Marine Geology 406 (2018) 27–33

Contents lists available at ScienceDirect

Marine Geology

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

Letter

Morphodynamics of the Qiantang Estuary, China: Controls of river flood events and tidal bores

Dongfeng Xie[a,b,*], Cunhong Pan[a,b], Shu Gao[c], Zheng Bing Wang[d,e]

[a] Zhejiang Institute of Hydraulics and Estuary, Hangzhou, China
[b] Zhejiang Provincial Key Laboratory for Estuarine and Coastal Research, China
[c] State Key Laboratory for Estuarine and Coastal Research, School of Marine Sciences, East China Normal University, Shanghai, China
[d] Faculty of Civil Engineering and Geosciences, Delft University of Technology, the Netherlands
[e] Deltares, P.O. Box 177, 2600 MH Delft, the Netherlands

ARTICLE INFO

Editor: E. Anthony

Keywords:
Morphodynamic equilibrium
Sediment transport
River discharge
Tidal bore
Qiantang Estuary
Hangzhou Bay

ABSTRACT

The importance of seasonal variations in river discharge on the morphological development of estuaries has been recognized in recent years, yet in situ observations about such variations are rare. Here we report a long-term dataset of bathymetry in the middle reach of the Qiantang Estuary, China, characterized by the presence of a large inner bar. Moreover, a hydrographic survey was carried out in the Yanguan reach where one of the largest tidal bores in the world occurs, covering a spring-neap tidal cycle in 2015. Meanwhile, detailed seasonal bathymetric data together with daily river discharges of 2015 were collected. The bed morphology shows strong seasonal and inter-annual variations. During the high flow season, the river flow erodes the bed and transports a large amount of sediments seaward. A good power-law relationship exists between the high river discharge and the channel volume at the upper estuary. Flood tides dominate under usual river flow condition. In particular, the tidal bore during spring and intermediate tides is characterized by large current velocity and high suspended sediment concentration, and transports a large amount of sediment landward. Over a year, a dynamic morphological equilibrium can be maintained. Moreover, the estuary has also been significantly influenced by the large-scale embankment in recent decades, constraining the lateral thalweg migration, bank erosion and point bar deposition, which usually occur in natural sinuous estuaries.

1. Introduction

Estuaries are defined as semi-enclosed coastal bodies of water which have free connection with the open sea (Fairbridge, 1980). They are among the most important interfaces on earth. They provide navigation channels, ports, land resources, conditions for recreational activities, and so on. They also play an important role in global carbon/biogeochemical cycling, and provide habitats for flora and fauna. Estuaries are fairly ephemeral features at the geological time scale and frequently influenced by natural changes and human interventions (e.g. Dyer, 1995; Savenije, 2005; Townend et al., 2007; Wang et al., 2015). From the management point of view, it is of major significance to understand and predict the sediment transport and morphological evolution in estuaries.

Morphological evolution in an estuary is controlled by the nonlinear interactions among hydrodynamics, sediment transport and bed level changes (e.g. Dyer, 1995; Hibma et al., 2004; Dalrymple and Choi, 2007). In recent years, many morphodynamic models have revealed that an equilibrium state of morphology can be reached asymptotically when erosion and deposition balance over a long enough time span, assuming that the river discharge is much smaller than the prevailing tidal discharge and can be ignored (e.g. Lanzoni and Seminara, 2002; van der Wegen and Roelvink, 2008; Leonardi et al., 2013). On the other hand, it has been recognized that seasonal variations of river discharge play an important role on the morphological development in estuaries, especially at the landward end where smaller channel cross sections and tidal prisms prevails (e.g. Perillo, 1995; Savenije, 2005; Shaw and Mohrig, 2014; Guo et al., 2014; Zhang et al., 2016). In the case of a near-equilibrium of an estuary, sediment import during low flows can approximately balance sediment export during high flow over a seasonal cycle (Uncles et al., 1998; Hoitink et al., 2017). It would be valuable to offer a better illustration of such concept, using a time series of morphological and hydrological data from a real estuary.

Sand bars, one of the most important sedimentary systems within an

* Corresponding author.
E-mail address: dongfeng.xie@hotmail.com (D. Xie).

https://doi.org/10.1016/j.margeo.2018.09.003
Received 26 June 2018; Received in revised form 4 September 2018; Accepted 5 September 2018
Available online 06 September 2018
0025-3227/ © 2018 Published by Elsevier B.V.

