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Shallow landslides forecasting at a regional scale: the effect of root cohesion on distributed slope stability simulations

Elena Benedetta Masi, Guglielmo Rossi, Veronica Tofani, and Filippo Catani
University of Firenze, Earth Sciences, Firenze, Italy

Vegetation plays a crucial role in slope stability affecting soil behaviour through many hydrological and mechanical processes.
At the catchment scale, the hydrological effects of interception, suction, evapotranspiration and infiltration strongly affect runoff processes, whilst at the local scale the mechanical effect of root reinforcement is the leading factor for slope stability. Root systems of plants increase the shear strength of soils through a combined action by the large and the small roots: large woody roots can anchor the superficial soil layers to more stable substrates crossing potential planes of weakness; small roots strengthen the bounds with the soil particles increasing the overall cohesion of the matrix soil-roots.
The belowground conditions that determine the root reinforcement are extremely variable, so that field measurements of the additional cohesion provided by roots can vary by an order of magnitude even for plants of same species and age. The extreme variability of this parameter coupled to the practical difficulties in assessing its spatial variations, especially for large areas, represent a significant limit in including proper values of root cohesion in slope stability models.
In this study we analysed the effect of the roots cohesion on slope stability simulations obtained using the HIRESSS model. HIRESSS is a physically based distributed slope stability simulator developed to provide results in near real time and for large areas. For the latest version, the simulator was modified to insert the root reinforcement among the geotechnical parameters that considers to compute the factor of safety in probabilistic terms. A comparison of the results between two different simulations was performed: considering a large area (900 km2) and 30 days of precipitations, in one case the root cohesion was set to zero for all the area, in the other case different values of the parameter based on the plant species was instead inserted in the model.
To build a map of the root cohesion for the study area, the following solution was adopted to solve the problem of the evaluation of the parameter: the distribution of plant species in the area was obtained from CORINE land cover 2012 4th level map, then a value of root cohesion and a range of variation was defined for each plant species based on the most recent literature in this field, finally, to reproduce the natural variability, the root reinforcement was treated as variable in Monte Carlo simulations, as well as the other geotechnical parameters.
The results of the simulations for the study area were processed and analysed in order to evaluate the effect of root cohesion on failure probabilities. The results were also analysed considering landslide actual events to assess the contribution of the parameter to the HIRESSS forecasting capabilities.