Mediterranean cork oak woodlands and global changes: Synergistic and negative effects of recurrent droughts and shrub encroachment

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Motivation

- Risk for **extreme droughts** in the Mediterranean
- Effects can be exaggerated by **shrub invasion**
- Threatening the existence of valuable ecosystems
- Synergistic effects of **both stressor** unknown

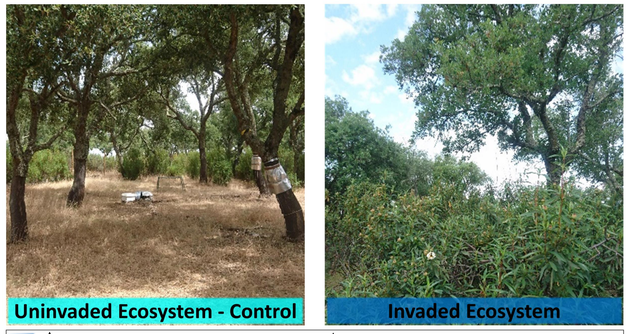

Figure 1: Concept of ecosystem response to drought and shrub encroachment (modified after Caldeira et al., 2015).

Objectives

- **Species-specific responses** and **competition effects** under extreme drought
- **Stress tolerance** and **critical thresholds** for **ecosystem functioning and resilience**

Methods

- Ecosystem in South-East Portugal dominated by **cork oak** (*Quercus suber*) and **gum rockrose** (*Cistus ladanifer*)
- Installation of rainout shelter (45 % exclusion) and shrub removal in control plots
- Four treatments (see Fig. 1) with 36 trees and 18 shrubs in 3 blocks
- Measurement of water and carbon fluxes

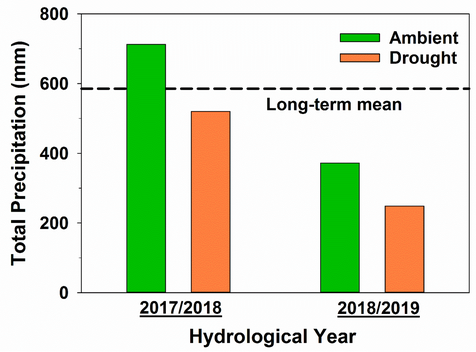

Figure 2: Precipitation in 2017/18 and 2018/19.

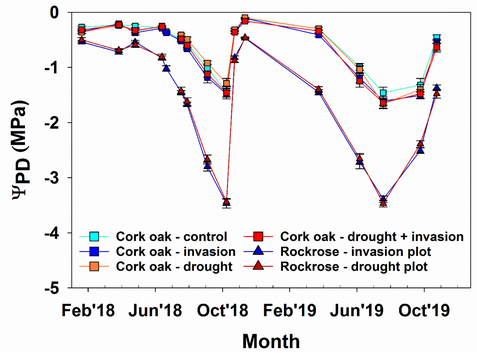

Figure 3: Pre-dawn leaf water potential for all treatments.

Results I

- Wet and cold spring 2018, late on-set of moderate drought
- Natural and experimental drought in 2019
- Species-specific responses in Ψ, sap flux density and $\delta^{18}O$
- Invaded and/or drought stressed trees with lower Ψ (2019)

- Sap flux of shrubs four-fold higher than of trees in 2018
- Maximum shrub sap flow reduced by 47 % in 2019
- Sap flux of invaded and drought stressed trees reduced by over 50 % during drought in 2019

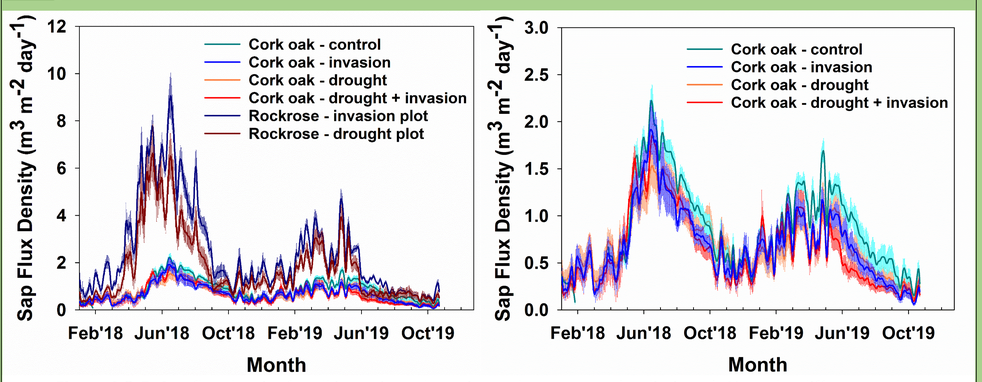

Figure 4 & 5: Sap flux density for all investigated species and treatments (preliminary). Note the different scales.

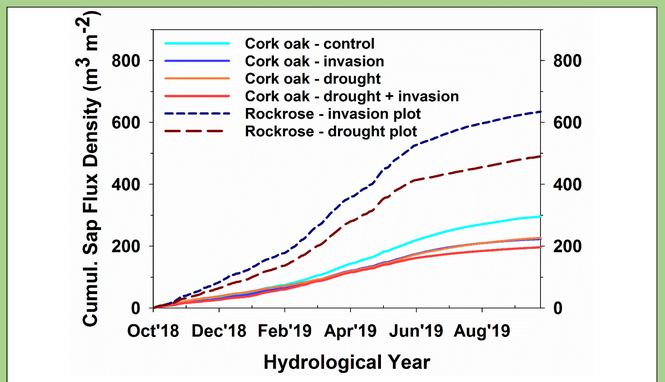

Figure 6: Cumulative sap flux density for all treatments in 2018/19 (preliminary).

Results II

- Combined effects reduced tree sap flux by 33 % cumulatively in a dry hydrological year
- Trees use deeper water resources than shrubs
- Data from 2019 will reveal the effect of drought and invasion on tree water sources

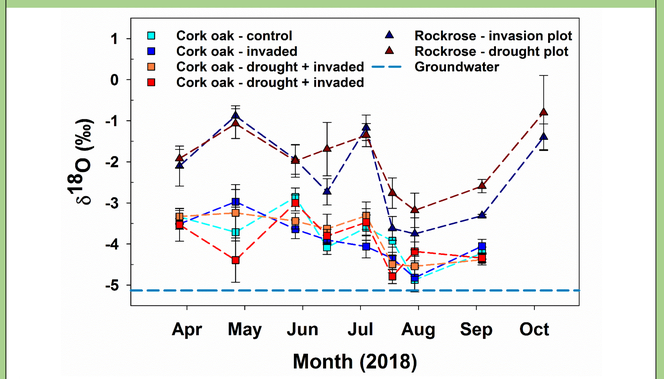

Figure 7: $\delta^{18}O$ signature of xylem water for all treatments (preliminary).

Conclusion

- Different drought adaptation strategies of species
- Invasion under moderate drought manageable
- Effects under extreme drought more visible
- Negative synergistic effects of drought and invasion

References

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- Dubbert et al. (2019), New Phytol. 222, doi:10.1111/nph.15670