ENVIRONMENTAL STUDY FOR WESTERN ROSETTA PROMONTROY

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Abstract

The rate of erosion at Rosetta promontory represents the highest shoreline regression documented along the Egyptian Nile Delta coast. The objective of this study is to formulate and simulate alternatives interventions to protect the coast of Western Rosetta from erosion, and to determine the most effective engineering solution for shore-protection problem, considering the environmental impact of shore-protection structures on the studied and adjacent coasts. The numerical solution shore evaluations model GENESIS was1 used to study the Western Rosetta Promontory utilizing available data. Finally, it was found, for preventing erosion and establishing the studied and adjacent areas, that groins to be extended 0.33 of the average surf zone width, spacing between to be twice of the groin length, the alignment of groins with respect to the shore to be 90^o and the crown height to be at mean sea level

Introduction

The Egyptian northern coast of the Nile Delta that is about 260 km from Alexandria to Port Said has been dynamically unstable for the last century. In the middle of the last century the construction of the different barrages was started and followed by the construction of the Aswan low Dam to control the irrigation water. The Nile Delta coast thus started to erode especially at the two promontories Rosetta and Damitta. The erosion had remarkably increased after the construction of Aswan high Dam in 1964.

The rate of erosion at Rosetta promontory represented the highest shoreline regression documented along the Nile Delta coast. The eroded shoreline will negatively effect the functions of beach at Rosetta area as a recreational area. The shoreline erosion menaces agricultural areas and negatively effects the surfaces and ground water quality. Sea can approach the dwelling zone and influences the housing and the area utilities and hence the future development and population settlement of the area. It is expected the beach erosion will continue in the following changes in the region.

The main objective of this study is to formulate and simulate alternative interventions to protect the Western Rosetta area from erosion, and to determine the most effective engineering solution to a shore-protection problem, considering the environmental impact of shore-protection structures on the studied and adjacent areas.

The present condition of western Rosetta Promontory has been assessed. Moreover, the future shoreline position has been predicted through the numerical model simulation (GENESIS ver. 2.0, Hanson and Kraus 1989) after 15 years. A groin system is suggested and tested to get the proper design elements.

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Materials and Methods
Numerical Model

The governing equations used in the GENESIS model are presented to allow understanding of the concepts underlying the model. Solution of the sand continuity and transport equations forms the basis of the GENESIS model as it does for any other one-line model of shoreline evolution. The equation may be expressed as:

$$\frac{\partial y}{\partial t} + \frac{1}{D_b + D_c}\frac{\partial Q}{\partial x} = 0 \qquad (1)$$

Where:

Y : shoreline position; T : time;

D_b : average berm; D_c : depth of closure;

Q : longshore sediment transport; and X : distance alongshore.

Assumptions in driving Equation (1) are that the form of beach profile remains constant over the long term and that vertical extent of beach change occurs between the landward and seaward limits of the profile (D_b, D_c respectively). Thus accretion or erosion of the profile is associated with a seaward or landward transition of the shoreline.

The empirical relationship for alongshore-sand transports used in GENESIS assumes that sand is transported alongshore by the action of breaking waves. The equation used is

$$Q = (H_2 C_g)_b (\alpha_1 \sin 2\theta_{bs} - \alpha_2 \cos\theta_{bs} \frac{\partial H_b}{\partial x}) \qquad (2)$$

Where:

H : wave height;

C_g : wave group speed;

b : conditions at breaking; and

θ_{bs} : angle between the breaking wave crest and shoreline

The non-dimensional coefficient a_1 and a_2 are given by:

$$\alpha 1 = \frac{k1}{16(S-1)(1-p)}, \qquad \alpha 2 = \frac{k2}{16(S-1)(1-p)\tan\beta} \qquad (3)$$

Where:

K_1 and K_2 :empirical coefficients; $S = \rho_s/\rho$

ρ : density of water; P : porosity of the sand ;and

β : average nearshore bottom slope between the shoreline and approximately $2H_b$

Data collection
Shoreline Data

As for the shoreline changes, Shore Protection Authority (SPA) publishes the main source. These maps showed the shoreline change at Rosetta for the years, 1992, 1993, 1994, 1995, and 1996. Another source of data is sketches by Coastal Research Institute (CRI). The mentioned sketches showed the shoreline change at Rosetta for the years, 1971, 1982, 1987, 1988, 1989, 1990, and 1993.

Wave data

The main sources for the wave data are measurements collected by CRI for a period of six years from 1985 to 1990 and 1996 at Abu Quir and Ras El-Bar. The analyzed data are filed in a form of a table of deep-water wave heights, wave periods, and direction for each day.

