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Analysis of hydrological and geotechnical aspects related to landslides caused by rainfall infiltration

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A landslide is defined as a perceptible downward and outward movement of slope-forming soil, rock, and vegetation under the influence of gravity.
Landslides can be triggered by both natural and human-induced changes in the environment. However rainfall is recognized as a major precursor for many types of slope movements.
As a result of rainfall events and subsequent infiltration into the subsoil, the soil moisture can be significantly changed with a decrease in matric suction in unsaturated soil layers and/or increase in pore-water pressure in saturated layers. As a consequence, in these cases, the shear strength can be reduced enough to trigger the failure.
An effective way to develop such an understanding is by means of computer simulation using numerical model.
As part of the project PON "Integrated Early Warning System" our main objective was just to develop a numerical models that was able to consider the relation between rainfall, pore pressure and slope stability taking into account several components, including specific site conditions, mechanical, hydraulic and physical soil properties, local seepage conditions, and the contribution of these to soil strength.
In this work the mechanism behind rainfall-triggered landslides is modeled by using combined infiltration, seepage and stability analyses. This method allows the evaluation of the terrain and its response based on geological, physical, hydrogeological and mechanical characteristics.
The model is based on the combined use of two modules: an hydraulic module, to analyze the subsoil water circulation due to the rainfall infiltration under transient conditions and a geotechnical module, which provides indications regarding the slope stability.
With regard to hydraulic module, variably saturated porous media flows have been modeled by the classical nonlinear Richards equation; in the geotechnical module the differential equilibrium equations have been solved taking into account the linear constitutive equations (plane stress) and strain-displacement relationship.
By means of the model it is possible to analyze subsoil water circulation, safety factor of the slope subjected to gravity loading and to the pore pressure calculated from hydraulic module, displacement, strain and stress under the effect of rainfall infiltration.
As an application case, the analysis and the representative results obtained for the Torre Orsaia landslide (Campania region - Southern Italy) are described.