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ORIGINAL ARTICLE

Assessment of a combination between hard structures and sand nourishment eastern of Damietta harbor using numerical modeling

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Abstract Damietta harbor was constructed in 1982 as an inland harbor with its 15 m depth navigation channel and two jetties acting like an obstacle to not allow sediment deposition in the harbor. On the other hand, they significantly affect the northern coast shoreline and hinder the sediment circulation in Damietta promontory. Satellite images show that new headlands are being implemented in the coastal shores of As-senaneyah. The proposed project consists of implementation of four headlands with length of 160 m, spacing of 400 m and using 150,000 m^3 nourishment in those spacing between the hard structures only once during the construction time. Litpack 1D-model is used to predict shoreline responses to number of different five scenarios considered as combination between hard structures such as headlands and sand nourishment. A total number of 32 profiles were used to assess the shoreline changes along Gamasa, Damietta and Ras El-bar resort from 2010 to 2015. This study prevails a high erosion rate of the eastern and western shorelines of the proposed headlands. Nourishment of 200,000 m^3/year is found to be a reasonable solution due to simplicity of being attained from Damietta harbor's annual dredged materials which was reported to be average of 1 million m^3/year.

1. Introduction

Along northern coasts of Egypt, shoreline changes are found to be high due to harbor construction and shore protection structures [1,2]. In 1982, a conclusion was made to construct a new inland harbor of Damietta shown in Fig. 1A [3]. The construction of the harbor, especially its jetties is considered as a sediment trap which hinders natural circulation of sediment along east part of the Nile delta. Sogreah (1982) had predicted erosion east of the harbor and is definite that the effect would be most severe for a distance of 500–1000 m along the shoreline [4]. El.Asmar (2002) results show that significant amounts of erosion could be detected using Remote sensing method for some 6.2 km beyond the eastern jetty, toward the coastal resort of Ras El-Bar [5]. El.Asmar (2002) prescribed

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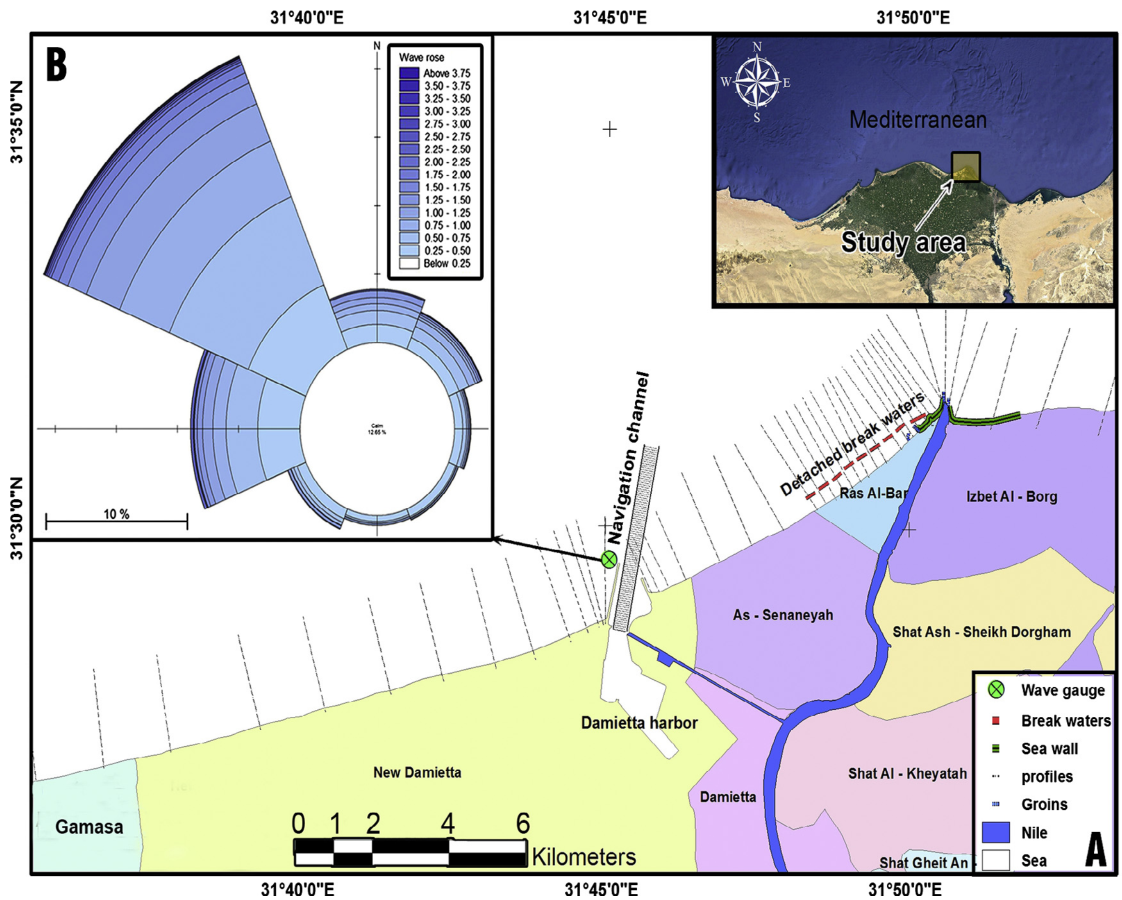

