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Numerical Simulation of Accidental Oil Spill in Min River Estuary

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ABSTRACT

In order to meet the demand of local economic development, Fujian Province will implement a shipyard project in Min River Estuary recently. During the shipyard construction period, in Min River Estuary the potential oil spill risk will greatly increase. Based on a 2-D hydrodynamic model of Min River Estuary, an oil spill numerical model by using MIKE is developed, taking into account the variables of wind, the spilling position and the occurrence moment. The results show that the sweeping range and the trajectory of the spilled oil are closely related to the spilling position and the wind condition.

KEY WORDS: Min River estuary, oil spill, numerical model, oil film trajectory, shipyard

1. Introduction

The rapid development of economy makes energy demand grow intensely, which promotes oil exploration industry and the seagoing oil transportation, at the same time also increases the potential risk of the oil spill accident. A major oil spill can contaminate the shoreline, cause long-term damage to the aquatic environment for fishery and wild-life.

When the liquid oil is spilled on the surface of the sea it spreads, forming a thin film, the so-called oil slick. Under surface wave action and upper layer turbulence, a coherent oil slick will break up into small particles. The oil particles move horizontally on the surface owing to current, wind-induced surface speed, wave drift and horizontal diffusion. Because of sea-surface agitation, some particles entrain and diffuse in the water column. Once in the water column, the entrained droplets move in the three spatial directions. Vertical displacements are due to buoyancy and turbulent diffusion (Wang and Shen, 2010).

Oil spill model is the core part of the oil spill emergency response system, which can predict the change of oil composition, property, stage and fate of the spilled oil and provide scientific information for decision-making such as choosing the proper cleaning method and evaluating the damage. Many studies have been conducted on the simulation of oil spill behavior and fate of marine oil spill (Huang and Wang, 2011; Papadimitrakis et al., 2006; Chao et al.2001, Sugioka et al., 1999; Shen & Yapa, 1988; Yapa et al. 1994, Spaulding, 1995; Lonin, 1999) but few in Min River Estuary.

Min River is located in the east of Fujian province, with a second largest runoff discharge in China. Min River flows from the junction of Min, Zhe and Gan Provinces in the southeast part of China. Min River Estuary starts from the Nantai Island, covering the Min'an canyon, Tingjiang, Meihua channel and Changmen Channel. The estuary is divided into four branches (Fig.1), and is shaped by runoff-tide interaction and intensive sediment transport (Dai and al, 2012).

The shipbuilding industry is considered as the traditional industry of Fujian Province in China due to the long history and the advantageous geographical condition. At the same time, the local economic development further promotes the rapid development of the shipbuilding industry. A series of important projects are being planned and will be implemented in five years, among which a shipyard is going to be constructed in the south part of Culu Island.

Before the construction, an accurate understanding of the possible effects on the hydrodynamic conditions is required and numerous studies have been carried out to investigate this estuary (Zheng et al., 2012a; Zheng et al., 2012b). Meanwhile this project will increase greatly the potential oil spill risk in Min River Estuary, so it's important and necessary to simulate an oil spill model to predict the spilled oil sweeping range and the trajectory.

In this study a 2-D tidal flow mathematical model of Min River Estuary is established which provides the hydrodynamic data for the oil spill model. Then an oil spill model is developed to compare the different oil spill trajectories under different conditions, taking into account the variables of wind, the oil spill moment and the spilling position.

2. Model description

This paper is based on two main modules: hydrodynamic model and oil spill model by using MIKE. The hydrodynamic module is described first which will provide the hydrodynamic data for the oil spill simulation. Next, the oil spill module is presented.