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A performance-based approach to landslide risk analysis

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An approach for the risk assessment based on a probabilistic analysis of the performance of structures threatened by landslides is shown and discussed.
The risk is a possible loss due to the occurrence of a potentially damaging event. Analytically the risk is the probability convolution of hazard, which defines the frequency of occurrence of the event (i.e., the demand), and fragility that defines the capacity of the system to withstand the event given its characteristics (i.e., severity) and those of the exposed goods (vulnerability), that is:
Risk=p(D>=d|S,V)
The inequality sets a damage (or loss) threshold beyond which the system's performance is no longer met. Therefore a consistent approach to risk assessment should: 1) adopt a probabilistic model which takes into account all the uncertainties of the involved variables (capacity and demand), 2) follow a performance approach based on given loss or damage thresholds.
The proposed method belongs to the category of the semi-empirical ones: the theoretical component is given by the probabilistic capacity-demand model; the empirical component is given by the observed statistical behaviour of structures damaged by landslides.
Two landslide properties alone are required: the area-extent and the type (or kinematism). All other properties required to determine the severity of landslides (such as depth, speed and frequency) are derived via probabilistic methods. The severity (or intensity) of landslides, in terms of kinetic energy, is the demand of resistance; the resistance capacity is given by the cumulative distribution functions of the limit state performance (fragility functions) assessed via damage surveys and cards compilation.
The investigated limit states are aesthetic (of nominal concern alone), functional (interruption of service) and structural (economic and social losses). The damage probability is the probabilistic convolution of hazard (the probability mass function of the frequency of occurrence of given severities) and vulnerability (the probability of a limit state performance be reached, given a certain severity).
Then, for each landslide all the exposed goods (structures and infrastructures) within the landslide area and within a buffer (representative of the maximum extension of a landslide given a reactivation), are counted. The risk is the product of the damage probability and the ratio of the exposed goods of each landslide to the whole assets exposed to the same type of landslides.
Since the risk is computed numerically and by the same procedure applied to all landslides, it is free from any subjective assessment such as those implied in the qualitative methods.