Model Calibration and Verification

Calibration was made for two years interval between 30 Oct. 1992 and 30 Oct. 1994. It was found that, the average absolute error between the calculated shoreline (Oct.1994), and measured shoreline (Oct.1994) was 1.20 m. Verification was made two years interval between 30 Oct. 1994 and 30 Oct. 1996. Similar to the case of the calibration, the measured and calculated shoreline positions for the verification are a good agreement. Its found from the resulted of calibration and verification that K_1 and K_2 values equal 0.4 and 0.30.

Results and Analysis

The first run was performed with no protection works to determine the natural beach profile. Figure (1) show the shoreline positions throughout and at the end of simulation period. From Figure (1) it was noticed that the shoreline was in full retreat.

Three run were performed to show the effect of gap distance, the effect of gap distance is illustrated for the model runs where the length was fixed at 0.67 of average surf zone width (SW_{av}) and the gap was varied between values of 1.56, 1.17 and 0.67 SW_{av} Figure (2), (3) and (4) represent relations between the alongshore distances and the shoreline change for different gap distance. For the gap distance equal 0.67 of surf, the groin system is effective in preventing beach erosion

By comparison the results of different the gap distance, it is clear that the shorter the gap distance the less the erosion and for the gap distance equal 0.67 SW_{av}, erosion is prevented and shoreline is restorted.

Three run were performed to show the effect of groin length, the effect of groin length is illustrated for the model runs where the gap distance was fixed at 0.67 SW_{av} and the groin length was varied between values of 0.33, 0.67 and 1.00 SW_{av}. Figure (5), (6), and (7) show the relations between the alongshore distances and the shoreline change for different groin length.

By comparison the results of different the groin length, it was concluded that the short groins have lower effect in minimizing the shoreline change than the longer groins, as the longer groins have better effect in reducing the coming wave energy.

Two run were performed to show the effect of crown level the effect of crown level of the groins is illustrated for the model runs where the gap distance and the groin length were fixed at 0.67 and 0.33 SW_{av} Figures (8) and (9) represent relations between the alongshore distances and the shoreline change for different crown level.

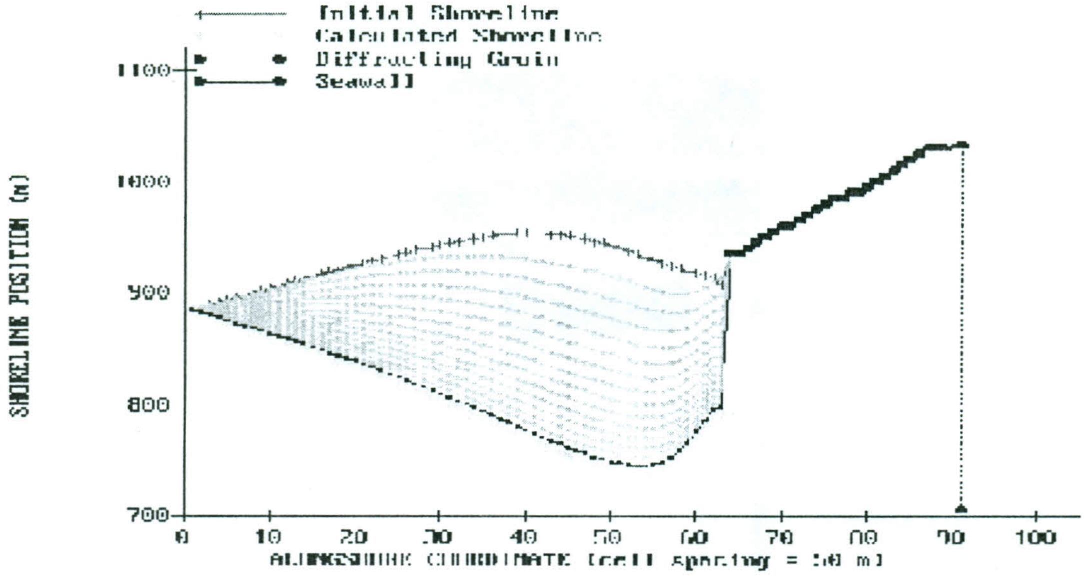

Figure 1. Shoreline positions for existing case.

