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Developing model concepts for simulating water infiltration into macroporous soils for understanding triggers for landslides

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There is a strong relation between rainstorm events and the occurrence of landslides. However, the processes which trigger a landslide are often not fully understood. Detailed simulations of the infiltration and water flow can help to improve our understanding of failure processes and the verification of hypotheses. The DFG-Research Unit "Natural Slope" studies the mechanisms which lead to a slow creeping landslide at the alpine slope Heumöser Hang in Ebnit (Austria). The group carries out a multitude of field measurements to determine the structure of the slope and the failure processes. In combination with simulations of the water infiltration and deformation processes this can help to understand the failure processes which lead to creping of the slope. During the field studies, a large number of macropores were found in some parts of the slope. Tracer experiments showed fast breakthrough curves, indicating a strong influence of the macropores on water infiltration and flow. Since water flow is strongly influenced by the macropores and the fast water infiltration can lead to a rapid pressure reaction it is important to include them in the models concepts. Thus, we developed two different models for simulating water flow and infiltration processes in macroporous soils on different scales.

The first model was developed to understand the principles of macropore flow, water infiltration and water exchange between the macropore and the surrounding soil matrix. Therefore, a laboratory experiment with a single macropore placed in a sand filled container was designed. Different infiltration rates into the macropore were investigated to study macropore flow and water exchange. Water flow in the matrix was simulated with a two-phase flow model. Additionally, a conceptual model, describing water flow in the macropore, was developed and coupled with the two-phase model to describe macropore flow in the whole domain. The model was used to estimate the range of exchange coefficients and to test transfer equations for the water exchange between matrix and macropore. Further we developed a two-phase dual-permeability model to simulate water and gas flow in macroporous soils on the field scale. This is important issue when simulating the water infiltration at the macroporous parts of the multi-layered slope Heumöser Hang. Since it is not clear whether the air can escape during the rapid infiltration and air pressure effects may be important, we decided to use a two-phase (water /gas) model instead of the Richards equation for our simulations. In this contribution we will present both model concepts and simulation results of different studies to show the capabilities of both models.

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