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The support of monitoring for the computation of a debris-flow rainfall threshold

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Hydrologic conditions leading to debris flow initiation may vary substantially, depending primarily on rainfall pattern and soil types but also on topography and morphology of the bedrock underlying the soil. In high mountainous areas, debris flows are typically initiated by failure/erosion of a torrent bed due to surface water flow. Here, concentrated overland flow is rapidly delivered at the outlet of small, steep rocky basins feeding ephemeral channels filled by loose debris. Such geological conditions are typical of the Dolomite region (Italian Alps), which is characterized by widespread debris flow activity triggered by severe summer thunderstorms. Critical reckoning of real-time data (rainfall, pore-water pressure measurements into the channel bed), video recordings, and field observations for one of these catchments allowed to characterize the hydrological response of the initiation area to rainfalls of varying intensity and duration. Three different responses were discriminated: -A(no response): the pressure sensors buried in the channel bed show no response in terms of positive pore pressures while surface runoff is not present in the channel; -B(subsurface stormflow): a transient pore water pressure response is measured within the channel bed by the buried sensors while surface runoff is not present in the channel; -C(surface flow): surface water flow in the channel bed and debris flow initiation. The observed behaviour was then reproduced by means of a simple hydrological model based on the kinematic wave assumption to simulate the generation of channel runoff. Experimental data and extensive analyses demonstrated that the channel runoff along the debris-incised channel can be adequately predicted by simply subtracting from the inflow hydrograph at the basin outlet a channel outflow component which include soil storage and steady, slope-parallel subsurface flow within the channel bed. The proposed model was able to reproduce the observed hydrological response of the initiation area for a wide range

of rainfall intensity and duration, thus providing a physical basis for understanding the empirical hydrologic thresholds delivered from real data. In particular, the computed “channel runoff threshold” and the empirical “debris flow triggering threshold” were found to be very close each other: the range of rainfall impulses that are strong enough to produce channel runoff but not to trigger a debris flow seems to be so narrow that can be ignored for any practical purposes. As a consequence, in our basin, the choice of a suitable criterion for critical discharge is far less important than a reliable prediction of runoff discharge in the initiation area.