Geophysical Research Abstracts,
Vol. 11, EGU2009-10937-1, 2009
EGU General Assembly 2009

Comparison and validation of shallow landslides susceptibility maps generated by bi-variate and multi-variate linear probabilistic GIS-based techniques. A case study from Ribeira Quente Valley (S. Miguel Island, Azores)

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Slope instability research and susceptibility mapping is a fundamental component of hazard assessment and is of extreme importance for risk mitigation, land-use management and emergency planning. Landslide susceptibility zonation has been actively pursued during the last two decades and several methodologies are still being improved. Among all the methods presented in the literature, indirect quantitative probabilistic methods have been extensively used.

In this work different linear probabilistic methods, both bi-variate and multi-variate (Informative Value, Fuzzy Logic, Weights of Evidence and Logistic Regression), were used for the computation of the spatial probability of landslide occurrence, using the pixel as mapping unit. The methods used are based on linear relationships between landslides and 9 considered conditioning factors (altimetry, slope angle, exposition, curvature, distance to streams, wetness index, contribution area, lithology and land-use). It was assumed that future landslides will be conditioned by the same factors as past landslides in the study area.

The presented work was developed for Ribeira Quente Valley (S. Miguel Island, Azores), a study area of 9,5 km2, mainly composed of volcanic deposits (ash and pumice lapilli) produced by explosive eruptions in Furnas Volcano. This materials associated to the steepness of the slopes (38,9% of the area has slope angles higher than 35º, reaching a maximum of 87,5º), make the area very prone to landslide activity.

A total of 1.495 shallow landslides were mapped (at 1:5.000 scale) and included in a GIS database. The total affected area is 401.744 m2 (4,5% of the study area). Most slope movements are translational slides frequently evolving into debris-flows. The landslides are elongated, with maximum length generally equivalent to the slope extent, and their width normally does not exceed 25 m. The failure depth rarely exceeds 1,5 m and the volume is usually smaller than 700 m3. For modelling purposes, the landslides were randomly divided in two sub-datasets: a modelling dataset with 748 events (2,2% of the study area) and a validation dataset with 747 events (2,3% of the study area).

The susceptibility algorithms achieved with the different probabilistic techniques, were rated individually using success rate and prediction rate curves. The best model performance was obtained with the logistic regression, although the results from the different methods do not show significant differences neither in success nor in prediction rate curves. These evidences revealed that: (1) the modelling landslide dataset is representative of the entire landslide population characteristics; and (2) the increase of complexity and robustness in the probabilistic methodology did not produce a significant increase in success or prediction rates. Therefore, it was concluded that the resolution and quality of the input variables are much more important than the probabilistic model chosen to assess landslide susceptibility.

This work was developed on the behalf of VOLCSOILRISK project (Volcanic Soils Geotechnical Characterization for Landslide Risk Mitigation), supported by Direcção Regional da Ciência e Tecnologia - Governo Regional dos Açores.