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Triggering and run-out of superficial landslides caused by heavy rainfall: coupled modeling at the catchment level

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Heavy rainfall can trigger superficial slope instabilities, such as landslides, debris flows and other related instability phenomena, in mountainous areas. These phenomena are a threat to settlements and infrastructure. In Switzerland natural hazards cause 6 mio Euro of damages every year. On the average, about 10The threat due to natural hazards can be reduced, by integrating them into land use management and urban planning. Computer simulation is one of a few possibilities to objectively assess the hazard due to a process, by simulating its localization and expansion. The key criteria for the choice of a simulation approach are its validity, applicability and user-friendliness. Since the hazard assessment is part of the risk management procedure, its capacity to be integrated into a spatial modeling environment (GIS) is crucial. We present a coupled modeling approach to assess the hazardness of rainfall triggered superficial slope instabilities. The approach has two components: the triggering of slope instabilities due to heavy precipitations and its run-out on the hill slope. The aspect of triggering of instabilities is taken account of by a mixed geotechnical-hydrogeological model. Available models are by Montgomery Dietrich (1993), Dietrich Montgomery (1998), Pack et al. (1998) and Baum et al. (2002), all of them based on a infinite slope model (Haefeli 1948). The hydrological part is treated in a steady-state or transient manner. The output is usually expressed in terms of the factor of safety. The spatial distribution of the run-out process is done according to dfwalk (Gamma 1999), a conceptual model, which is based on a multiple flow direction-Monte Carlo approach to develop the expansion pattern of the debris flow and a 2-parameter, 1-D frictional model to determine the velocity and run-out distance, and a rather simple algorithm to simulate material deposition, based on velocity and the local slope. Due to its conceptual

character, the model has to be parameterized using historical events. Both modeling aspects are sequentially coupled and implemented in a in a GIS environment (ArcGIS). The approach is best suited for the hazard assessment at the regional scale of hydrological catchments. The model is raster-based. In a first step it elaborates a map of unstable cells in response of an event of heavy precipitation. From these locations the run-out model is run to simulate the spatial pattern of the process. We present a few applications of the coupled model to past events in the Swiss Southern Alps.

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