The impact of land reclamation on ecosystem under a highly energetic coastal circulation with massive macro-vortices

Chang HE, Zhen-Yu YIN

Department of Civil and Environmental Engineering, University of the Hong Kong Polytechnic University, Hong Kong, China

Alessandro STOCCHINO

Department of Civil and Environmental Engineering, University of the Hong Kong Polytechnic University, Hong Kong, China

State Key Laboratory of Marine Pollution, City University of Hong Kong

Hong Kong, China

Wing-Hong WAI

Department of Civil and Environmental Engineering, University of the Hong Kong Polytechnic University, Hong Kong, China

Hong Kong (HK), located downstream of the Pearl River Estuary (PRE), intends to conduct reclamation works to ease the great need for land. Dredging processes during land reclamation projects can release a large amount of sediment and strike the balanced ecosystem with high suspended sediment concentration (SSC). Sediment which already absorbed various pollutants from PRE, such as nutrients and toxicants, could desorb pollutants back into the marine system around HK. It is essential to understand the sediment transport under a highly energetic coastal circulation with massive macro-vortices around HK waters and evaluate the local sediment concentration and its residence time during the dredging processes to protect the local ecosystem.

A high-resolution with unstructured-grids model was set up using the Finite-Volume Coastal Ocean Model (FVCOM) coupling with sediment module around the PRE and HK waters. The horizontal grids have spatial resolutions that vary from 50 m to 10 km over the entire domain. The flow pattern around the PRE-HK has been analyzed based on the model output. Tidal and wind forcing generated massive macro-vortices around islands and headlands. Those macro-vortices provided unbalanced inward pressure to concentrate mass as well as extend the residence time. The special and temporal distribution of sediment concentration during and after the dredging process is analyzed to present a general view of the interaction between vortical structure and mass transport. In addition, the bottom shear stress and sediment fluxes are evaluated considering that fine sediment of d50 = 0.01 mm could be easily suspended by local currents. More attention would be paid to bio-sensitive sites around HK to assess the damage to the marine ecosystem brought by the dredging process.

This study can provide an example to understand the sediment transport in an energetic estuary with massive macro-vortices and also help identify the environmentally unfriendly sites which should be well protected from the reclamation works.