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Evaluation of debris-flow mitigation structures on runout using a computational model and field-monitoring data

Christoph Graf and Brian W. McArdell

WSL Swiss Federal Research Institute, Avalanches, Debris Flows and Rockfalls, Birmensdorf, Switzerland (christoph.graf@wsl.ch)

Recent channel changes caused by rock avalanches in the source area of a catchment near Preonzo, Switzerland, resulted in the unexpected bypass of existing mitigation structures. Two debris flow deflection dams were built in the source area to re-direct debris flows back into the old channel which connects to an existing debris flow retention basin. The torrent is monitored by an automated debris-flow observation station which provides information on front velocities and flow depths of torrential events such as debris flows and flash floods. Following construction of the deflection dams, the station was moved to the new channel and successfully recorded several debris-flow events. Numerical simulation was used to evaluate the effectiveness of such mitigation measures. Using the RAMMS (Rapid Mass Movements) simulation software, which describes the flow of debris using the 2D shallow water equations for granular flows and a Voellmy relationship for the friction, we describe simulations where we evaluate the effectiveness of the new deflection dams. First the model was calibrated using data from an event in 2004, then the dams were incorporated into the topography using the RAMMS model, and finally the model was run over the new topography using data from an event that occurred in 2007. Results indicate that the new deflection dams should function as intended for debris flows of about the same size as the event in 2004, however larger flows are expected to overtop the deflection dams. In general, the ability to incorporate mitigation structures into the topography has proven to be a useful tool for the rapid evaluation of protection measures, also for other Alpine debris flow problems. However several complicating issues arise, such as local flow deposition causing channel blockage. A modified version of the Voellmy friction relation, where the friction is a function of the internal random kinetic energy of the flow, provides a more realistic description of in-channel deposition.