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Antecedent rainfall effects on the annual variability of water repellency in a patchy-vegetated Mediterranean hillslope (Almogía experimental field site, Southern Spain)

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Several abiotic and biotic factors have been reported to describe runoff generation in Mediterranean hillslopes: e.g., slope gradient, micro-topography, vegetation pattern, soil water content, rock fragment size and distribution on soil surface, crusts, organic matter, etc. However, few investigations have been focused on the influence of soil repellency to water as runoff mechanisms. Two factors used to control water repellency in Mediterranean environments: soil moisture and organic matter content. There is a direct control of temporal rainfall distribution on soil water repellency: generally, it tends to increase during dry weather while it decreases or completely vanishes after heavy precipitation or during extended periods with high soil water contents. Also, water repellency used to be higher in soils with litter, roots, resins, waxes and other organic substances from some types of vegetation as they can be a source of hydrophobic substances, including some typical species of the Mediterranean scrublands. Studies in unburnt Mediterranean environments or burnt long time ago and more exactly of water repellency related to some vegetal shrub species are not very frequent in scientific literature. The aim of this study is to assess the influence of the rainfall variability in the water repellency of soils from a patchy-vegetated Mediterranean hillslope. The objectives are next: i) to analyze the effects of the rainfall variability on water repellency during one complete year; and ii) to determine the differences in water repellency of soils under a Mediterranean shrub specie (Cistus monspeliensis) and bare soil.
The study site corresponds to one hillslope located in Montes de Málaga (South of Spain) under dry-Mediterranean climate. The hillslope was characterized by: southfacing, mean slope gradient of 27%, metamorphic geology (phyllites), patchy-vegetated pattern and sporadic grazing. The site was cultivated with cereal and disperse almond trees until the 1950s, and not affected by fire during last 50 years. A meteorological station was installed to register rainfalls. Every month, during one complete hydrological year, water repellency was measured using the Water Drop Penetration Time (WDPT) technique. The method was applied on soil covered by Cistus monspeliensis shrub and on bare soil. Bare soil was covered by annual plants during the rainy season. The procedure was applied on smoothed horizontal soil surfaces of in situ undisturbed soils after removal of litter and organic material carefully. A total of 192 experiments were carried out under shrub and on bare soil respectively. Following a widely used classification, water repellency was classified in: WDPTs$\leq$5 s wettable soil, 5–60 s as slight, 60–600 s as strong, 600–3600 s as severe, and >3600 s as extreme water repellency. Likewise, soil water content was also sampled monthly by means of the gravimetric method coinciding with the WDPT test.
The results showed a higher water repellency under Cistus monspeliensis than under bare soil in general. There was a direct relation between the temporal variability of rainfall and soil water content and water repellency. This influence was more evident in the case of the soil under Cistus monspeliensis due to it is a vegetal specie that secretes organic substances triggering hydrophobity in soils. Nevertheless, the water repellency could become severe in bare soil when soil water content was lesser than 0.05 cm3 cm-3. Summary, the results indicated that rainfalls and thus soil water content became controlling factors of water repellency at the study site constituting runoff factors all of them.