Analysis of Stability of Deep Tidal Channel of Lianzhou Bay

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Abstract. To investigate the dynamic mechanism of maintaining the deep tidal channel of Lianzhou Bay in nature status, a numerical model of Lianzhou Bay was established based on ECOMSED (Estuarine and Coastal Ocean Model).The measured Salinity distribution shows that the freshwater has small effect on the deep tidal channel areas; The maximum shear stress in the tidal cycle is much larger than others in the area of the deep tidal channel.

Introduction

Deep tidal channel, formed by tidal erosion, is a common landform in continental shelves and seacoasts. Cao *et al.*[1]considered that the deepening of the channel was caused by vertical transport of sediment of the whole bay; combined with the side-scanning sonar mosaic diagram; Yang *et al.*[2]calculated sediment flux and the re-suspension flux in deep tidal channel in the north of Hangzhou Bay and the analysis results showed that the transportation direction of suspended sediment in the deep tidal channel was not absolutely the same with the direction of the residual current;

Deep tidal channel of Lianzhou Bay is not only a natural deep-water channel of Beihai Bay, but also an important channel connecting water in Lianzhou Bay and water outside Lianzhou Bay. The location and topographyof Lianzhou Bay are shown in Fig. 1.Liu *et al.*[3]classified landforms under and around Lianzhou Bay and expounded detailed forms, characteristics and distribution rules of landform units such as undersea delta, tidal erosion channel *etc*. Based on analysis of drilling and exploration data, Research of Chen *etal.*[4,5]pointed out that the landform of Lianzhou Bay enabled the tidal flood current to accumulate on the top of the bay and as a result, the flow rate in falling tide was larger than that in rising rate, which formed the tidal erosion channel in the bay.

The above researches are mainly carried out by analyzing local dynamic characteristics or sediment transport characteristics of the deep tidal channel. Compared with influence of local environment, substance transport of the region and the control of surrounding circulation system are more important in development of the deep tidal channel. Taking the deep tidal channel in Lianzhou Bay as an example, the stability of the deep tidal channel is affected by factors as follows: firstly, sediment carried by Nanliu River; secondly, local erosion balance.

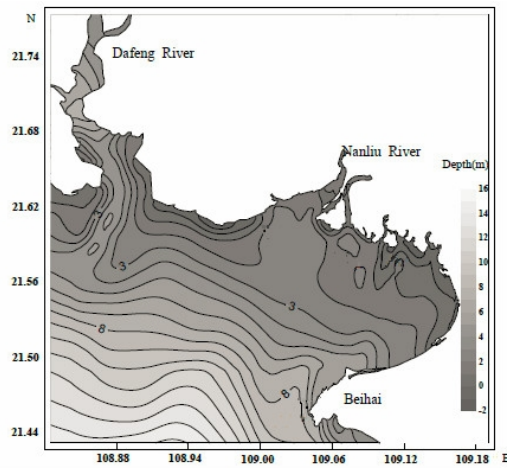

Fig. 1.Study area and topography

Extension of Freshwater from Nanliu River in the Bay

Nanliu River basin is a typical southern subtropical monsoon climate, As the largest river disemboguing into Lianzhou Bay, Nanliu River has an annual average runoff of $68.3\times10^8 m^3/a$[6].The runoff of Nanliu river runoff vary with the seasons,so the salinity of estuarine waters and its spatial distribution is also an obvious seasonal variation[7].Fig. 2 show thesalinity distribution in four seasons in Lianzhou Bay.In spring,the salinity around river mouth is below to 15 and away from the river mouth salinity increased gradually in the flow direction. The runoff of Nanliu river is increasing during summer, so the salinity in the river mouth is generally lower than 5,Plume of the Lianzhou Bay make the northern half of the water salinity values less than 15, and salinity peak is formed in the middle of the Lianzhou Bay, salinity values in the front quickly by 20 increased to 30.The autumn runoff reduction cause Nanliu river estuary's salinity increased to about 22;In winter, the salinity around the river mouth can reach to 29-30 because the minimize of the Nanliu river runoff, and the salinity of the water in the northwest coast of Beihai peninsula can over 31.The coastal water area from Dijiao to Guantou Ridge is always under the control of water with a salinity above 25. Therefore, the diluted water of rivers has a relative small effect on the deep tidal channel areas.

