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Debris-flow triggering, run-out and spreading scenario modelling for hazard analysis.

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Mountain torrent valleys are regularly exposed to catastrophic debris flow associated to intense storms or rapid snowmelt. This is particularly true for clay shale basins of southeast France known for their high susceptibility to trigger muddy debris flows which are characterized by huge volume of debris and high velocities. These debris flows can be released by two main types of mechanisms: on the one hand, triggering can occur in a torrential stream after intense and localised thunderstorms and the concentration of loose material provided by shallow landslides affecting the watershed slopes; on the other hand, triggering can occur by mobilization of part of active landslides. This paper presents a methodology to estimate hazard associated to muddy debris flows based on realistic scenario for the Faucon torrent (south French Alps) where two huge debris flows occurred in 1996 and in 2003. As the debris-flow process is classically depicted in three stages (triggering, run out, spreading), three steps modelling procedure has been performed:

(1) The triggering stage has been analysed by coupling the Seep/W and FLAC2D hydro-mechanical models. The Champerousse landslide, located on the upper part of the Faucon catchment, has been chosen for this study. Firstly, the groundwater table level has been simulated for several hydrogeological conditions. Secondly, the shape and the depth of the slip surface have been calculated with FLAC for the SEEP/W simulated groundwater table level in order to estimate the potential volume of material

able to be released.

(2) The run-out stage has been analysed with the J-DFM code; the potential volume released from stage 1 is used as input value. The J-DFM code takes into account scouring phenomena. Several configurations of input material volume have been tested.

(3) The spreading stage has been analysed with the Cemagref 2D code. The volume of material reaching the spreading area has been defined according to the run-out scenarios. For these simulations, a high-resolution DTM (1m cell size) has been built in order to take into account the micro-morphology of the fan.

Results of these simulations show that the upper part of the Faucon catchment (the Champerousse landslide) can provide a large amount of material (10 000 to 25 000 m^3) to the torrent. According to the run-out simulations, the volume of material increases (40 000 to 60 000 m^3) during the run-out stage due to scouring phenomena. The spreading simulations show that such volume can cause some significant overflowing on the alluvial fan (height of deposits > 2 m).