Geophysical Research Abstracts
Vol. 18, EGU2016-5992, 2016
EGU General Assembly 2016

Woody debris transport modelling by a coupled DE-SW approach

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The presence of wood in rivers is gaining more and more attention: on one side, the inclusion of woody debris in streams is emphasized for its ecological benefits; on the other hand, particular attention must be paid to its management, not to affect hydraulic safety. Recent events have shown that wood can be mobilized during floodings (Comiti et al. 2008, Lange and Bezzola 2006), aggravating inundations, in particular near urban areas. For this reason, the inclusion of woody debris influence on the prediction of flooded areas is an important step toward the reduction of hydraulic risk.
Numerical modelling plays an important role to this purpose. Ruiz-Villanueva et al. (2014) use a two-dimensional numerical model to calculate the kinetics of cylindrical woody debris transport, taking into account also the hydrodynamic effects of wood.
The model here presented couples a Discrete Element approach (DE) for the calculation of motion of a cylindrical log with the solution of the Shallow Water Equations (SW), in order to simulate woody debris transport in a two-dimensional stream. In a first step, drag force, added mass force and side force are calculated from flow and log velocities, assuming a reference area and hydrodynamic coefficients taken from literature. Then, the equations of dynamics are solved to model the planar roto-translation of the wooden cylinder.
Model results and its physical reliability are clearly affected by the values of the drag and side coefficients, which in turn depend upon log submergence and angle towards the flow direction. Experimental studies to evaluate drag and side coefficients can be found for a submerged cylinder, with various orientations (Gippel et al. 1996; Hoang et al. 2015). To extend such results to the case of a floating (non-totally submerged) cylinder, the authors performed a series of laboratory tests whose outcomes are implemented in the proposed DE-SW model, to assess the effects of these values on the dynamic of woody debris motion.

References

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