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Research paper

Impact of river training on the hydraulics of Shenzhen river

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Abstract

Shenzhen River is a tidal river on the border between Hong Kong and Shenzhen. It flows southwest towards Deep Bay in the Pearl River Estuary in south China. In the past, Shenzhen River was narrow, meandering and only capable of conveying floods of return period 2–5 years. To alleviate the flooding hazard, Hong Kong and Shenzhen governments have carried out the Shenzhen River Regulation Project jointly since 1995. The river downstream has been trained to cater for flooding of 50-year return period. However, unexpectedly, the trained Shenzhen River has been seriously silted by 3 m of sediment 5 years after the completion of river training. This diminishes the effectiveness of river training on enhancing flood discharge capacity.

We present a study on the impact of river training on Shenzhen River hydraulics by an integrated three-dimensional numerical hydrodynamic model. The model is verified against field data and shows good agreement with the observed hydrodynamics; wetting and drying of inner Deep Bay tidal flats are successfully simulated. The model simulations show that river training has drastically altered the hydraulics of Shenzhen River. Tidal propagation in the river has changed from a damped tidal oscillation to a more standing wave character with less amplitude damping. Tidal current is reduced by about 50%. Vertical salinity stratification and gravitational circulations are formed within the trained river in the dry season. The bottom upstream residual current in the two-layered residual circulation strongly suggests the input of sediment from Deep Bay and sediment trapping in the river.

Keywords: River training; Estuarine circulation; Numerical hydrodynamic model

1. Introduction

Deep Bay (Shenzhen Bay) is a semi-enclosed bay located at the east shore of the Pearl River Estuary (Fig. 1(a)). It is surrounded by the New Territories of the Hong Kong Special Administrative Region (SAR) in the southeast and Shenzhen Special Economic Zone (SEZ) in the north and west, with an opening to the southwest. The bay is 13.9 km long and 4–8 km wide. Contrary to its name, Deep Bay is a shallow bay with an average depth of 3 m and extensive tidal flats in the inner area.

In 2003, population in the Deep Bay watershed is about 3 million; about 75% is in Shenzhen. Shenzhen SEZ has been exhibiting double-digit economic growth over the past three decades. Its annual gross domestic product is US$115 billion in 2008. The rapid development has resulted in drastic changes on the Deep Bay coastline and its related watershed. Despite the intense human activities, Deep Bay has great ecological importance with the internationally recognized Maipo Marshes (a Ramsar wetland) in Hong Kong and the Futian National Nature Reserve in Shenzhen.

Shenzhen River is a tidal river on the border between Hong Kong SAR and Shenzhen SEZ. The 33 km river main stem originates in northeast Hong Kong and flows southwest towards Deep Bay. The total area of drainage basin is 312.5 km^2, for which 60% area is in Shenzhen (Fig. 1(b)).

Before 1995, Shenzhen River was narrow and meandering. The average river width was only 10–20 m upstream and about 140 m at the connection with Deep Bay. The average

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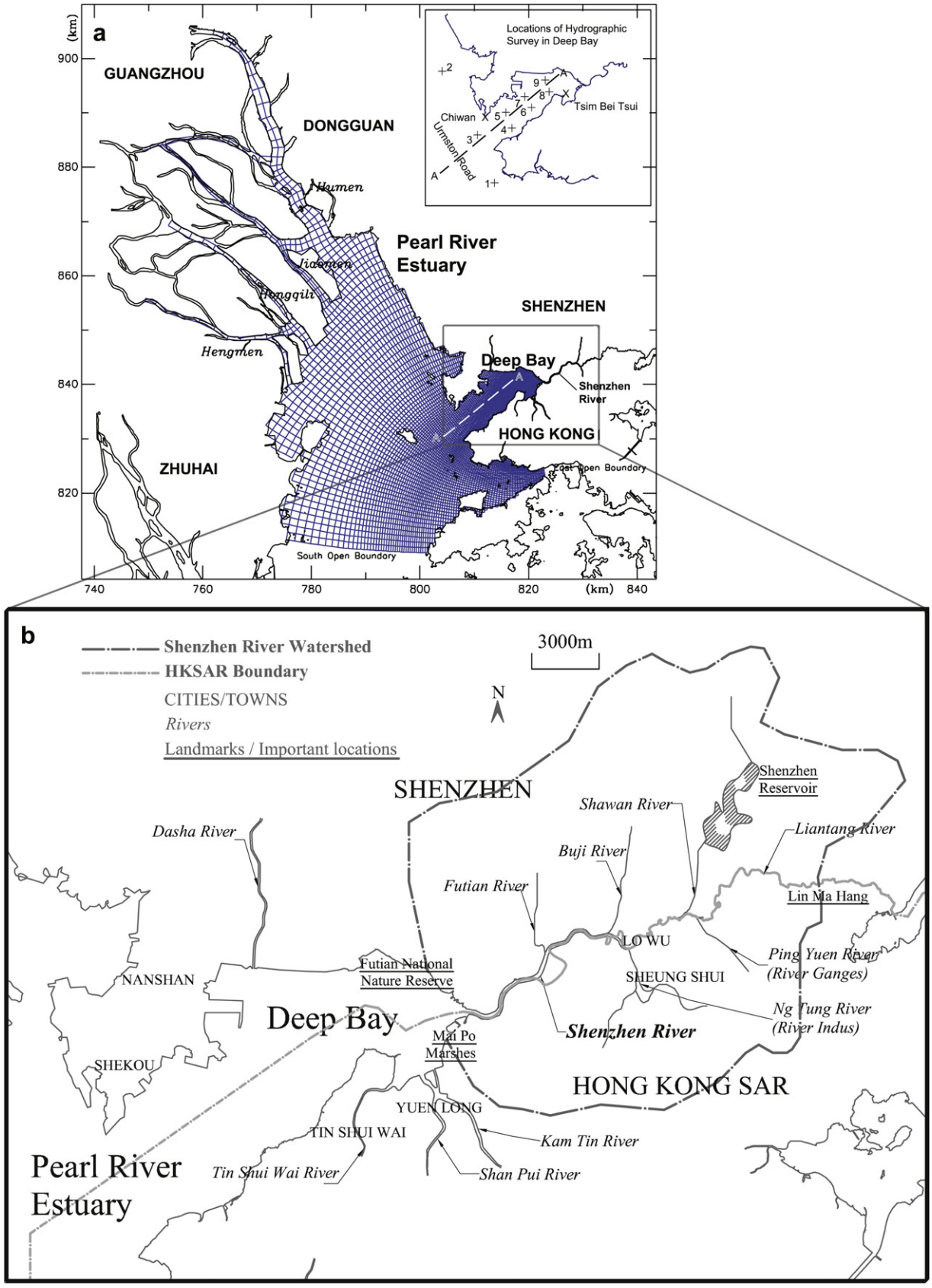

Fig. 1. (a) Pearl River Estuary and the model grid in this study. (b) Deep Bay and Shenzhen River watershed.