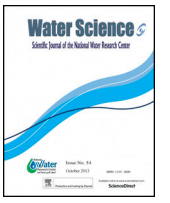
Water Science

ScienceDirect

Water Science xxx (2017) xxx–xxx

journal homepage: www.elsevier.com/locate/wsj



Research Article

Optimum use of dredged materials for sustainable shoreline management in Nile Delta

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Received 12 July 2017; received in revised form 30 October 2017; accepted 6 December 2017

Abstract

Coastal zone of Egypt Nile Delta is exposed to an extensive changes due to natural and artificial influences. These changes have induced erosion problems along coastlines of Nile Delta. Near or foreshore replenishment is an alternative approach in many areas instead of hard structures to avoid negative impact of coastal structures. The frequent maintenance dredging works of ports approach channels could be considered as possible sources of sand, which may be used to address sediment budget and to help overcome coastal erosion at key strategic locations. Two-dimension morphological numerical model (2DH) was developed using Delft3D to study and predict the effect of using dredged sediment from the approach channel on minimizing the retreat of shoreline at the area subjected to erosion. The morphological simulation runs included 8 model scenarios to test the effect of dumping the dredged materials at various locations with different quantities. Analysis of model results were carried out to assess the optimum location and quantities of the nourishment using the dredged materials. The results showed that, the directly placement of dredged materials at shoreline was found to be the most effective choice enhancing the stability of the shoreline. The applications through the current case study could help and guide for integrated management processes and practice.
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Keywords: Erosion; Nile Delta; Approach channel; Morphology; Dredged material

1. Introduction

The coastal erosion causes extensive flooding of sea with negative impact on the local economies of the region represented by the loss of land, coastal tourism, industrial development and fishing practices. In addition to ecological impact which threatens marine animals. Coastal management dealing with erosion problems and long term coastline stability basically relies on the balance between rate of sediment supply and transport. Along the coastline of Nile Delta,

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Peer review under responsibility of National Water Research Center.

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https://doi.org/10.1016/j.wsj.2017.12.001
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Please cite this article in press as: Bahgat, M., Optimum use of dredged materials for sustainable shoreline management in Nile Delta. Water Sci. (2017), https://dx.doi.org/10.1016/j.wsj.2017.12.001

sediment transport by waves have significant effects on the morphological changes of the Mediterranean coast of Egypt. Rosetta and Damietta branches are the two main branches connecting main River Nile stream to the Mediterranean Sea, these two branches are the conveyors not only with the fresh water to Nile Delta but also sediment loads to nourish the coastline. After completion of Aswan high dam (AHD) in 1968, amounts of sediment had been settled upstream AHD and there is no longer sufficient sediment supply to nourish the Nile Delta coastline and prevent coastal erosion (Lotfy and Frihy, 1993; Stanley, 1996). Shortage in sediment supply resulting loss of several beaches and blockage navigation channels by sediment, as well as flooding of coastal villages (Herbich et al., 1998). Many researchers at different times studied coastal processes and erosion occurs along the Nile Delta coastlines (Fanos, 1995; Frihy et al., 1991; Frihy and Komar, 1993; Sogreah, 1982; Eldeberky, 2011). The sea level rise is one of the factors that threaten the retreat of the Egyptian Mediterranean coast. Hereher (2015) classified the Nile Delta coast as a highly vulnerable area under the threat of sea-level rise.

Protection and development measurements including construction of coastal protection structures like detached breakwaters and seawalls had been attained (Dewidar and Frihy, 2007). These coastal hard structures projects have managed to adjust erosion fronting them, but on the other hand they caused lack of sediment supply in areas further away, causing retreating of coastline. Beach nourishment is considered the only soft shore protection methods that is widely applied for coastal safety, beach widening and provide the benefits claimed by the coastal engineering community (Castelle et al., 2009; Luo et al., 2015; Roberts and Wang, 2012). The nourishment projects started in the US (Coney Island) in 1923 then expanding eventually to Europe until the early 80s (Hansona et al., 2002). The early of 90s beach nourishment project started to be applied for practice in china (Cai et al., 2010). Karambas and Samaras (2014) evaluated the beach nourishment by comparing the results of an advanced wave and sediment transport numerical model with experimental data of cross-shore profiles and morphology evolution. A shoreface nourishment (underwater nourishment) acts as a submerged structure such as soft reef berm or submerged, hard-rock breakwater which have an effect to reduce wave height in the nearshore zone at the lee side (van Duin et al., 2004). The performance of beach nourishment needs more understanding through predictive models of beach behavior in response to varying hydrodynamic forces and adequate pre- and post-emplacement monitoring to allow for objective project assessment and necessary adjustment of designs (Davison et al., 1992).

The approach channels of ports suffer from continuous sedimentation problems which makes a frequently maintenance dredging program is necessary to overcome such problem. Most of dredged spoil materials is dumping in the offshore direction far from the site of source to ensure that sediment will not return to the approach channel. Moreover this method is costly, a monitoring program and management process of dredged material disposal sites should be design by the decision-making authorities (OSPAR, 2009).

Since the disposal sediments from maintenance dredge works are similar to the natural sediments, approach channels of ports are seen as possible sources that may be used to address sediment budget and help combat coastal erosion problems at key strategic locations.

In Egypt, Damietta port navigation channel could be used as a source of sediment budget where, the amount of siltation in Damietta port navigation channel is about 1 million cubic meter annually. The current research is part of the project of adaptation to climate change in the Nile Delta through Integrated Coastal Zone Management, (Ivica Trumbić, Consultant-June 2013).

2. Study area

Coastal strip from the mouth of the River Nile of Damietta branch and Port-Said is suffering from erosion with different rates. Most erosion is encountered close to the River Nile mouth and decrease eastward (El-Asmar and Hereher, 2011). The maximum erosion rate with landward shoreline displacement occurred at 7.8 km east of Damietta promontory mouth. Izbat-Alburj city is located at the end of the Nile River, north of Damietta city, about 15 km on the eastern bank of Damietta branch of the Nile River at its mouth to the Mediterranean Sea. Recently, the Shore Protection Authority (SPA) had built a new seawall revetment with length about 7 km from the river mouth to the eastern direction. At the end of seawall revetment in the eastern side of Izbat-Alburj, the erosion rate had rapidly increased during the period 2003–2012 as shown in the satellite images in Fig. 1a and b where, old coastal highway connecting Damietta and Port-Said cities affected by erosion.

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