Assessing predictive capacity and conditional independence of landslide predisposing factors for shallow landslides susceptibility models

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The aim of this study is to identify the landslide predisposing factors combination, using a bivariate statistical model that best predict landslide susceptibility. The best predictive model should have a good performance in terms of suitability and predictive power, and should be based on landslide predisposing factors that are conditionally independent.

The study area is the Santa Marta de Penaguião council (70 km2) located in the Northern Portugal. Several destructive landslides occurred in this area in the last decades promoting landscape degradation and other negative human and economic impacts.

A landslide inventory was built in 2005-2009 using aerial photo-interpretation (1/5.000 scale) and field work validation. This inventory contains 767 shallow translational slides. The landslide density is 11 events/square kilometre, and each landslide has, on average, 136 m2 and the depth of the slip surface typically ranges from 1 to 1.5 m.

The landslide layer was crossed individually with seven landslide predisposing factors (Aspect; Curvature; Slope Angle; Geomorphological Units; Land Use; Inverse Wetness Index; Lithology) and each class within each predisposing theme was weighted using the Information Value Method.

In order to identify the best combination of landslide predisposing factors, all possible combinations were tested which resulted in 120 predictive models. The goodness of fit of each landslide susceptibility model was evaluated by constructing the Success Rate Curves and by computing the Area Under the Curve (AUC).

The best landslide susceptibility model was selected according to the model degree of fitness and on the basis of a conditional independence criterion. Two tests were performed to the entire dataset to assess conditional independence: the Overall Conditional Independence (OCI) and the Agterberg & Cheng Conditional Independence Test (ACCIT) (Agterberg and Cheng, 2002).

The best landslide susceptibility model was constructed with only three landslide predisposing factors (slope angle, inverse wetness index and land use) and was compared with a model developed using the total set of landslide predisposing factors.

Finally, the predictive capacity of the selected landslide susceptibility model was evaluated by computing Prediction Rate Curves based on the partitioning of landslide inventory using temporal, spatial and random criteria. The same procedure was applied to the seven-factors model for comparison purposes.

Results showed that the model of spatial distribution of landslide susceptibility built with three factors is not significantly different from the one produced with the total set of factors. Therefore, it is shown that it is possible to produce a reliable landslide susceptibility model using only a few landslides predisposing factors and fulfilling the conditional independence hypothesis.