Abstract

In this thesis diverse aspects related to numerical modeling of bottom boundary layer (BBL) characteristics in the Hooghly estuary, India have been investigated. Efforts were made to study and simultaneously provide better parameterization of physical mechanisms which control the dynamics in the Hooghly basin. The influence of particle shape on drag coefficient for commonly occurring sediment particles in coastal environment has been studied. The study has practical implications on behavior of particle settling velocity. A comprehensive analysis was performed to obtain the functional dependence between drag coefficient and various shape factors utilizing the field measured data. The study brings to light that Krumbein Shape Factor fits well for a wide variety of sediment particles commonly found in coastal environments. The overall merit of the proposed formulation is also discussed. The importance of wave-current interaction in the Hooghly basin has been investigated. A BBL model was used for the basin integrating inputs from hydrodynamic and SWAN wave models. The role of the combined wave-current interaction and its effect on total bottom stress has been investigated. The results obtained from this study were validated with measurements conducted at Haldia channel in the Hooghly basin. The bottom sediment characteristics in shallow water can influence resistance to flow and hence the surface wave characteristics. Varying water levels in combination with diverse sediment-water rheology can affect the bottom friction. These points out the importance to develop formulation for the varying bottom friction in coastal environment with implications on wave characteristics. The new parameterization was validated with significant wave heights obtained from ENVISAT observations. Finally, a modified version of suspended sediment concentration (SSC) model is reported for the Hooghly estuary which incorporates various physical parameterizations. Validation exercise was carried out between the existing and upgraded SSC models. The study highlights the importance of sediment flux type boundary condition that substantially improved computed SSC for the Hooghly basin. The modified models were tested with fine grain sandy particles and have limitations in the presence of soft mud.

Key words: BBL, particle shape, drag coefficient, bottom friction, SSC, Hooghly estuary