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Event-scale soil moisture dynamics in open evergreen woodlands of southwest Spain

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Rangelands with a disperse tree cover occupy large areas in the southwestern part of the Iberian Pensinsula and are also found in other parts of the Mediterranean. In these grazed, savannah-like ecosystems water constitutes an important limiting factor for vegetation growth because of the strong summer dry period, being annual potential evapotranspiration nearly twice the annual rainfall amount. Previous studies by other authors have found lower values of soil water content below the tree canopy as compared to the open spaces, covered only by herbaceous vegetation. The differences of soil moisture between tree covered and open areas vary along the year, commonly being highest during autumn, low when water content is close to saturation and the inverse during summer. Our studies indicate that the spatial variation of soil moisture is more complex.
The main objective of this study is to analyze soil moisture dynamics at the event scale below tree canopies (Quercus ilex) and in the open spaces. Because soils are commonly very shallow (Cambisols) and a high concentration of grass roots is found in the upper five centimetres, soil moisture measurements were carried out at 5, 10, 15 and 30 cm depth. The study area is located in Extremadura. Soil moisture is measured continuously with a time resolution of 30 minutes using capacitive sensors and rainfall is registered in 5-minute intervals. Data from the hydrological year 2010-11 are presented here.
The main factors which produced variations in soil moisture in the upper 5 cm were amount and duration of the rainfall event. Rainfall intensity was also significantly related with an increase of the water content. At greater depth (30 cm) soil moisture was more related with antecedent rainfall, as for example the amount of precipitation registered 30 and 45 days prior to the event. Maximum increases produced by a rainstorm were approximately 0.20 m3m-3 in grasslands and 0.17 m3m-3 below tree canopy. However, in the uppermost soil layer and with rainfall amounts of less than 5 mm, below the tree canopy only few events (15%) produced a notable response in soil moisture, as opposed to the grasslands (42%), which points to the role of rainfall interception by the tree. Furthermore, at greater soil depth low rainfall events only produced an increase of water content in few occasions. This fact is important because more than 50% of the events registered less than 5 mm of rainfall.
Soil moisture dynamics were directly related with the wetting process, which varied according to soil cover and its antecedent water content, the characteristics of the rainfall event and the soil depth considered. In the uppermost soil layer of the grassland 86% of the maximum soil moisture values were registered during the event, whereas below the tree canopy the increase was slower and maximum values were registered at the end or after the rainfall event. At depth water dynamics were fairly similar with respect to vegetation cover, depending closely on the antecedent rainfall amounts.
Furthermore, abrupt increases of soil moisture were observed during some events, presumably related with preferential flow through macropores.