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Sensitivity analysis of a new dual-porosity hydroloigcal model coupled with the SOSlope model for the numerical simulations of rainfall triggered shallow landslides.

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Morphology and extent of hydrological pathways, in combination with the spatio-temporal variability of rainfall events and the heterogeneities of hydro-mechanical properties of soils, has a major impact on the hydrological conditions that locally determine the triggering of shallow landslides. The coupling of these processes at different spatial scales is an enormous challenge for slope stability modeling at the catchment scale. In this work we present a sensitivity analysis of a new dual-porosity hydrological model implemented in the hydro-mechanical model SOSlope for the modeling of shallow landslides on vegetated hillslopes. The proposed model links the calculation of the saturation dynamic of preferential flow-paths based on hydrological and topographical characteristics of the landscape to the hydro-mechanical behavior of the soil along a potential failure surface due to the changes of soil matrix saturation. Furthermore, the hydro-mechanical changes of soil conditions are linked to the local stress-strain properties of the (rooted-)soil that ultimately determine the force redistribution and related deformations at the hillslope scale. The model considers forces to be redistributed through three types of solicitations: tension, compression, and shearing. The present analysis shows how the conditions of deformation due to the passive earth pressure mobilized at the toe of the landslide are particularly important in defining the timing and extension of shallow landslides. The model also shows that, in densely rooted hillslopes, lateral force redistribution under tension through the root-network may substantially contribute to stabilizing slopes, avoiding crack formation and large deformations. The results of the sensitivity analysis are discussed in the context of protection forest management and bioengineering techniques.