Challenges in modelling landslide susceptibility on terraced slopes in the Douro Valley (Portugal)

Susana Pereira[1,2*], Carlos Bateira[2*], Pablo Valenzuela[3], Fernando Alves[4], Mário Natário[4], Joana Valente[4]

[1]Centre of Studies in Geography and Spatial Planning, Geography Department, Faculty of Arts and Humanities, University of Porto, Porto, Portugal

[2]Centre of Geographical Studies, Institute of Geography and Spatial Planning, University of Lisbon, Lisbon, Portugal

[3]Departamento de Geografia e Geologia,Universidade de León, León, Spain

[4]Symington Family Estates, Vinhos SA, Vila Nova de Gaia, Portugal

*Correspondance to: Susana Pereira; e-mail: sspereira@letras.up.pt

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The study area is a hydrographic basin (0.42 km^2) located in the Quinta do Bomfim estate (Pinhão), composed of stratified levels of phyllites, quartz metagreywackes and schist intercalations dating from the pre-Cambrian, occupied with vineyards in terraces and land embankments, predominantly south-facing, with altitudes ranging between 62 and 394 m. Recently, the estate developed a renovation process with the re-construction of land embankments, mostly from large 2-row terraces to narrow terraces (1 row), along with new drainage systems. These changes in soil physical conditions promoted water erosion and slope instability.

This work discusses the main challenges and constraints of modelling and validating landslide susceptibility on a terraced area of the Douro Valley, where vineyard production must be profitable, and the effects of erosion on steep slopes should be minimized.

The main constraints in the landslide inventory are related to the small size of the shallow translation slides (average area 62 m^2, depth of the main scarp < 1 m), the intensive use of machinery in agricultural works that erases the landslide features in the field a couple of weeks after the landslide events. Other constraints are related to selecting the predisposing factors that are more adequate to access landslide susceptibility in terraced slopes. Additionally, it is challenging to select the modelling strategies using the information value method and logistic regression, with landslides represented as areas and points, and the validation strategies using different random partitions and ROC curves.

The methodology includes the following steps. (1) Landslide event inventory using fieldwork, orthophoto maps (10 x 10 cm) and Lidar (50 x 50 cm) images; (2) Map of predisposing factors datasets supported by a high-resolution DEM (10 x 10 cm): slope angle, slope aspect, slope curvature of the transversal profile, inverse wetness index, height of the superficial runoff depth and terraces height; geology (1: 50 000 scale) and the superficial formations depth; (3) Application of logistic regression and information value methods to assess each predisposing factor's importance and the landslide susceptibility zonation; (4) Computation of the ROC curve ; (5) Compare the two models susceptible areas.

Almost ~200 shallow translation slides were inventoried. Results show that slope, terrace height, superficial formation depth and superficial runoff depth were considered the more important variables in both models. The slope classes 25.1 – 30 and 30.1 – 35 degrees stand out (55% of the landslides). In the variable height of terraces, the 3.1 – 4 and 4.1 - 5 m classes present higher susceptibility values; however, 84% of landslides occurred on terraces with heights between 1 and 3 m. The highest susceptibility in the superficial formation depth is in the 1.1 – 1.5 m class (46.6% of landslides). In the variable superficial runoff depth, the infiltration process develops in classes <0.05 m located preferably on terrace platforms, where 96% of landslides were recorded, proving to be a good predisposing factor for slope instability.

The susceptibility models obtained present an AAC of the success rate curve > 0.80 and a prediction rate ~ 0.77, which are considered satisfactory results.

Acknowledgements: Research funded in the framework of the project LivingSoiLL - Co-creating solutions for soil health in Living Labs, Programme Horizon Europe Framework Programme (HORIZON-MISS-2023-SOIL-01). Living labs: Portugal, Spain, France, Poland, and Italy.

KEYWORDS: Douro Valley, landslides, susceptibility, terraced slopes