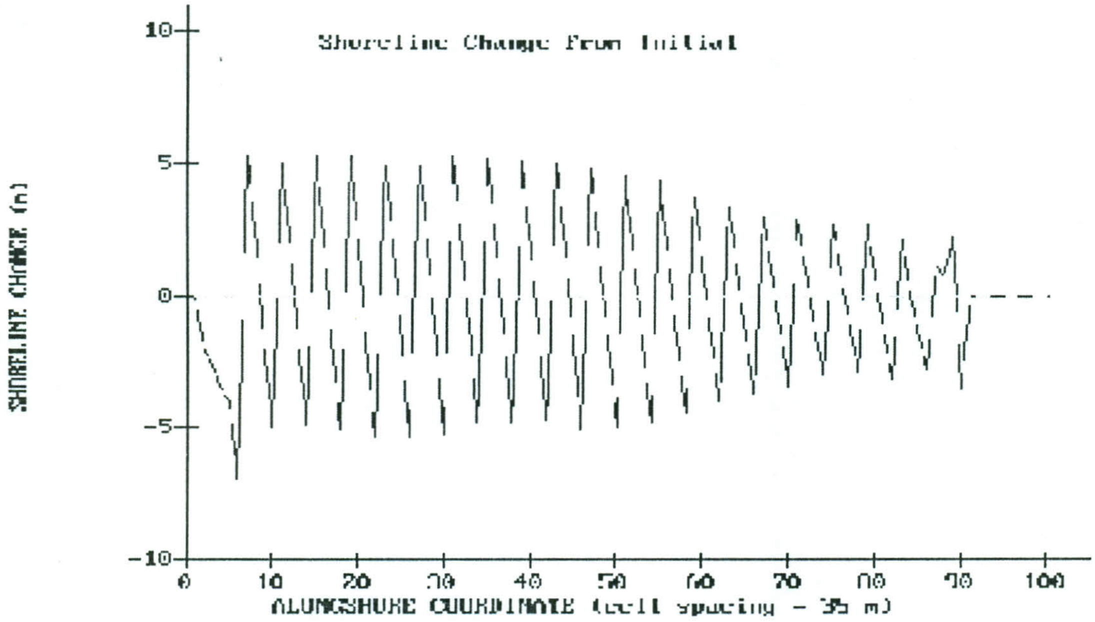

Figure 2. Relation between the longshore distance and the shoreline change for gap distance equals 1.56 SW_{av}

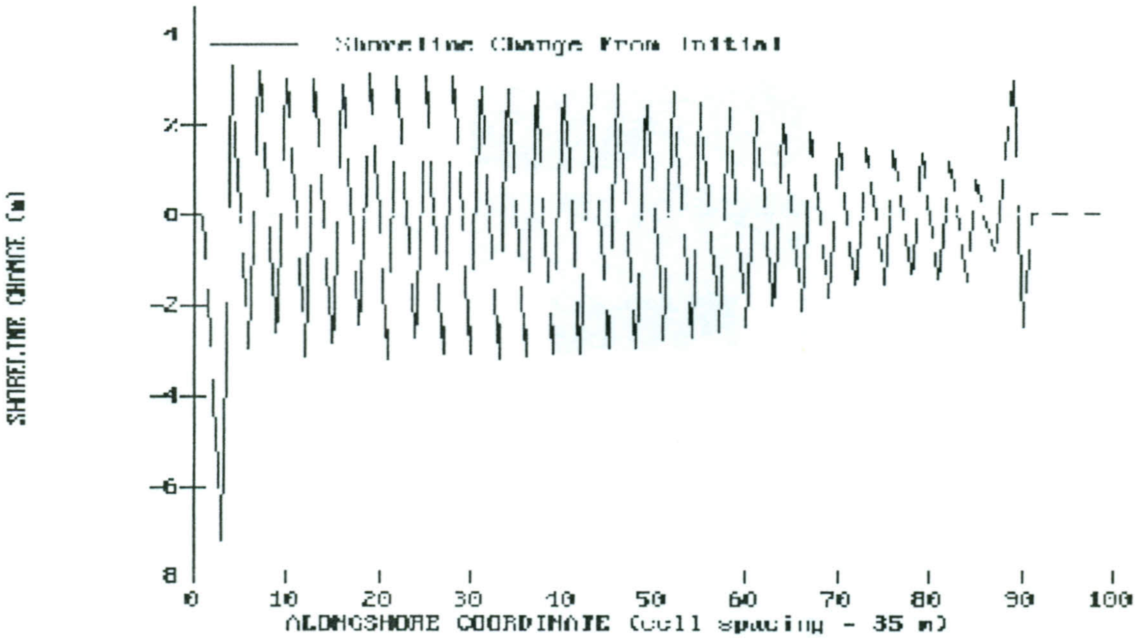

Figure 3. Relation between the longshore distance and the shoreline change for gap distance equals 1.17 SW_{av} .

