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Spatio-temporal dynamics of soil water in a semi-arid Mediterranean ecosystem: implications for plant dynamics and spatial pattern.

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Soil water presents high temporal and spatial variability in drylands. The temporal variability is determined by the heterogeneous and unpredictable rainfall pattern in these ecosystems. The spatial variability is associated to the well-known "source-sink" eco-hydrological dynamics occurring in drylands, related to the patchy vegetation and bare soil structure with water run-off generated on the bare soil patches and water infiltration preferentially into vegetated areas. These run-off – run-on systems has been extensively studied and the processes involved are well known, including the role of different plant types capturing the water run-on, increasing infiltration and reducing evaporation under plant canopies. However, integrative studies of hydrological and ecological processes in a whole ecosystem during a prolonged time period are scarce, despite the relevance of this approach to understand the role of hydrological processes (and what hydrological process are most important) determining plant dynamics and spatial pattern. We present an eco-hydrological study conducted in a semiarid Mediterranean ecosystem in the Middle Ebro Valley (NE Spain), where soil water content and patterns of plant establishment were followed during 30 months in 4 microsites: open bare areas, under two shrub species (Salsola vermiculata and Artemisia herba-alba) and one perennial grass species (Lygeum spartum). These 4 microsites represent the vast majority of the land in the ecosystem under study. Water infiltration, photosynthetic photon flux and soil temperature were also recorded in the 4 microsites. Simultaneously, seedling establishment and survival were recorded twice per year in the same microsites. Lygeum spartum was the microsite with the largest increment in water infiltration, and with the largest reduction in both solar radiation and soil temperature when compared with the measurement in the open bare areas. However, soil water content after rainfall under the canopy of Salsola vermiculata was the largest, indicating that canopy interception could be a less relevant process under the canopy of S. vermiculata than under the canopy of L. spartum. Moreover, there was an interactive effect of the soil water content before rainfall and the magnitude of the rainfall with the microsite (i.e. wet bare soils infiltrated more water than dry bare soils, being this difference less relevant in the vegetated microsites). Patterns of seedling establishment and survival correlated to patterns in soil water content, pointing out the relevance of the eco-hydrological spatio-temporal heterogeneity in the dynamics and spatial pattern of plant communities. Seedling establishment occurs in the first centimetres of soil, where competition for water (under Lygeum spartum) and evaporation (in the open bare soil areas) seems to reduce the water availability for plant establishment.