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Abstract

The present study describes a numerical method for evaluating channel changes and acquiring suitable information to improve the management of those rivers dominated by suspended sediment. The influence of a lateral bed slope on suspended sediment transport is studied first, focusing on the erosion and deposition process in the near-bank region. An expression for the erosion term that includes the lateral bed slope is derived based on the principle of sediment transport by turbulent diffusion. The lateral profile of the sediment concentration is also derived theoretically from a depth-integrated convection equation in an idealized flow field. Numerical computations suggest that riverbed evolution, such as scour holes and ridges due to erosion and deposition in the bank area, is amplified by the effects of the lateral bed slope. As such, the present study proposes a modified erosion rate term in the governing equations for bed sediment and sediment within the flow body.

The formation and migration of sandbars in the Brahmaputra River are studied using a two-dimensional depth-integrated numerical model, remote sensing data, and measured cross-sections. To overcome the limited data availability, the initial channel topography are set from the remote sensing data. The performance of the model was verified using field data from field investigations and remote sensing data. The computed results suggest that the model captures the formation and deformation of sandbars, the maximum bed scouring and aggradation, the bedload and suspended load transport rate, and the suspended sediment concentration well. The simulated results are matched with field observation.

In the present study, I propose a bank erosion model that is capable of computing the bank shifting using coarse-sized grids. In developing the model, I assumed that the riverbank erosion was continuous, despite the intermittent behavior of the riverbank's collapse. The eroded sediment in the near-bank region is instantly counterbalanced by the slip-type failure of the adjacent riverbank. To overcome the issue of movable boundaries, I used flexible grids in the near-bank region to maintain similarity in bank shape. The proposed model for riverbank erosion and the erosion term corrected with the lateral bed slope are introduced to a two-dimensional 2D depth-integrated model with general coordinate system developed by Takebayashi et al. The results suggest that proposed model captures the gradual shifting of a riverbank with a coarse-sized grid. The corrected erosion rate term is suitable for covering the bank erosion in the Brahmaputra River.

Remote sensing data are analyzed to validate the results obtained from the numerical simulations. Assuming that an edge exists between two land covers, I propose the modified gradient-based method (MGBM) to highlight the edge between water and soil for automatically detecting sandbar. The results obtained using the proposed method were verified by means of field investigations, which were conducted to identify edges by travelling along the sandbars with a manned boat tethered to a tetra-head boat mounting with an acoustic Doppler current profiler (ADCP) and global positioning system (GPS). The sizes and shapes of sandbars identified by the proposed method coincided with those in the field investigations.

In the final part of the study, water and river management policy in Bangladesh are reviewed. The findings of the present study are used to conceptually improve the existing policy practice.

Key words: Numerical Model, Channel Changes, Suspended Sediment, Turbulent Diffusion, Modified Erosion Rate, Remote Sensing