

MODERN SHORELINE CHANGES ALONG THE NILE DELTA COAST AS AN IMPACT OF CONSTRUCTION OF THE ASWAN HIGH DAM

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ABSTRACT

The major objective of this study is to detect the morphological changes of the Delta coast line during last 35 years, and to define coastal geomorphic features along the northern part of the Nile Delta. The Nile Delta coast was determined by comparing satellite images and historical charts with present-day conditions. The erosion and accretion shorelines are influenced by transport processes, including sediment provenance from different sources: eroded Nile delta coast, relict sediments from the former Nile tributaries and mouths, and sediment supply by land valleys and from wind-blown sand.

Key Words: *Mediterranean Sea, Sea Level Changes, Nile Delta Coast, Aswan High Dam*

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1. INTRODUCTION

The construction of the Aswan High Dam was started in storage Nile Water on 1964, and fully finished six years later. The construction of the Dam has changed the hydraulic regime of the river downstream. The erosion of the Nile Delta coast was first observed in 1898, but accelerated after the construction of the Dam. One of the major environmental problems of the Dam was the potential drop in river channel downstream of the Dam become silt-free water, and coastal erosion in the Nile Delta coast.

Before the construction of the Dam, silt used to be spread over land or carried to the delta coast. It is estimated that each year floods used to deposit 12 million tones of silt on land along the delta and Nile valley north of the High Aswan Dam. The reduction in soil fertility due to the loss of the nitrogenous component of the silt now has to be compensated for by the annual addition less than 13 thousand tones sediments (Frihy, 1988).

The study area is located on the northern coast of the Nile Delta, between Rosetta and Damietta mouths (Fig.1). It has a length of about 170 km., it consists of the following geomorphic units in addition to the barriers unit near the northern coastline of Sinai (out side of the study area) :

- a. The mouths unit of Nile Delta braches in Rosetta and Damietta.
- b. El Burullus lagoon unit.
- c. The coastal plain unit.
- d. The coastal dunes unit.
- e. The coastal sabkhas unit.

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The morphological changes of the Nile Delta coast have been studied during last century such as: Lewis, 1931, Lafond, 1939, Aki, 1953, El-Ashry and Wantless, 1967, Zenkovich, 1967, Mohamed, 1968, Moussa, 1973, UNESCO DTR, 1973&19760, Frihy, 1975, Manohar, 1976, Misdorp and Sestini, 1976, El-Fishawi, 1977, Hamama, 1978, Rashed, 1978, Anwar et al.,1979, Abdela, 1987, Frihy, 1988, and El-Sayed, 2005.

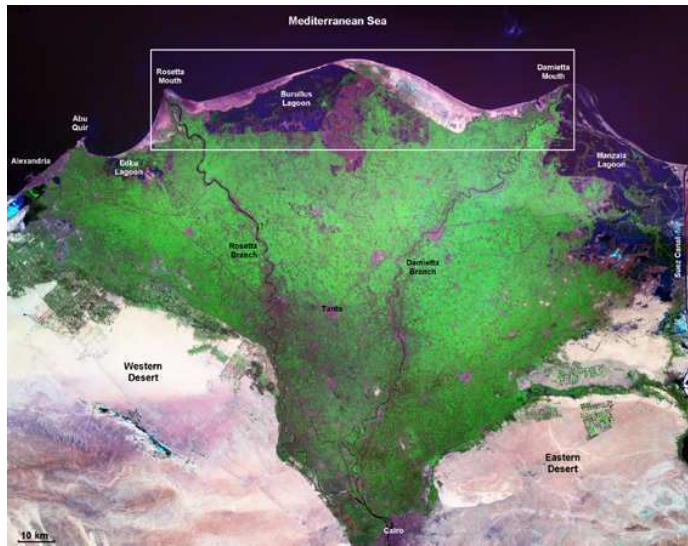


Fig.1. Location of study area

The major objective of this study is to detect the morphological changes of the Delta coast line during last 35 years, and to define coastal geomorphic features along the northern part of the Nile Delta. Some of the modern changing shoreline positions along the Nile Delta coast were determined by the following methods:

