EGU2020-20491
https://doi.org/10.5194/egusphere-egu2020-20491
EGU General Assembly 2020

Solving the erosion transport equation on three dimensional catchments

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Modeling the kinematic wave equation and sediment transport equation enables a deterministic approach for predicting surface runoff and resulting sediment transport. Both the kinematic wave equation and the sediment transport equation are first order differential equations. Moreover the kinematic wave equation is a quasilinear problem. In many engineering applications this set of equations is solved on one-dimensional representative cross-sections. However, a proper selection of representative cross-section(s) is cumbersome. On the other hand integrating this set of equations on real catchment topography yields difficulties for standard variational methods such as continous Galerkin method. These difficulties are two-fold (1) the nonlinearity of the kinematic wave, and (2) the absence of diffusion term, which acts as a stabilization term for convection-diffusion equation. In a theory, the Peclet number of numerical stability reaches infinity.

In this contribution we will focus on a stable numerical approximation of this convection-only problem using least square method. With this method we are able to reliably solve both the kinematic wave equation and the sediment transport equation on computational domains representing real catchment topography. Several examples representing real-world scenarios will be given.