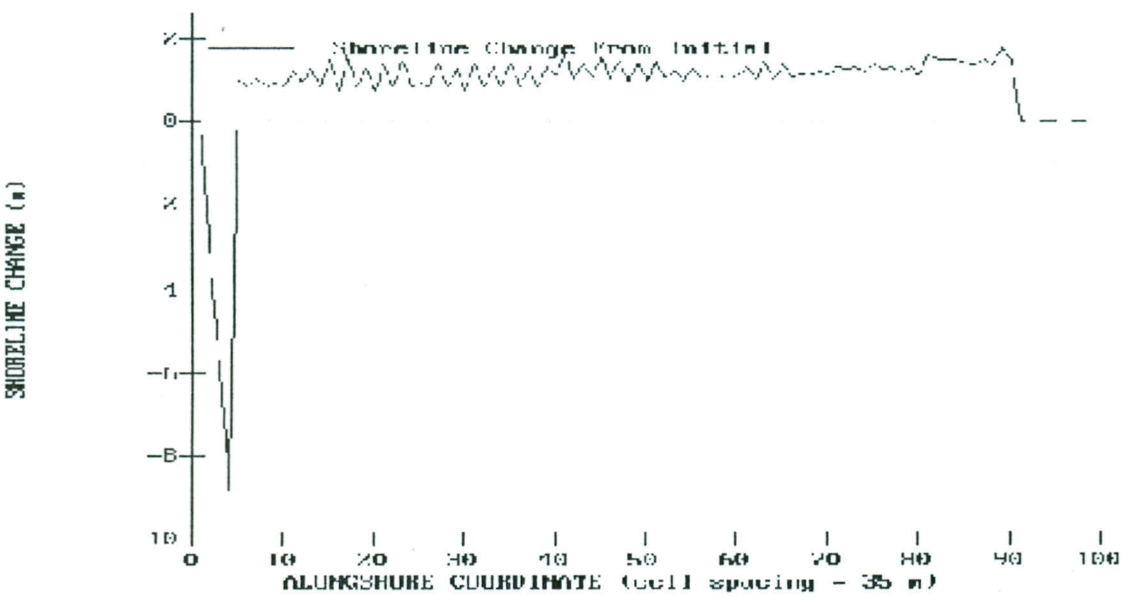

Figure 4. Relation between the longshore distance and the shoreline change for gap distance equals 0.67 SW_{av} .

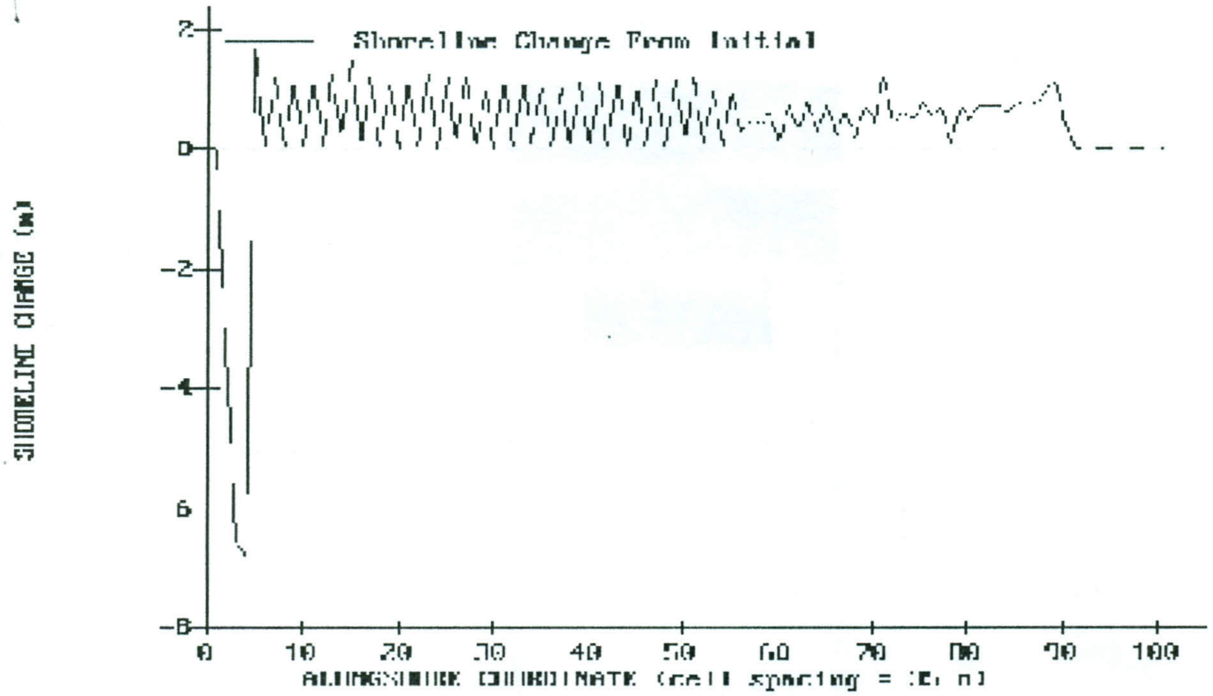

Figure 5. Relation between the longshore distance and the shoreline change for groin length equals 0.33 SW_{av} .

