pattern in East Africa. During the 20th Century, the Nile floods exhibited a significantly lower-than-average annual flow due to low rainfall as compared to the 19th Century. The periods of low floods (RIEHL and MEITIN, 1979; HASSAN, 1981) coincide with the coastal recession which has occurred since the beginning of the present century.

On a large scale, mean sea level in the Mediterranean has risen over the past 40 years at an average rate of more than 3 mm/yr (EMERY, 1980). In the Nile delta, loading from the 3 km-thick deposits of lower Pliocene-Quaternary sediments may accelerate submergence of land or relative sea-level rise (EL ASKARY and FRIHY, 1986; COUTELLIER and STANLEY, 1987; SESTINI, 1988). In addition, tectonic action, such as faulting may also cause rapid subsidence in the northeastern part of the delta (NEEV *et al.*, 1985). Based on carbon-dated core sections, STANLEY (1988) has reported the highest rates of land subsidence of 3.5 to 5.0 mm/yr in that region. Records from tide gauges at Alexandria and Port Said indicate submergence of land or rise of sea level (0.7 to 4.8 mm/yr, EMERY *et al.*, 1988).

The action of waves and currents are the major agents which affect the sea bottom and shore. Wave action along the Nile delta coast is seasonal in nature. The wave climate of the winter and spring months is more severe than the summer, with alternating large storms (significant wave heights = 2–3 m and NNW or WNW direction) and calm periods (ELWANY *et al.*, 1988). The erosion of the bottom by storm waves is most intense in winter. However, in summer, sea swells attack the coast with wave heights varying from 40 to 75 cm (MANOHAR, 1976b). Summer swells predominant directions are also NNW or WNW. Swells shift sediments shoreward in the form of bars, which gradually merge with the shore. However, continued summer swells cause sea level to rise in the central part of the delta coast (MANOHAR *et al.*, 1977). This rise, together with the wave action, causes destructive action on dunes and beaches. Wave refraction also has a destructive effect. The divergence and convergence patterns of wave orthogonals indicate higher transport rates at areas of wave convergence, particularly at the promontories while the embayments are subjected to less transport (QUELENNEC and MANOHAR, 1977 and INMAN *et al.*, 1976).

Current systems beyond and within breaker zone and littoral current are produced by the waves approaching the delta at an angle. The current beyond the breaker zone shows a circulation system of rip currents with velocities of 20 to 30 cm/sec. These occurred locally in front of the promontories, lake inlets and drains (MANOHAR *et al.*, 1977 and EL GINDY *et al.*, 1984). Along the coast the strongest predominant littoral current trends to the east, with the exception of the western side at the Rosetta promontory and locally west of the Damietta promontory (FANOS, 1986). Typical velocities are on the order of 20 to 50 cm/sec.

MATERIALS AND METHODS

Several bathymetric surveys have been carried out on the Nile delta shelf since 1800. One fairly accurate evaluation is the bathymetric survey during the period 1919/22 by the Admiralty survey ship "Endeavour," on scale of 1:235,410. The soundings of this survey are rather accurate and sufficiently closely spaced for comparison. As far as the density of soundings is concerned, the soundings in the nearshore zone, up to 30 m depth, are 200 m apart. The most recent, intensive survey was carried out in 1986 by the Shore Protection Authority (SPA), through more than 100 profile lines covering the entire inner continental shelf from Alexandria to Damietta promontory. The bathymetric survey of 1986, on a scale of 1:100,000 has an average survey soundings every 500 m. Short-term changes usually appear as a result of seasonal activity (SHORE PROTECTION MANUAL, 1984). Only the overall, net changes were determined during long-term period.

The two bathymetric maps (1919/22 and 1986) were matched to the same scale and carefully overlapped. The overlapping was carried out based on fixed points such as forts, towns and the meandering course of the Nile. Of course there has been a slight shift to maintain complete coincidence of the fixed points. However, the accuracy after shifting is in the range of 300 meters in the inner shelf zone. Forty profile lines bordering the coastal zone from Alexandria in the west to Damietta promontory in the east are selected from the 1986 map. Similar profile lines were also plotted on the 1919/22 map. The profile lines are roughly perpendicular to shore, extending seaward from a baseline to the 30 m depth contour. The baseline is constructed on the two maps, bordering the 1986 shoreline at fixed distance of about 1 km backshore. The profile lines are 2 to 7 km apart, and were selected to cover the whole area particularly the relatively unstable coastal zones (Figure 1). The two sets of bathymetric data were transformed into a matched set of coastal profiles in the following way. Along each individual profile line, distances from baseline and water depth were selected at fixed intervals of 1.0 km. Bathymetric changes across each successive profile are graphically expressed in terms of : (1) lateral shift in depth contours at 5, 10, 15, 20 and 25 m, (2) vertical point-by-point depth changes in meter, and (3) volume changes (in m^3) based on erosion and accretion within the different profile depth zones; 0–5, 5–10, 10–15, 15–20, and 20–25 m. The calculated volume change was based on areas of erosion and accretion in square meters (cross section, Figure 2) multiplied by the distance to the next profile. Net volume changes were computed as the sum of all positive and negative changes within the different profile depth zones. Net volume changes are also determined along each profile line from the shore up to 25 m depth. Shoreline changes along the study area were also determined on the basis of the two maps.

