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Exact solutions of ideal dam break flood for arbitrary cross-section

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Abstract: Even though it oversimplifies reality, the dam-break problem for frictionless fluids provides predictions relevant to various manmade and natural dam-break floods. The exact solution can also be used to test numerical schemes. However, as far as we are aware, exact solutions derived from the nonlinear shallow-water equations hold only for infinitely wide cross-sections, a feature that contrasts with most natural streams. In this study, we start from the nonlinear shallow-water equations for arbitrary cross-section and model the ideal dam-break flood resulting from the sudden release of an inviscid, incompressible fluid on frictionless bed. Two cases are considered downstream of the wave front: the wet and dry bed. For both cases, irregular cross-section entails changes in the expression of the Riemann variables. For wet beds, an implicit solution is worked out using the Riemann method, which makes it possible to find approximate solutions (to any order). For dry beds, a closed-form solution can be derived. The solutions show that for the same initial conditions, the flood wave features depend a great deal on the cross section. The talk is illustrated with various examples, which show that the assumption of infinitely wide cross section should be used carefully when modeling real dam break floods.

Keywords: Dam break, Arbitrary cross-section, Riemann solver, Exact solution.