Modelling land subsidence processes induced by fast rainwater infiltration through fractures into the unsaturated zone

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Abstract The aim of this work is to better understand rainfall-induced fast infiltration of water through fractures into the subsurface, as well as to estimate its influence on mechanical deformation, i.e. land subsidence. Flow in the partially saturated soil (matrix, fracture) is described with the model concept of two-phase flow in porous media and the stress–strain analysis is carried out with the hardening soil model (elasto-plastic model) using a double stiffness concept for elasticity in combination with isotropic strain hardening. Flow and deformations are weakly coupled. In this research several numerical studies are presented. An analysis of the influence of fracture and surface inclination on flow and deformation is carried out. The results of the numerical study show that infiltration into a system with a horizontal surface and without fracture only leads to vertical deformations. Infiltration into a system with a vertical fracture has nearly no influence on the deformation because the water mainly propagates in the vertical direction due to gravity. Infiltration into a system with a horizontal surface and an inclined fracture results in considerable horizontal and vertical deformations. Such deformations are further increased when the surface is inclined.

Key words subsidence; fracture; rainwater infiltration; numerical modelling; unsaturated zone