Using a grab sampler a total of 50 samples of surficial sediment from the inner continental shelf off the Nile delta were collected by the Research Vessel "Shawatti III" of the Coastal Research Institute (CRI), Egypt in 1984 (Figure 1). Grain-size analyses were made using standard sieve and pipette techniques at one phi intervals; 0.0, 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0 and 10.0. The graphic mean grain size (Mz) was computed from grain size data according to FOLK and WARD (1957).

RESULTS AND DISCUSSION

Slope Gradient

The slope values of the re-constructed (1986) profiles were classified into three main categories which range seaward from steep to gentle (Figure 3); slope I (> 10°), slope II (3°–10°) and slope III (1°–3°). Slope I extends laterally along the coast to the 10 m depth followed generally by slope II and III. Slope II is found as scattered zones in shallow depths near the coast and around the 30 m isobath. Slope III dominates the nearshore zone between 10 and 30 m depth.

Sediment and Texture

Analyses of surficial sediments reveal three major textural zones as one moves in the seaward direction from the coast, on the basis of mean grain size data (Figure 4). The fine and very fine sand is generally parallel to shoreline and bounded on its seaward side by medium and coarse sand and mud (silt plus clay).

Horizontal Changes of Shorelines and Bottom Contours

The overall shoreline changes from Alexandria to Port Said show remarkable local erosion alternating with accretion (Figure 5). The maximum bottom erosion (landward shift) over the period from 1919/22 to 1986 occurred at Rosetta promontory (7 km), east Burullus (1 km) and Damietta promontory (2 km). On the other hand, bottom accretion (seaward shift) was detected at east Rosetta (0.6 km), west Burullus (0.7 km) and Gamasa (3.5 km).

Shoreline retreat along the study area was estimated to be 5.0, 0.4 and 1.4 km at Rosetta promontory, Burullus and Damietta promontory, respectively, whereas shoreline accretion of 1.2, 0.4, 1.1 and 1.4 km was documented at Abu Khashaba, west Burullus, Gamasa and Damietta spit, respectively. The spit, east of the Damietta promontory, had been formed recently since it is not present in the shoreline of 1919/22 and is detected only in the map of 1986 (Figure 5).

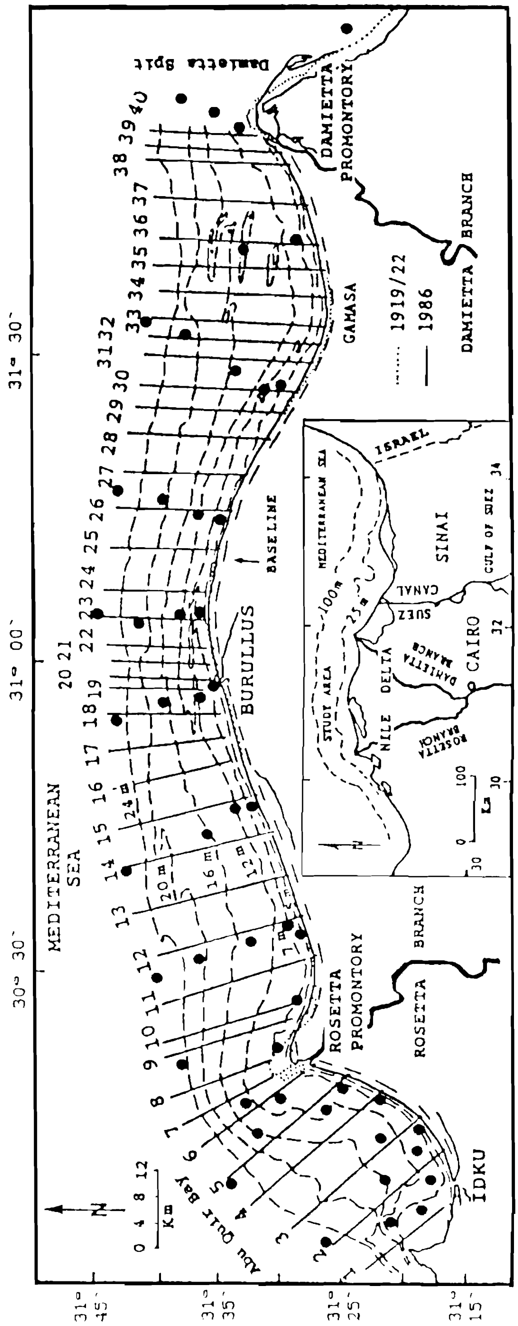

Figure 1. Study area showing the position of the bathymetric profile lines along the Nile delta coast, bottom sample locations and simplified contours of the 1986.

