EGU21-12220
https://doi.org/10.5194/egusphere-egu21-12220
EGU General Assembly 2021

Combining new techniques to investigate water dynamics above a shallow restrictive layer.

Giorgio Capello[1], Marcella Biddoccu[1], Simone Di Prima[2,3], and Laurent Lassabatere[3]
[1]Istituto di Scienze e Tecnologie per l'Energia e la Mobilità Sostenibili (STEMS), Consiglio Nazionale delle Ricerche / National Research Council, Strada delle cacce, 73, 10135 Torino, Italy (giorgio.capello@stems.cnr.it)
[2]Agricultural Department, University of Sassari, Viale Italia, 39, 07100 Sassari, Italy
[3]Univ Lyon, Université Claude Bernard Lyon 1, CNRS, ENTPE, UMR 5023 LEHNA, F-69518, Vaulx-en- Velin, France

Adopting integrated measurement techniques may enhance our understanding of hydropedological processes within the critical zone. To investigate lateral subsurface flow due to lithological discontinuities, a ponding infiltration test, two GPR surveys, and soil penetration resistance (PR) measurements were conducted on a 1 m^2 plot in a vegetated area located in the university campus of Doua (Lyon, France). A GPR grid with 0.2 m intervals was established. In the center of the grid, around the root system of a hawthorn shrub, an infiltration test was conducted using an automated single-ring infiltrometer proposed by Concialdi et al. (2020), to infiltrate a shear-thinning viscous solution (1 g L^{-1} Xanthan gum powder). The viscous solution was expected to fill preferential pathways due to the roots, with limited infiltration into the soil matrix, and thus reveal complex geometries or macropore networks in highly heterogeneous soils. To create three-dimensional (3D) representations of the infiltrated solution, two GPR surveys were carried out just before and 20 min after the infiltration test, using a GSSI (Geophysical Survey System Inc., Salem, NH) SIR 3000 system with a 900 MHz antenna. A total of 24 radargrams were collected in time mode by moving the antenna along the survey lines and recording the markers position along the survey line intersections. After the second GPR survey, PR was measured at each of the 36 intersection points of the grid using an electronic hand-pushed cone penetrometer. The cone had a 30° angle and a base area of 1 cm^2, inserted into the soil at a constant speed of 2 cm s^{-1} to a depth of 0.8 m. These measurements were aimed to highlight contrasting penetration resistance characteristics between different soil horizons. We also determined the soil bulk density from 24 undisturbed soil cores (~ 100 cm^3) collected at different depths from 0 to 50 cm. Finally, an auger was used to extract a 0.69-m-depth soil core for the direct observation of lithological heterogeneities.

Differenced radargrams from pre- and post-infiltration surveys allowed to detect the 3D infiltration bulb, which was vertically elongated and irregularly shaped, but with an evident horizontal divergence between the depth of 20 and 30 cm. Below 30 cm depth, a significant increasing of soil PR and BD (respectively higher than 2.5 MPa and 1.50 g cm^{-3}, between 30 and 50 cm depth) was detected, indicating the presence of a underlying layer, which was also identifiable by visual observation of the soil core. This dense layer impeded water flow. Consequently, the

liquid solution partially diverged laterally and accumulated upside this layer, and partially infiltrated into the dense layer along preferential flow paths in correspondence with the plant root system, as detected by the 3D GPR diagram. Summing up and considering every aspect, this study allowed to identify water perching above a shallow restrictive layer for a better understanding of the water dynamics of the investigated soil. This study shows the benefits to couple different types of soil physics approaches to relate hydrological processes to the soil hydraulic and mechanical properties.