Figure 1 (A) Layout of study area including Damietta harbor and protection structures and (B) wave gauge station location and wave rose measured in the study area in 2010.

that 10.5 km of shoreline would be affected due to the harbor construction [5]. These results indicate that the impact of harbor construction on the Nile Delta shoreline has affected a larger area than that predicted by Sogreah (1982) at the time of construction [4]. A retreat of the shoreline is documented about 5 m/year at Ras El-Bar resort [6,7]. Fig. 1A shows the study area representing 5.5 km western of Damietta harbor and 9.5 km western of the harbor including the 9 detached breakwaters and extending to the western jetty of Damietta promontory which can be assumed as a closed boundary for the sediment movement. Ras El-bar nearshore region showed continuous deepening of the water depth and steepening of its underwater shore slope. Through the period from 1986 to 2000 a series of eight detached breakwaters 200 m in length with 200 m spaces in between were constructed to protect the western side of Damietta promontory along a distance of 3 km [8]. Salient has already been noticed along the shores of Ras El-Bar; however, erosion pattern was highly perceived for the distance of 4 km bounded by the detached breakwaters in the east and the eastern jetty of Damietta harbor in the west.

Ongoing research pursues using Numerical modeling simulations for this classic case of erosion caused by artificial human interference responding to littoral obstacle in the existence of natural longshore sediment transport. Thus, this paper presents a methodology to assess and evaluate number of combinations between nourishments along with hard structures using numerical modeling [9].

2. Study area

The study area was assessed by 32 bathymetric profiles surveyed by CoRI reaching the 8 m depth with average length of 1 km for five continuous years [10]. Fig. 2 represents the average shoreline change rate/year through analyzing surveyed shorelines from 2010 to 2015 with total of 32 profiles distributed on a distance of 15 km along Gamasa, Damietta and Ras El-Bar shores. The data reveal an accretion pattern western of the harbor with values range from 10 to 20 m/year over distance of 3 km while an erosive pattern can be determined on the eastern side of the harbor with values range from −5 to −8 m/year over distance of 3 km. Shoreline bounded with the detached breakwaters can be observed to have salient phenomenon with an average advancing shoreline of 4 m/year [10].

Wave data in 2010 for a full year were recorded by a current and wave gauge S4DW deployed near the bottom (0.5 m above sea bottom) at the western side of the navigation channel of the harbor at a water depth of 12 m and the wave rose was concluded as shown in Fig. 1B. The wave rose shows that Maximum wave height during the strongest storms is almost 6.0 m, while significant wave height is 4.2 m from N (January 2010). Wave period is ≤8 sec for 98.2% of the time (60.4% of the time between 7 and 8 sec). The monthly maximum peak wave period fluctuates between 7.0 and 13.2 sec. The predominant wave direction throughout is from the N-NW (86%)