Morphodynamic numerical modeling of sediment transport and deposition around run-of-river dams

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Abstract.

Low-head or Run-of-River (RoR) dams exist on all types of rivers throughout the United States, yet the exact mechanisms of how sediment moves around the structures have not been well researched. Due to the increasing use of RoR dams in small hydroelectric projects, there is a need to better understand the controlling factors of how sediment passes over these dams. A one-dimensional morphodynamic model was developed to investigate the effects of RoR dams on channel morphology over long time scales. The model solves the energy equation to compute the flow field in the vicinity of the dam, computes grain-size-specific sediment transport rates, and uses sediment mass conservation and vertical storage bookkeeping to calculate the evolution of bed elevation, the bed surface grain-size distribution, and the vertical pattern of stratigraphy. The model's hydraulic calculations were calibrated using data collected from a series of flume experiments preformed with a model RoR dam. Numerical experiments designed to investigate how the grain size distribution, flow rate (steady and unsteady), and dam height act as controls on sediment passage over RoR dams were conducted using parameters reported in the literature for a RoR dam in northern Delaware. Lateral influences on morphology around RoR dams, such as width constrictions, were investigated with a two-dimensional morphodynamic model, Nays2DH, which is distributed with the free and open-source iRIC software interface. The 1D model and a toolbox from the results will be implemented into iRIC for further investigation by other researchers in the field.