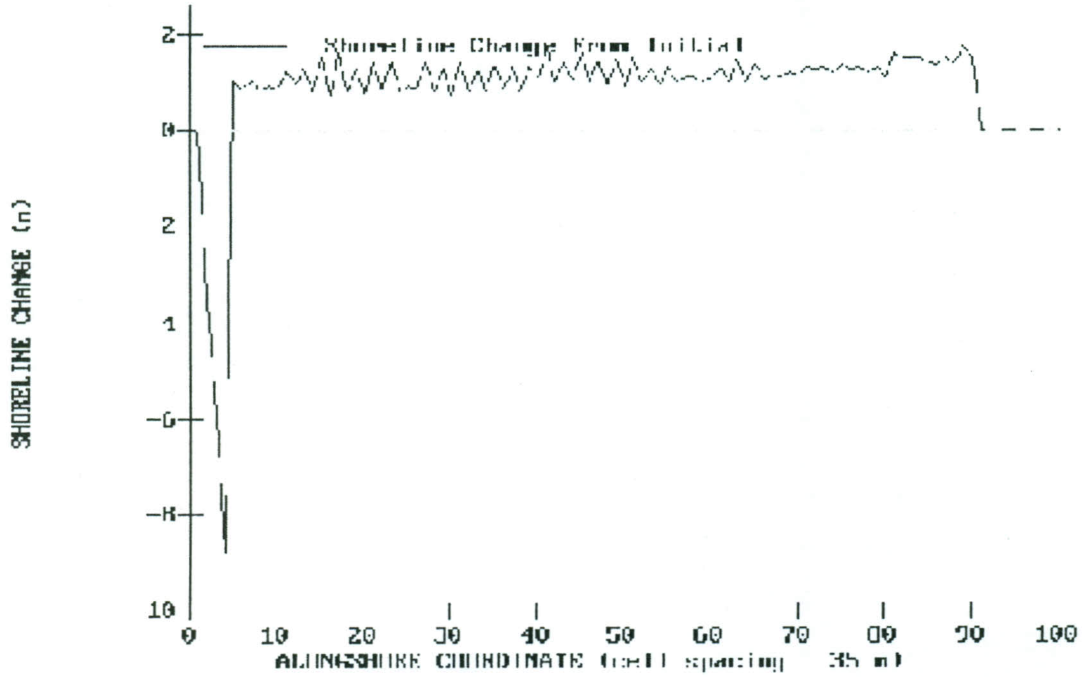

Figure 6. Relation between the longshore distance and the shoreline change for groin length equals 1.00 SW_{av} .

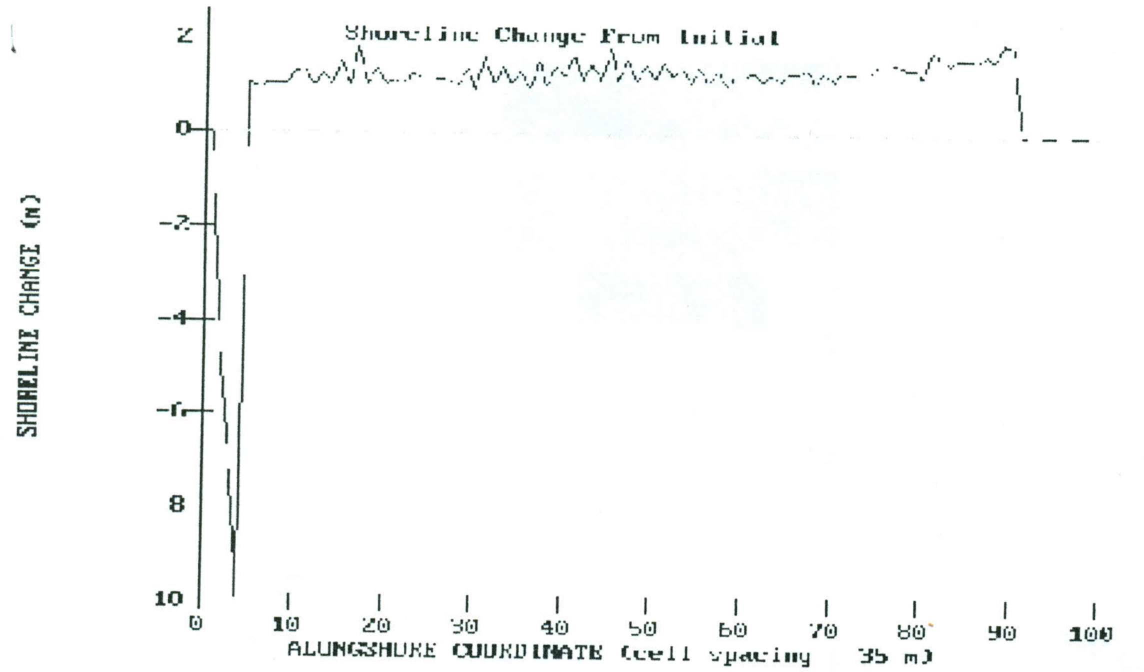

Figure 7. Relation between the longshore distance and the shoreline change for groin length equals 1.33 SW_{av} .