1. Comparing two satellite images (Landsat TM: May1984 & Jul 2001 – Resolution 30m,7 bands), aerial photographs taken in 1955 and historical maps in 1900, 1925 and 1970 by using ERDAS IMAGINE 8.4 software .
2. Field observation of the study units.
3. Sediments samples has been collected for grain size analysis.
4. Analyze the collected data by GIS techniques.

2. RESULTS AND DISCUSSION

Every year before construction of the Aswan High Dam, water flooded from Nile during August-October through its branches (Rosetta and Damietta), but after building it a huge amount of water and alluvial sediments storage behind the Dam since 1964, the mean annual amount of Nile water is reduced from 34 billion cubic meters to less than $\frac{1}{3}$ its amount before construction the dam, the sediment load is reduce too from 60-180 million tons to less than 15 million tons after building it , which was the main source of accretion on the coast line and the two promontories of Rosetta and Damietta, but it has removed gradually from this date (Sharaf El Din, 1977). The present study shows that there are some

morphological changes of the geomorphic units of the northern portion of the Nile Delta depicted as a result of construction of the High Aswan Dam (fig.2 & Tab.1):

The evaluation of the major topographic units between 1925-2001(km3)

Table 1

Topographic Unit	1925	1970	1984	2001
Data Source	Topographic Maps		Landsat TM images	
El Burullus lagoon unit	8658.5	5674.7	553.4	489.8
Lagoon islands unit	43.7	65.6	317.2	292
The coastal dunes unit	1085.6	704.3	1032.8	567
The coastal sabkhas unit	1173	736.4	265.1	59

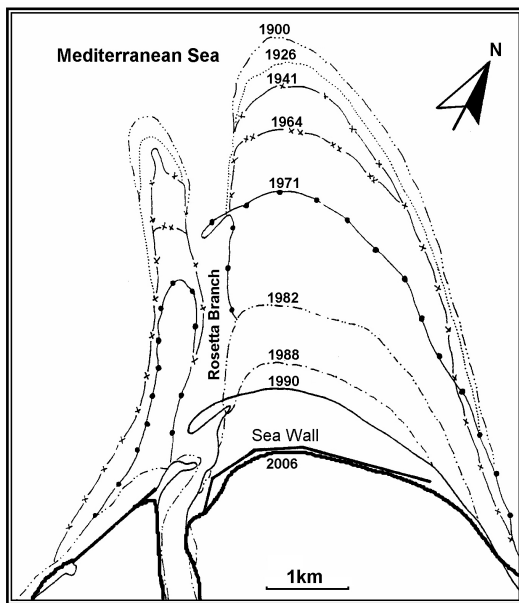


Fig.2. Major geomorphic units of The northern portion of the Nile Delta

2.1. The mouths unit of Nile Delta braches in Rosetta and Damietta

2.1.1. Erosion of the Rosetta promontory began about 1900 after construction the Aswan Low Dam, the western and eastern sides of the mouth lost between 1900 – 1964: 879 and 1282 meters, it's average rate about 13.7 and 20 m/yr. The storage of water Nile started on 1964 at Lake Nasser in the front of the High Dam, it increased the erosion rate between 1964-2006 to 95.3 and 124.8 m/yr (tab.2 & Fig.3).

