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The influence of anisotropy on preferential flow in landslides

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Infiltration is one of the most important landslides triggering mechanisms and it is controlled by the hydraulic characteristics of the soil, which depends on the degree of saturation, the existence of preferential flow paths and by anisotropy. Many soils, indeed, exhibit a certain degree of anisotropy due to the stratification associated with soil forming process. Recently, various authors investigated the effect of rainfall in layered soils and its effect on rainfall triggered landslides by means of experimental, conceptual, numerical and theoretical approaches. However, the combined effect of anisotropy and preferential flow on infiltration process and related to rainfall induced landslides has, according to the authors best knowledge, not been studied yet. Aiming at better understanding the soil hydrological processes which take place during an infiltration process, the stability of a synthetic hill slope is numerically investigated.

The geometry we considered for the model is a slope with two different layers: the upper soil layer consists of sandy loam, while the lower soil layer is made out of clay. The geometry was studied using both a single permeability and a dual permeability model. In the first case the hydraulic conductivity at saturation was considered isotropic, equal in all directions. Then the vertical component of the hydraulic conductivity tensor at saturation was reduced, while in the third scenario the horizontal component was reduced. In this way the anisotropy effects on both the principal directions were studied. In the dual permeability model, the influence of the anisotropy was considered only in the preferential flow domain, and the hydraulic conductivity at saturation of the soil matrix domain was defined as being isotropic. In order to evaluate also the effects of rainfall intensity on the slope, two different rainfall events were studied: a low intensity rainfall with a long time duration ($2\ \mathrm{mm\,h^{-1}}$,$150\ \mathrm{h}$) and an high intensity rainfall with a short duration ($20\ \mathrm{mm\,h^{-1}}$,$15\ \mathrm{h}$).

The results show that the anisotropy facilitates the saturation process in the slope and that the vertical component of the soil water flow is set especially in the soil matrix domain, while the lateral component dominates in the preferential flow domain. In some scenarios the patterns of the water content in the unsaturated soil layers suggest the possibility of the onset of a perched water table.