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SENSITIVITY ANALYSIS OF SHALLOW LANDSLIDE PREDISPOSING FACTORS ON TERRACED SLOPES IN THE DOURO VALLEY

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Purpose: The study area is located on an estate in the village of Pinhão within the UNESCO World Heritage landscape of the Douro Valley (Portugal). The vineyards (74.6 ha) are organized in terraces, predominantly south-facing, with altitudes ranging between 62 and 394 m. The area has a Mediterranean climate type with an annual average rainfall of 658 mm. Recently, the estate developed a renovation process with the re-construction of land embankments, mostly from large 2 rows terraces to narrow terraces (1 row), along with new drainage systems. These changes on soil physical conditions promoted water erosion and slope instability. An extraordinary rainfall episode occurred on 26th December 2022 triggered a multiple landslide event affecting the renovated areas. The main purpose of this work is to stablish statistical relations between an event landslide inventory and a set of predisposing and triggering factors that control slope instability in man-made slopes.

Methods: Methodology was developed in 5 mains steps. (1) Characterization of the critical rainfall triggering conditions of the landslide event, through the computation of I-D rainfall thresholds considering the RP; (2) Development of a landslide event inventory (location, area, length and volume) using field work and ortophotomaps (10x10 cm); (3) Creation of landslide predisposing factors datasets of the general slope (slope angle, slope aspect, slope curvature), terraces morphology (cut slope heigh and angle, platform weight and angle) and hydrological works on slopes (diversion channels, paths) derived from a detailed DEM (10 x 10 cm); lithology, soil texture and soil depth estimation; (4) Perform a logistic regression analysis to assess each predisposing factor importance to explain landslide susceptibility; (5) Computation of the success rate curve to estimate the general quality of the model.

Results: This study was focused on an elongated sub-basin of 0.42 km2 which geological and morphological characteristics are representative of the whole study area. The altitude ranges from 85 m to 394 m and is mainly composed of stratified levels of phyllites, quartz metagreywackes and schist intercalations dating from the pre-Cambrian. Almost ~200 shallow translation slides were inventoried. The landslides show an unevenly distribution, being more concentrated in the upslope sector, characterized by a general convex morphology of the general slope, with higher cut slopes and where the remobilized antrosoil layer is deeper. The height of the affected terraces range between 1.5 m and 4 m. The length of the landslide main scarp range between 1.5 m to 50 m, with an average 12.4 m, exposing the vineyards roots, planted in the external border of the terrace platform. The heigh of the scarp is lower than 0.5 m and the mobilized material generally experiment a short displacement without surpass the lower terrace.

Conclusions: The work is a contribution to predict landslide susceptibility areas triggered by high intensity rainfall events, and to estimate future potential damages and economic losses associated with the vineyards production decrease on affected terraced slopes. These results may be applicated to adjust guidelines for terraces construction to avoid the effects of soil erosion and landslides.