Application of Particle Tracking Model to Predict Particulate Transport in Danshuei River Estuarine System

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Abstract

A three-dimensional baroclinic circulation model was implemented and applied to simulate the hydrodynamics in the Danshuei River estuarine system and its adjacent coastal sea. The model employs a semi-implicit finite-element Eulerian-Lagrangian (SELFE) algorithm to solve the shallow water equations. The entire domain is discretized in the horizontal and vertical directions. Unstructured triangular grids are used in the horizontal direction. The hybrid coordinates constructed by S-coordinate and Z-coordinate are used in the vertical direction. The measured data including the amplitudes and phases, time-series water surface elevation, velocity, and salinity in 2000 were used to calibrated and validate the model. The results reveal that the model simulation and measured data are in good agreement. A Lagrangian particle tracking model coupled to a three-dimensional hydrodynamic model was applied to predict the transport and dispersion of particulate pollutant in the model domain under different freshwater discharges from upstream boundaries. The results reveal that the tidal currents, freshwater discharge, and topography greatly determine the horizontal distribution and dispersal of particulate pollutant in the Danshuei River estuary and coastal sea.

Introduction

Estuaries, which act as the transition zone between the upland wetlands and the coastal ocean, are important nursery regions and feeding grounds for a very large number of marine species. However, due to increasing development pressure, they are more and more being called upon to act as repositories for immediate direct point discharges of contaminants, indirect pollutant input through non-point land sources and atmospheric pollutant deposition. Unfortunately, neither the estuaries nor the coastal ocean are capable of assimilating pollutants indefinitely and the environmental concerns now require that any pollutant released in the coastal zone should be heavily regulated and properly managed. Predicting the transport and fate of pollutants in the estuaries and coastal zone appears as one of the most important challenges of the

environmental sciences (Bilgili et al., 2005).

Lagrangian particle methods appear as a very handy and naturally suited set of tools to investigate the transport pathways in the estuaries and coastal ocean (Dias et al., 2001; Periznez and Elliot, 2002; Periznez, 2004, 2005; Zheng, 2003; Blumberg, 2004; Bilgili et al., 2005; Suh, 2006; Lane and Prandle, 2006; Cereoj and Dias, 2006). In this study, a three-dimensional hydrodynamic model, SELFE (Zhang and Baptista, 2007), with lagrangian particle tracking schemes was calibrated and verified with measured data. The model was then applied to predict the transport and dispersion of particulate pollutant in the estuary-ocean under different freshwater discharges from upstream boundaries.

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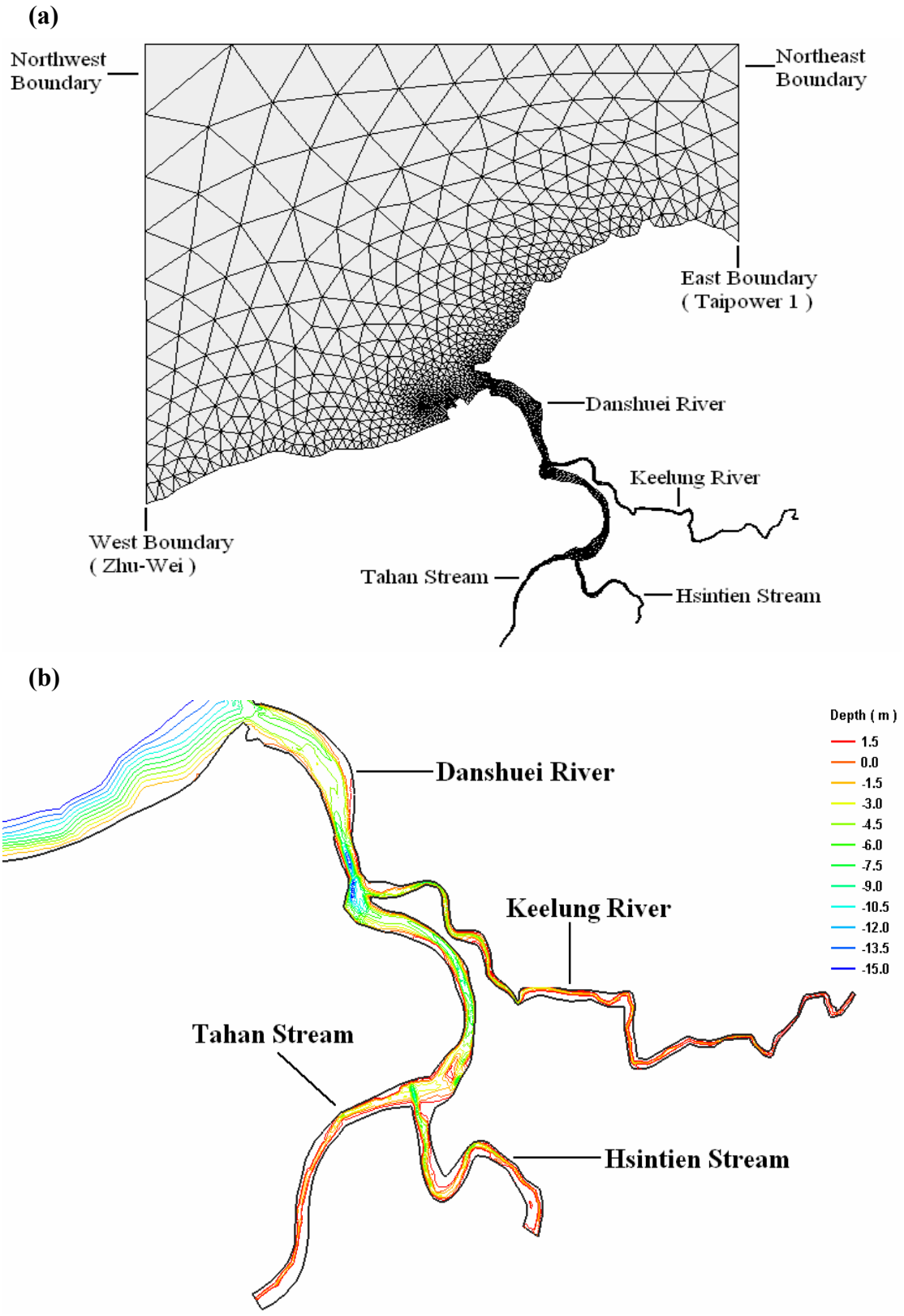