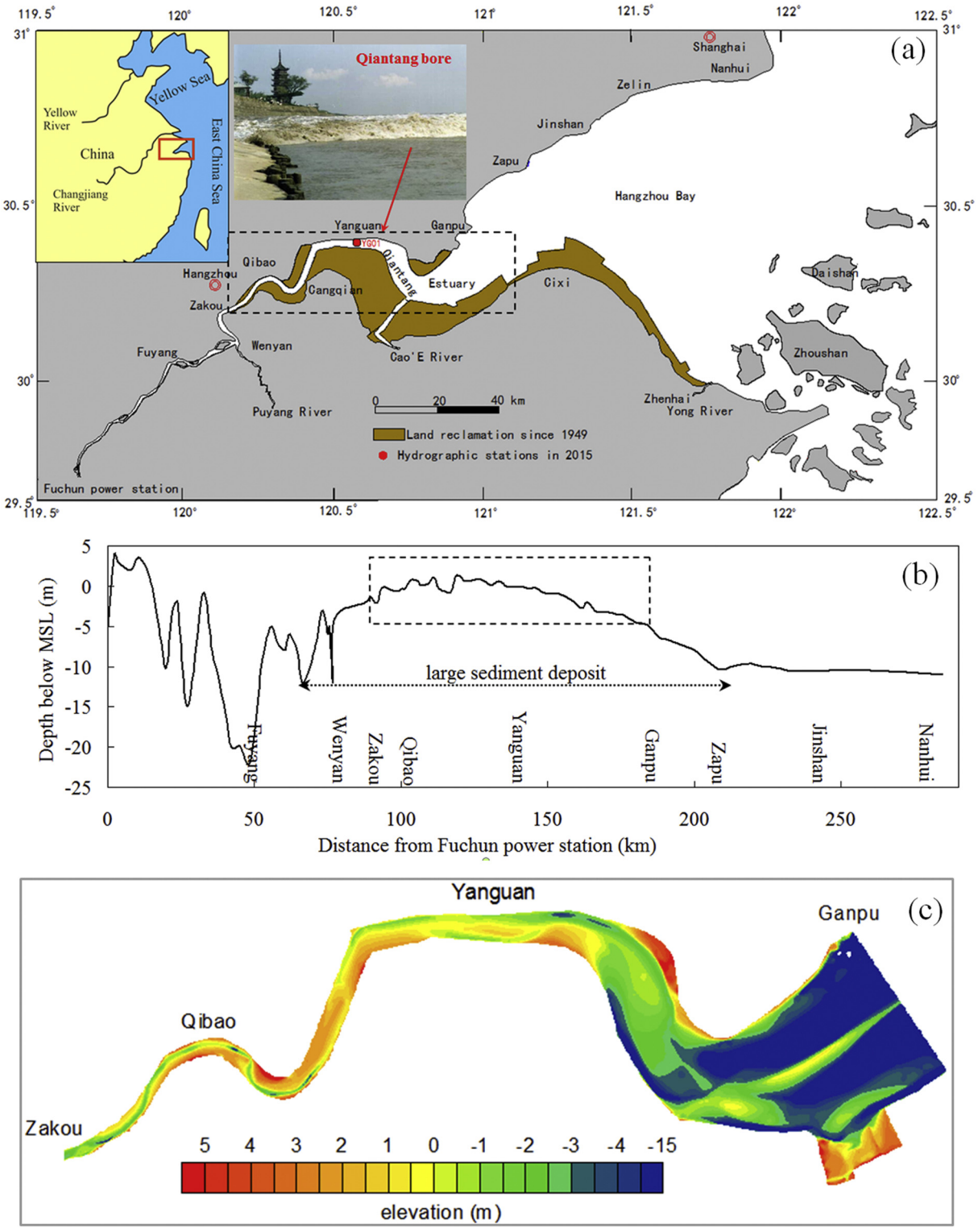

Fig. 1. (a) Location of the Qiantang Estuary, in which YG01 denotes the hydrographic observation station in October 2015. (b) The lateral-averaged longitudinal bathymetry along the estuary measured in 2014. (c) Bathymetry of the middle estuary measured in April 2015. Panels a and b were modified from Xie et al. (2017a). The bed elevations in panels b and c are with respect to the Chinese National Vertical Datum of 1985. The dashed box in panels a and b denotes the middle reach of the estuary, as shown in panel c.

estuary, can form when the estuary received sufficient sediment supply (Dyer, 1995; Gao and Collins, 2014). One typical example is the large subaqueous bar in the upper and middle reaches of the Qiantang Estuary, China. It starts at about 80 km from the mouth, extends by about 130 km longitudinally, and has a height of 10 m above the baseline at the top part (Fig. 1). Based on sedimentological surveys, it has been revealed that the sediment of this large deposit is from the adjacent Changjiang River (Chien et al., 1964; Chen et al., 1990). Yu et al. (2012) reproduced the formation of the large bar in Qiantang Estuary using a long-term morphodynamic model by assuming that the river

Download English Version:

https://daneshyari.com/en/article/9533533

Download Persian Version:

https://daneshyari.com/article/9533533

Daneshyari.com