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

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Objectives

- 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

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

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 δ18O
- 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

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

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

- Caldeira et al. (2015), Sci. Rep. 5, doi:10.1038/srep15110
- Dubbert et al. (2019), New Phytol. 222, doi:10.1111/nph.15670

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

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

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

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).

Figure 7: δ18O signature of xylem water for all treatments (preliminary).