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A comparative 2D modeling of debris-flow propagation and outcomes for end-users

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In Alpine regions gravity-driven natural hazards, in particular debris flows, endanger settlements and human life. Mitigation strategies based on hazard maps are necessary tools for land planning. These maps can be made more precise by using numerical models to forecasting the inundated areas after a careful setting of those 'key parameters' (K-P) which directly affect the flow motion and its interaction with the ground surface.
Several physically based 2D models are available for practitioners and governmental agencies, but the selection criteria of model type and of the related K-P remain flexible and partly subjective. This remark has driven us to investigate how different models simulate different types of debris flows (from granular to muddy debris flows, going through intermediate types), in particular when the flow is influenced by the presence of deposition basins.
Two commercial 2D physical models (RAMMS and FLO-2D) have been tested for five well-documented debris flows events from five Italian catchments were different geology and flow dynamics are observed: 1) a viscous debris flow occurred in 2009 in a catchment with a metamorphic geology (Gadria torrent, Bolzano Province); 2) the 2009 granular debris flow in an granitic geological setting (Rio Dosson, Trento Province); 3-4) two events occurred in the 'rio Val del Lago' and 'rio Molinara' (Trento Province) in 2010 where porphyritic lithology prevails (intermediate granular debris flow); 5) the Rotolon torrent (Vicenza Province) 2009 debris flow containing sedimentary rocks enclosed in an abundant clay-rich matrix (intermediate viscous case). Event volumes range from 5.000 to 50.000 cubic meters. The Gadria, Rotolon and Val del Lago events are also influenced by artificial retention basins.
Case study simulations allowed delineation of some practical end-user suggestions and good practices in order to guide the model choice and the K-P setting, particularly related to different flow dynamics. The presence of mitigation structures (e.g. check dams and retention basins) demands both the implementation of a precise topography and the introduction of devices to better model sediment trapping and functionality of open/closed check dams. The study results represent: i) a first support for practitioners to directly manage debris-flow simulations; ii) an help for local authorities to give the right value to simulations carried out by practitioners and scientific community; iii) a warning that hazard maps should not be based just on model simulation results.