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Shallow landslide stability computation using a distributed transient response model for susceptibility assessment and validation. A case study from Ribeira Quente valley (S. Miguel island, Azores)

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In the last 15 years, several heavy rainstorms have occurred in Povoação County (S. Miguel Island, Azores), namely in the Ribeira Quente Valley. These rainfall events have triggered hundreds of shallow landslides that killed tens of people and have been responsible for direct and indirect damages amounting to tens of millions of Euros. On the 6^{th} March 2005 an intense rainfall episode, up to 160 mm of rain in less than 24 h, triggered several shallow landslides that caused 3 victims and damaged/blocked roads.

The Ribeira Quente Valley has an area of about 9.5 km^2 and is mainly constituted by pyroclastic materials (pumice ash and lapilli), that were produced by the Furnas Volcano explosive eruptions.

To provide an assessment of slope-failure conditions for the 6^{th} March 2005 rainfall event, it was applied a distributed transient response model for slope stability analysis. The adopted methodology is a modified version of Iverson´s (2000) transient response model, which couple an infinite slope stability analysis with an analytic solution of the Richard‘s equation for vertical water infiltration in quasi-saturated soil.

The validation was made on two different scales: (1) at a slope scale, using two distinct test sites where landslides were triggered; and (2) at the basin scale, using the entire landslide database and generalizing the modeling input parameters for the regional spatialization of results. At the slope scale, the obtained results were very accurate, and it was possible to predict the precise time of the slope failures. At the basin scale, the obtained results were very conservative, even though the model predicted all the observed landslide locations, in the 23.7% of the area classified as untable at the time of the slope failures.

This methodology revealed to be a reasonable tool for landslide forecast for both temporal and spatial distributions, on both slope and regional scales. In the future, the model components will be integrated into a GIS based system that will publish the FS values to a WebGIS platform, based on near real time ground-based rainfall monitoring. This application will allow the evaluation of scenarios considering the variation of the pressure head response, related to transient rainfall regime. The resultant computational platform combined with regional empirical rainfall triggered landslides threshold (Marques et al. 2008) can be incorporated in a common server with the Regional Civil Protection for emergency planning purposes.

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