EGU22-10859
https://doi.org/10.5194/egusphere-egu22-10859
EGU General Assembly 2022

Using the Dual Porosity Approach to Quantify Non-uniform Fluxes for the Estimation of Hydrological and Stability Performance of Sloped Covers over Coal

Thomas Baumgartl[1], Qi Shao[2], and **Vilim Filipović**[3]
[1]Future Regions Research Centre, Federation University Australia, Churchill, Australia (t.baumgartl@federation.edu.au)
[2]Department of Infrastructure Engineering, University of Melbourne, Melbourne, Australia (shao.q@unimelb.edu.au)
[3]University of Zagreb, Faculty of Agriculture, Department of Soil Amelioration, Zagreb, Croatia (vfilipovic@agr.hr)

Environmental impacts of open-pit coal mining include issues such as fire risk, large-scale slope instability and groundwater contamination. Because of the man-made landforms used to cover open-pit mines and the coal material itself, soil hydrology can be affected in a way that non-uniform fluxes and preferential flow may occur. The aim of this study was to evaluate soil hydraulic properties of open-pit mines and coal material and to implement dual porosity approach into numerical experiments to quantify non-uniform fluxes and slope stability. Water retention and hydraulic conductivity curves were estimated for both coal and clay (overlaying material) using the combination of Dewpoint potentiometer WP4C and HYPROP devices. Mechanical properties were determined additionally using the Unconfined Compressive Strength test. Numerical simulations have been performed using HYDRUS 2D/3D and associated SLOPE CUBE module to assess the hydrological and mechanical behavior of coal-cover slope models under different climatic scenarios. Results showed that coal has very different hydraulic properties from the soil, with three to four orders of magnitude smaller saturated hydraulic conductivity, two orders of magnitude larger air entry point, and larger material strength parameters. The effects of present cracks/fractures on hydraulic properties of both, soil cover and coal have been taken into account by the bimodal properties determined using an extended van Genuchten-Mualem (Durner) model. Comparison of hydraulic conductivity curves indicates that the identified cracks/macropores play an important role in increasing hydraulic conductivity when the material is close to saturation. Therefore, 5% and 10% crack-weighting factors were adopted in numerical simulations for coal and topsoil/cover, respectively. The underlying coal changes its pore size distribution dramatically, depending on the degree of drying, which was confirmed during evaporation experiments. Numerical experiments showed higher risk to slope stability during the wetter years, albeit still on an acceptable level. The challenge remains on how to adequately quantify water balance in coal material with present preferential flow, and with the additional complexity of changing pore size distribution properties over time.