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Integration of data-driven and physically-based methods to assess shallow landslides susceptibility

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Approaches used to assess shallow landslides susceptibility at the basin scale are conceptually different depending on the use of statistic or deterministic methods. The data-driven methods are sustained in the assumption that the same causes are likely to produce the same effects and for that reason a present/past landslide inventory and a dataset of factors assumed as predisposing factors are crucial for the landslide susceptibility assessment. The physically-based methods are based on a system controlled by physical laws and soil mechanics, where the forces which tend to promote movement are compared with forces that tend to promote resistance to movement. In this case, the evaluation of susceptibility is supported by the calculation of the Factor of safety (FoS), and dependent of the availability of detailed data related with the slope geometry and hydrological and geotechnical properties of the soils and rocks. Within this framework, this work aims to test two hypothesis: (i) although conceptually distinct and based on contrasting procedures, statistic and deterministic methods generate similar shallow landslides susceptibility results regarding the predictive capacity and spatial agreement; and (ii) the integration of the shallow landslides susceptibility maps obtained with data-driven and physically-based methods, for the same study area, generate a more reliable susceptibility model for shallow landslides occurrence.
To evaluate these two hypotheses, we select the Information Value data-driven method and the physically-based Infinite Slope model to evaluate shallow landslides in the study area of Monfalim and Louriceira basins (13.9 km2), which is located in the north of Lisbon region (Portugal).
The landslide inventory is composed by 111 shallow landslides and was divide in two independent groups based on temporal criteria (age $\leq$ 1983 and age > 1983): (i) the modelling group (51 cases) was used to define the weights for each predisposing factor (lithology, land use, slope, aspect, curvature, topographic position index and the slope over area ratio) with the Information Value method and was used also to calibrate the strength parameters (cohesion and friction angle) of the different lithological units considered in the Infinity Slope model; and (ii) the validation group (60 cases) was used to independent validate and define the predictive capacity of the shallow landslides susceptibility maps produced with the Information Value method and the Infinite Slope method. The comparison of both landslide susceptibility maps was supported by: (i) the computation of the Receiver Operator Characteristic (ROC) curves; (ii) the calculation of the Area Under the Curve (AUC); and (iii) the evaluation of the spatial agreement between the landslide susceptibility classes. Finally, the susceptibility maps produced with the Information Value and the Infinite Slope methods are integrated into a single landslide susceptibility map based on a set of integration rules define by cross-validation of the susceptibility classes of both maps and analysis of the corresponding contingency table.

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