CHAPTER 78

THE NILE DELTA COASTAL PROTECTION PROJECT

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ABSTRACT

The Nile Delta Coast on the Mediterranean Sea was formed through many centuries. The two existing main branches of the River Nile, i.e. Rosetta and Damietta, succeeded over the ages in forming two peninsulas or protrusions in the sea. By the end of the 19th century erosion started at several important points of the coast, causing damages to the national economy, either directly or indirectly. This erosion has increased tremendously during the last decade.

Several field and laboratory studies were carried out during the last few years, concentrating on the severely attacked areas, such as Ras-El-Bar, Burullos, Rosetta,Maadia.

Based on the quick field and laboratory studies, remedial constructions are designed for the locations of severe erosion. Groins for Ras-El-Bar with artificial sand feeding and stone pitching and a wall for the Damietta estuary. A large groin for Burullos outlet which developed some advantageous changes even before finishing its execution,, and sea wall for Maadia. All the above projects are discussed and explained.

A long term study project was started early in 1971 to collect the data necessary for a better understanding of the problem. The aims of this project are as follows: (1) To determine the historical formation of the Delta and forecasting future changes ; (2) Study the Meteorology and the Hydrodynamics of the area ; hindcasting and starting a new forecasting technique for them; (3) Planning and design of protective constructions for the coast is to be gained.

All the above will be based on an extensive field data collection programme, mathematical models and hydraulic scale models.

Introduction

The Nile Delta Coast, on the Mediterranean Sea, was found through many centuries. The existing main branches of the River Nile, i.e. Rosetta and Damietta, succeeded over the ages in forming two peninsulas or protrusions in the sea. By the end of the 19th century, erosion was observed at several important points of the coast, causing damage to the national economy, either directly or indirectly. This erosion is increased tremendously during the last decade.

The relative stability of a shoreline within a given area is dependent on the material and energy available to the shore. Forecasting the behaviour of a certain shore area requires data on the different aspects of the phenomena. But since most of the phenomena affecting a coast-line are random, they require many years of record in order for the result to be statistically significant.

Data are scarce on the different phenomena occuring on the Coast of Egypt. However, the problem areas cannot wait for many years for collecting field data. Therefore, the beach protection plan for the Northern Coast of Egypt is divided into two parts, viz, the short term plan and the long term plan.

The purpose of this paper is to explain the different technical aspects of these two plans and what has been accomplished.

Description of the Problem

The present Delta region, as shown in Fig.(1) has been created by the continuous discharge of large quantities of sediment into the Mediterranean by the Nile during thousands of years. In the course of time the supply of sediment by the Nile exceeded the losses due to wave and current action, resulting in a continuous advance of the shoreline towards the sea. This process continued until sometime in the last century, when it seemed to be reversed. Around the year 1900, the loss of land from Damietta and Rosetta peninsulas was observed. Figs.(2),(3) show the historical changes recorded at both these two locations. Between 1998 and 1954, the Rosetta peninsula receeded about 1.7 km., whilst between 1902 and 1940 the Damietta peninsula receeded about 1.8 km.

The problem has not attracted the proper attention until it started to affect the National economy and the welfare of the people living on the coast. Erosion attacked the beach summer resorts, waves flooded villages on the coast, estuaries blocked, fisheries are deteriorating and danger existed of severe salt water intrusion. The annual loss was estimated in 1970 to be about six million Egyptian Pounds (about $\$ 15 \times 10^6$).

