MODELLING OF COHESIVE SEDIMENT TRANSPORT AND BED DYNAMICS IN ESTUARIES

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Estuaries, the transition zones between the rivers and the sea, show a complex dynamic behaviour. Salt water intrusion and mixing of salt and fresh water can lead to a complex stratification pattern with associated density currents. Cohesive sediment transport in estuaries can bring about the occurrence of a turbidity maximum, which induces problems, both ecological and economical. The movement of cohesive sediments frequently causes siltation to occur in waterways, harbor docks, or erosion in estuarine banks. To deal with these problems, expensive dredging operations or bank protections are generally needed. The contaminated materials from industrial and municipal effluents, or accidental oil spills, can also release heavy metals, mineral oils and other toxic contaminants, which may then be absorbed onto fine sediments and be available for resuspension by strong tidal currents, short wave action and dredging operations. Therefore, accurate predictions of cohesive sediment transport processes in estuarine and coastal waters are of vital importance to environmental management.

The aim of this work to describe a fully integrated three-dimensional hydrodynamic, wave and sediment transport model for coastal and estuarine environments, including consolidation processes. The model is designed to simulate with as much realism as possible time-dependent distributions of water levels, currents, temperature, salinity, tracers, cohesive sediments and waves in marine and freshwater systems. This model consists of hydrodynamic module, wave module and sediment transport module.

The hydrodynamics model is based on the hydrostatic and Boussinesq approximations, and uses a vertical sigma co-ordinate with a staggered grid. In addition to the momentum and continuity equations, the model solves two transport equations for salt and temperature and an equation of state to include the baroclinic effects. The simulation of cohesive sediment transport processes is performed by solving the 3D-conservative advection-diffusion equation, in the same grid used by the hydrodynamic model. Resuspension of sediments due to wind-generated waves is an important source of sediment to the water column in many coastal ocean systems. The effects of wind waves on bottom shear stress, which controls sediment resuspension, can be accounted for by the model. Temporally and spatially variable wind wave parameters, i.e., mean period, significant wave height and direction, can be calculated by WAM, stored in a computer file and then input to the model.

The consolidation model account for the mass conservation of pore water and relate its expulsion between particles to vertical gradient of excess pressure by means of the permeability, following the Darcy law. The excess pore water pressure itself can be deduced from the total stress after water weight and effective stress removal. When combined with water mass conservation, this approach leads to the Gibson equation (Gibson *et.al.*, 1967), providing constitutive relationships between the permeability and the effective stress and void ratio.

Figure 1 shows the distribution of significant wave height of the Java Sea that was calculated by WAM model.

The final goal of the model is to apply it to the cases of real estuaries validating the capability to reproduce actual morphological changes in cohesive beds.

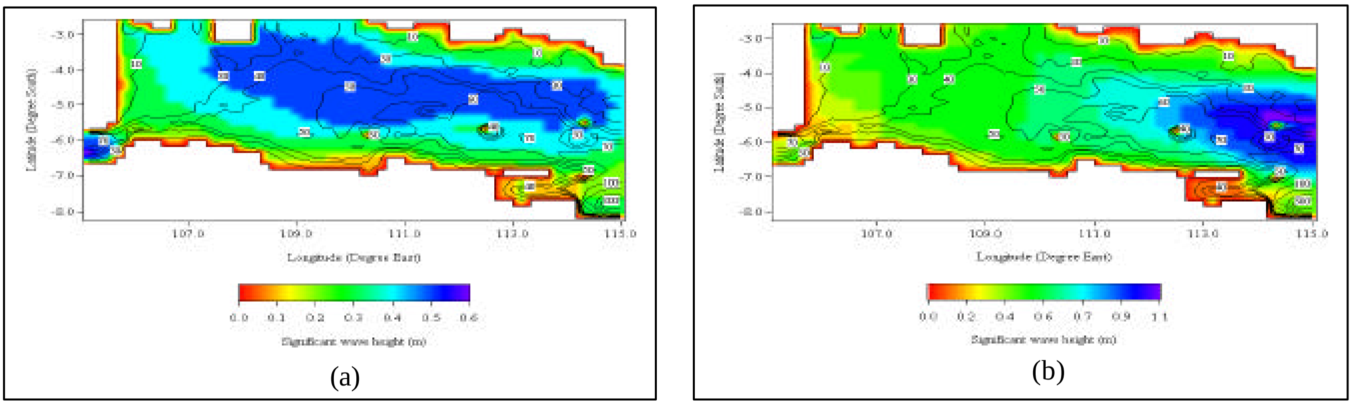

Figure 1. WAM wave fields of the Java Sea: (a) typical east monsoon, (b) typical west monsoon