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Effect of the rheological parameters of a clayous mud on its inertial dam-break flow

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Abstract

A dam-break flow is a scenario of initiation of certain geological flows (debris flows, mudflows, lahars, etc.). In this work, the flow generated by the collapse of a dam retaining a clayous mud is considered theoretically, in the case where the inertial forces are the dominant ones.

After long and intense rains in a mountainous region, large quantities of muddy fluids flow in the torrents. For some reason, this flow can be obstructed by a given obstacle (branches, debris, stones, plants, etc.). When the hydrostatic pressure exerted by the fluid exceeds a given yield value, the dam collapses and the fluid is released inside and outside the torrent bed as well.

The dam-break flow was studied extensively in the literature when the fluid is water. As for any gravity current, the flow description depends on the time scale. Immediately after the dam collapse, the inertial forces are the dominant ones. Then, a viscous regime takes place were the viscous forces become the dominant ones.

For a Newtonian fluid, Arattano and Savage developed a kinematic wave theory to model the flow in the inertial regime. In the present study, we implement this kinematic wave theory in the case of a muddy fluid, gifted with a Herschel-Bulkley equation of state. The equations governing the flow are put in a non dimensional form and solved analytically. We specially focus on the effect of the rheological parameters,

i.e. yield stress, consistency and power law index on the flow development. The flow configuration studied here can model a muddy flash flood.