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Prediction of runoff-generated debris flows using hydrological modeling

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In the Dolomites area, steep rocky cliffs are incised by several chutes that concentrate runoff and deliver it to the scree at their base. This interaction prompts erosive actions, creating channels for debris flows. After intense, short-lasting rainfall, the resulting runoff carries a significant amount of loose debris, forming a solid-liquid surge. This surging flow entrains boulders, gravel, and sand along its path, transforming into an increasingly substantial stony debris flow. To explore how headwater rocky catchments respond hydrologically and trigger stony debris flows, we utilize data gathered from three monitoring stations placed in distinct debris-flow catchments. These stations, located in the debris-flow initiation area of the basins, capture videos and flow-stage data, enabling us to observe the timing and type of the incoming flows. Over 15 years of monitoring, numerous instances of runoff and mass-transport phenomena have been documented. This comprehensive dataset is precious for analyzing the hydrological behavior of small, steep headwater basins and investigating stony debris flow initiation. An existing hydrological model has been partially reformulated, and its updated version was calibrated using the hydrographs measured via a sharp-crested weir. Testing this updated model against observations from two larger debris-flow catchments affirms its capability to replicate the initial phases of a debris flow, particularly when the sediment concentration is quickly increasing. Moreover, combining simulated runoff volume with the entrained sediment volume in the Rovina di Cancia catchment, estimated through DEM of Differences for the debris-flow events that occurred from 2009 to 2022, provides values for solid concentration suitable for predicting sediment volumes carried by debris flows.