Wave-Induced Sediment Transport along the Abandoned Yellow River Delta in Jiangsu Coast, China

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ABSTRACT

The Abandoned Yellow River Delta (denoted as “AYRD” hereafter) located in the north of Jiangsu Coast, China, was formed and developed during the years 1128-1855, when the old Yellow River reached the Jiangsu Coast and discharged into the south Yellow sea. Since 1855, the Yellow River has shifted its course to the Bohai Sea. The subaqueous delta was eroded due to the cut off of the sediment supply. Now, the coast of the AYRD is exposed to the wave action of the South Yellow Sea due to the lack of shelter of offshore sandbars, so the wave-induced sediment lifting effect is strong, leading to the obvious sediment resuspension in the subaqueous delta under the wave action. Based on the field data, we analyzed the law of water and sediment movement and established a two-dimensional hydrodynamic and sediment transport numerical model (Delft3D), coupled to the wave model to simulate the sediment transport. The results show that the suspended sediment concentration (denoted as “SSC” hereafter) is high nearshore and low offshore. During the flood tide, the sediment is transported to the south, and to the north in ebb tide, but the net transport direction is to the south, which is an important source of material in the central coast of Jiangsu. Due to the breakwater construction, the sediment transport from north to south has been intercepted, a small amount of siltation has occurred in the south and inside of the breakwater. which greatly reduces the SSC in the port area and the nearby estuaries but has little impact in the far estuaries.

KEY WORDS: Abandoned Yellow River delta; suspended sediment transport; breakwater

INTRODUCTION

The long-term and main hydrodynamic factors in offshore area are wave and current (Lu et al., 2005). Under the action of wave and current, sediment is continuously suspended, transported and settled. After a long period of continuous action, it causes erosion and accumulation of seabed, and then affects the development and evolution of seabed topography and geomorphology (Gao et al., 2015). There is a dynamic balance between the distribution of SSC in the coastal area and the erosion and deposition of sediment on the seabed, which is usually achieved by hydrodynamic conditions and is adjusted with the fluctuation of tidal current in the tidal area (Zhou et al., 2014). However, the construction of breakwater and other coastal protection works have a great influence on the hydrodynamic forces and sediment movement in offshore area (Chen et al., 2008). The original hydrodynamic and sediment conditions have changed, resulting in the siltation of the port channel, the siltation and scour of the beach and the deformation of the shoreline. Therefore, grasping the sediment movement law of the coast and reasonably predicting the coastal changes under the influence of artificial structures are of theoretical significance and application value.

In this paper, our goal is to gain the understanding of the law of sediment and flow movement of AYRD through analysis of field data and numerical simulation. The research results are of great significance to the daily maintenance and subsequent planning of coastal port channel construction.

STUDY AREA

General information

The AYRD, located in Binhai, Yancheng, Jiangsu Province, from Guanhe Estuary to Sheyang Estuary, is the most prominent part of the north Jiangsu coast (see Fig.1). The turning point of this area is the north mouth of the Abandoned Yellow River mouth. The coastline trend changes from NW~SE to S~N, which belongs to the erosive silt coast. From 1128 to 1855 A.D., the Yellow River flowed into the Huaihe River in the south and deposited large amounts of sediment on the coast of northern Jiangsu (Liu et al., 2013; Su et al., 2017a). After 1855 A.D., the tail of the Yellow river changed from Shandong to Bohai Sea. The deposition process of the AYRD, which used to be dominated by land sediment, changed into the erosion process dominated by marine power (Su et al., 2017b). The source of great quantities of sediment on the Jiangsu coast was cut off, which made the coastline near the abandoned Yellow River Estuary recede and the subaqueous delta eroded. After the 1970s, a series of coastal protection projects slowed down the erosion of the coastline, but the erosion continued.

According to the survey data in 1989,1994 and 2004, the underwater isobaths of the AYRD kept moving inwards. Until 2004, the isobaths of - 5m, - 10m and - 15m were about 1.25km, 2.0km and 4.3km away from...