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Numerical results on perched waters in 1D and sloping 2D gradually layered soils

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The hydraulic conductivity at saturation K_s usually decreases across the upper soil layers. This pattern strongly characterises the soil water circulation and affects a number of physical phenomena, including perched water formation and landslide triggering mechanisms.

Aiming at better understanding the involved hydrological processes, the case of infiltration at constant rate in an undeformable soil layer of finite depth, with exponentially decreasing K_s, was numerically investigated. Both one–dimensional and sloping two–dimensional cases were simulated by means of Hydrus1D and Hydrus2D/3D. At the bottom of the domain saturation conditions were assumed, thus representing both the presence of a water table or of a soil layer which is not able to act any retention.

The 1D simulations confirmed previous theoretical analyses of the steady case, providing the threshold of the infiltration rate above which a saturated layer onsets, its thickness, the maximum pressure head and its position within the saturated layer. They moreover enlightened soil water dynamics before the steady state is reached. Accordingly with an analytical solution of the Richards equation for a gradually layered soil, a peak of water content onsets at the soil surface. It is then enveloped as the maximum water content moves downward. Then two different behaviours can be expected. Either the soil saturation is reached at one point, thus leading to a perched water table which rapidly reaches steady conditions, or the peak vanishes and the solution recovers its monotonicity with a flux in the direction of the increasing water content.

The 2D simulations, instead, reveal how a greater infiltration rate is required for the perched water to onset, with respect to the 1D case, due to the lateral flux which strongly increases as a saturated layer is formed. If slopes one order of magnitude longer than the soil depth are considered, an almost uniform flux can be observed in a long branch of their central part, thus allowing to perform stability analyses in the framework of the infinite slope approach.