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Distinct element modelling of triggering and evolution of a flow landslide in central Italy Apennines

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In recent years, great progress has been made in the development of integrated strategies for the mitigation of landslide hazard. However, landslides still have a large social, economic and environmental impact over mountainous regions. This is partly due to the complexity of the driving mechanisms responsible of slope failure and to the difficulty associated to the recognition, prediction and mitigation of these natural events. Among the most important challenges for the experts, the following are worth mentioning: the analysis and prediction of the stability of a given slope; the assessment of the potential failure mechanism and velocities; the evaluation of the extent of the area endangered by the landslide, and the design of possible remedial measures. In this work, our attention is focused on the analysis of groundwater-induced, rapid shallow landslides by means of the Discrete Element Method (DEM). In the DEM, the discrete soil/debris elements are modelled as circular (2d) particles, interacting through cohesive-frictional sliding contacts. The particles may represent individual grains in a granular body (e.g., sand, gravel) or they may be bonded together through specified bond strengths to represent clusters of particles or a solid mass. This provides the possibility of simulating fracturing through intact material whenever the stresses in the sliding mass are sufficiently high to break the interparticle bonds. One of the most interesting features of the DEM approach is the possibility of characterizing the complex dynamical response of a large granular assembly by means of a very limited number of model constants, which have all a clear physical interpretation at the microscopic level. In this work, the DEM code PFC-2d has been used to analyse a real landslide which occurred in the central Italy Apennines. The role of the groundwater pressures on the activation and the dynamics of the flowing granular mass are taken into due account by adding to the dynamic equilibrium equations of each particle the seepage forces corresponding to the actual pore pressure field in the soil mass. The comparison between the predictions obtained in a series of parametric DEM simulations and the available experimental evidence gathered from field observations demonstrate the good predictive capabilities of the DEM in the analysis of fast granular flows, and provides important information concerning the role of the different model parameters on such important aspects of the landslide dynamics as travel distance, average velocity and overall mass flow.