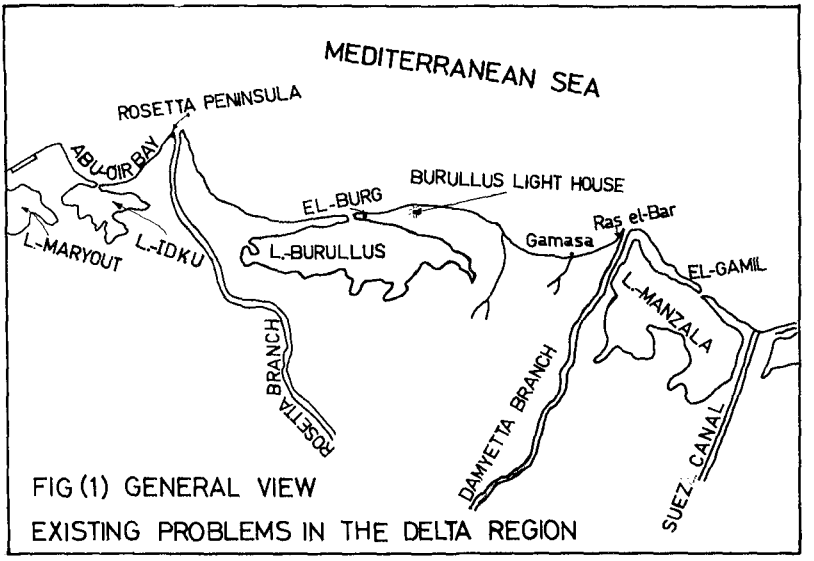


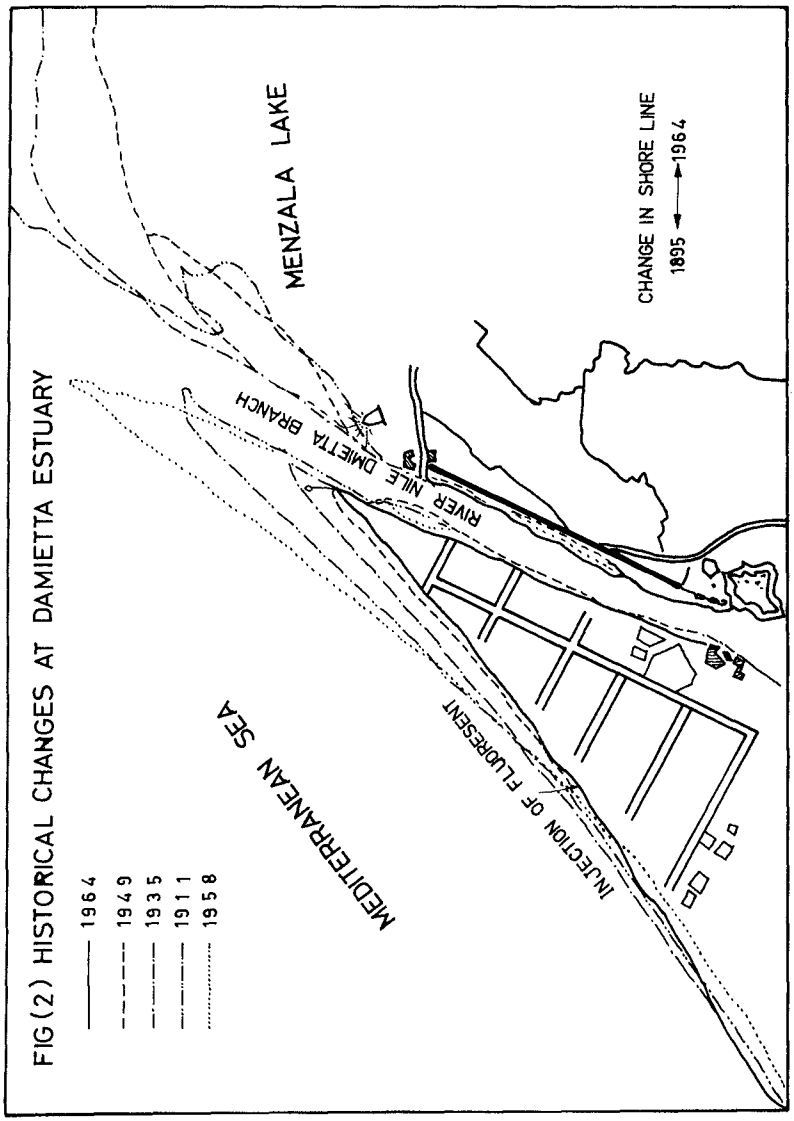
FIG (1) GENERAL VIEW
EXISTING PROBLEMS IN THE DELTA REGION

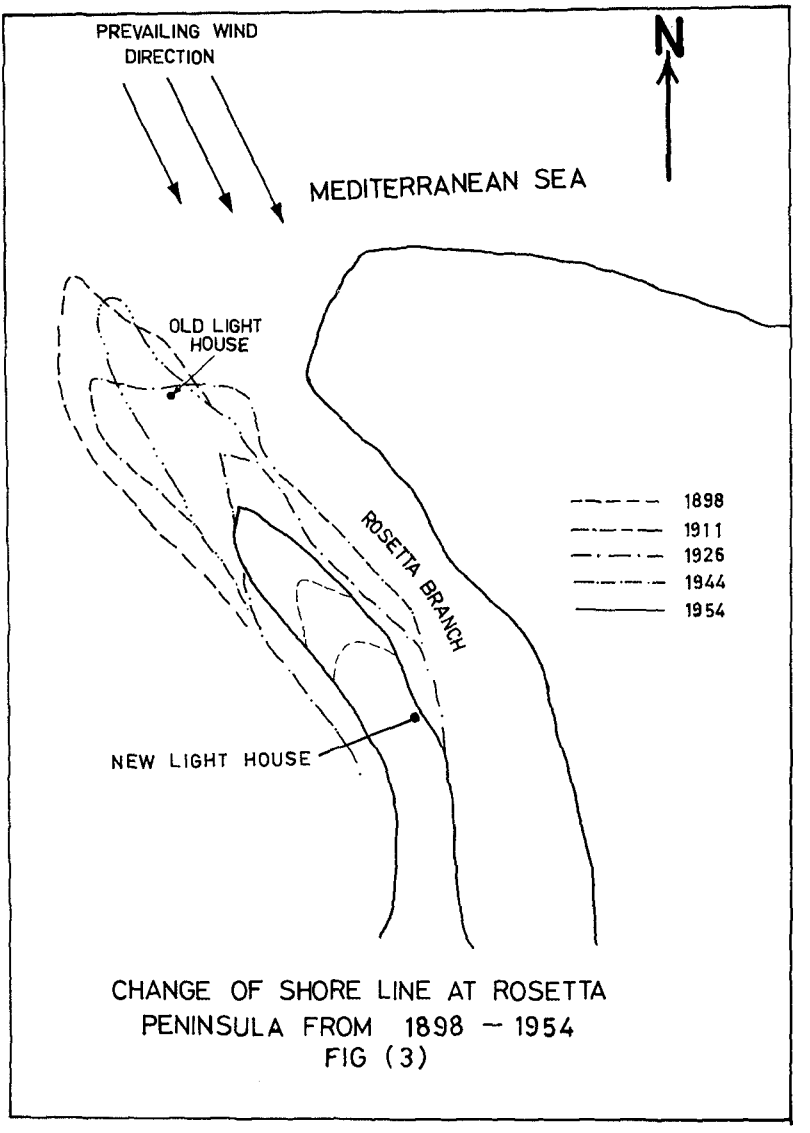
In 1964, the Suez Canal Research Centre, by a contract from the Ministry of Scientific Research, completed the first systematic study both in the field and laboratory about Lake Menzala exit.(1) The exit was migrating to the east at a fast rate, at the same time it is blocked for fishermen a sizable portion of the year. A short groin on the east side and stone pitching to the east side of the exit have been recommended. However, it was not executed due to financial difficulties.

