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Extreme drought event and shrub invasion combine to reduce ecosystem functioning and resilience in water-limited climates

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Extreme droughts and plant invasions are major drivers of global change that can critically affect ecosystem functioning. Shrub encroachment is increasing in many regions worldwide and extreme events are projected to increase in frequency and intensity, namely in the Mediterranean region. Nevertheless, little is known about how these drivers may interact and affect ecosystem functioning and resilience to extreme droughts.

Using a manipulative shrub removal experiment and the co-occurrence of an extreme drought event (2011/2012) in a Mediterranean woodland, we show that the native shrub invasion and extreme drought combined to reduce ecosystem transpiration and the resilience of the key-stone oak tree species. We established six 25 x 25 m paired plots in a shrub (Cistus ladanifer L.) encroached Mediterranean cork-oak (Quercus suber L.) woodland. We measured sapflow and pre-dawn leaf water potential of trees and shrubs and soil water content in all plots during three years. We determined the resilience of tree transpiration to evaluate to what extent trees recovered from the extreme drought event. From February to November 2011 we conducted baseline measurements for plot comparison. In November 2011 all the shrubs from one of all the paired plots were cut and removed.

Ecosystem transpiration was dominated by the water use of the invasive shrub, which further increased after the extreme drought. Simultaneously, tree transpiration in invaded plots declined much stronger (67 $\pm$ 13 %) than in plots cleared from shrubs (31 $\pm$ 11%) relative to the pre-drought year. Trees in invaded plots were not able to recover in the following wetter year showing lower resilience to the extreme drought event. Our results imply that in Mediterranean-type of climates invasion by water spending species can combine with projected recurrent extreme droughts causing critical drought tolerance thresholds of trees to be overcome increasing the probability of tree mortality (Caldeira et.al. 2015).

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