Rainfall thresholds for the possible initiation of landslides in different environmental settings in Italy

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The large physiographic variability and the abundance of landslide and rainfall data make Italy an ideal site to investigate variations in the rainfall conditions that can trigger rainfall-induced landslides.

To build a catalogue of 2309 rainfall events with – mostly shallow – landslides in Italy between January 1996 and February 2014, we used accurate landslide information and rainfall data captured by 2228 rain gauges. For each rainfall event with landslides, we reconstructed the rainfall presumably responsible for the failure, in terms of rainfall duration D (in hours) and cumulated event rainfall E (in mm). Adopting a power-law threshold model, we calculated objective and reproducible ED thresholds. We defined a national threshold for Italy, and 26 regional thresholds for environmental subdivisions based on topography, lithology, land-use, land cover, climate, and meteorology. We used the thresholds to assess the rainfall conditions that can result in landslides in different environmental settings in Italy.

We found that the national and the environmental thresholds are similar, and cover a small part of the possible DE domain. The finding encourages the use of empirical rainfall thresholds for landslide forecasting in Italy, but poses an empirical limitation to the possibility of defining accurate thresholds for small geographical areas. We observed differences between some of the thresholds. With increasing mean annual precipitation (MAP), the thresholds become higher and steeper, indicating that more rainfall is needed to trigger landslides where the MAP is higher. We also observed that the thresholds become higher for stronger rocks, and that forests exhibit a higher threshold than agricultural areas.

We maintain that our findings foster the understanding of the rainfall conditions responsible for landslides, and we expect that our results will have an impact on the definition of new rainfall thresholds for possible landslide occurrence in Italy, and elsewhere.