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Forecasting earthquake-induced landslides at the territorial scale by means of PBEE approaches

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Models for predicting earthquake-induced landslide susceptibility on a regional scale are the main tools used by the Civil Protection Agencies to issue warning alarms after seismic events and to evaluate possible seismic hazard conditions for different earthquake scenarios.
We present a model for susceptibility analysis based on a deterministic approach that subdivides the study area in a finite number of cells, assumes for each cell a simplified infinite slope model and considers the earthquake shaking as the landslide triggering factor. In this case, the stability conditions of the slopes are related both to the slope features (in terms of mechanical properties, geometrical and topographical settings and pore pressure regime) and to the earthquake characteristics (in terms of intensity, duration and frequency). Therefore, for a territorial analysis, the proposed method determines the limit conditions of the slope, given the seismic input, soil strength parameters, slope and depth of slip surface, and groundwater conditions for every cell in the study area. The procedure is ideally suited for the implementation on a GIS platform, in which the relevant information are stored for each cell.
The seismic response of the slopes is analyzed by means of the Newmark's permanent displacement method. In Newmark's approach, seismic slope stability is measured in terms of the ratio of accumulated permanent displacement during the earthquake and the maximum allowable one, depending – in principle – on the definition of tolerable damage level. The computed permanent displacement depends critically on the actual slope stability conditions, quantified by the critical acceleration, i.e. the seismic acceleration bringing the slope to a state of (instantaneous) limit equilibrium.
This methodology is applied in a study of shallow earthquake-induced landslides in central Italy. The triggering seismic input is defined in terms of synthetic accelerograms, constructed from the response spectra obtained from the prescriptions of the Italian Building Code. The amount of displacement computed through these relations provides a criterion to predict the occurrence of slope failures. As result of the study we provide preliminary maps showing the potential of seismically induced landslide displacements as a tool to provide seismic landslide scenarios and earthquake-induced landslide with similar range of ground shaking.