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Modeling debris flow processes in river-ravine confluences by coupling mudflows and sediment transport models.

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Debris flows present serious hazards to low-lying communities and local socio-economy. These events show to be increasing in frequency given recent climatic changes. Intense rainfall between 24th and 26th of March 2015 took place in the North of Chile. Due to this exceptional event, several debris flow events were triggered in sub-catchments causing river blockage and avulsion. These phenomena occur mainly due to the debris flows deposits interacting with main rivers. In risk management, it is a common practice to represent this kind of events as a single solid-liquid mixture with fixed rheology, where calibration of rheologic parameters is required. Nevertheless, rheologic behavior changes even along the debris flow, where the front transports a more viscous suspension including boulders while the tail has lower solids concentrations.
We apply a 2D numerical model (FLO-2D) to simulate debris flows (ravine) – river interactions under changing rheology in the Crucecita, a small lateral catchment draining to the El Carmen river, Huasco Province, Chile. We represent the event in our model based upon a division of waves with different rheological properties, validated against field observations of six different deposits created during this event in the alluvial fan. According to rainfall records and estimated flow rates, we found that the hydrograph of the whole event can be divided in four waves where, depending on the sediment concentration, either mudflow or the sediment transport model dominates. Thanks to the coupling of FLO 2D with a self-updating python routine we were able to create a chain of models where topography, rheologic parameters, hydrograph and FLO 2D model itself are updated after running a wave. Using this methodology, we were able to successfully reproduce the observed geomorphological changes, in particular, the main river blockage and avulsion occurred during this event in the Crucecita catchment.