BEST-WR for the hydraulic characterization of hydrophilic and water-repellent soils

Simone Di Prima[1,2], Ryan D. Stewart[3], Majdi R. Abou Najm[4], Ludmila Ribeiro Roder[5,6], Filippo Giadrossich[1], Rafael Angulo-Jaramillo[2], Deniz Yilmaz[7], Pier Paolo Roggero[1], Mario Pirastru[1], and Laurent Lassabatere[2]

[1]University of Sassari, Department of Agricultural Sciences, Italy (sdiprima@uniss.it)

[2]Université de Lyon; UMR5023 Ecologie des Hydrosystèmes Naturels et Anthropisés, CNRS, ENTPE, Université Lyon 1, Vaulx-en-Velin, France

[3]School of Plant and Environmental Sciences, Virginia Polytechnic Institute and State University, Blacksburg, VA, United State

[4]Department of Land, Air and Water Resources, University of California, Davis, CA 95616, United States

[5]Department of Architecture, Design and Urban planning, University of Sassari, Viale Piandanna, 4, 07100 Sassari , Italy

[6]School of Agriculture, São Paulo State University (UNESP), Fazenda Experimental Lageado, 18610-034 Botucatu, SP, Brazil

[7]Civil Engineering Department, Engineering Faculty, Munzur University, Tunceli, Turkey

Water-repellent soils usually experience water flow impedance during the early stage of a wetting process followed by progressive increase of infiltration rate. Current infiltration models are not formulated to describe this peculiar process. Similarly, simplified methods of soil hydraulic characterization (e.g., BEST) are not equipped to handle water-repellent soils. Here, we present an adaptation of the BEST method, named BEST-WR, for the hydraulic characterization of soils at any stage of water-repellency. We modified the Haverkamp explicit transient infiltration model, included in BEST for modeling infiltration data, by embedding a scaling factor describing the rate of attenuation of infiltration rate due to water repellency. The new model was validated using analytically generated data, involving soils with different texture and a dataset that included data from 60 single-ring infiltration tests. The scaling factor was used as a new index to assess soil water repellency in a Mediterranean wooded grassland, where the scattered evergreen oak trees induced more noticeable water repellency under the canopies as compared to the open spaces. The new index produced results in line with those obtained using the water drop penetration time test, which is one of the most widely test applied for quantifying soil water repellency persistence. Finally, we used BEST-WR to determine the hydraulic characteristic curves under both hydrophilic and hydrophobic conditions.