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Regional scale landslide risk assessment with a dynamic physical model – development, application and uncertainty analysis

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Landslide risk must be assessed at the appropriate scale in order to allow effective risk management. At the moment, few deterministic models exist that can do all the computations required for a complete landslide risk assessment at a regional scale. This arises from the difficulty to precisely define the location and volume of the released mass and from the inability of the models to compute the displacement with a large amount of individual initiation areas (computationally exhaustive). This paper presents a medium-scale, dynamic physical model for rapid mass movements in mountainous and volcanic areas. The deterministic nature of the approach makes it possible to apply it to other sites since it considers the frictional equilibrium conditions for the initiation process, the rheological resistance of the displaced flow for the run-out process and fragility curve that links intensity to economic loss for each building. The model takes into account the triggering effect of an earthquake, intense rainfall and a combination of both (spatial and temporal). The run-out module of the model considers the flow as a 2-D continuum medium solving the equations of mass balance and momentum conservation. The model is embedded in an open source environment geographical information system (GIS), it is computationally efficient and it is transparent (understandable and comprehensible) for the end-user.

The model was applied to a virtual region, assessing landslide hazard, vulnerability and risk. A Monte Carlo simulation scheme was applied to quantify, propagate and communicate the effects of uncertainty in input parameters on the final results. In this technique, the input distributions are recreated through sampling and the failure criteria are calculated for each stochastic realisation of the site properties. The model is able to identify the released volumes of the critical slopes and the areas threatened by the run-out intensity. The obtained final outcome is the estimation of individual building damage and total economic risk.

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