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Reconstruction of rainfall events responsible for landslides using an algorithm

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In Italy, intense or prolonged rainfall is the primary trigger of damaging landslides. The identification of the rainfall conditions responsible for the initiation of landslides is a crucial issue and may contribute to reduce landslide risk. Objective criteria for the identification of rainfall conditions that could initiate slope failures are still lacking or ambiguous. The reconstruction of rainfall events able to trigger past landslides is usually performed manually by expert investigators. Here, we propose an algorithm that reconstructs automatically rainfall events from a series of hourly rainfall data. The automatic reconstruction reproduces the actions performed by an expert investigator that adopts empirical rules to define rainfall conditions that presumably initiated the documented landslides. The algorithm, which is implemented in R (http://www.r-project.org), performs three actions on the data series: (i) removes isolated events with negligible amount of rainfall and random noise generated by the rain gauge; (ii) aggregates rainfall measurements in order to obtain a sequence of distinct rainfall events; (iii) identifies single or multiple rainfall conditions responsible for the slope failures. In particular, the algorithm calculates the duration, D, and the cumulated rainfall, E, for rainfall events, and for rainfall conditions that have resulted in landslides. A set of input parameters allows the automatic reconstruction of rainfall events in different physical settings and climatic conditions.

We tested the algorithm using rainfall and landslide information available to us for Sicily, Southern Italy, in the period between January 2002 and December 2012. The algorithm reconstructed 13,537 rainfall events and 343 rainfall conditions as possible triggers of the 163 documented landslides. Most (87.7%) of the rainfall conditions obtained manually were reconstructed accurately.

Use of the algorithm shall contribute to an objective and reproducible definition of rainfall conditions responsible for landslides in different geographic areas, reducing the current subjectivity inherent in the manual treatment of the rainfall and landslide data.