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Impact of recurrent extreme drought events and shrub invasion on Mediterranean cork oak ecosystem functioning and resilience

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Extreme drought events and plant invasion are concurrently threatening water-limited ecosystems. Especially in the Mediterranean Basin, extreme drought events have increased in the past years with detrimental effects on many ecosystems. Such events rapidly increase the vulnerability of forest ecosystems by decreasing soil water resources, reducing fitness and growth of trees and finally leading to increased mortality rates. Shrub invasion can further exaggerate these effects and dangerously decrease tree resilience, eventually turning ecosystems into an alternate state of degraded shrublands. However, experimental evidence on the interaction of recurrent extreme drought and plant invasion is still scarce and inconclusive, as synergistic effects of different stressors are often neglected.

Thus, we aim to gain a comprehensive knowledge of the underlying mechanisms of recurrent extreme droughts, shrub invasion and their cumulative effects in a Mediterranean ecosystem. To this end, an open savannah-type cork oak (*Quercus suber*) ecosystem invaded by the native shrub *Cistus ladanifer* was chosen in South-Eastern Portugal. In three experimental blocks, a rainout shelter (30 %) was installed in an uninvaded and invaded cork-oak stand, supplemented by corresponding control plots, in December 2017. Measurements of water and carbon fluxes of trees (n = 36), shrubs (n = 18) and the ecosystem in total will allow to unravel species-specific responses and competition effects under recurrent extreme droughts. We aim to determine the stress tolerance and critical thresholds of physiological functioning for both species as well as for the entire ecosystem. Hence, these data will help to predict the vulnerability of cork oak ecosystems to progressing climate change and support future management and conservation decisions for these valuable ecosystems.

The first year of measurements was dominated by a wet and cold spring, which was followed by a drought period from July to the middle of October. Due to the heavy spring rainfall, no significant effects could be observed between treatments. However, a species-specific behaviour was evident. Pre-dawn leaf water potentials (Ψ_{PD}) of *C. ladanifer* decreased from -0.57$\pm$0.03 MPa to -3.46$\pm$0.05 MPa in the drought period. On the other hand, Ψ_{PD} of *Q. suber* did not fall below -1.48$\pm$0.06 MPa in any treatment. In addition, ecosystem transpiration was clearly dominated by shrubs with maximum sap flow rates (8.8 ± 0.8 m^3 m^{-2} day^{-1}) over three-fold higher than those of trees. These differences clearly point towards two distinctly different drought adaptation strategies of the investigated species.