

Theoretical and numerical analysis of the influence of the bottom friction formulation in free surface flow modelling

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Abstract

Bottom friction modelling is an important step in river flow computation with 1D or 2D solvers. It is usually performed using energy slope based formulations established for uniform flow conditions, or using a turbulent regime based approach relying on turbulence analysis. However, these formulations are often applied under conditions of relative roughness which lie far outside of their validity fields. Furthermore, the theoretical definition of the roughness coefficients, defined by the different authors of both approaches, is not valid for usual numerical flow modelling, considering numerical approximations. The value of this coefficient becomes generally dependent on the flow conditions. Following the definition of the flow validity field of the main friction formulations proposed in literature, an original formulation has been developed. It combines 2 explicit turbulent regime based formulations smoothly linked by a polynomial expression, providing a continuous formulation covering the wide range of roughness usually encountered in river flows. The formulation is suitable to model, with a unique value of the friction coefficient, river flows with a wide range of hydrodynamic properties (water depth, discharge). The efficiency of this new formulation, fitted to explicit friction formulations and numerically adjusted, is demonstrated through various 1D and 2D practical applications.

Keywords: friction, river flow, modelling