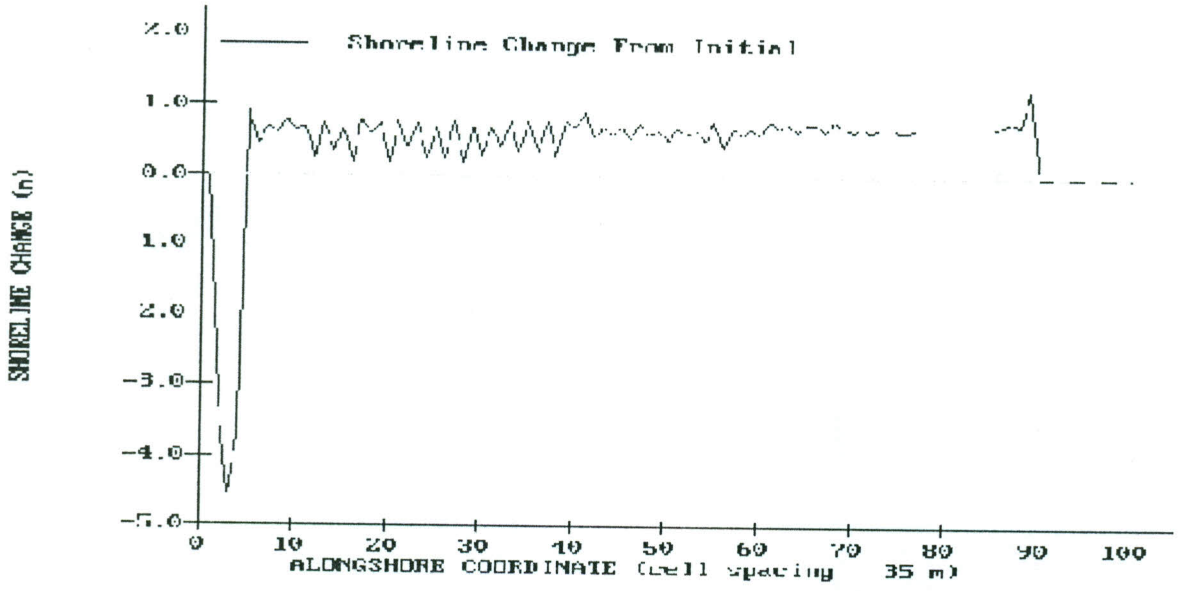

Figure 8. Relation between the longshore distance and the shoreline change for the crown level at M.S.L.

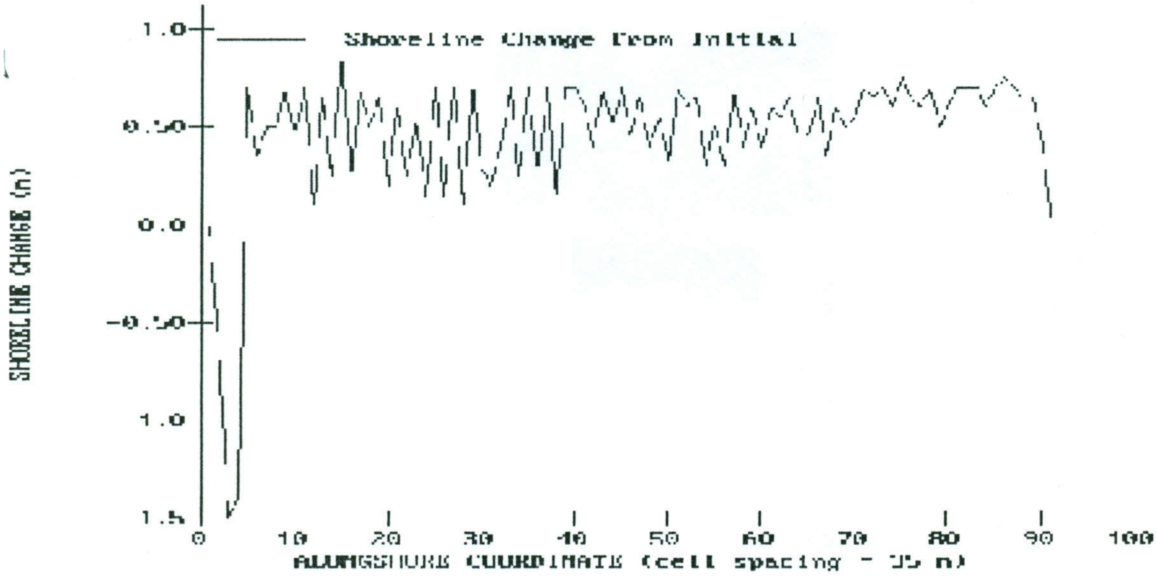

Figure 9. Relation between the longshore distance and the shoreline change for the crown level at a half wave height below M.S.L..

