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Numerical analysis of stabilization effects of protection forests on hillslopes prone to shallow landslides: application of the SOSlope model to St. Antönien (Switzerland)

Massimiliano Schwarz (1,2) and Denis Cohen (2)

(1) Bern University of Applied Sciences, Mountain Forests and Natural Hazards, Forestry, Zollikofen, Switzerland (massimiliano.schwarz@bfh.ch), (2) EcorisQ

Shallow landslides are local phenomena determined by heterogeneous predisposition (such as soil depth, soil properties, and root distribution) and triggering factors (intense rainfall). Several numerical models exist that implement using different methods heterogeneities and physical processes. In this study we discuss the results of the model SOSlope applied to the area of St. Antönien, Switzerland, where several events of shallow landslides were documented in the past. The peculiarity of the SOSlope model is to consider the heterogeneity of soil properties with stochastic approaches coupled with a detailed calculation of the contribution of root reinforcement for both stress and strain behaviors of soil. Distribution of roots are derived from digitizing the position and dimension using the FINT tool (EcorisQ.org). Root reinforcement is calculated at a 1-m scale using the Root Bundle Model approach calibrated with field pullout experiments. Root reinforcement is implemented in the model as changes in the stress-strain behavior of soil under tension, compression, and shearing.
The application of the model allows for a comparison of the susceptibility of a hillslope to fail considering different scenarios of forest structure, and thus of root reinforcement distribution.
The results show that the stabilization effects of roots in a protection forest increase non linearly with increasing tree density and dimensions. Depending on local topography and soil depth, the protective effects of forests change considerably within a few meters.
This work presents for the first time the application of a detailed root-reinforcement calculation on the analysis of the protective effect of forests on hillslopes prone to shallow landslides. The application of SOSlope helps to better understand the mechanisms of shallow landslide triggering on vegetated hillslopes.