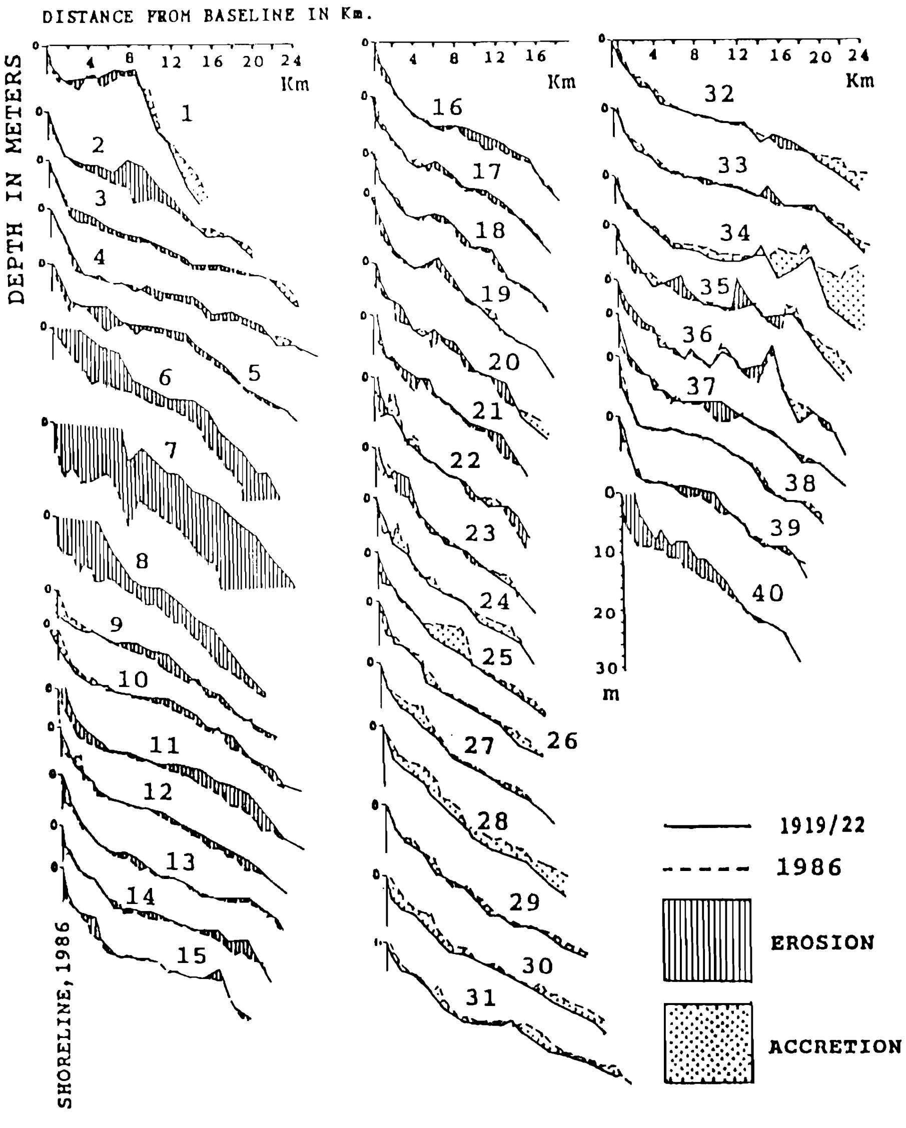

Figure 2. Bathymetric profile survey changes during 1919/22–1986 showing areas of erosion, accretion and stability.

Vertical Changes

Detailed analysis of the re-constructed profiles revealed several distinctive erosion/accretion characteristics (Figure 2). Along individual profile line, in general, the erosional pattern is greater than the accretion one (Figure 6). The sea bottom off the Rosetta and Damietta promontories experienced maximum erosion of 6 m and 3 m, respectively; while a wide zone of accretion (3 m shift) was documented in front of Gamasa stretch. Small patches of stable zones were scattered all over the study area. At Abu Quir Bay the shallow depths were eroded while the outer parts are accreted.

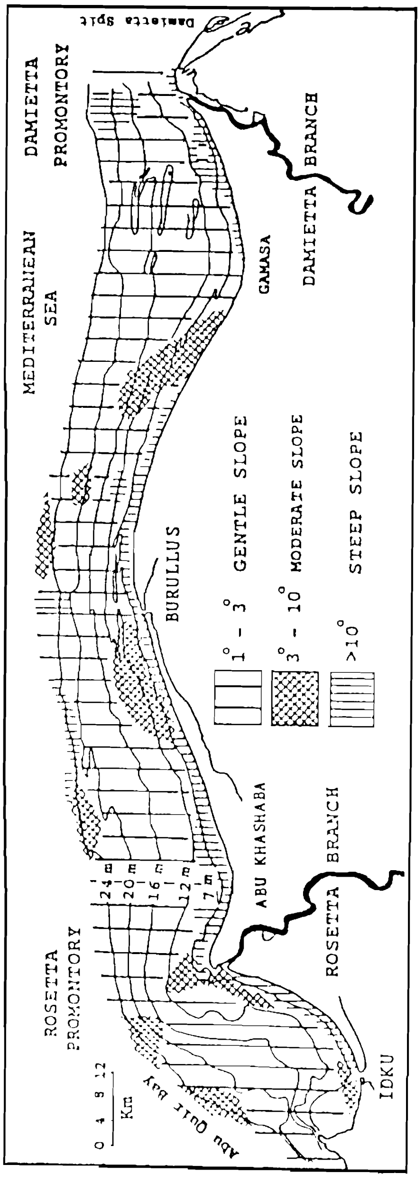

Figure 3. Bottom slope gradient of the inner continental shelf off the Nile delta, based on the 1986 survey.