Then the Suez Canal Research Centre carried out a thorough field and laboratory study, in 1965, 1966 by a contract with the Ports and Lighthouses Administration, for the New Damietta Harbour(2). The Ras-El-Bar area, east of the Damietta branch of the Nile, was covered in this study. The study included wave and current recordings, hindcasting of sea waves, water level variations, littoral current, beach profile changes and borings.

During the same years, the Ministry of Irrigation Experiment Station carried out a laboratory test for Lake Burullos exit(3) and a long groin on the west side was recommended to keep the exit open all over the year.

Until 1968, the interests of the beach protection were scattered around concerned Ministries and Departments, but the


FIG(2) HISTORICAL CHANGES AT DAMIETTA ESTUARY
1964
1949
1935
1911
1958
MEDITERRANEAN SEA
MENZALA LAKE
RIVER NILE DMIETTA BRANCH
INJECTION OF FLUORESENT
CHANGE IN SHORE LINE
1895 ⟵ ⟶ 1964



CHANGE OF SHORE LINE AT ROSETTA PENINSULA FROM 1898 – 1954
FIG (3)

whole beach protection problem did not take any serious consideration. But in 1968, the Beach Protection Board of Egypt was reformed and immediately it started the beach protection plan of the Northern coast. This plan is divided intc two parts, viz, the short term plan and the long term plan.

The Short Term Plan

For the areas that cannot wait for the extensive long term study, a one year study programme was planned and executed in certain areas, amomng which the following examples are thosem :

1. Ras-El-Bar and the Damietta Estuary.
2. Burullos Lake Exit.
3. Idku Lake Exit.

The study plan included measurements of wave heights using the O.S.P.O.S. (Van Essen, Holland) and the Ultrasonic (Sogreah) Wave Recorders. Puddle Wheel and OTT Current Meters were used to measure the currents. Tide gauges were used to record the continuous variation of the water levels. Topographic and hydrographic maps were prepared. Meteorological data were recorded and waves hindcasted from the synoptic weather charts. Fluorescent tracer experiments were carried out to determine mainly the direction of the littoral drift and its magnitude whenever possible.

Then remedial measures were suggested, designed and executed in the danger areas. A summary for each location is given in the following :

1. (a) Ras-El-Bar Summer Resort

The beach of Ras-El-Bar is shown in Fig.(4). The beach extends west of the Damietta estuary to a length of about 4.0 km. It has a direction approximately NE to SW. The following data were concluded from the fast study programmes :

a - Wind and Waves. The predominant wind direction comes somewhere between the NW and WNW directions. The wind rose at the Ras-El-Bar beach is shown in Fig.(5). Most of the storms occur in the winter season and they mostly have the same direction as the predominant wind.

The waves were recorded a good part of the years 1964 and 1965. When the wave gauges were not in operation for a reason or another, hindcasting from the weather charts were carried out. The characteristics of the recorded waves are :

Maximum recorded wave height	=	3.95 meters
Maximum recorded wave period	=	9.30 sec.
Significant wave height	=	1.56 meters
Significant wave period	=	7.5 sec.

