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Size and time distributions of landslide events

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Surprisingly the analysis of landslide inventories has shown that landslide events associated with different triggers can be characterized by the same probability distribution. Inventory maps show that such a probability distribution exhibits two regimes: an increasing behaviour for small landslides and a power-law scaling, with a negative scaling exponent, for large landslides. Conversely from other approaches that retrieve the characteristic distribution a posteriori as the best fit of data sets of specific events, we propose a cellular automaton model able to reproduce the landslide size distribution a priori by means of some characteristic parameters. From the comparison between our synthetic probability distribution and the landslide area probability distribution of three landslide inventories, we estimated the typical size of a single cell of our cellular automaton model, ranging from 35 sq m to 100 sq m, which is a crucial information if we are interested in monitoring a test area. We characterize the landslide frequency-size distribution by varying the model parameters and find that to determine the probability of occurrence of a landslide of size s it is crucial to get information about the rate at which the system is approaching instability rather than the nature of the trigger. As the rate is increased, the model has a crossover from a critical regime with power-laws to non power-law behaviors. We also introduce a landslide-event magnitude scale based on the driving rate. Large values of the proposed intensity scale are related to landslide events with a fast approach to instability in a long distance of time, while small values are related to landslide events close together in time and approaching instability slowly.
Another key aspect for hazard prediction is the inter-event occurrence time statistics. The inter-event occurrence time is the interval between events whose sizes are above a given threshold. Analyses of time series of events have shown that the inter-event occurrence time distribution seems to obey a Weibull distribution with the shape parameter less than one. Such a feature suggests temporal clustering of landslide events. We use our cellular automaton model to study whether simulated landslide events are correlated in time. We characterize the inter-event time distribution by varying the size threshold and the parameters of the model. We find that as the rate at which the system approaches instability is increased, the time distribution has a crossover from different regimes. This result states again the key role of such a rate for landslide hazard assessment.