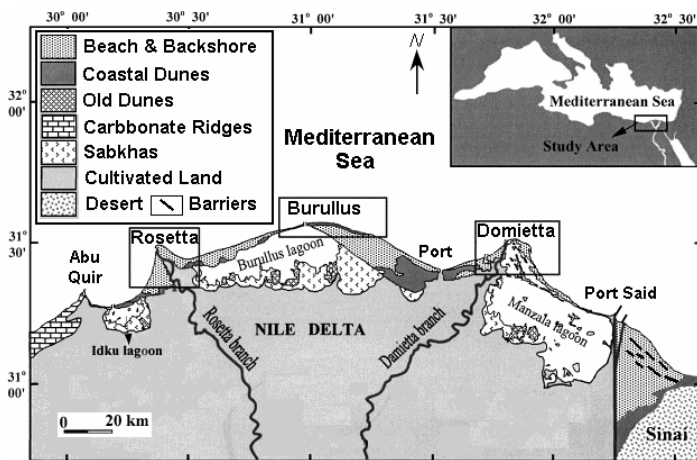


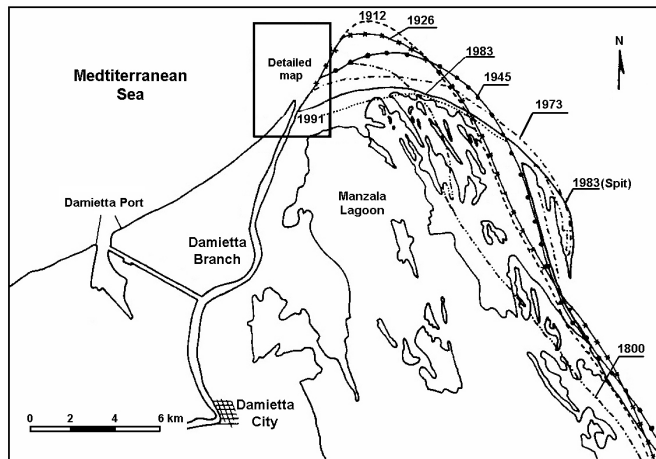
Fig.3. Morphological changes of The Rosetta mouth from 1900 to 2006 (After: Fanos, 1995)

*Annual rates of erosion on both western and eastern sides
of Rosetta mouth (promontory) between 1900-2006*

Table 2

Period		Western Side		Eastern Side	
		Erosion distance (m)	Erosion Rate (m/yr)	Erosion distance (m)	Erosion Rate (m/yr)
Before construction of the Aswan High Dam	1900-1926	243	9.3	396	15.2
	1926-1941	191	12.7	298	19.9
	1941-1964	445	19.3	588	25.6
	1900-1964 / Sub Total	879	13.7	1282	20
After construction of the Aswan High Dam	1964-1971	826	118	1555	222.1
	1971-1982	2796	254.2	1652	150.2
	1982-1988	381	63.5	826	137.7
	1988-1990	0	0	318	159
	1990-2006	0	0	890	55.6
	1964-2006 / Sub Total	4003	95.3	5241	124.8
Total Period		4882	46	6523	61.5

2.1.2. *Coastline changes of Damietta promontory* are similar to those of the Rosetta area. Erosion of the Damietta promontory started about 1900 too, it lost about 3.7 km between 1900-1991 averaged 40.7 m/yr. The average rates of the western and eastern sides between



1900 and 1973 was about 35 and 40 m/yr, but it increased to more than 100 m/yr after construction of The High Dam, although some protected walls and groins have been constructed during this period (Fig.4&5). The W/E currents accreted a 4.5 km long spit near the eastern side of the Damietta promontory, that spit appeared on 1983 aerial photos with observed and recorded by (Frihy, 1988).

