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Rainfall-runoff response and temporal soil moisture dynamics in a Mediterranean forest soil

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The monitoring of the temporal variation of soil moisture can be used to identify critical thresholds over which surface runoff can be generated, depending also of the intrinsic characteristics of the rainfall events. The objective of this work is to characterize the response curves of soil moisture to different rainfall events and to analyze they relationship with runoff generation at plot scale, in a forest soil developed on limestone in a Mediterranean semi-arid ecosystem.

The study has been carried out in the Experimental Station of Porta-Coeli (Valencia, Spain) in a system of four erosion plots (40 x 8 m) of closed type. Daily data at one hour intervals for 41 rainfall events registered have been analyzed during years 2006, 2007 and 2008.For each rainfall event the following variables have been considered: the antecedent (SMant) and the maximum values of soil moisture (SMmax) and their relationship (SMant/SMmax), rainfall volume, rainfall intensity (I30) and runoff yield.

Results showed three different response curves for soil moisture. Type I was characterized by a SM increase at the beginning of rainfall followed by a smooth decrease, with a SMant/SMmax of 0.75, which was indicative of storage of water in the soil, in spite of runoff was produced. Type II curves showed fast response and a quick and sharp decrease when rainfall cease, with SMant/SMmax of 0.46 and high runoff yield values. Finally, Type III curves showed low response, with a SMant/SMmax ratio of 0.96, and the soil moisture was maintained constant during several days after the rainfall. Rainfall volume and I30 showed significant and positive correlations with runoff yield. The SMant/SMmax relation showed significant and negative correlation coefficients with the runoff generated in the different rain events, whose intrinsic characteristics were highly variable. Runoff yield depends of SMant in that way that low rainfall volume and high SMant (around 10%) produced runoff. However, when SMant is less than 5%, it was necessary a rainfall volume higher than 20mm to produce runoff. In this study, the combination of few spatial points for soil moisture measurement, but with temporal high resolution and continuous extent provides sufficient information on the behavior of the runoff volume generated in the experimental plots.

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