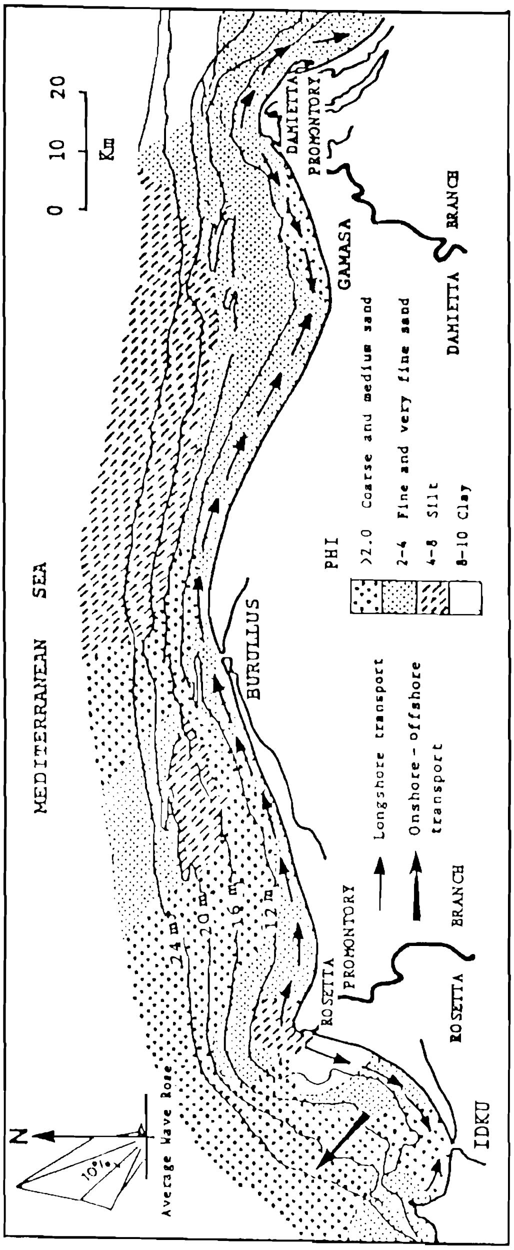

Figure 4. Map of the inner continental shelf of the Nile delta. Shown are the distribution of graphic mean grain size (Mz) and generalized transport pattern inferred from the morphological features resulted from the shoreline and bottom changes between 1919/22 and 1986. The average annual wave-rose diagram for the Nile delta coast is after Quelennec (1976).

Volumetric Changes

The volumetric changes within different depth zones (0–5, 5–10, 10–15, 15–20 and 20–25 m) vary greatly along the shore (Figure 7). It can be noticed, that maximum net of erosion of 400 × 10^6 m^3 and 50 × 10^6 m^3 occurred at the Rosetta and Damietta promontories, respectively. The shelf zone of Gamasa shows remarkable maximum accretion. Comparison of horizontal contour shifts and volume changes

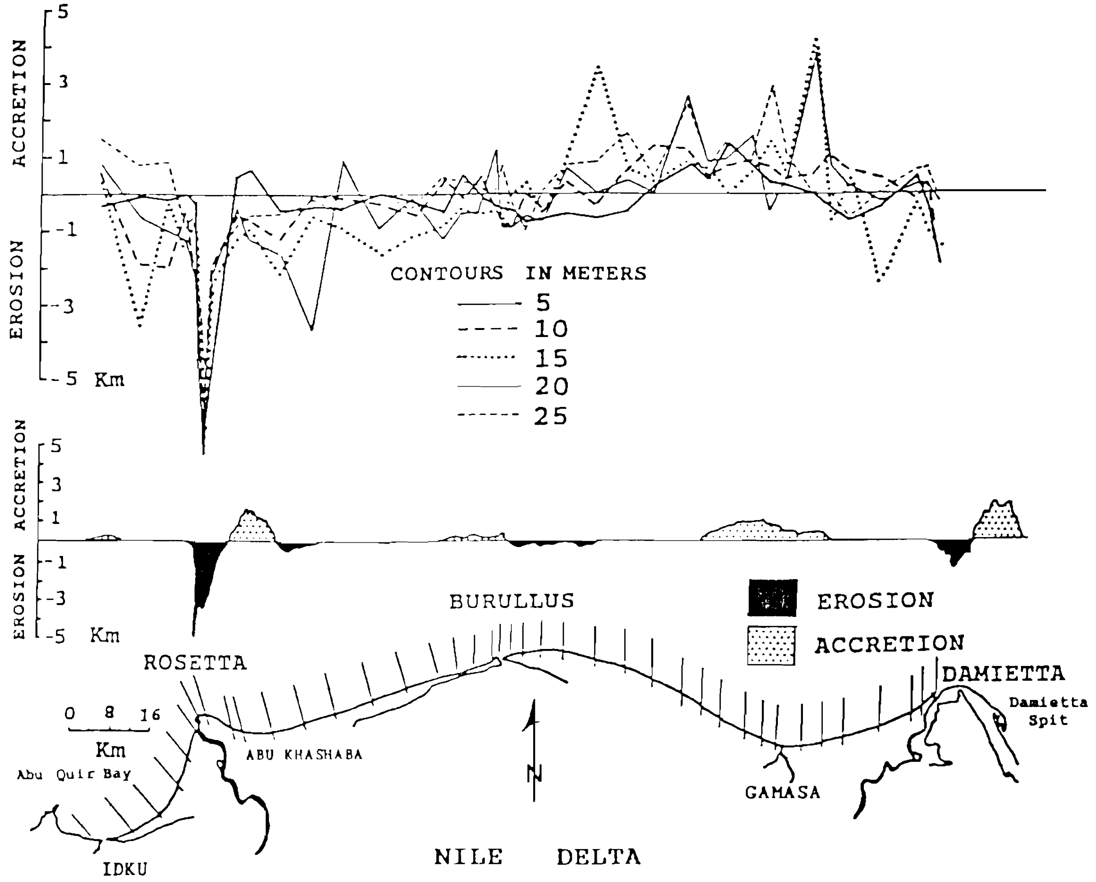

Figure 5. (Top) Values of lateral shift in bottom contours from baseline during 1919/22–1986 across the study area; landward (erosion) and seaward (accretion). (Bottom) Shoreline changes during 1919/22–1986 along the study area.

