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Catchment scale geomorphological control on stress induced slope instability

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Topography affects groundwater hydrology, the spatial location of the water table and the asymptotic distribution of suction in the vadose zone. Topographically driven flows create, at catchment scale, spatial patterns of soil moisture and pore pressure distributions that change in time, in response to rainfall infiltration. This affects the interparticle stresses, and ultimately the soil shear stress. Therefore, topography affect slope stability mainly through two types of processes involved: hillslope hydrology and geomechanical stability. The former determines soil moisture changes and all related processes, such as changes in pore water pressure and consequent changes in soil shear strength; the latter determines the soil thickness and the sediments available for potential failures. While the run-off and groundwater saturated flows are driven by gravity and ultimately by topography, less trivial is understanding whether the landscape morphology has a bearing on subsurface flows in the vadose zone, where transient fluxes seem to have a prevalent vertical component, at least in the short term, for points where $\epsilon = H/\sqrt{A} << 1$, ($H$ is the vertical soil depth and A is the upslope contributing area; Iverson, 2000). The issue, in this case, is therefore shifted to understanding whether short-term, 1-dimensional fluxes are somehow affected by topography and to which extent this influences slope stability. Alternatively, if lateral fluxes occur in the vadose zone, the issue is investigating if they affect slope stability. Therefore, this study tries to assess and quantify the impact of topography on shallow slope stability both in the vadose and in the saturated zone. This is performed using a distributed, physically-based model GEOtop-FS. This model has a coupled hydrological-geotechnical nature, and approaches the slope stability analysis from a probabilistic standpoint, which allows to take into account soil strength parameter variability. A statistical analysis, performed on planar, convergent and divergent sites, suggests that: 1. at a first order of

approximation vadose fluxes do not affect slope stability; 2. lateral groundwater fluxes enhance the flux toward hollows in concave sites, resulting in an increasing probability of failure.