



Rainfall thresholds for landslides forecasting based on a Bayesian methodology

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Rainfall thresholds are defined by several authors as the critical values taken by one, or more than one, precipitation features such as intensity, duration, antecedent volume, which trigger surface landslides. Rainfall thresholds may be, for instance, the minimum intensity and duration of rainfall inducing a landslide. Two types of rainfall thresholds are described in the literature: (1) empirical/statistical thresholds based on historic analysis of relationship rainfall/landslide occurrence; (2) physically based thresholds obtained by coupling hydrological and stability numerical models that take into account the relationship between rainfall, pore pressure and slope stability. This work stresses the importance of deriving rainfall thresholds by using the concept of landslides hazard based on the probability of occurrence of a landslide conditional on a number of triggering causes. The Bayes' theorem it is thus used to estimate the probability of a landslide given two antecedent rainfall characteristics, selected among five considered, which play a physical role in the triggering mechanism. The proposed approach is demonstrated on the basis of the Emilia-Romagna region historical database containing more than 2000 landslides from 1951, to determine the rainfall thresholds corresponding to the landslides occurrence probability. The obtained results can be shown to be physically meaningful, demonstrating at the same time the relevance of the selected rainfall features in predicting landslides. As a matter of fact we implemented a numerical experiment which, by means of the infinite slope model and the Iverson model for the soil water pressure propagation, simulated the factor of safety consequent to several rainfall inputs with different temporal features. It is showed that the trend of the landslides probability function is very similar to the trend of the factor of safety obtained with the physical models confirming the reliability of the Bayesian methodology.