Junction riemann problem for shallow water equations in networks

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ABSTRACT

: In this paper, the Riemann solution of an extended Riemann problem in channel networks is presented. The Riemann problem at a junction network is well defined in the literature. However, it is limited to symmetric networks. Here, we extend the Riemann problem to non-symmetric networks such that neither the channel width equality nor the discharge equality are assumed. The Riemann solution is given under subcritical flow conditions to ensure the existence and uniqueness of the solution at the junction. Taking into account the mass and energy conservation laws, the necessary conditions for the Riemann solution are drawn. The results are summarized in a theorem. The theorem is illustrated with a set of numerical examples.

In order to perform a one-dimensional simulation in channel networks, the inner boundary conditions at the junction (i.e., the channel intersection point) are required. It has turned out that the classical models (i.e., the Equality, Gurram, Hsu models) that have been used to supply such a boundary suffer from many drawbacks.

Thus, here we propose to use the Riemann solution at the junction networks to provide proper boundary conditions. Then, we compare all the junction models together. The junction models are validated against experimental results found in the literature for steady state flows. Generally, the Riemann model shows good results in matching the experimental data. In particular, the Riemann model shows the best results when the bottom discontinues at the junction. For the unsteady state flows, we perform prototype case studies to test the junction models in the channel networks, and the numerical solutions are compared with the analytical solutions. The Riemann model continues to show the best results that agree with the analytical solutions. However, the validation of the junction models in the unsteady state flows remains for future work due to the limited amount of real data.