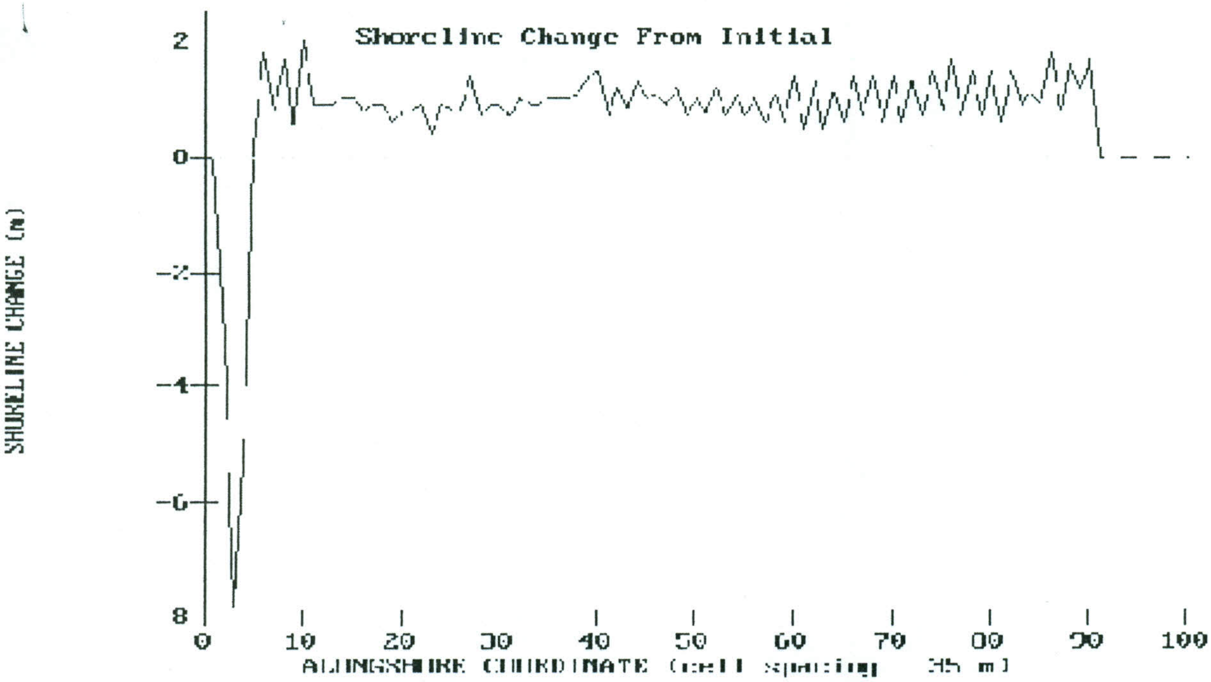

Figure 10. Relation between longshore distance and the shoreline change for the angle of alignment equal 100^0.

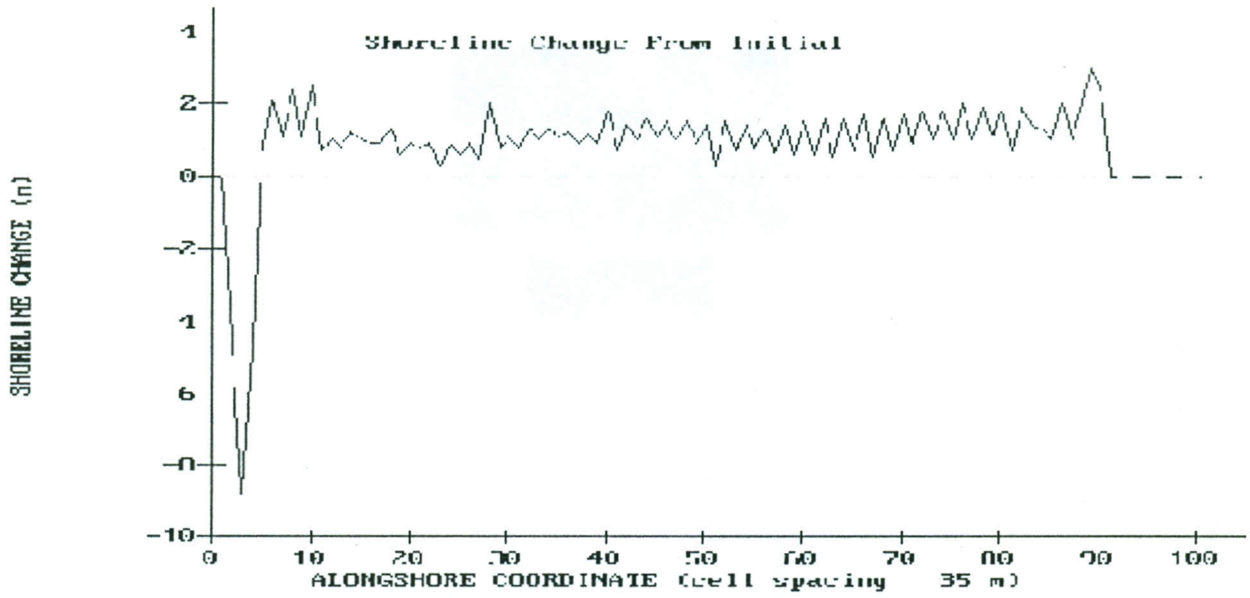

Figure 11. Relation between longshore distance and the shoreline change for the angle of alignment equal 105^0.