Fig.4. Morphological changes of the Damietta mouth from 1800 to 1991 (After: Fanos, 1995)

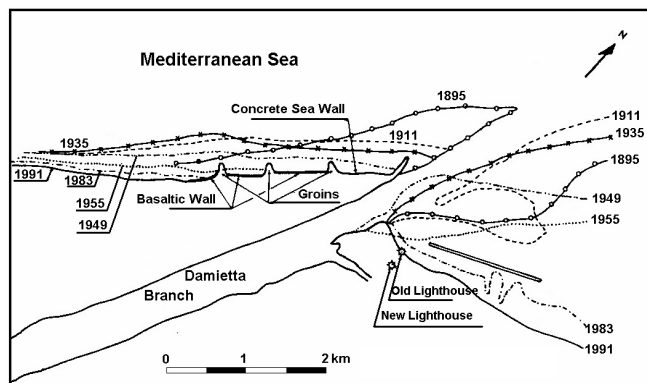


Fig.5. Detailed map of morphological changes of the Damietta mouth from 1895 to 1991 (After: Fanos, 1995)

2.2. El Burullus lagoon unit: it is one of five shallow lagoons along the coastal plain of the Nile Delta (Maryut and Idku to the west of Rosetta Branch, El Burullus in the middle Delta

coast and finally El Manzala and EL Bardawil to the west of Damietta Branch. The total area of El Burullus lagoon is reduce during last century from 5600 km³ (1925) to 317.2 km³ (1984) then to 197.8 km³ (2001) as a result of the human activities and land reclamation projects, specially after construction of the High Aswan Dam. Some years ago depth of that lagoon was varies between 0.5 and 3 meters, but now it becomes more shallow as a result of sediments accumulation by geomorphic processes and human activities. The total area of the lagoon islands is increase from 65.6 km³ (1925) to 292 km³ (2001) due to accumulate the deposits on the lagoon bottom.

2.3. The coastal plain unit

The Nile Delta coastal plain wasted by erosion more than 30.86 km² between 1925 and 2001, most of these areas lies in the western sides of The Rosetta and Damietta promontories. The average of erosion increased from 91.4 during the period (from 1925 to 1984) to 130.8 acres/yr during the modern period (1984-2001) as a result of storage the Nile water in Lake Nasser. In the other hand the coastal plain extended by accretion processes not more than 24.43 km² from 1925 to 2001, and the average reduce from 93.7 acres/yr before 1984 to less than 30 acres/yr (Tab.3).

Morphological changes of the Nile Delta coastline sectors from 1925 to 2001 (in Acres)

Table 3

Sectors	Erosion		Accretion	
	1925-1984	1984-2001	1925-1984	1984-2001
Rosetta mouth	2952	1682	-	-
East of Rosetta mouth	-	-	1381	270
East of El Burullus lagoon	-	-	1338	152
West of El Burullus lagoon	-	-	1126	-
Damietta mouth	2450	541	-	-
West of Damietta mouth	-	-	1572	-
Separated areas	-	-	114	83
Sub total	5402	2223	5531	505
Annual rate	91.6	130.8	93.7	29.7
Total	7625 Acre= 30.86 k.m.2		6036 Acre= 24.43 k.m.2	

The coastline has been divided into 7 sectors from west to east (Fig. 5), which show morphological changes of coastline between 1984 and 2001. The Nile Delta coastline is generally convex shape in three promontories at The Rosetta mouth, Burullus lagoon neck and The Damietta mouth, they separated with two concave wide bays, as a result of action of the NW prevailing wind, and W/E longshore currents effects, the eastern sides of these promontories are retrograded by coastal erosion, but accretion took place to the outer eastern sides of these promontories and bays.

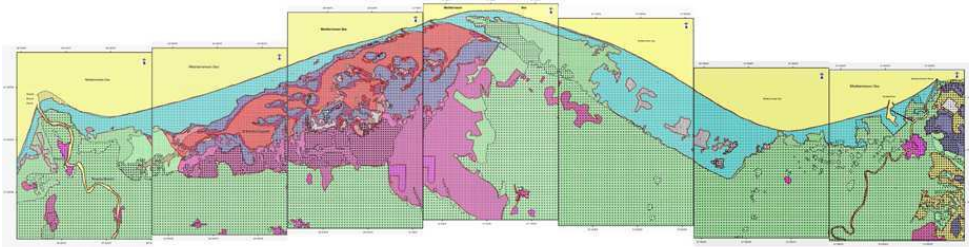


Fig.6. Morphological changes of the Nile Delta coastline between 1984-2001

2.4. Grain Size analysis

14 beach samples were collected for grain size analysis, nine samples got from erosional beaches and five samples collected from accretional beaches. The statistical data (Fig. 7 & 8 and Tab.4) shows that most of the study area beaches are composed from coarse to very fine sand, but erosional beaches are contained more finer grains than accretional beaches, because the dynamic processes can transport fine grains more easy than coarse grains.