(Figures 5 and 7) indicates very close similarity in erosion and accretion trends across the study area.

Influence of Sediment Textures, Slope Gradient and Water Depth Upon the Bottom Changes

Three different environmental and sedimentological variables (sediment textures, slope gradient and water depth) were statistically correlated with vertical bottom changes to assess the influence of each upon the erosion/accretion distribution. The sediment texture represents weight percent of sediment in eleven class intervals for 46 bottom samples. These samples cover the shelf area from Abu Quir Bay to Damietta estuary. The results of correlation analysis are shown as a matrix of correlation coefficient in Table 1. It shows that there is no significant relationship between bottom changes (erosion/accretion values) and sediment textures, slope gradient and water depth. Only one case shows that accretion is positively correlated with Phi 8 (very fine silt).

Sediment Transport

Having recognized changes in bottom sediments and shorelines between 1919/22 and 1986 surveys, it is possible to interpret sediment transport direction along the delta coast. The direction of longshore sediment transport is inferred from the resulted morphology of ero-

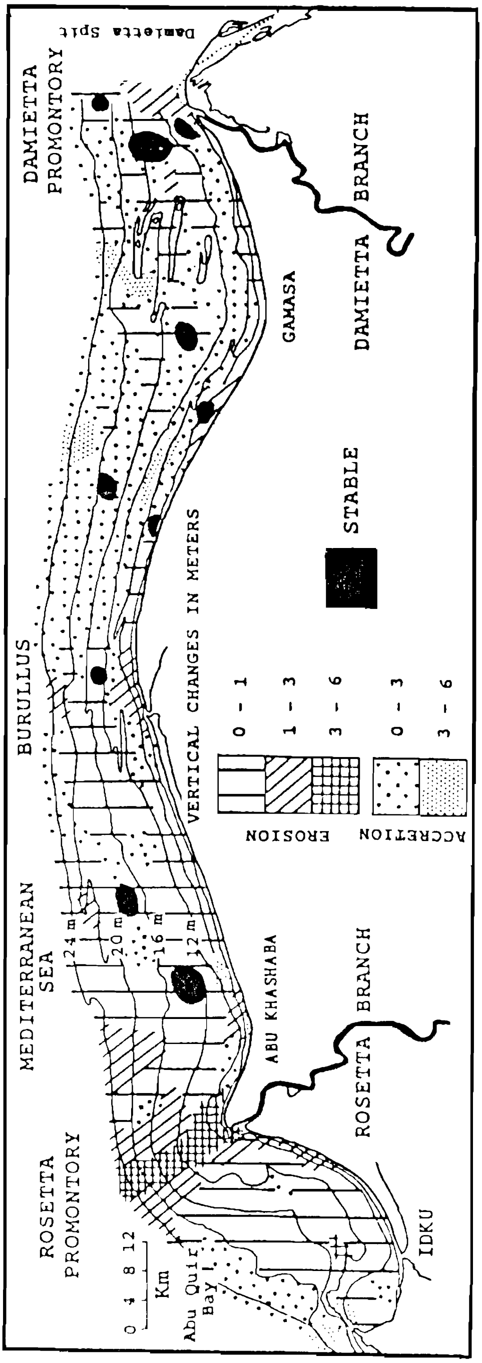

Figure 6. Bottom erosion, accretion and stability from 1919/22 to 1986 on the inner continental shelf off the Nile delta.

sional and accretionary patterns (Figure 4). The dominant sediment drift is generally from west to east associated with local reversals to the west. The transport pattern shows a divergence of drift at the Rosetta and Damietta promontories, with convergence near Idku inlet in Abu Quir Bay and Gamasa embayment. The erosion/accretion pattern as well as the profile analysis also indicates an onshore-offshore exchange of sediments at Abu Quir Bay (Figure 4). The reconstructed sediment transport pattern is in good general agreement with earlier studies along the delta coast (QUELENNEC and MANOHAR, 1977; MANOHAR *et al.*, 1977; FANOS, 1986; EL GINDY *et al.*, 1984; COLEMAN *et al.*, 1981). The marked variability of erosion/accretion pattern (Figure 6). can be attributed to the prevailing coastal processes along the delta coast. Swells during spring and summer, are predominantly approached from NNW/WNW causing easterly transport. The west-east longshore current transports sediment from the eroded zones and deposited them on sinks (embayments) of accreted areas. On the other hand, the NNE waves cause local westerly sediment drift. A number of studies in sediment transport along the Egyptian coast have accounted for such a pattern, *e.g.*, MANOHAR (1976a), MANOHAR *et al.*, (1977), and MANOHAR (1981). Furthermore, the east gyre (INMAN and JENKINS, 1984) also influences transport.

