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Comparative study of the spreading dynamics of a granular mass and its shallow-water counterpart

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Natural catastrophic flows often involve a discrete solid phase made of rocks and unconsolidated soils. The granular nature of the material is a source of great difficulties in the modelling of the flow dynamics and rheology. In particular, the dissipation process or, on the contrary, the exchange of momentum during the flow are still poorly understood. Yet their roles in the flow dynamics may be of great importance. In spite of these difficulties, hydraulic approaches assuming an equivalent continuous media remain the most convenient tool for the modelling of such flows and the subsequent hazard prediction. Among them, the shallow-water model has proven to be relevant in numerous situations (Savage & Hutter 1989, Iverson 1997). However, the basic hypothesis of an horizontal plug flow dissipating its energy through basal friction are simplifications which may make the application of shallow-water model to some granular flows somehow dubious.

In this contribution, we compare systematically the behaviour of a spreading granular mass and its shallow-water counterpart. Therefore, a discrete element numerical scheme is applied to reproduce the collapse and the spreading dynamics of squat granular columns (Moreau 1988). These simulations have been successfully compared with experimental results and thus validated (Staron & Hinch 2004). Meanwhile shallow-water simulations of similar systems are performed (Mangeney-Castelneau *et al* 2003). The evolutions of the morphology of the spreading mass in the two cases are compared and show a good agreement. We evaluate the energy transfers in the discrete element simulations and establish that basal friction is a relevant description of the dissipation process, as postulated in shallow-water approximation. Varying the value of the coefficient of friction between the grains in the discrete element simulations, we investigate its effect on the effective frictional properties of the granular flow, and on the parametrization of the basal friction in the shallow-water flow. The influence of the friction on the spreading dynamics is also tackled. Finally, the approximation of a plug flow is discussed.