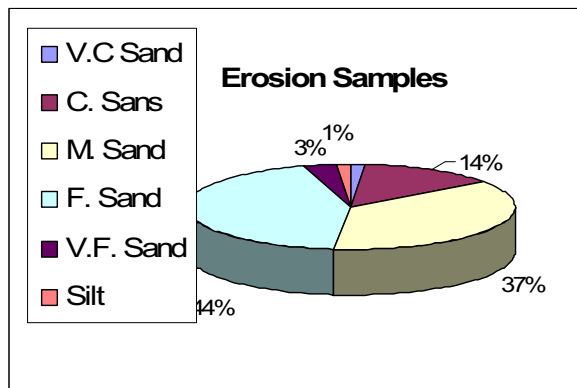


Fig.7. Size fraction of erosional beach samples

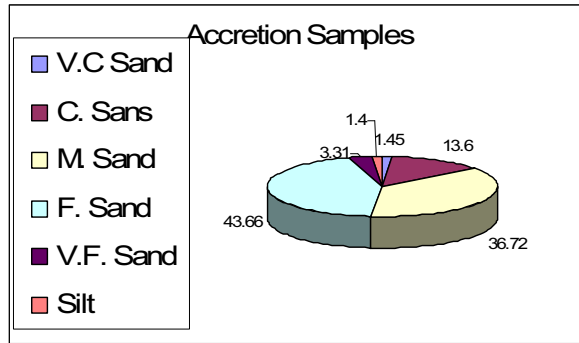


Fig.8. Size fraction of accretional beach samples

Statistical characteristics of the sediments

Table 4

Beach type	Sample No.	Weight % of fractions					
		V.C. Sand	C. Sans	M. Sand	F. Sand	V.F. Sand	Silt
		-1:0	0:1	1:2	2:3	3:4	>4 Φ
Erosion	1	0.21	1.92	8.67	74.88	13.53	0.79
	4	0.19	3.63	14.15	69.52	11.93	0.58
	5	0.24	4.22	12.75	69.35	12.85	0.59
	6	0.28	3.95	13.94	66.52	14.83	0.48
	7	0.36	3.48	13.17	68.94	13.63	0.42
	8	0.25	3.21	12.28	66.99	16.74	0.53
	9	0.31	3.07	13.43	66.84	15.84	0.51
	10	0.21	2.86	14.53	68.19	13.67	0.54
	14	0.28	3.75	13.85	67.23	14.38	0.51
Average		0.26	3.34	12.97	68.72	14.15	0.55
Accretion	2	0.79	14.52	39.31	41.68	2.52	1.18
	3	1.38	13.84	35.83	44.52	3.17	1.26
	11	1.53	12.73	34.58	46.15	3.29	1.72
	12	1.72	13.17	36.37	42.98	4.17	1.59
	13	1.83	13.73	37.51	42.30	3.39	1.24
Average		1.45	13.60	36.72	43.66	3.31	1.40

3. CONCLUSIONS

The Nile Delta coast was determined by comparing satellite images and historical charts with present-day conditions. The analyses identify into two patterns: erosion and accretion shorelines. These two patterns are influenced by transport processes, including sediment provenance from different sources: eroded Nile delta coast, relict sediments from the former Nile tributaries and mouths, and sediment supply by land valleys and from wind-blown sand.

