Computational slope stability experiments implementing root system morphology in a generic hillslope environment

Elmar Schmaltz (1), Martin Mergili (1,2), Stefan Steger (1), and Thomas Glade (1)

(1) ENGAGE - Geomorphological Systems and Risk Research, Institute of Geography and Regional Research, University of Vienna, Austria, (2) Institute of Applied Geology, Department of Civil Engineering and Natural Hazards, University of Natural Resources and Life Sciences (BOKU), Vienna, Austria

Albeit tree root systems are capable to reinforce soils on hillslopes and hold the potential to increase slope stability, the influence of root systems is often disregarded in physically-based slope stability models. In this study, we intend to improve the parameterisation of root reinforcement by analysing the effects of various root system types on slope stability in a fully quantitative way. Therefore, we apply the 2.5D-slip surface model *r.slope.stability* to 23 root system scenarios imposed on a pyramidoid-shaped generic landscape. Shallow and taproot systems, as well as a mixture of both are approximated with paraboloids. Different stand and patch densities are considered for several stand compositions. The slope failure probability (P_f) is derived for each raster cell of the generic landscape. Thereby, internal friction angle and soil cohesion are varied within a given space of parameter values. P_f is defined as the fraction of parameter combinations yielding a factor of safety <1. Root reinforcement is considered through a constant root cohesion imposed on all root systems. Average and standard deviation of P_f are analysed for each scenario. As expected, *r.slope.stability* yields the highest values of P_f for the scenario without roots. In contrast, homogeneous stands with taproot or mixed root systems provide the lowest P_f. Generally, P_f decreases with increasing stand density, whereby stand density appears to exert a more pronounced influence on P_f than patch density. For patchy stands, P_f increases with a decreasing size of the tested slip surfaces. The patterns provided by the computational experiments are largely in accordance with the results of previous studies and in-field observations. The findings of this study will be used to develop strategies towards appropriately parameterising 2.5D-slipsurface models to estimate root reinforcement in real-world case studies.