Geophysical Research Abstracts
Vol. 19, EGU2017-15027, 2017
EGU General Assembly 2017

Numerical modeling of suspended sediment tansfers at the catchment scale with TELEMAC

Florent Taccone (1,2), Germain Antoine (1,2), Olivier Delestre (3,4), Nicole Goutal (1,2)

(1) EDF R&D, LNHE, CHATOU, France, (2) Saint-Venant Laboratory for Hydraulics, CHATOU, France, (3) Laboratoire de mathématiques J.A. Dieudonné UMR 7351, NICE, France, (4) Ecole polytech Nice-Sophia, NICE, France

In the mountainous regions, the filling of reservoirs is an important issue in terms of efficiency and environmental acceptability for producing hydro-electricity. Thus, the modelling of the sediment transfers on highly erodible watershed is a key challenge from both economic and scientific points of view. The sediment transfers at the watershed scale involve different local flow regimes due to the complex topography of the field and the time and space variability of the meteorological conditions, as well as several physical processes, because of the heterogeneity of the soil composition and cover.

A physically-based modelling approach, associated with a fine discretization of the domain, provides an explicit representation of the hydraulic and sedimentary variables, and gives the opportunity to river managers to simulate the global effects of local solutions for decreasing erosion. On the other hand, this approach is time consuming, and needs both detailed data set for validation and robust numerical schemes for simulating various hydraulic and sediment transport conditions.

The erosion processes being heavily reliant on the flow characteristics, this paper focus on a robust and accurate numerical resolution of the Shallow Water equations using TELEMAC 2D (www.opentelemac.org). One of the main difficulties is to have a numerical scheme able to represent correctly the hydraulic transfers, preserving the positivity of the water depths, dealing with the wet/dry interface and being well-balanced. Few schemes verifying these properties exist, and their accuracy still needs to be evaluated in the case of rain induced runoff on steep slopes.

First, a straight channel test case with a variable slope (Kirstetter et al., 2015) is used to qualify the properties of several Finite Volume numerical schemes. For this test case, a steady rain applied on a dry domain has been performed experimentally in laboratory, and this configuration gives an analytical solution of the Shallow Water equations. The numerical scheme developed by Chen and Noelle (2015) appears to be the best compromise between robustness and accuracy. The sediment transport module SISYPHE of TELEMAC-MASCARET is also used for simulating suspended sediment transport and erosion in this configuration.

Then, an application to a real, well-documented watershed is performed. With a total area of 86.4 ha, the Laval watershed is located in the Southern French Alps. It takes part of the Draix-Bleone Observatory, on which 30 years of collected data are available. On this site, several rainfall events have been simulated using high performance clusters and parallelized computation methods. The results show a good robustness and accuracy of the chosen numerical schemes for hydraulic and sediment transport. Furthermore, a good agreement with measured data is obtain if an infiltration model is added to the Shallow Water equations. This study gives promising perspectives for simulating sediment transfers at the catchment scale with a physically based approach.

G. Chen et S. Noelle: A new hydrostatic reconstruction scheme motivated by the wet-dry front. 2015.

G. Kirstetter et al: Modeling rain-driven overland fow: empirical versus analytical friction terms in the shallow water approximation. Journal of Hydrology, 2015.