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Predicting extreme precipitation effects on the geomorphology of small mountain catchments, northern Apennines (Italy)

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Meteorological events characterized by extreme rainfall intensity have recently struck the hilly and mountainous territory of the northern Apennines (Italy) as well as many other geographic areas of the world. These extreme rainfall events trigger fast flows of debris along the slopes, stream channels, landslides, and floods, which damage many man-made structures such as roads, houses, water-pipes, etc. There is thus a strong practical interest in predicting the frequency and intensity of these effects for emergency management and to reduce the vulnerability of the territory.

In 2015 an intense rainfall event hit the Valleys of the Trebbia, Nure, and Aveto watercourses in the emilian-ligurian Apennines. In about 6 h a mesoscale convective system deployed a stunning amount of precipitation of 340 mm, with an extreme hourly rainfall intensity of >100 mm/h. During this event, several types of widespread effects on the ground developed i.e., fast flows of debris along the slopes and stream channels (a total number of 305 occurrences), shallow landslides (342) and overbank flooding occurred. Instrumental as well as geological and historical data clearly suggest that extreme rainfall events are increasing in the northern Apennines, in good agreement with the international literature. Through the optimal combination of rainfall data and radar volumes, in this work we present a detailed rainfall analysis, which will serve as a basis to create a quantitative correlation with debris flows over elementary hydrological units. The meteorological analysis of the storm led us to consider the 3 h accumulation rain field as the most relevant for flood triggering. This time interval is short enough to describe the intensity peak of macro precipitating structures, and at the same time it is long enough to allow the development of the debris and stream-flow processes described. The very good match between the 3 h peak intensity and the distribution of high-discharge and hillslope-debris flow support the hypothesis. The 3 h interval further emphasizes the meteorological event with respect to its overall duration of 6 h.

We aim at providing an objective basis for future predictions, starting from the recognition of the forcing meteorological events, allowed us to clearly identify high-intensity-precipitation thresholds triggering flood in small mountain catchments.

Keywords: floods; catchment; threshold; extreme rainfall events; northern Apennines

