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Sensitivity analysis of conditioning factors for landslide susceptibility evaluation in Santa Marta de Penaguião (Douro valley - Portugal

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The MapRisk project intends to develop a landslide hazard and risk analysis to support planning decisions at the municipal level. The municipality of Santa Marta de Penaguião (70 square kilometres) is one of the test sites of the project. The study area has been affected in recent years by destructive landslides that were responsible for deaths and house and roads destruction. Despite these losses, mitigation and zonation landslide programs are missing, and the land use planning at the municipal level did not solve yet the problem.
The study area is located in the Douro Valley region, mainly composed by metamorphic rocks (e.g., schist and quartzites). These rocks are strongly fractured, and weathered materials are abundant in clayed schist, mainly in those areas with agricultural terraces.
From the geomorphological point of view, the study area is characterized by a transition landscape between the Marão mountain and the transmontano plateau, with deep incised valleys, tectonic depressions and slopes controlled by the geological structure. This area is characterised by the vineyard monoculture cultivated in agricultural terraces over centuries to produce Oporto wine. The main landslide triggering factor is rainfall and the mean annual precipitation ranges from 2500 mm near Marão mountain to 700 mm in the Corgo´s Valley.
In this area there are historical records of destructive landslides, although they were aggregated in a landslide geodatabase only recently. The most complete landslide inventory was performed in 2005-2008 using aerial photographs interpretation at 1/5.000 scale and field work verification.
The geodatabase includes 725 landslides, most of shallow translational slide type (80% of total slope movements). The landslide density is 10.5 events/square kilometre, and the average landslide area is 535 square meters.
In this work we present the results of GIS based landslide susceptibility assessment for the shallow translational slides using two bivariate statistical models: information value and fuzzy-logic. Success rate and prediction rate curves were calculated for susceptibility models performed with the total set of shallow translational slides, and using a landslide training group and a landslide test group, which were randomly defined, each corresponding to 50% of the complete landslide population. The obtained prediction rates are higher for the Information value method, in all experiences, when compared with the fuzzy logic.
Using only the information value method, a sensitivity analysis was performed to identify the most important conditioning factors (8 spatial thematic layers) concerning the spatial distribution of shallow translational slides in the study area. Slope curvature, terrace structures build in slopes and lithology are the landslide conditioning factors that show the highest success rates. Susceptibility maps produced with different number of conditioning factors were tested and good results were achieved with only 4 factors (Slope curvature, terrace structures build in slopes, lithology and land use).
The obtained results must be carefully analysed, because they result from few inventories and some landslides were erased in landscape due to reconstruction of terraces and roads, and seasonal soil ploughing. The land use changes rapidly in order to get more space for vineyard plantations and the slope structures that sustained the soil erosion are replaced for slopes without soil support structures. In this context, the conditioning factors and susceptibility maps have a short temporal validity and need to be regularly updated in response to changes in land use.