CONCLUSION

Based on comparison of charts of 1919/22 and 1986, long-term bathymetric and shoreline analysis was carried out along the Nile Delta coastal zone. The changes are quantitatively documented on the basis of analyses of 40 bathymetric profiles up to 30 m in depth and 30 km in length from well defined baseline. The analyses of these profiles, in terms of changes in water depth, shifting of shoreline and bottom contours, as well as volumetric changes in bottom sediments identify areas of erosion, accretion and stability. The long-term changes over a 64-year period document net shoreline retreat at the Rosetta and Damietta promontories, east Burullus inlet and at Ras El-Bar, which reverse to accretion east of the Rosetta promontory, west Burullus inlet, Gamasa and at east Damietta spit. These erosion/accretion trends are

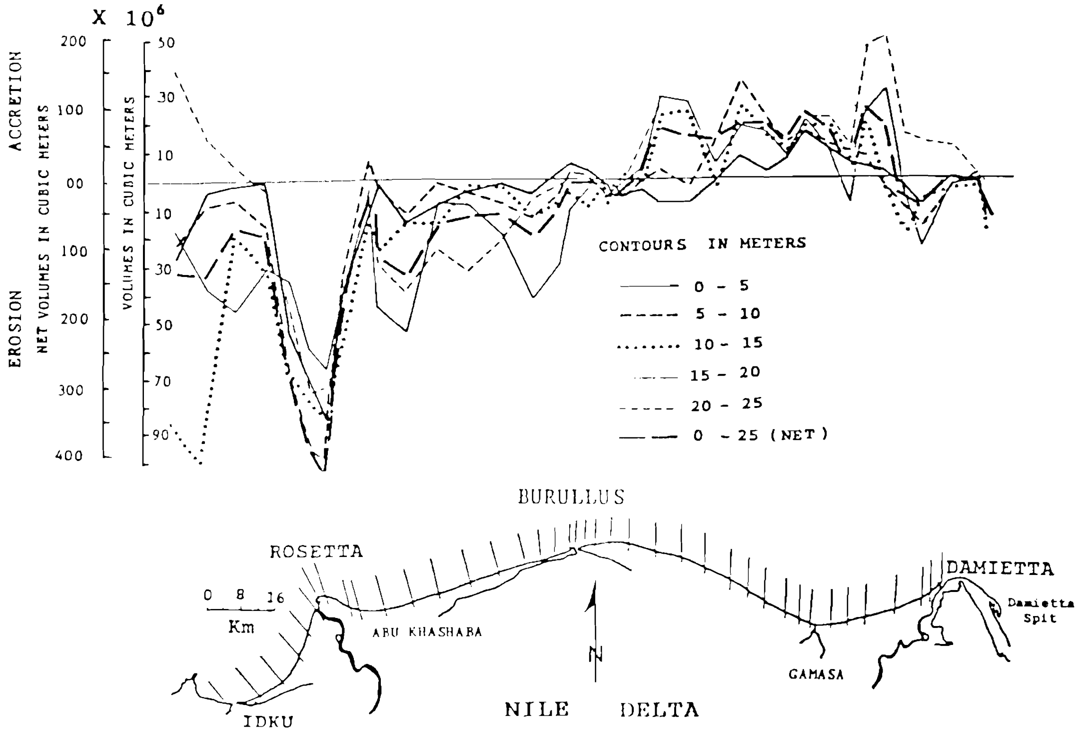

Figure 7. Volume changes at 5 meter contour intervals along the Nile delta coast from 1919/22–1986.

Table 1. *Correlation coefficient matrix of grain size distribution, slope gradient, water depth and vertical bottom changes of erosion and accretion. Correlation coefficients significant at the 95% confidence level ($r \geq 0.288$) are indicated by an asterisk.*

Variables	Erosion	Accretion	Slope	Depth
Phi 0	0.125	−0.094	−0.060	0.287
Phi 1	−0.045	−0.181	−0.141	−0.092
Phi 2	−0.024	−0.177	0.096	−0.044
Phi 3	−0.025	−0.109	0.303*	−0.230
Phi 4	0.145	0.102	0.248	−0.431*
Phi 5	−0.068	0.008	−0.211	−0.364*
Phi 6	−0.050	0.210	−0.239	0.434*
Phi 7	0.047	0.260	−0.240	0.527*
Phi 8	0.108	0.326*	−0.260	0.528*
Phi 9	0.140	−0.001	−0.255	0.209
Phi 10	−0.263	−0.176	−0.266	0.181
Erosion	1.000	0.339*	−0.168	0.034
Accretion		1.000	−0.058	0.140
Slope			1.000	−0.172
Depth				1.000

not correlated with bathymetric changes (*i.e.*, accretional shorelines are associated with areas of erosion, *e.g.*, Abu Khashaba and east Burullus inlet).

The erosional trend of the bottom dominates the inner continental shelf with accretion at sinks such as embayments and the down slope of the inner shelf. A sharp increase in bottom erosion was detected in front of the Rosetta and Damietta promontories, with bottom accretion at three major sinks; Abu Khashaba, Gamasa and at east Damietta spit. Part of these materials has been transported across the inner shelf to the deeper outer margin. The erosional and accretionary pattern of the inner continental shelf and its contiguous shoreline are generally attributed to sediment movement, in which the source of the accreted sand came from the tips of the eroded promontories, from Burullus headland, and partially from offshore sources as well. The deduced sediment movement, based on the documented erosion/accretion pattern, coincides with the directionality of the shore normal and alongshore current trend reported by other investigators.

A correlation analysis among vertical changes in sea bottom, grain-size class intervals, slope gradient, and water depth, only shows positive correlation between accretion and phi 8 (very fine silt).

ACKNOWLEDGEMENT

This paper is based on an M.S. Thesis by M.H. Ahmed, under the supervision of O.E. Frihy, S.M. Nasr and M.El Raey. Our sincerest appreciation is expressed to Prof. Dr. M.A.El Askary, Faculty of Science, Alexandria University, for his constructive review of the manuscript and most helpful comments.