REFERENCES

- Abdela, F.A., (1987), *Hydrographic condition on the Eastern side of Rosetta mouth*. M.Sc. Thesis. Alex. Univ. , 136 p.
- Anwar, Y.M.; Gindy, A.R.; El-Askary, M.A. and El-Fishawi, N.M., (1979), *Beach accretion and erosion*, Brulus-Gamsa coast, Egypt, Marine Geol. Research. 30:M1-M7.
- El-Ashry, M.T. and Wantless, H.R., (1967), *Shoreline feature and their changes*, Photogram. Eng., Vol.33, No. 2,pp.184-9.
- El-Fishawi, N.M., (1977), *Sedimentological studies of the present Nile Delta sediments on some accretional and erosional areas between Burullus-Gamasa*. M. Sc Thesis, Fac. Sci. Alex. Univ., pp.143-52.
- El-Sayed H.A., (2005), *Beach erosion and accretion between the mouth of Rosetta branch and Kitchener drain outlet*, Nile Delta Coast, Egypt. Bul. Soc. Geog. Egypte., Vol. 78, pp. 27-64.
- Fanos, A. M., (1995), *The impact of human activities on the erosion and accretion of the Nile Delta coast*, Jour. Coast. Res., Vol. 11, No. 3, pp.821-33.
- Frihy, O.E., (1975), *Geological study of Quaternary deposits between Abu Quir and Rosetta*, M. Sc. Thesis, Fac. Sci., Alex Univ., 103 p.
- , (1988), *Nile Delta shoreline changes: aerial photographic study of a 28- year period*, Jour. Coast. Res., Vol. 4, pp.597-606.
- Hamama, H.H., (1978), *Types and distribution of sediments and landforms in the Deltaic coastal zone between Ras El-Barr and Port Said*. M. Sc. Thesis, Fac. Sci., Mansoura Univ. 52 P.
- Lafond, E.G., (1939), *Sand movement near the beach in relation to tides and waves*. Proc.6 th Pacific Sci. Congr. pp.795-9.
- Lewis, W. V., (1931), *Effect of waves incidence on the configuration of a shingle beach*. Geog. Jour. Vol. 78, pp.131-48.
- Manohar, M., (1976), *Beach profiles: Proceedings UNESCO seminar on Nile Delta sedimentology*, Alexandria, pp.95-9.
- Misdorp, R. and Sestini, G., (1976), *Notes on a sediment map of the Endeavour Survey of 1919-1922*. Proceedings UNISCO seminar on Nile Delta sedimentology, Alexandria, Oct. 1975, pp. 191-204.
- Mohamed, M.A., (1968), *Continental shelf sediments of the Mediterranean Sea north of the Nile Delta in U.A.R.* M. Sc. Thesis, Univ. Alex., 90 p.
- Moussa, A.A., (1973), *Study of bottom sediments of Abu-Quir*. Ph. D. Thesis, Univ. Alex., 129 p.
- Rashed, M.A., (1978), *Sedimentological and Mineralogical studies of the coastal samples of Abu Quir Bay, Alexandria*, M. Sc. Thesis, Fac. Sci. Alex. Univ., 157 p.
- Sharaf El Din, S. H., (1977), *Effect of the Aswan High Dam on the Nile flood and on the esuarine and coastal circulation pattern along the Mediterranean Egyptian coast*. JSTOR: Limnology and Oceanography, vol.22, No2, 194p.
- UNESCO DTR., (1973), *Arab Republic of Egypt, Project EGY/70/581. Coastal erosion studies*. Tech. Rep. No.1., United Nations Development Corporation, Alexandria, Egypt, 66p.
- , (1976), *Proceeding of seminar on Nile Delta Sedimentology*, Alexandria, Oct. 1975, United Nations Development Project, Alexandria, Egypt, 257 p.
- Zenkovich, V. P., (1967), *Processes of Coastal Development*. Oliver and Boyd, Edinburgh and London, 738 p.