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Analysis of shallow landsliding and debris flows triggered by extreme precipitation: the October 1, 2009 event in Giampilieri (Sicily)

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The work aims to document and analyze the geomorphic impact of the flash flood event which affected the area of Giampilieri (Sicily) on October 1, 2009. The event was caused by a deep cyclone developed in the Southern part of the Mediterranean basin producing an intense rainstorm over the Ionic sea coast of Sicily, Italy. The analysis of the event suggested that more than 220 mm of rain fell in less than 4 hours with a peak of about 110 mm/hr in 5-minutes. Its probability was estimated as the equivalent of a 1 in 100 year return period. The storm caused forty casualties and significant damage to property, buildings, roads and bridges estimated close to 200 million Euro. The shallow landslides triggered by the precipitation are analyzed by using a model for the prediction of both topographic and climatic control on shallow landslide initiation processes. The model uses a 'quasi-dynamic' wetness index to predict the spatial distribution of soil saturation in response to a rainfall of specified duration. The model is coupled with a simple scaling GEV model for the assessment of the relationship between rainfall amount and corresponding exceedance probability. This allow to characterize the rainfall predicted to cause instability in each topographic element by duration and frequency of occurrence. Moreover, the model incorporates a generalization of the quasi-dynamic wetness index to describe runoff propagation on bare rock surfaces connected to downslope soil mantled topographic elements. This yields a simple model capable of describing the influence of upslope bedrock outcrops on the pattern of downslope soil saturation.
The application of the model to the study area provides a way to identify the relative potential for shallow landsliding as well as to evaluate the quality of the model description of the soil instability process. The model application is extended to nearby basins to evaluate the landsliding potential in areas not affected by the storm.
It is shown that the model reasonably reproduces the observed distribution of landslides, although spatial variability of soil properties and hydrologic complexities not accounted for by the model complicate prediction of where landslides occur within areas of similar topographic-climatic control.