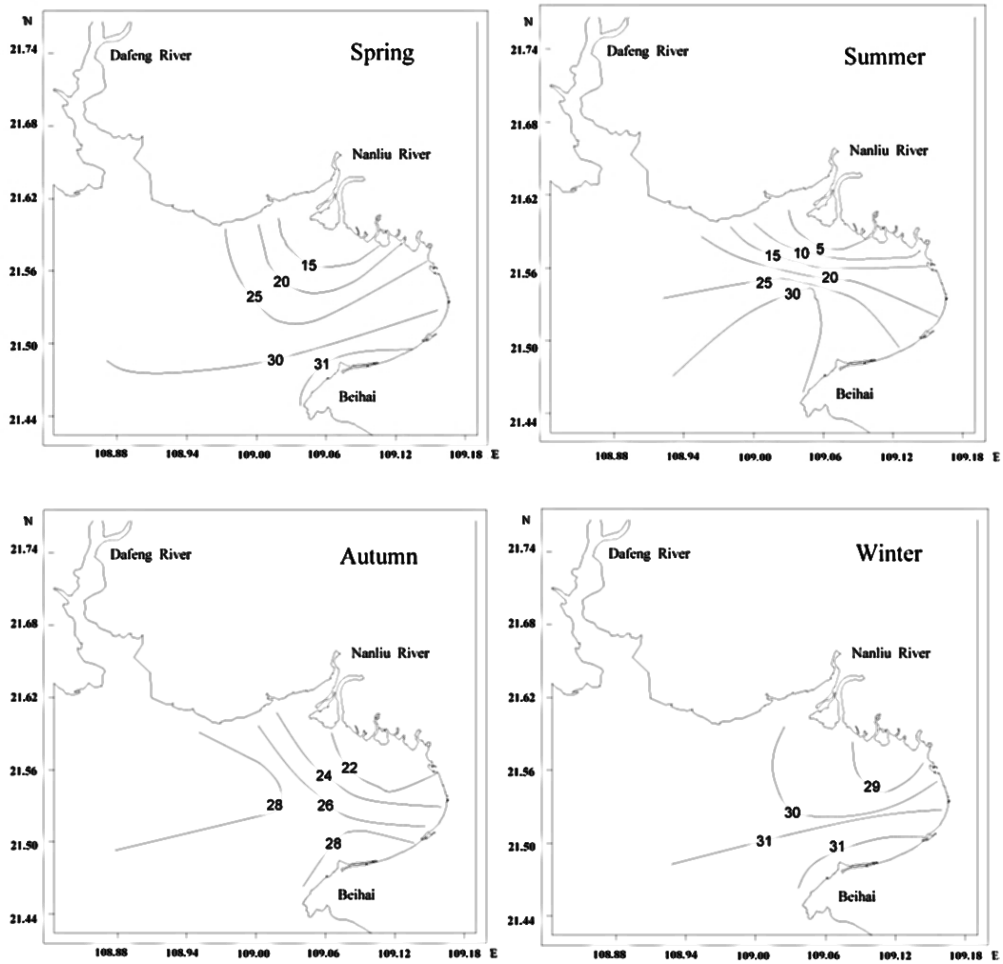

Fig.2. Salinity distribution in four seasons in Lianzhou Bay (Unit:ppt)

Distribution of Seabed Stress around the deep tidal channel

Hydrodynamic field of the sea determines the strength of shear stress undersea. In many numerical models for erosion and deposition of sediment, the deposition and re-suspension process of sediment is related to shear stress at bottom of sediment. According to ECOMSED model, the critical shear stress at bottom is a key parameter for deposition process or re-suspension process of sediment and the critical stress to eroding sludge and silty sediment is about 1dynes/cm$^{2.}$

Fig. 3 shows the distribution of maximum shear stress during the current tidal cycle. From the fig, we know that in area of the deep tidal channel, the maximum stress in the tidal cycle is larger than 1dynes/cm^2 and much larger than the bottom stress around.

In offshore area in the north of Lianzhou Bay, the maximum seabed shear stress is less than 1dynes/cm^2. Therefore, the sediment under the sea of this area is hardly eroded and is under the deposition status during a tidal cycle. However, in flood season, the flow rate in estuary of the river sharply increases and as a result, erosion and deposition may occur in local places. For most areas outside Lianzhou Bay, the maximum shear stress is larger than 1 dynes/cm^2, which indicates that erosion and re-suspension happen to sediment in most area. The seabed shear stress qualitative illustrates that, apart from offshore area in the north of Lianzhou Bay, most area is under a condition of dynamic balance.

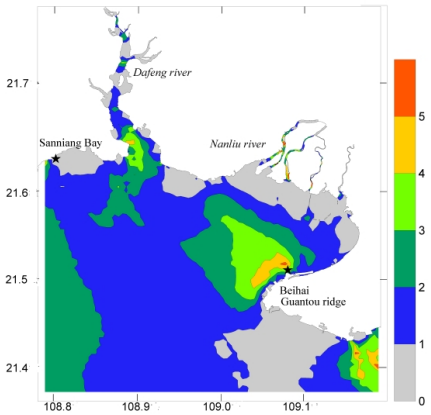

Fig.3.The maximum stress distribution of Lianzhou bay area (Unit: dynes/cm^2).

Conclusions

Freshwater of Nanliu River flows out of Lianzhou Bay mainly from the west of the bay, which goes against the water exchange in the northeast of Lianzhou Bay. However, on the other hand, as a result of the phenomenon mentioned above, part of sediment carried by freshwater of Nanliu river deposits on delta of Nanliu River and part of that enters the sea outside the bay. Little sediment settles on deep-water channel in deep tidal channel, which helps maintain the stability of the deep tidal channel.

The seabed shear stress of the deep tidal channel is much larger than the critical value of sediment deposition (1dynes/cm^2) and the flow rate in falling tide is much larger than that in rising tide. Hence, it is difficult for sediment at the bottom of the deep tidal channel to deposit and sediment around the deep tidal channel is under erosion status.

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