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Particle-based models for hydrologically triggered deep seated landslides

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In this work we explore the integration between existing soil infiltration modeling and particle based methods in order to simulate two and three-dimensional schemes of triggered deep seated landslides. In literature, usually, the infiltration models are based on continuum scheme, i.e. Eulerian approach by means of which it is possible to define the field of the pore pressure within a soil (e.g., Iverson, 2000). Differently the particle based method follow a discrete Lagrangian scheme that allow to identify the trajectory of the particles and its dynamical properties. At present we test some infiltration models based on classical and generalized Richards equations that are adapted to the molecular dynamics approach according to the failure criterion of Mohr-Coulomb to simulate the triggering mechanism. In case of analytical infiltration model solution, the latter is discretized, differently a numerical one is achieved and the increasing pore pressure effect is simulated at soil particle level, i.e. we can simulate the rainfall in terms of water mass and, using the response function, we take into account the absorbed water in time and space at each thickness of our fictitious soil. The inter-particle interactions are through a force that, in the absence of suitable experimental data and due to the arbitrariness of the grain dimension, is modeled by means of a potential similar to the Lennard-Jones one. For the prediction of the particle positions, after and during a rainfall, we use a molecular dynamics approach that results very suitable to simulate this type of systems. The outcome of simulations are quite satisfactory and we can claim that this types of modeling can represent a new method to simulate landslides triggered by rainfall. Particularly, the results are consistent with the behavior of real landslides, e.g., it is possible to apply the method of the inverse surface displacement velocity for predicting the failure time (Fukuzono 1985). An interesting behavior emerges from the dynamic and statistical points of view. In our simulations emerging phenomena such as detachments, fractures and arching are observed. Finally, in our simulated system, we can observed a transition of the mean energy increment distribution from Gaussian to power law varying the value of some parameters (i.e. viscosity coefficient) or, fixed all parameters, the same behavior can be observed in the time, during single simulation, due to the stick and slip phases.