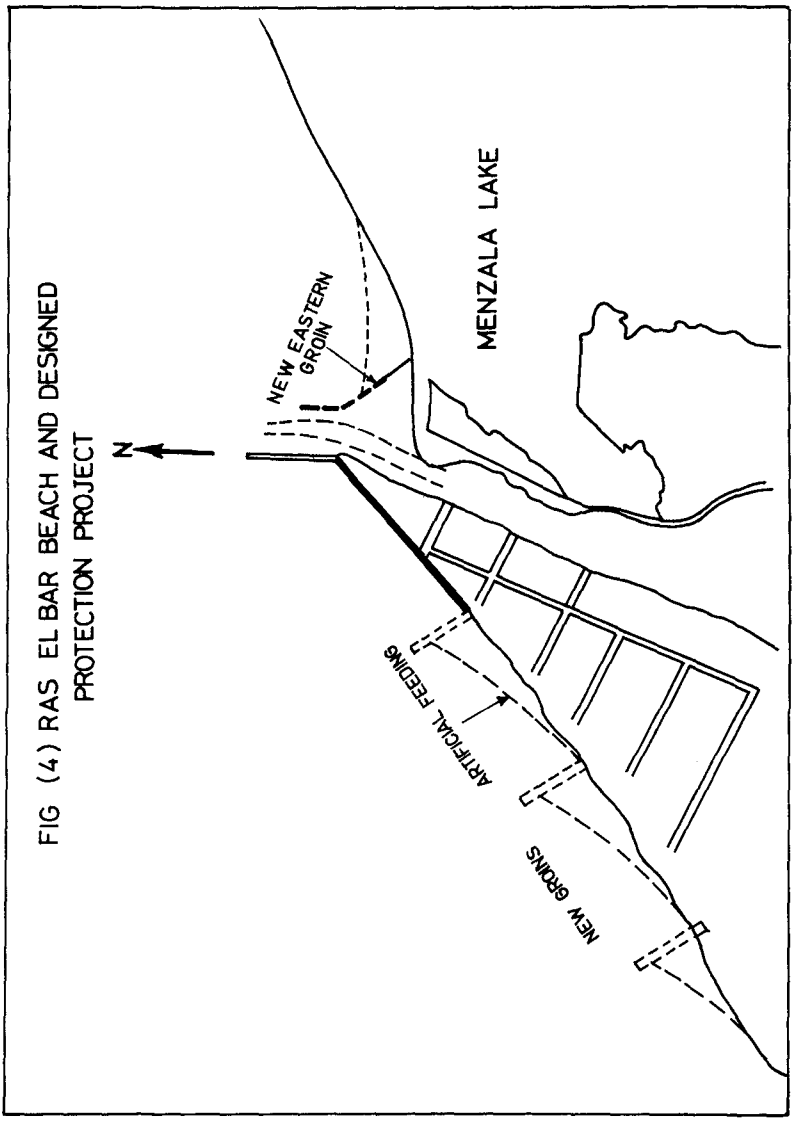


FIG (4) RAS EL BAR BEACH AND DESIGNED PROTECTION PROJECT

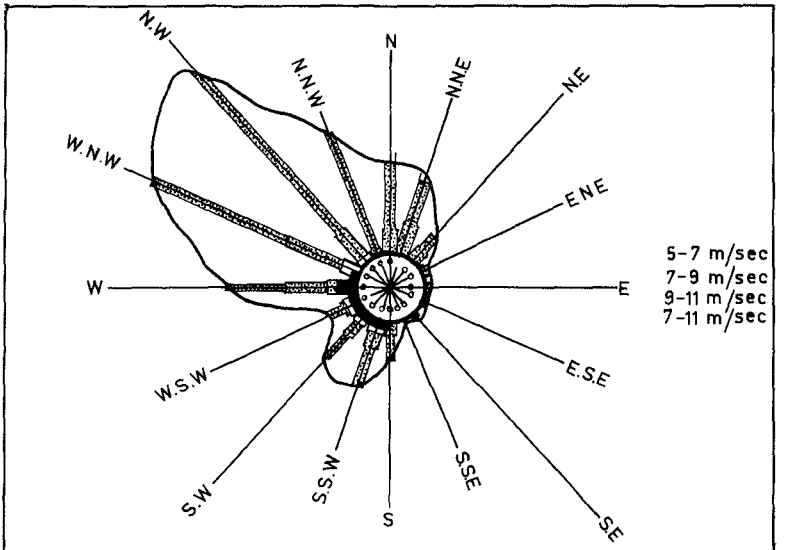


FIG (5) WIND ROSE AT RAS EL-BAR

b - Littoral Characteristics. Fig.(6) gives the wave energy rose. The littoral drift was estimated using Caldwell's formula[4]. Simultaneously some studies with fluorescent tracers[5] showed that the littoral drift to be from SW to NE.. Also, there are some indications that the sediment motion is concentrated in the breaker zone and no exchange of sediment occurs between the off-shore, on-shore areas.

c - Sediment Characteristics. The sediment constituting the beach is formed of silty sand with d_{50} = 0.12. The grain size increases as the estuary is approached from the west side.

d - Tides. Tidal variations in this part of the Mediterranean are not of a significant value. They are of the same order of magnitude as the wind set-up. The tidal range is about 30 cm. The maximum rise in the water level due to all the factors was found to be 1.00 m above datum, the datum being the lowest low water level.

e - Soundins. Several soundings were carried out to determine the characteristics of the soil layers.

