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A grain-fluid mixture model to characterize the dynamics of active landslides in fine-grained soils

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Dynamic continuum modeling of slow-moving landslides in fine-grained material is generally performed by means of visco-plastic models applying the approach of one-phase material. Shortcomings of this approach are the uncertainty of using physical realistic material parameters and that solid and fluid stresses are not considered separately. The objective of this work is to overcome the problems of the one-phase material approach by adopting the theory of grain-fluid mixture. Applying a two-phase model approach enables to
distinguish explicitly between 25 e.g. solid friction stress, fluid shear stress (viscous stress), buoyancy and momentum exchange between solid and fluid (seepage).
The model is implemented in a GIS (Geographic Information System) scripting language, which facilitate the use of complex three-dimensional (3D) topographies. The model is applied to and tested on the well-documented Super-Sauze landslide developed in reworked clay-shales. It is shown that the temporal and spatial varying moving pattern of the landslide can be reproduced. The numerical analysis reveals that viscous stresses produced by the fluid are irrelevant. Movements are mainly controlled by buoyancy, related to the evolution of the ground water level within the landslide that comes from water infiltration, and is introduced as a boundary condition. It is concluded that a two-phase, grain-fluid mixture model is convenient when landslide motion in fine-grained material is mainly controlled by the hydrological conditions (i.e. changes in pore water pressures), as in this example. The material parameters, as viscosity, calibrated to reproduce such landslide motion in models using the one-phase material approach, would take unrealistic values.