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Rainfall thresholds for the initiation of landslides in Italy

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Rainfall is a recognized trigger of landslides, and various investigators have long attempted to determine the amount of precipitation needed to trigger slope failures, and to establish rainfall thresholds for the initiation of landslides. Determining the amount of rainfall needed to trigger a landslide is a problem of both scientific and societal interest, and the literature on the topic is vast. In this work, we describe an attempt to establish rainfall intensity – duration (ID) thresholds for the initiation of landslides in Italy. For the purpose, we have compiled a database of 562 rainfall events that have resulted in landslides. The rainfall and landslide information was obtained by searching the literature, including international journals, proceedings of regional, national and international conferences, and national, regional, and local technical and event reports describing single or multiple rainfall-induced landslides. We plot the rainfall intensity-duration values in logarithmic coordinates, and we establish that with increased rainfall duration the minimum average intensity likely to trigger shallow slope failures decreases linearly, in the range of durations from 10 minutes to 4 days. Based on this observation, we determine minimum ID thresholds for the possible initiation of landslides. The threshold curves are obtained from the empirical rainfall data using two objective statistical techniques, one that exploits Bayesian inference and one that uses a modelling tool in the R statistical environment. The two procedures avoid subjectivity in the determination of the thresholds, a problem that affects several of the published rainfall thresholds for the initiation of landslides. To cope with differences in the intensity and duration of rainfall likely to result in slope failures in different climatic regions, we normalize the rainfall information. Normalization is performed using two climate indexes, the Mean Annual Precipitation (MAP) and the Rainy-Day-Normal (RDN). By comparing the obtained ID thresholds with other Italian ID thresholds in the literature, we establish that the new thresholds are not significantly lower than the other thresholds. We conclude proposing that the new ID thresholds be used in an Italian landslide warning system based on precipitation measurements and estimates.