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Estimation of dual permeability hydraulic properties and modeling the hydrological response of an experimental green roof

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Homogeneous soil and related darcean approaches are sometimes insufficient to describe flow processes in porous media. For this purpose, the double permeability (DP) approach was proposed by Gerke and van Genuchten (1993) and was then adapted by Lassabatere et al. (2014) to the quasi-exact implicit infiltration model of Haverkamp et al. (1994). The separation into two compartments called fast-flow and matrix regions with related volumetric fractions allows the modeling of preferential flow in soils. The inverting procedure from multiple-tension disc infiltration experiments proposed by Lassabatere et al. (2014) allows the estimation of DP hydraulic soil properties, i.e., the quantification of the volumetric fractions occupied by the two regions and their related hydraulic properties. This approach was applied to the studied experimental green roofs. Green roofs are structures known to play the role of buffer medium by absorbing the peak loads in the stormwater networks (thus reducing the risk of floods) and contributing to the attenuation of the urban heat island. The quantified hydrological contribution of these structures at the urban scale can be approached with the help of numerical modeling. In this study, we investigated the numerical modeling of the flow in vegetated roofs, which remain a challenging topic. In this study, multiple-tension infiltrometry tests were applied to experimental lysimeters simulating a vegetated roof (Yilmaz et al., 2016). These experimental infiltration data were inverted using the DP approach to estimate the properties of the material constitutive of the studied green roofs. Then Hydrus 1-D software was used to model the runoff produced by the experimental roof for several rainfall events. For this purpose, a summer period with three successive rain events was chosen, and the ability of DP to simulate the observed runoff was investigated. The results allow the validation of the proposed characterization and modeling method and provide material for understanding the hydraulic behavior of green roofs and the permanence of preferential flow in these structures.

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