World Academy of Science, Engineering and Technology
International Journal of Environmental and Ecological Engineering
Vol:11, No:07, 2017

Landslide Hazard Assessment Using Physically Based Mathematical Models in Agricultural Terraces at Douro Valley in North of Portugal

Authors : C. Bateira, J. Fernandes, A. Costa

Abstract : The Douro Demarked Region (DDR) is a production Porto wine region. On the NE of Portugal, the strong incision of the Douro valley developed very steep slopes, organized with agriculture terraces, have experienced an intense and deep transformation in order to implement the mechanization of the work. The old terrace system, based on stone vertical wall support structure, replaced by terraces with earth embankments experienced a huge terrace instability. This terrace instability has important economic and financial consequences on the agriculture enterprises. This paper presents and develops cartographic tools to access the embankment instability and identify the area prone to instability. The priority on this evaluation is related to the use of physically based mathematical models and develop a validation process based on an inventory of the past embankment instability. We used the shallow landslide stability model (SHALSTAB) based on physical parameters such us cohesion (c'), friction angle(ϕ), hydraulic conductivity, soil depth, soil specific weight (ϱ), slope angle (α) and contributing areas by Multiple Flow Direction Method (MFD). A terraced area can be analysed by this models unless we have very detailed information representative of the terrain morphology. The slope angle and the contributing areas depend on that. We can achieve that propose using digital elevation models (DEM) with great resolution (pixel with 40cm side), resulting from a set of photographs taken by a flight at 100m high with pixel resolution of 12cm. The slope angle results from this DEM. In the other hand, the MFD contributing area models the internal flow and is an important element to define the spatial variation of the soil saturation. That internal flow is based on the DEM. That is supported by the statement that the interflow, although not coincident with the superficial flow, have important similitude with it. Electrical resistivity monitoring values which related with the MFD contributing areas build from a DEM of 1m resolution and revealed a consistent correlation. That analysis, performed on the area, showed a good correlation with R2 of 0,72 and 0,76 at 1,5m and 2m depth, respectively. Considering that, a DEM with 1m resolution was the base to model the real internal flow. Thus, we assumed that the contributing area of 1m resolution modelled by MFD is representative of the internal flow of the area. In order to solve this problem we used a set of generalized DEMs to build the contributing areas used in the SHALSTAB. Those DEMs, with several resolutions (1m and 5m), were built from a set of photographs with 50cm resolution taken by a flight with 5km high. Using this maps combination, we modelled several final maps of terrace instability and performed a validation process with the contingency matrix. The best final instability map resembles the slope map from a DEM of 40cm resolution and a MFD map from a DEM of 1m resolution with a True Positive Rate (TPR) of 0,97, a False Positive Rate of 0,47, Accuracy (ACC) of 0,53, Precision (PVC) of 0,0004 and a TPR/FPR ratio of 2,06.

Keywords : agricultural terraces, cartography, landslides, SHALSTAB, vineyards
Conference Title : ICGTNH 2017 : International Conference on Geospatial Technologies for Natural Hazards
Conference Location : London, United Kingdom
Conference Dates : July 24-25, 2017