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Numerical shockwave anomalies in presence of hydraulic jumps in the SWE with variable bed elevation.

Adrian Navas-Montilla (1) and Javier Murillo (2)

(1) Universidad de Zaragoza, Zaragoza, Spain (anavas@unizar.es), (2) Universidad de Zaragoza, Zaragoza, Spain (Javier.Murillo@unizar.es)

When solving the shallow water equations appropriate numerical solvers must allow energy-dissipative solutions in presence of steady and unsteady hydraulic jumps. Hydraulic jumps are present in surface flows and may produce significant morphological changes. Unfortunately, it has been documented that some numerical anomalies may appear. These anomalies are the incorrect positioning of steady jumps and the presence of a spurious spike of discharge inside the cell containing the jump produced by a non-linearity of the Hugoniot locus connecting the states at both sides of the jump. Therefore, this problem remains unresolved in the context of Godunov's schemes applied to shallow flows. This issue is usually ignored as it does not affect to the solution in steady cases. However, it produces undesirable spurious oscillations in transient cases that can lead to misleading conclusions when moving to realistic scenarios. Using spike-reducing techniques based on the construction of interpolated fluxes, it is possible to define numerical methods including discontinuous topography that reduce the presence of the aforementioned numerical anomalies.

References:
T. W. Roberts, The behavior of flux difference splitting schemes near slowly moving shock waves, J. Comput. Phys., 90 (1990) 141–160.
Y. Stiriba, R. Donat, A numerical study of postshock oscillations in slowly moving shock waves, Comput. Math. with Appl., 46 (2003) 719–739.
E. Johnsen, S. K. Lele, Numerical errors generated in simulations of slowly moving shocks, Center for Turbulence Research, Annual Research Briefs, (2008) 1–12.
D. W. Zaide, P. L. Roe, Flux functions for reducing numerical shockwave anomalies. ICCFD7, Big Island, Hawaii, (2012) 9–13.
D. W. Zaide, Numerical Shockwave Anomalies, PhD thesis, Aerospace Engineering and Scientific Computing, University of Michigan, 2012.
A. Navas-Montilla, J. Murillo, Energy balanced numerical schemes with very high order. The Augmented Roe Flux ADER scheme. Application to the shallow water equations, J. Comput. Phys. 290 (2015) 188–218.
A. Navas-Montilla, J. Murillo, Asymptotically and exactly energy balanced augmented flux-ADER schemes with application to hyperbolic conservation laws with geometric source terms, J. Comput. Phys. 317 (2016) 108–147.
J. Murillo and A. Navas-Montilla, A comprehensive explanation and exercise of the source terms in hyperbolic systems using Roe type solutions. Application to the 1D-2D shallow water equations, Advances in Water Resources {98} (2016) 70–96.