M.Sc. THESIS

ONE DIMENSIONAL NUMERICAL SIMULATION OF FLOW BEHAVIOR IN IRRIGATION CANALS

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2012-MS-WRE-09

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2015

ABSTRACT

Numerical modeling has become very popular in the past few decades, mainly due to the increasing availability of more powerful and affordable computing platforms. Much progress has been made, particularly in the fields of flow behavior and sediment transport. Numerical models are used for the same reasons as physical models; i.e., the problem at hand cannot be solved directly for the prototype. The process from prototype data to the modeling and to final interpretation of the results is complex and prone to many errors.

One-dimensional models are usually based on the same conservation principles as the multidimensional models. Most of the sediment transport models are one dimensional, especially those used for long-term simulation of a long reach. One-dimensional models generally require the least amount of field data for calibration and testing. The numerical solutions are reasonably stable and require the least amount of computer time and capacity. Numerical water routing models are often limited in their application because of either the underlying simplifications, the restrictions imposed by stability considerations or the complexity of the numerical scheme solving the governing equations.

In the present research work the Saint–Venant equations are solved through the MacCormack explicit finite difference scheme. The scheme is second order accurate, and allows simultaneous solution of the water and sediment equations, thereby obviating the need for iterations. It is a coupled solution as it is a two-step predictor corrector method. Boundary conditions are solved by using separate subroutine in the main programme, in cases where downstream boundary is simulated by Manning's equation. The characteristic equations are simultaneously used to

simulate unknown boundaries of the physical system which are not specified through boundary conditions, which lead to give very accurate results.

Model gave results in terms of bed level changes, flow depth and discharge provided physical boundaries of the system were valid for simulation time. Simulation was also done for real channel data with assumed trapezoidal section and results of the model were compared with the published results. Model execution and accuracy was very sensitive to time step and stability. Different simulations showed 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 pseudo sometimes. For future studies multifarious relationships for sediment discharge computation can be utilized since governing equations are solved by explicit numerical scheme.