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Integrating soil structure in hydrologic models of the unsaturated zone

Efthymios Chrysanthopoulos[1], Christos Pouliaris[1], Kostas Markantonis[1], Ioannis Tsirogiannis[2], and Andreas Kallioras[1]
[1]School of Mining and Metallurgical Engineering, Laboratory of Engineering Geology and Hydrogeology, National Technical University of Athens, Athens, Greece(echrysanthopoulos@metal.ntua.gr)
[2]Department of Agriculture, University of Ioannina, Arta, Greece

Most hydrologic models of the unsaturated zone predict soil hydraulic parameters using empirical equations (Pedotransfer functions - PTFs) driven by a limited set of soil characteristics, predominantly soil texture. Despite the increasing capabilities of PTFs, due to the advancement of machine learning algorithms and neural networks over the course of the years, several researchers have pointed out that PTFs integrate limited or any information for soil structure (Novick et al., 2022). Soil structure, which is not correlated with soil texture, is affected by several factors, such as climate variations, biophysical activity, clay minerals, and the growth of roots, which determines the process of water movement in the unsaturated zone.

In this study, two laboratory methods were implemented (centrifuge and salt solution method) in order to define the water–retention curve of 1 m. undisturbed soil sample from an experimental kiwi field, located in the Epirus region (NW Greece). The water–retention curve correlates volumetric soil water content (θ) with matric potential, which becomes more negative when soils dry and is recognized as the fundamental driver of water flow in the unsaturated zone. Furthermore, a new permeability cell was constructed to conduct the falling head permeability method on undisturbed soil samples to determine saturated hydraulic conductivity (Ksat). The combination of all these methods led to a complete characterization of the undisturbed samples' hydraulic properties.

Subsequently, Hydrus-1D model was chosen to simulate the water movement in the soil–crop system within the experimental kiwi field, both by integrating predicted soil hydraulic properties from soil texture data and by embedding those measured from laboratory methods. The results generated by the different approaches were compared and an inverse modeling process was followed to improve the efficiency of the model's predictions based on observations.

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