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A first attempt to evaluate the impact of agricultural practices on slope stability

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Shallow landslides induced by rainfall are very common movements that occur in hilly and mountainous areas causing losses of human life, ecological and environmental impacts and considerable economical costs. The predisposing factors for shallow landslides are represented by morphology, lithology, soil type, land cover, and land use, and their changes. Land use is constantly evolving because it is linked to human activities; the increase of population pressure and economic development forced more people to use all areas available.

A lot of scientific contributions analyzed the positive effects of vegetation cover on slope stability, focusing on the mechanical effects of vegetation (both vegetation cover and roots) in terms of providing additional mechanical root reinforcement. Conversely, the effects of agricultural practices on slope stability conditions are poorly investigated. Indeed, while agriculture contributes positively to the landscape, biodiversity, climate and fires, on the other hand, improper agricultural practices and soil uses can modify the mechanical properties of the involved soils leading to a possible increase of instability phenomena.

To evaluate the effect of agricultural practices on the slope stability conditions, we present an application of a probabilistic, physically-based model for the triggering of rainfall-induced landslides (PG_TRIGRS – a probabilistic, geostatistic-based extension of the TRIGRS model) to the Collazzone area, a cultivated area located in Umbria, central Italy, characterized by a high susceptibility to landslides, which is studied and periodically monitored through systematic image analysis and on-site surveys.

The method applied in this research included the comparison between landslides observed in situ and the spatial distribution of the probability of failure derived from the application of PG_TRIGRS model, which models the study area in a GIS grid and treats each cell as an infinite slope. More in detail, a heuristic approach was adopted: after a first run of the model with unbiased parameters, the slope stability analysis has been carried out assuming several percentages of reduction of the effective soil cohesion (c') to mimic an increasing impact of agricultural practices on the strength conditions.

A back-analysis methodology, with the support of sensitivity indices, was adopted to provide a preliminary quantitative evaluation of the effect induced by agricultural practices on the mechanical properties of the soil. To test the reliability of the method, standard contingency matrix and skill scores were adopted and the best compromise between correct and incorrect

model outcomes was obtained considering a reduction of c’ between 20% and 30%.
In conclusion, we could estimate that in the analyzed area the agricultural practices can cause a 20 to 30% reduction in soil.