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Observation of initiation conditions and role of sediment availability in runoff-generated debris flows at Cancia (North Eastern Italian Alps).

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In alpine areas, abundant coarse hillslope sediment is commonly found at the toe of rocky cliffs. Ephemeral channels originate where lower permeability bedrock surfaces concentrate surface runoff. Debris flows initiate along such channels following intense rainfall and determine the progressive erosion and deepening of the channels. Runoff-generated debris flows are common in alpine areas but were observed also in recently burned steeplands, steep volcanic terrain and other environments. In any case, the process of channel infilling assumes notable relevance for debris flow initiation in the vast majority of basins, where sediment supply cannot be considered actually unlimited. Sediment recharge mechanisms include rock fall and dry ravell processes following debris flow, channel-bank failures, bed load by water flow and/or very small debris flows.

Here we document debris flow activity that took place in an active debris flow basin of the eastern Italian Alps during the year 2015. The Cancia basin is located on the southwestern slope of Mount Antelao (3264 m a.s.l.) in the dolomitic region of the Eastern Italian Alps. The 2.5 km2 basin is incised in dolomitic limestone rocks.

The data consist of repeated topographical surveys, distributed rainfall measurements, time-lapse (2 sec) videos of two events and pore pressure measurements in the channel bed. During July and August 2015, two debris flow events occurred, following similarly intense rainstorms. Given that events were closely spaced in time (16 days), we can document the impact of debris availability on flow dynamics and magnitude. Our data clearly illustrate how debris entrainment along the channel substantially contributes to the overall mobilized volume. The surging nature of the flow is observed at short distance from the initiation area where mobilized sediment is still limited compared to the event volume. Elevation-change models show that erosion is not evenly distributed along the flow path. It deepens the channel bed with maximum values of about 7 m and clearly dominates where the channel slope exceeds 20°. Further downstream, it is common to have sediment accumulation and depletion that occur alternately for the two successive events. This behavior indicates that sediment availability along the channel strongly influences the flow along the prevailing-transport reach. Most of the sediment deposited by the July event along this reach was entrained by the event that followed. Most of the sediment deposited by the August event was deposited where erosion by the previous event was more severe. Whenever deposition becomes dominant, the channel rapidly fills up with sediment producing potential flow avulsion. The comparison between the simulated water discharge and the overall volume of sediment mobilized by the two debris flows allows constraining their solid concentration.