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Linking hydrogeological and geomechanical landslide modelling

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The geomechanical analysis of both large slope instabilities and shallow landslides requires considering the time evolution of the pore water pressure (PWP) distribution. As it is well known, in fact, PWP increase within the slop is the main factor leading to acceleration of large landslides and to soil slips triggering.

The effects of the PWP evolution is however different depending on the type of considered landslide. While considering the large slow-moving landslides, the slip surface is often situated below the groundwater level and the slip surface is in a fully saturated condition. In this case, the goal of the geomechanical modeling is to pursue quantitative relationships between the position of the groundwater level and the velocity of the soil mass. Unsaturated conditions of the superficial soil layers must be fully considered in the case of shallow soil slips. Their triggering is in fact mostly related to the suction reduction induced by rainfall infiltration and the consequent loose of available shear strength. In this regard, the aim of the geomechanical modeller is to assess the critical distributions of PWP that may trigger the slips. Those distributions can subsequently be related to specific rainfall patterns for the establishment of rainfall thresholds.
In any case, a proper quantification of the PWP evolution is a fundamental aspect in order to get reliable predictions of the soil slope behaviour. This work aims to present several methods to consider the hydrogeological inputs from the the geomechanical modelling perspective. The cases of uncoupled, partially- and fully- coupled hydrogeological and geomechanical modelling are presented and discussed. Emphasis is on the physical mechanisms, relating to the landslide behaviour, that are duly considered or neglected for the different levels of coupling. Modern trends in geomechanics for landslide analysis are briefly introduced, highlighting their requirements in terms of hydraulic characterization of the involved materials.

Modelling of case studies is presented in order to emphasize the proper link between the two aspects (hydro and geomechanical) of the landslide modelling process. This approach could bring toward an improved understanding of the slope response and an enhanced prevision capability.