1D and 2D Debris Flow Modeling with HEC-RAS

Alejandro Sanchez¹, Stanford Gibson², Cameron Ackerman², and Ian Floyd³

¹Hydrologic Engineering Center, United States Army Corps of Engineers, United States of America (alejandro.sanchez@usace.army.mil)
²Hydrologic Engineering Center, United States Army Corps of Engineers, United States of America
³Coastal Hydraulics Laboratory, Engineering Research and Development Center, United States Army Corps of Engineers, United States of America

The Hydrologic Engineering Center River Analysis System (HEC-RAS) is a free software developed by the United States Army Corps of Engineers for simulating hydraulics, sediment transport, and water quality. We present on the recent and ongoing developments of non-Newtonian flow and mobile bed modeling within HEC-RAS. The numerical models solve the one-dimensional (1D) St. Venant equation, and the two-dimensional (2D) Diffusion Wave and Shallow Water Equations with corrections and modifications for non-Newtonian flows and steep slopes. The equations are solved using a combination of Finite-Difference and Finite-Volume methods on unstructured grids (for 2D). Several flow resistance laws are implemented including the Bingham, Coulomb, Herschel-Bulkley, and Voellmy models. Sediment transport is simulated in 2D with a total-load advection-diffusion model with corrections for steep slopes and high concentrations. A subgrid modeling approach is utilized for hydraulics and sediment transport, which allows for larger computational cells while maintaining accuracy. The numerical models have been verified with analytical test cases, and validated with small and large scale physical experiments and field applications. The results demonstrate the applicability of HEC-RAS as a tool for natural hazard studies involving non-Newtonian flows.