Based on the above studies, groins and artificial feeding to build the eroded beach were chosen as remedial measures. Fig.(4) shows the plan of the new project. The

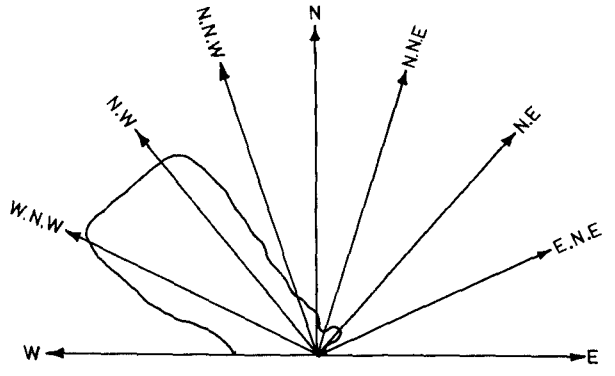


FIG (6)ENERGY ($H^2.T$) CONTAINED IN WAVES ADVANCING IN THE DIFFERENT DIRECTIONS AT RAS EL-BAR

part near the existing groin on the estuary was protected to a length of 400.0 meters by a sea wall. The first of the new groins will start immediately after the sea wall. Three groins are planned for this year as an experimental stage, before covering the whole beach with groins. The distance between the groins is taken 350 m. The groins are extending 120 m in the sea and 30.0 m as a tie to the land. A representative cross-section of the groin is shown in Fig.(7). The seaward end of the groins are protected by heavy hollow squares. Artificial feeding of coarse sand will be supplied from a nearby quarry and dumped between the groins and to the west of westward groins. These groins may be sufficient to preserve the beach, however, some periodical artificial feeding might be needed after the storm season every year.

(b) Damietta Estuary

Before 1964, which is the year during which the High Dam started preventing the sediment being carried out by the Nile, the estuary used to be open to navigation. After that it is changed into a tidal inlet with a very small tidal prism.

The field studies carried out by the Suez Canal Research Centre for the Ministry of Scientific Research(6)

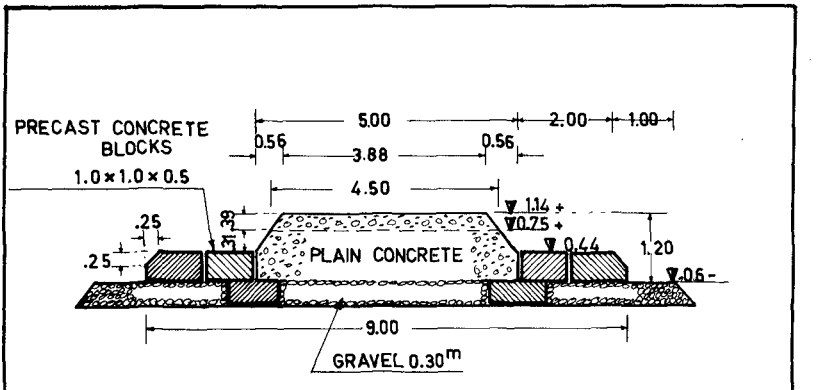


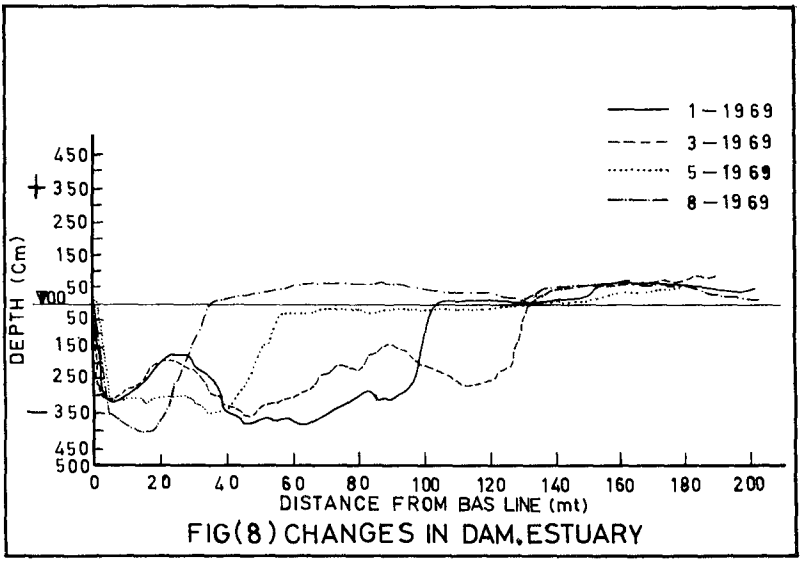
FIG (7) CROSS SECTION OF RAS EL-BAR GROIN

indicated the changes shown on Fig.(8). These cross-sections were sounded after completely dredging the inlet for navigation. Field indications and calculations of the stability of the inlet indicated that the stable area of the exit is about 100 m distributed over a wide section. Thus, no depth is left for safe navigation of fishing boats.

