Geophysical Research Abstracts
Vol. 17, EGU2015-12986, 2015
EGU General Assembly 2015

Space-time organization of debris flows-triggering rainfall: effects on the identification of the rainfall threshold relationships

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Debris flow occurrence is generally forecasted by means of empirical rainfall depth-duration thresholds which are often derived based on rain gauge observations (Guzzetti et al., 2008). Rainfall sampling errors, related to the sparse nature of raingauge data, lead to underestimation of the intensity-duration thresholds (Nikolopoulos et al., 2014, Nikolopoulos et al., 2015). This underestimation may be large when debris flows are triggered by convective rainfall events, characterized by limited spatial extent, turning into less efficient forecasts of debris flow occurrence. This work investigates the spatial and temporal structure of rainfall patterns and its effects on the derived rainfall threshold relationships using high-resolution, carefully corrected radar data for 82 debris flows events occurred in the eastern Italian Alps.

We analyze the spatial organization of rainfall depths relative to the rainfall occurred over the debris flows initiation point using the distance from it as the main coordinate observing that, on average, debris flows initiation points are characterized by a maximum in the rainfall depth field. We investigate the relationship between spatial organization and duration of rainfall pointing out that the rainfall underestimation is larger for the shorter durations and increases regularly as the distance between rainfall measurement location and debris flow initiation point increases.

We introduce an analytical framework that explains how the combination of the mean rainfall depth spatial pattern and its relationship with rainfall duration causes the bias observed in the raingauge-based thresholds. The consistency of this analytical framework is proved by using a Monte Carlo sampling of radar rainfall fields.

References

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