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The influence of seasonal climate on the morphology of the mouth-bar in the Yangtze Estuary, China

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ABSTRACT

The geomorphology of the Yangtze Estuary in the Changjiang River Delta in Eastern China has been the subject of extensive research. This study extends previous work to examine the influence of wind-waves on the mouth-bar, where about half of the river-borne material settles to the bed. The site is located just outside of Changjiang River mouth, which is meso-tidal and subject to seasonally varying river flows and wind-wave conditions. Modeling was performed with a coupled wave-current hydrodynamic model using TELEMAC and TOMAWAC and validated against observed data. Bottom Shear Stress (BSS) from river, tide and waves based on the numerical model output was used to infer the respective contribution to the evolution of the subaqueous delta. Our examination did not however extend to modeling the sediment transport or the morphological bed changes. The results suggest that (i) the dominance of river discharge is limited to an area inside the mouth, while outside, the mouth-bar is tide-wave dominant; (ii) considering just the tide, the currents on the shallow shoals are flood dominant and deep channels are ebb dominant, which induces continued accretion over the shallows and erodes the deeper parts of the mouth-bar until the tidal currents become too weak to transport sediment; (iii) whereas waves are very efficient at reshaping the shallow shoals, with the effect being subtly dependent on the depth distribution over the mouth-bar; (iv) the stability of shallow shoal morphology is highly dependent on the presence of seasonal wind-waves and characterized as “summer storing and winter erosion”, while deep channels perform like corridors of water and sediment, exporting sediment all year round. The nature of the mouth-bar response has important implications for coastal management, such as the ongoing deep water channel maintenance, reclamations and coastal defense measures.

Keywords: Bottom shear stress; wave-current interaction; mouth bar; estuary geomorphology; seasonal; Yangtze Estuary

1 Introduction

Estuary geomorphology is strongly controlled by hydrodynamics from both fluvial and marine processes (Dai et al., 2014), i.e. the driving forces of river, tide and waves. The Yangtze Estuary, located at the landward margin of the East China Sea shelf (Figure 1a), connects the river to the open sea and has evolved under these complex interactions. The previous main outlet of the North Branch had shifted to the South Branch, following the divergence of the mainstream in the