Model experiments by the Suez Canal indicated that the inlet can best be protected by a groin built on the eastern side. This groin starts just a little west of the nodal point, formed by the diffracted waves, and projects out in the direction of the tip of the existing groin as shown in Fig.(9). Pitching of the eastern side of the inlet might prove necessary, also some minor periodical dredging after some time.

2. Burullos Lake Exit

The situation in Burullos Lake Exit is quite different from that of Damietta estuary. Burullos Lake is a big lake receiving the drainage water from almost all the middle part of the Nile Delta. The people of El-Borg, just east of the exit, earn their living from fishing. When the exit closes up for navigation during storms, and it is not kept open by dredging, fish will not go in and out and the fishing boats cannot pass. At the same time the beach is eroding tremend-



FIG(8) CHANGES IN DAM. ESTUARY

ously fast to such an extent that the village of El-Borg is said to be transferred about 2.0 km to the south during the last century. Now the sea forms the northern border of the village. Fig. (9) shows the situation at this area. During the fourties, it was found necessary to build a seawall north of ths village with some short groins to preserve the beach. However, the groins were too short to be effective but ths village was protected from the attack of the sea.

A short study was carried out by the Suez Canal Research Centre in 1969 for the Ministry of Scisntific Research[7], to determine the necessary information on which a fast temporary measure can be taken to keep the exit open.

This study showed that the littoral drift is going predominantly from the west to the east. It also showed that the current in the exit is not strong snough to give the required depth and width for navigation and safe fish migrations. Sediment samples were collected which showed distinctly that the sediment in this area is coarser than Ras-El-Bar.

Based on the above studies a groin was proposed and executed west of the exit, as shown in Fig.(9). The groin starts west of the exit and extends in a direction 15^{0} west of north. The total groin length is planned to be 200 m in the sea and

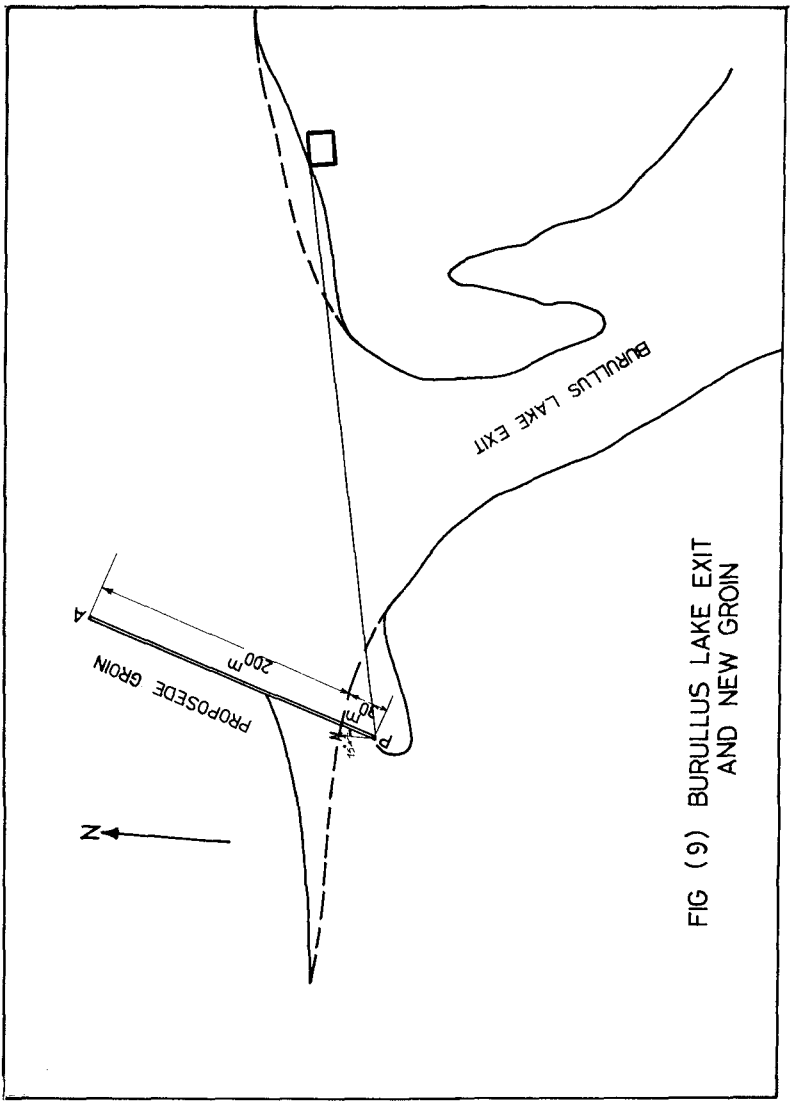


FIG (9) BURULLUS LAKE EXIT AND NEW GROIN

20 m as a tie to the land.

