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Soil wetting processes at high temporal resolution in a semiarid mediterranean watershed with scattered tree cover

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Soil wetting processes play a key role for the distribution of water and solutes and thereby for the water availability for plants. However, characterization of such processes (from slower to faster flows), frequency of occurrence, and factors that cause them, are still poorly known. This characterization is important in hydrological studies because enables a better understanding of spatio-temporal variability of water resources and allows improving the design of models.

Using a method based on the maximal soil water increase registered by a sensor over a minimum given time interval during a rainfall event, types of soil wetting processes were classified and quantified. For this, capacitance sensors which registered the volumetric water content at high temporal resolution (30-min) along of more than two hydrological years (mainly for 2010–2011 and 2011–2012), were installed in soil profiles at 5, 15 cm, and 5 cm above the bedrock and depending on soil depth. This distribution along the soil profile is justified because soils are generally very shallow and most of the roots are concentrated in the upper layer. The sensors were gathered in 9 soil moisture stations characterized by lithology, topographic position, as well as by different vegetation covers: under tree canopy, under shrub, and in open spaces or grasslands. Besides, the data mining technique Multivariate Adaptive Regression Spline (MARS) was used to identify and rank the factors influencing flow types as well as modelling their occurrence. The work was carried out in an experimental catchment of the Spanish region of Extremadura.

Results indicated that there is a general behavior or pattern of soil moisture dynamics in the catchment with a dominant occurrence of slower soil wetting processes (>50%), which may be considered as matrix flows, and a low occurrence of those faster processes (<30%), considered as preferential flows. Nevertheless, when the total volume of water is considered then preferential flow becomes the dominant process, so that the ecological role of both flow types becomes prominent in water-limited environments. Statistical multivariate analyses based on data-mining techniques proved that although both flow types depend on variables associated with precipitation and antecedent soil moisture conditions, faster soil wetting processes are mainly related to variables as rainfall intensity and topography, while slower soil wetting processes are related to soils or vegetation.