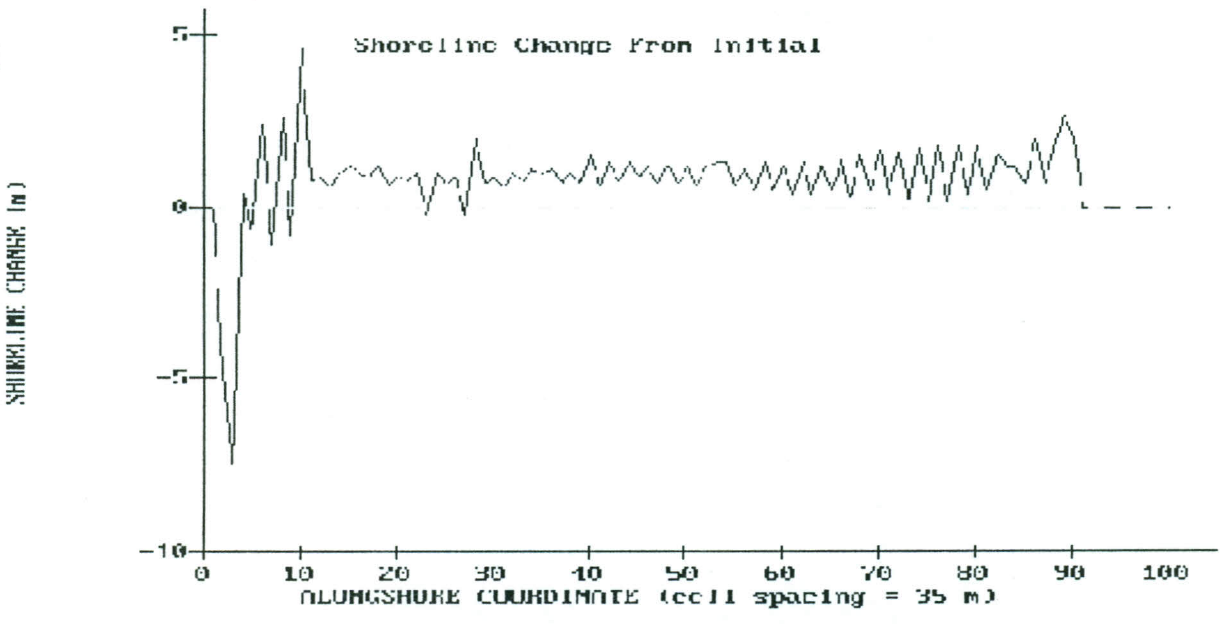

Figure 12. Relation between longshore distance and the shoreline change for the angle of alignment equal 110^0.

By comparison the results of different crown height of groin, it was concluded that the use of submerged groins is for the advantage of groins because they may facilitate the passage of accreted material from the up-drift side to the down-drift side beach and create a smoothly connected shoreline.

The effect of the groins alignment with respect to the shoreline is tested. The groins with 0.67 SW_{av} apart were placed at water depth 1.0 m and the groins have length of 0.67 SW_{av}. Figures (10), (11), and (12) represent relations between the alongshore distances and the shoreline change for different angle of groins alignment. By comparison the results of different angle of groins alignment, it was noticed that the accretion increases inside the groin system with alignment increases from 90^o to 105^o.

Considering the local conditions and the environmental requirements, the groins system can be used to prevent the erosion and stabilizing the shoreline. The groins to be extended 0.33 SW_{av} , spacing between to be twice of the groin length, the alignment of groins with respect to the shore to be 90^o and the crown height to be at mean sea level

Conclusions

The rate of erosion at Rosetta promontory represents the highest shoreline regression documented along the Nile Delta coast. The eroded shoreline will negatively affects the beach at Rosetta area as a recreational area and the other functions. In this study the Western Rosetta promontory was studided. The comparison between the groins systems and the free shoreline result showed that the rate of erosion was reduced by means of all groins systems. The groins stooped most of the littoral drift in the near shore area. It was found, for preventing erosion and establishing the studied and adjacent areas, that groins to be extended 0.33 SW_{av} , spacing between to be twice of the groin length, the alignment of groins with respect to the shore to be 90^o and the crown height to be at mean sea level

References

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