Figure 1. (a) An unstructured grid representing the modeling domain, (b) contour of bottom topography in the Danshuei River estuarine system.

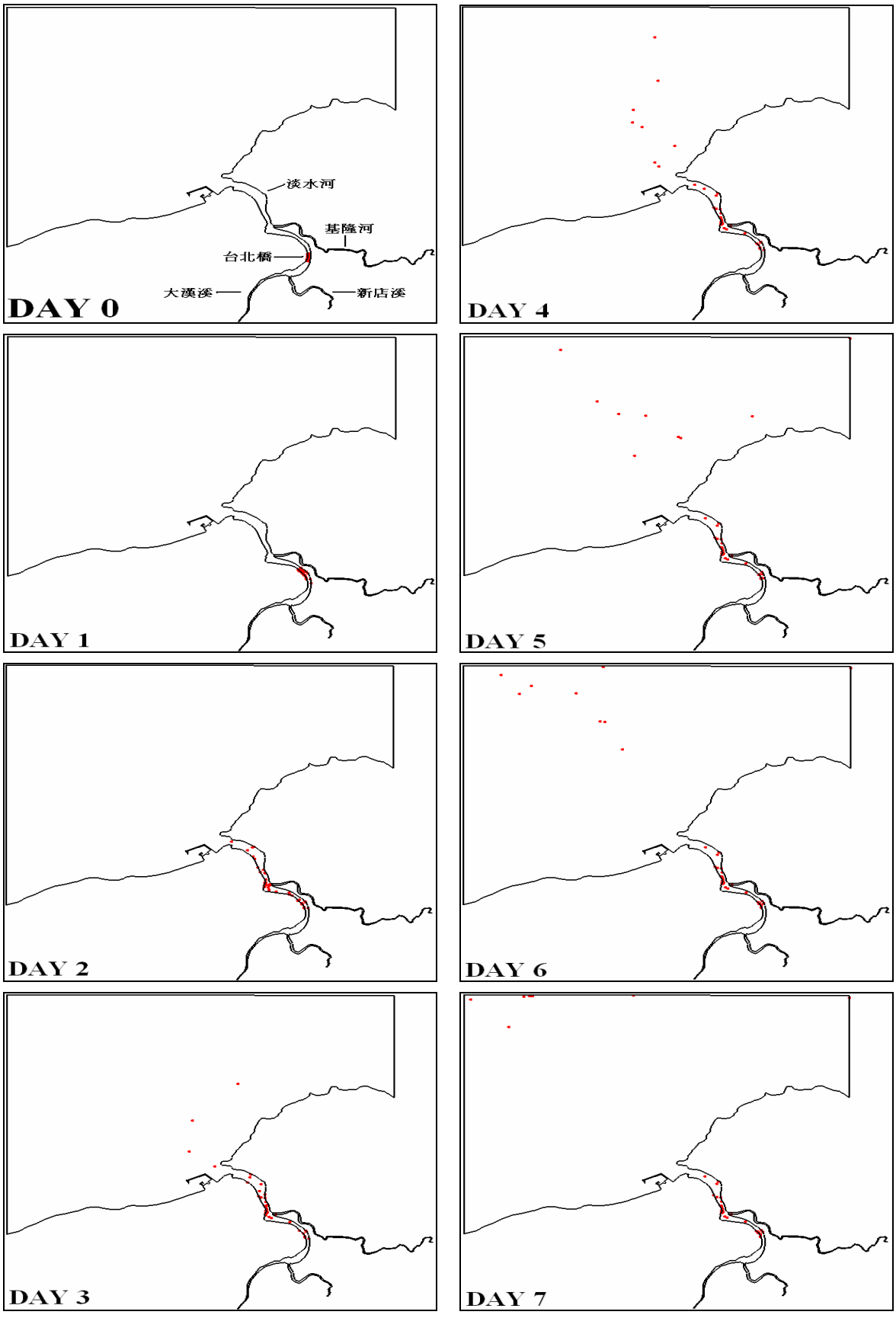

Figure 2. Model simulation of particles tracking: particles release from Taipei Bridge (Danshuei River) under mean flow conditions.