LITERATURE CITED

COLEMAN, J.M.; MURRAY, S.P., and SALAMA, M., 1981. Morphological and dynamic sedimentation of the Eastern Nile Delta shelf. *Marine Geology*, 42, 301–326.

COUTELLIER, V., and STANLEY, D.J., 1987. Late Quaternary stratigraphy and paleogeography of the eastern Nile Delta, Egypt. *Marine Geology*, 77, 257–275.

EL ASKARY, M.A. and FRIHY, O.E., 1986. Depositional phases of Rosetta and Damietta promontories on the Nile Delta coast. *Journal of Africa Earth Sciences*, 5, 627–633.

EL GINDY, A.; ABO ZED, A., and FARAG, E., 1984. Circulation pattern beyond the breaker zone along the Nile Delta coast during winter. *Internal Report, Coastal Research Institute, Alexandria, Egypt*, 9p.

ELWANY, M.H.; KHAFAGY, A.A.; INMAN, D.L., and FANOS, A.M., 1988. Analysis of waves from arrays at Abu Quir and Ras El Bar, Egypt. *Advances in Underwater Technology, Ocean and Offshore Engineering*, 16, 89–97.

EMERY, K.O., 1980. Relative sea levels from tide-gauge records. *Proceedings National Academy of Science* (USA), 77, 6968–6972.

EMERY, K.O.; AUBREY, D.G., and GOLDSMITH, V., 1988. Coastal neo-tectonics of the Mediterranean from tide-gauge records. *Marine Geology*, 81, 41–52.

FANOS, A.M., 1986. Statistical analysis of longshore current data along the Nile Delta coast. *Water Science Journal* (Egypt), 1, 45–55.

FOLK, R.L. and WARD, W.O., 1957. Brasos River bar, a study in the significance of grain size parameters. *Journal of Sedimentary Petrology*, 27, 3–27.

FRIHY, O.E., 1988. Nile Delta shoreline changes: Aerial photographic study of a 28-year period. *Journal of Coastal Research*, 4, 597–606.

FRIHY, O.E.; EL FISHAWI, N.M., and EL ASKARY, M.A., 1988. Geomorphological features of the Nile delta coastal plain: A review. *Acta Adriatica* (Jugoslavia), 29, 51–65.

FRIHY, O.E., and KHAFAGY, A.A., 1989. Climatic changes and shoreline migration trends at the Nile delta promontories. *International Seminar on Climatic Fluctuations and Water Management*, Cairo, Egypt (in press).

HASSAN, F.A., 1981. Historical Nile floods and their implications for climatic changes. *Science*, 212, 1142–1145.

INMAN, D.L.; AUBREY, D.G., and PAWKE, S.S., 1976. Application of nearshore processes to the Nile Delta, a preliminary report. *Proceedings UNESCO Seminar on Nile Delta Sedimentology*, Alexandria, Egypt, 205–255.

INMAN, D.L. and JENKINS, S.A., 1984. The Nile littoral cell and man's impact on the coastal zone of the southeastern Mediterranean. *Scripps Institution of Oceanography Ref. Series 84–31*, University of California, La Jolla, 43p.

KHAFAGY, A.A., and MANOHAR, M., 1979. Coastal Protection of the Nile Delta. *Nature and Resources* (UNESCO, Paris), 15, 7–13.

KLEMAS, V. and ABDEL-KADER, A.M., 1982. Remote sensing of coastal processes with emphasis on the Nile Delta. *In: International Symposium on Remote Sensing of Environments*, Egypt, 27p.

MANOHAR, M., 1976a. Beach profiles. *Proceedings UNESCO Seminar on Nile Delta Sedimentology*, Alexandria, 95–99.

MANOHAR, M., 1976b. Dynamic factors affecting the Nile Delta Coast. *Proceedings UNESCO Seminar on Nile Delta Sedimentology*, Alexandria, 104–129.

MANOHAR, M., 1981. Coastal processes at the Nile delta coast. *Shore and Beach*, 49, 8–15.

MANOHAR, M.; NAFOA, M., and SHARAKY, N., 1977. Longshore currents along the Nile Delta coast. *Proceedings UNESCO Seminar on Nile Delta Coastal Processes with special Emphasis on Hydrodynamical Aspects*, Alexandria, 235–254.

MISDORP, R., 1977. The Nile promontories and the Nile continental shelf. *Proceedings UNESCO Seminar on Nile Delta Coastal Processes*, Alexandria, 456–551.

MISDORP, R. and SESTINI, G., 1976. Notes on sediments map of the Endeavour survey of 1919–1922. *Proceedings UNESCO Seminar on Nile Delta Sedimentology*, Alexandria, 191–204.

NEEV, D.; GREENFIELD, L., and HALL, J.K., 1985. Slice tectonics in the Eastern Mediterranean Basin.

In: D.J. STANLEY and F.C. WEZEL, (Eds.), *Geological evolution of the Mediterranean Basin.* New York, pp. 249–269.

QUELENNEC, R.E., 1976. Study of wave-runs in Nile Delta nearshore wave records (Burullus). *Proceedings UNESCO Seminar on Nile Delta Processes,* Alexandria, 157–179.

QUELENNEC, R.E. and MANOHAR, M., 1977. Numerical wave refraction and computer estimation of littoral drift, application of the Nile Delta coast. *Proceedings UNESCO Seminar on Nile Delta Coastal Processes,* Alexandria, 408–432.

