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Influence of root distribution and compressibility of rooted soil on the triggering mechanism of shallow landslides

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The triggering mechanisms of shallow landslides in vegetated slopes are strongly influenced by the presence of roots. The mechanical properties of rooted soils are reported in numerous studies and are widely discussed in the context of slope stability calculations. However, the quantification of root reinforcement and its implementation in slope stability calculation is difficult due to the complexity of the mechanical interactions between roots and soil. Next to the well-documented contribution of roots to shear and tensile strength of soils, there are no studies that discuss the effects of roots on the compressibility of soils and how this mechanical property influences the triggering and size of shallow landslides. In this study we present a new model (SOSlope) for the simulation of shallow landslides failure that includes, in addition to shear and tensile root reinforcement, the contribution of plant roots to the stiffness and maximum strength of soils in compression. Based on the general concept of the fiber bundle model, we derived the stress-strain behavior of rooted soils under different types of mechanical solicitations including the effects of the spatial root distribution and the mechanical properties of roots and soil. The model simulates the effects of the spatial and temporal variability of root reinforcement on the stability of a slope. Including the compressive behavior or rooted soils is particularly important to estimate how vegetation stabilizes slopes with protection forest and bioengineered slopes. Results of the model are compared to classical methods for slope stability calculation and to field observations. This study represents an important improvement for the evaluation of planting strategies within the scope of bioengineering measures and for the definition of criteria for a sustainable protection against shallow landslides and erosion.