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Impact of herbaceous understory vegetation to ecosystem water cycle, productivity and infiltration in a semi arid oak woodland assessed by stable oxygen isotopes

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Water is one of the key factors driving ecosystem productivity, especially in water-limited ecosystems. Thus a separation of these component fluxes is needed to gain a functional understanding on the development of net ecosystem water and carbon fluxes. Oxygen isotope signatures are valuable tracers for such water movements within the ecosystem because of the distinct isotopic compositions of water in the soil and vegetation.

Here, a novel approach was used (Dubbert et al., 2013), combining a custom build flow-through gas-exchange branch chamber with a Cavity Ring-Down Spectrometer in a Mediterranean cork-oak woodland where two vegetation layers respond differently to drought: oak-trees (Quercus suber L.) avoid drought due to their access to ground water while herbaceous plants survive the summer as seeds. We used this approach to quantify the impact of the understory herbaceous vegetation on ecosystem carbon and water fluxes throughout the year and disentangle how ET components of the ecosystem relate to carbon dioxide exchange.

Partitioning ecosystem ET and NEE into its three sources revealed that understory vegetation contributed markedly to ecosystem ET and gross primary production (GPP; max. 43 and 51%, respectively). It reached similar water-use efficiencies (WUE) as cork-oak trees and significantly contributed to the ecosystem sink-strength in spring and fall. The understory vegetation layer further strongly inhibited soil evaporation (E) and, although E was large during wet periods, it did not diminish ecosystem WUE during water-limited times (Dubbert et al., 2014a). Although, during most of the year, interactions with trees neither facilitated nor hampered the development of the understory vegetation, strong competition for water could be observed at the end of the growing period, which shortened the life-cycle of understory plants and significantly reduced the carbon uptake of the ecosystem in spring (Dubbert et al., 2014b). Finally, herbaceous understory vegetation strongly increased rain infiltration, specifically during strong rain events.

In conclusion, bene[U+FB01]cial understory vegetation effects were dominant. However, the observed vulnerability of the understory vegetation to drought and competition for water with trees suggests, that increased drought and altered precipitation pattern as predicted in future climate change scenarios for the Mediterranean basin not only threaten understory development. They also very likely decrease rain in[U+FB01]ltration and ground water recharge by decreasing understory vegetation cover and increasing amount of heavy precipitation events with high run-off from sealed bare soils. This in turn can severely diminish cork-oak productivity and hence the resilience of the ecosystem toward drought (Costa e Silva et al., in rev.).

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