RIEHL, H. and MEITIN, J., 1979. Discharge of the Nile River: a barometer of short-period climate variations. *Science,* 206, 1178–1179.

SESTINI, G., 1976. Geomorphology of the Nile Delta. *Proceedings UNESCO Seminar on Nile Delta Sedimentology,* Alexandria, 12–24.

SESTINI, G., 1988. Nile Delta depositional environments and geological history. *In:* K.G. WHATELEY and K.T. PIKERING, (Eds.), *Deltas: Sites and Traps for Fossil Fuels.* London: Blackwell Scientific Publications, Geological Society Special Publication No. 41, pp. 99–127.

SHORE PROTECTION MANUAL, 1984. Coastal Engineering Research Center, Department of USA Army, Vicksburg, Mississippi, 1:214p.

SMITH, E.S. and ABDEL-KADER, A., 1988. Coastal erosion along the Egyptian Delta, *Journal of Coastal Research,* 2, 245–255.

STANLEY, D.J., 1988. Subsidence in the Northeastern Nile Delta: rapid rates, possible causes, and consequences. *Science,* 240, 497–500.

SUMMERHAYES, C.P.; SESTINI, G.; MISDORP, R., and MARKS, N., 1978. Nile Delta, nature and evolution of continental shelf sediments. *Marine Geology,* 27, 43–65.

TOMA, S.A., and SALAMA, M.S., 1980. Changes in bottom topography of the western shelf of the Nile Delta since 1922. *Marine Geology,* 36, 325–339.

□ RESUMEN □

Las observaciones del cambio en un largo período de la línea de costa y de las cartas batimétricas en la plataforma continental más interior del norte del delta del Nilo están basadas en la comparación de dos cartas batimétricas realizadas en 1919/22 y 1986. Los cambios se representaron tras el análisis de 40 perfiles batimétricos en profundidades de agua de hasta 30 metros y se realizaron sobre 30 km de costa. La comparación a lo largo de estos perfiles fue hecha en términos de cambios en la profundidad del agua, cambios en los contornos del fondo y cambios volumétricos del sedimento del fondo, identificando áreas de erosión (Bahía de Abu Quir, Promontorio de Rosetta, Este de Burullus y Promontorio de Damietta) y acreción (Costa de Abu Khashaba, Estuario de West Burullus, Gamasa y Flecha de Damietta). Estos cambios son debidos generalmente a los movimientos del sedimento a largo plazo, en los cuales la mayoría de la arena viene de los extremos de los promontorios erosionados, así como de fuentes exteriores. El análisis estadístico indica que las áreas de potencial erosión y acreción no están relacionadas con la textura del sedimento, el gradiente de la pendiente o la profundidad del agua.—*Department of Water Sciences, University of Cantabria, Santander, Spain.*

□ RÉSUMÉ □

Deux cartes bathymétriques dressées à partir de sondages en maille serrée effectués en 1919/22 et en 1986 ont été comparées. Elles ont permis d'évaluer les modifications à long terme de la ligne de rivage et du proche plateau continental. L'évolution est determinée d'après l'analyse de 40 profils bathymétriques effectués jusqu'à 30 m de profondeur et répartis jusqu'à 30 km de la côte. La modification de la profondeur, le déplacement des contours du fond, le déplacement volumétrique de sédiments ont permis d'identifier des zones d'érosion (Abu Quir Aba, Promontoire de Rosette, est du Burullus et promontoire de Damiette), et des zones d'accumulation (côte d'Abu, Khashaba, ouest du détroit du Burullus, pointes de Gamasa et de Damiette). Ces modifications sont pour la plupart dues à un mouvement de sédiments à long terme; la plupart des sédiments accumulés proviennent du large et des pentes érodées des promontoires.—*Catherine Bressolier, Géomorphologie EPHE, Montrouge, France.*

□ ZUSAMMENFASSUNG □

Beobachtungen von Langzeitveränderungen der Küstenlinie und der bathymetrischen Verhältnisse am inneren Kontinentalschelf nördlich des Nildeltas basieren auf dem Vergleich von zwei bathymetrischen Karten von 1919/22 und 1986, die auf einem engmaschigen Lotungsnetz beruhen. Die Veränderungen wurden aufgezeichnet nach der Analyse von 40 bathymetrischen Profilen in Wassertiefen bis 30 m und die bis ca. 30 km vor die Küste reichen. Der Vergleich zwischen diesen Profilen hinsichtlich der Veränderung der Wassertiefe, Veränderung der Bodenkonturen und mengenmäßige Veränderungen der Bodensedimente zeigt Gebiete mit Erosion (Abu Quir-Bucht, Rosetta-Vorgebirge östlich von Burullus und am Damietta-Vorgebirge) und Anlagerung (Abu Khashaba-Küste, West Burullus-Zufluß, Gamasa- und Damietta-Haken). Diese Veränderungen beruhen i.w. auf Langzeitveränderungen in der Sedimentverlagerung, wobei ein Großteil des angelagerten Sandes von den erodierten Vorgebirgsspitzen wie aber auch küstenferneren Quellen entstammt. Die Korrelationsanalyse zeigt, daß Gebiete mit hoher potentieller Erosion und Anlagerung nicht mit der Textur der Sedimente, der Hangneiung und der Wassertiefe korrelieren.—*Ulrich Radtke, Geographisches Institut, Universität Düsseldorf, F.R.G.*