NUMERICAL MODELLING OF UNSTEADY FLOW IN LOOSE BOUNDARY CHANNELS

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ABSTRACT

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In this study development and testing of a numerical model is reported. This model is applicable to man made channels and natural rivers with its limitations. Development of a one dimensional explicit sediment routing model is the main objective of this thesis. Transport of sediment in rivers is described by three equations: mass balance and momentum equations of De Saint Venant for open channel flow and a continuity equation for the sediment transport. For the solution of these three hyperbolic partial differential equations a finite difference approach using explicit scheme of MacCormack is selected. It is a coupled solution as it is a two step predictor corrector method. It is an enhancement of hydraulic model of explicit finite difference scheme of MacCormack for wide rectangular channel to a sediment routing model. It has been extended to rectangular and assumed trapezoidal section incorporating the effect of lateral inflows of water and sediment. Boundary conditions are solved by using a separate subroutine in the main programme in cases where downstream boundary is simulated by Manning's equation. Method of characteristics is used to simulate unknown boundaries of the physical system which are not specified through boundary conditions. Third characteristic root for bed perturbations at downstream is linearized and an extrapolated value of sediment discharge is used in it. A simplified sediment transport equation is used for study. Model gives results in terms of bed level changes, flow depth and discharge provided physical boundaries of the system are valid for the simulation time. Simulation is also done for real river data with assumed trapezoidal section and results of this model are compared with the published results of a model based on implicit Preissmann scheme. Model execution and accuracy is very sensitive to time step and stability. It is found to be inefficient due to very small time steps involved. Different simulations show good accuracy when applied within the limitations of the model. Qualitative trends of results are in good agreement with previous studies. However, quantitative estimates may be misleading sometimes. Model exclusively studies the test-cases/classical problems presented and needs modification for a new scenario accordingly.