Execution started April 1971. By the end of 1971, 130 m were executed in the sea and it was found that it is necessary to extend the shore tie to about 40.0 m. The executed part of this groin proved to be a success. The beach west of the groin started building up. By the end of 1971, about 40 m of beach was gained. A navigable channel was opened by the flowing water, without any dredging, with its depth reaching about 2.5o m allowing a fair size of fishing boat to go in and out. The groin will be completed to its planned length this year. Fig.(10) shows a representative cross-section of the groin.

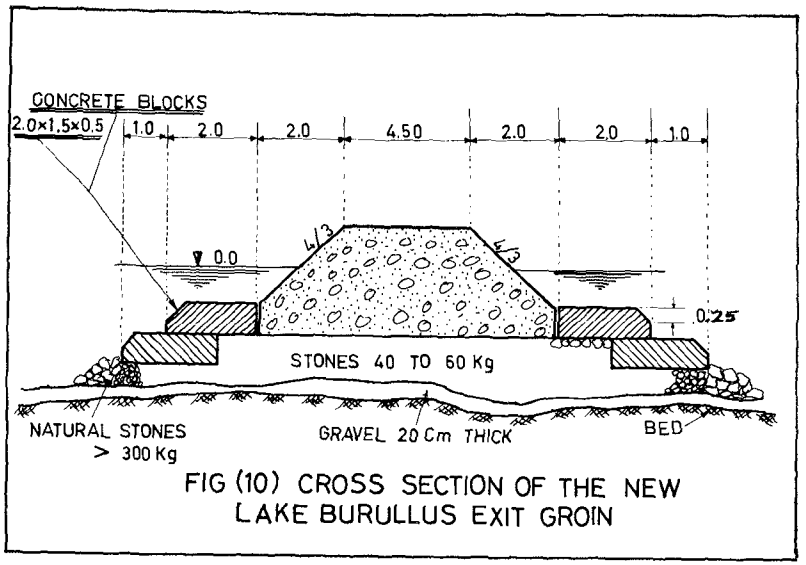


FIG (10) CROSS SECTION OF THE NEW LAKE BURULLUS EXIT GROIN

3. Idku Lake Exit

The village of El-Maadia is situated directly west of the exit. The problem there started as a fishing problem.

The exit used to be quite blocked for navigation. In the fourties the eastern groin was constructed. Sand accumulated east of it, but it did not solve the problem of clearing the exit. Then during the fifties the western groin was constructed and the eastern groin extended inwardly in the exit. The waves entering the exit obliquely are reflected on the eastern groin and hit the shore south of the western groin causing a big belly in the exit, and started attacking the village houses and destroy them. Moreover, the village level was quite low, therefore during the storms the village is almost completely flooded. Sand accumulated also directly west of the western groin. Idku lake is a medium size lake which receives the drainage water of the lands west of the Nile Delta. The outward flow is quite heavy. Thus with the two groins east and west of the exit, it can keep a good navigation channel for fishing boats. However, they might need a little extention. But the village have to be protected from the high water and the fast erosion that is taking place in front of it.

A short field study programme was carried out also by the Suez Canal Research Centre for the Ministry of Scientific Research[8], which revealed most of the facts discussed. It revealed also that the littoral drift in this area is sometimes to the west and sometimes to the east. Hydrographic and topographic surveys were carried out. Current measurements in the exit and on the beach were made. Water level variations were recorded and soil characteristics studied.

The above studies allowed the planning of the project to give immediate protection for the area. The general plan of the project is shown skematically on Fig.(11). Execution started in April 1971 and was completed early this year.

In all the above areas, records are going to be made continuously on the effect of such structures on the beach, at the same time testing the durability of the tried types of structures. This will help in the long period studies as field experiments for the overall protection project of the Delta.

The Long Term Plan

The establishment of satisfactory solutions for the various problems on the Delta coasts require full knowledge of the following three main groups of factors :

1. Historic development of the Delta shores
2. Present state of the Delta shores
3. Forces acting on the Delta shores

With regard to the historic development of the Delta shores, the present stats of knowledge indicates that it has been formed by the continuous discharge of large quantities of sediments into

