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Advanced distributed modelling of slope stability using root reinforcement and geostatistical parameterization of geotechnical soil properties

Elena Benedetta Masi[1], Anita Stagnozzi[2], Silvia Stagnozzi[2], Gianluigi Tonelli[2], Francesco Veneri[2], Veronica Tofani[1], and Samuele Segoni[1]
[1]University of Florence, Department of Earth Sciences
[2]University of Urbino "Carlo Bo", Department of Pure and Applied Sciences

A physically based model for shallow landslide triggering (HIRESSS – HIgh REsolution Soil Stability Simulator) was applied in a 100 km^2 test site in Central Italy (Urbino, Marche region). The objectives were assessing the influence of additional cohesion provided by roots and testing the effectiveness of a geotechnical characterization performed in an another area, but on similar lithologies.

We performed two different simulations considering the rainfall event of January-February 2006, which triggered 14 landslides in the area. For both the simulations, rainfall data were fed into the model using the measurements at hourly time step of a nearby rain gauge station, while soil thickness was estimated using a state-of-the-art empirical model based on geomorphological parameters derived from curvature, slope gradient, lithology and relative position within the hillslope profile. Geotechnical input data were varied among the two simulations. In the first one, a few in-situ and laboratory tests were performed to characterize the main lithologies, while the remaining lithologies were characterized using literature data. In the second simulation, the main geotechnical and hydrological parameters (cohesion, internal friction angle, soil unit weight, hydraulic conductivity) were fed into the model using a geostatistical characterization performed on hundreds of measurements carried out in another Italian region, with similar lithologies. Furthermore, in the second simulation the additional cohesion provided by the plant roots was also taken into account.

The results obtained with the two simulations were validated considering the landslide dataset collected by field work and image interpretation shortly after the rainfall event studied. We discovered that the second simulation provided much more reliable results, with the areas surrounding the landslide locations characterized by much higher values of failure probability.

The outcome is very important to address future research in distributed slope stability modelling because it proved that: (i) additional root cohesion is an important factor that can be used to get more reliable results; (ii) when in need of characterizing the geotechnical parameters of the study area, instead of using just a few measurements performed therein, it is preferable to integrate

also data coming from different areas but with similar lithologies if they were robustly characterized in geostatistical terms purposely for distributed slope stability studies.

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