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Modelling of overland flows in a terraced vineyard affected by road-induced shallow landslides

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Land degradation represents one the main issue affecting agricultural systems, especially in those areas that are characterized by agricultural practices on steep hillslopes. The occurrence of erosion processes and landslides is closely linked with the presence of road networks. Factors like inefficient of absent drainage systems, wasteful road management and not optimal planning, as well as specific geomorphological and hydrological elements directly encourage landslides activation. In this connection, the combined use of Remotely Piloted Aircraft Systems (RPAS) and photogrammetric techniques (e.g. Structure from Motion; SfM) allowed to elaborate multi-temporal (therefore 4D) high-resolution Digital Elevation Models (DEMs), so as to detect geomorphological changes affecting earth surface at specific spatial and temporal scale. At the same time, the adoption of several models allows to compute specific hydrological analysis, for instance investigating the alteration of surface water flow dynamics due to the presence of specific features like roads. In this context, this research aims to propose a multi-temporal analysis of the road-induced water flow alterations in a shallow landslide-prone agricultural system. SIMWE model (Mitasova et al., 2013) was applied focusing on different geomorphic and rainfall scenarios, looking at the presence of the road network within the study area and assuming its absence through specific DEM post-processing procedures. In this connection, the possibility to perform multi-temporal hydrological simulations at the hillslope scale, to analyse the role played by the road in landslides activation is still a challenge to be investigated. In this article, we considered a case study placed in northern Italy, where two shallow landslides were observed below a rural road located within a terraced vineyard. Multi-temporal hydrological simulations were conducted to further analyse the evolution of road induced water flows deviations, thus stimulating landslides occurrence on the detected hillslopes. Maximum water depths equal to 0.60 m and 0.46 m were noticed close to specific zones of the road sections located above the first and the second landslide respectively. The simulations computed assuming the absence of the road revealed the lack of water flows deviations involving the landslide zones, underlining the fact that the road absence would avoid significant changes in water flow paths toward the collapsed zones. The key role played by the road in water flows deviation and in the evolution of the observed land degradation dynamics was attested through the comparison of the thematic maps resulted from each simulation. This work could be a solid starting point for further analyse the roads impact on runoff dynamics at a wider scale, aiming to plan and propose mitigation interventions so as to reduce the occurrence of future risk scenarios. At the same time, efficient design of drainage

systems along the roadway could be conducted starting from the outcomes presented in our research, so as to prevent the activation of similar land degradation processes.

Reference

Mitasova H., Barton C.M., Ullah I., Hofierka J., Harmon R.S. 2013. GIS-Based Soil Erosion Modeling. Treatise on Geomorphology (3), 228-258.