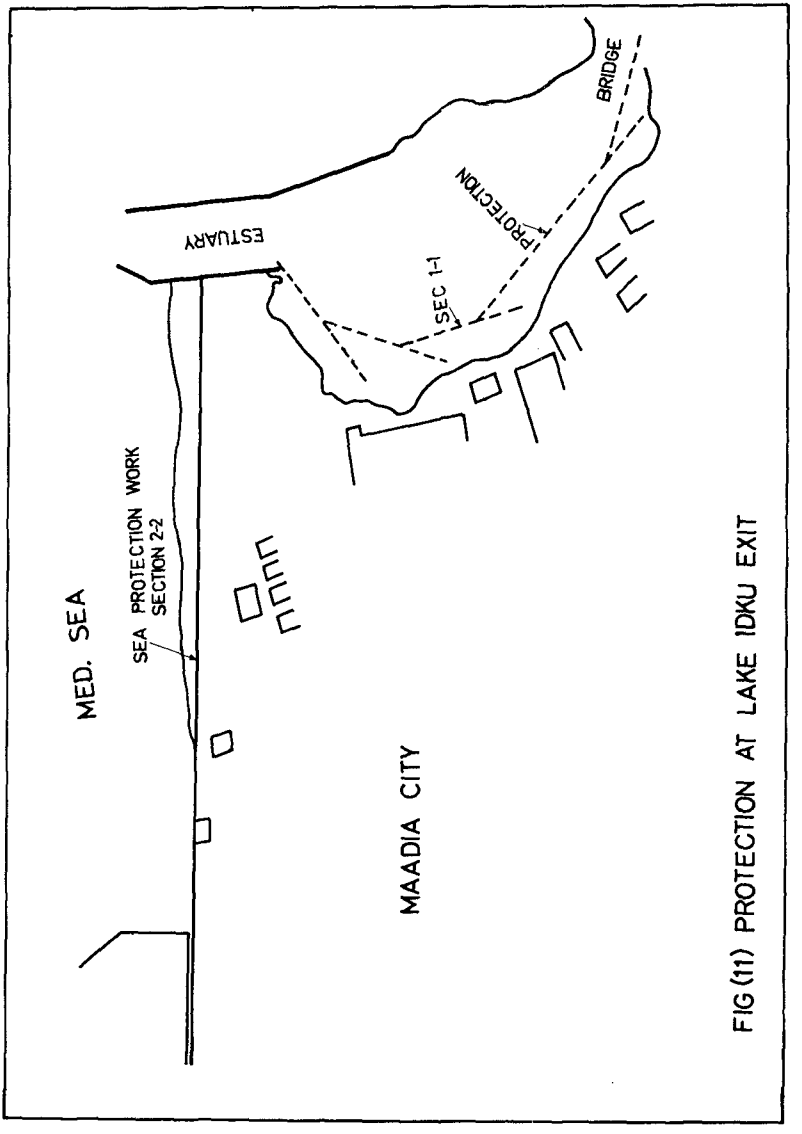


FIG (11) PROTECTION AT LAKE IDKU EXIT

the Mediterranean by the River Nile during thousands of years. The positive instability of these shores, causing accretion, seemed somehow to be reversed to negative instability causing erosion. What happened in the different phenomena involved in causing that change represents the first challenge to the shore protection experts in Egypt for the next few years. Whether it is regulating structures on the river Nile that caused decreased amount of sediments, or some cyclic changes of the meteorology of the Mediterranean Sea, or some changes in the climatology of the Nile origin in Abyssinia, that remains to be completely studied.

The construction of the Aswan High Dam might have changed the entire hydraulic regime of the Delta. This may cause difficulty in using the presently collected data in hindcasting what might had happened in the past and again what may occur in the future. This will need a careful and extremely thorough study of the existing situation and of any changes that take place. Therefore, a complete description of the Delta shores, from Alexandria to Port Said, should be completed and followed up as soon as possible.

This forms the base of planning for the long term study. The required description of the Delta shores consists of the following three groups of information :

i - Geographical, geological and geomorphological description

ii - Description of the meteorological conditions

iii - Description of the hydraulic conditions of the sea area, river mouths and the Lake outlets, including the characteristics and movements of sediments

The long term plan started in the middle of 1971 and the project personnel started collecting and analysing the following data :

A. Topographic work

1. Detailed topographic maps
2. Geological, lithological and geomorphological data
3. 83 profiles seaward to 6.0 m water depth and landward from the coast lines have been carried out. This will be repeated yearly to follow up the changes in the beach.

B. Hydraulic data

1. Water level variations along the coast and in the Lakes and the relation between them
2. Characteristics of the sea and lake water and their variations

3. Lake exits discharge measurements
4. Current measurements in the sea
5. Wave measurements, forecasting and hindcasting
6. Littoral drift measurements using radioactive or fluorescent tracers and other means
7. Model experiments for special areas

C. Meteorological Observations

D. Soil Samples

This includes surface soil samples, deep and shallow borings both on land and in the sea.

The United Nations Special Fund assisted the project by an amount of about £ 1.000.000 in the form of special equipment, some experts and some fellowships for training some of the project personnel abroad.

The first phase of this project is planned to be covered in about 3 years, ending in 1974. By that time the Institute of Coastal Studies and Protection is planned to be in full operation .

Conclusion

From the above discussions and presentation, it can be concluded that many studies are needed in order to protect the Nile Delta coast. The studies in progress might prove to be an opening to a diversity of some more studies both applied and academic. However, the short term plan is obviously needed to protect the dangerously attacked areas, until the final long term studies are ready to be applied. Also they are needed as full-scale field experiments from which data can be used in further protection structures along the coast.

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