Extreme drought event in Central-Europe in 2018: Its impact on beech forests and their recovery

University of Basel

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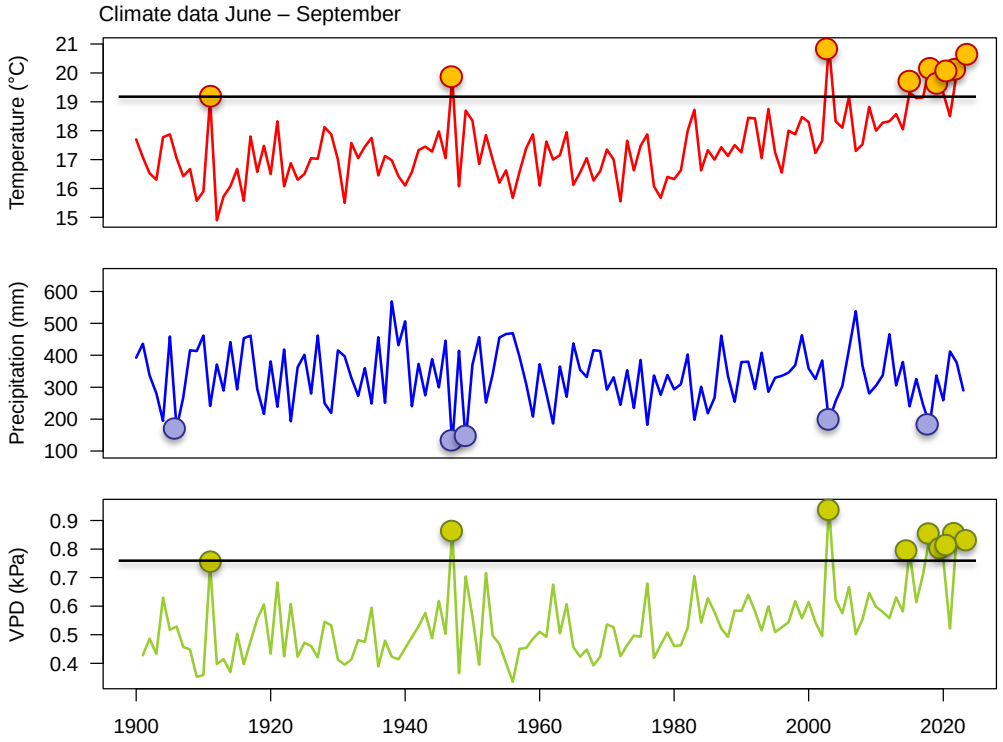
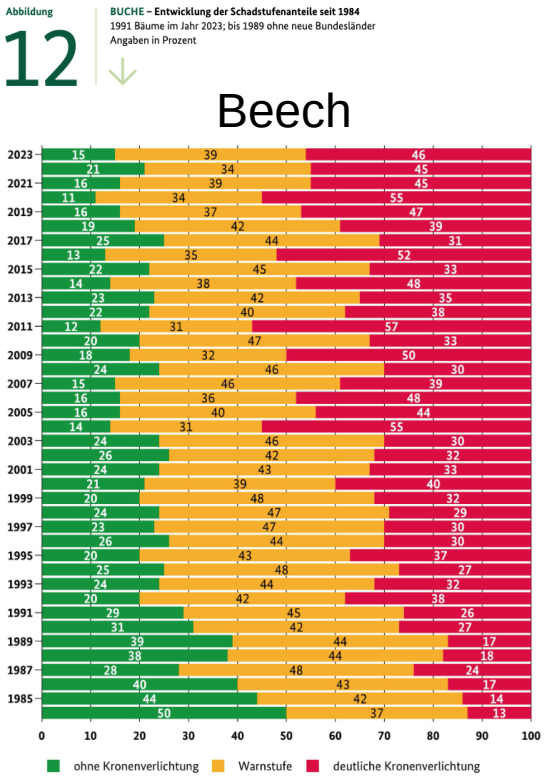
University of Basel

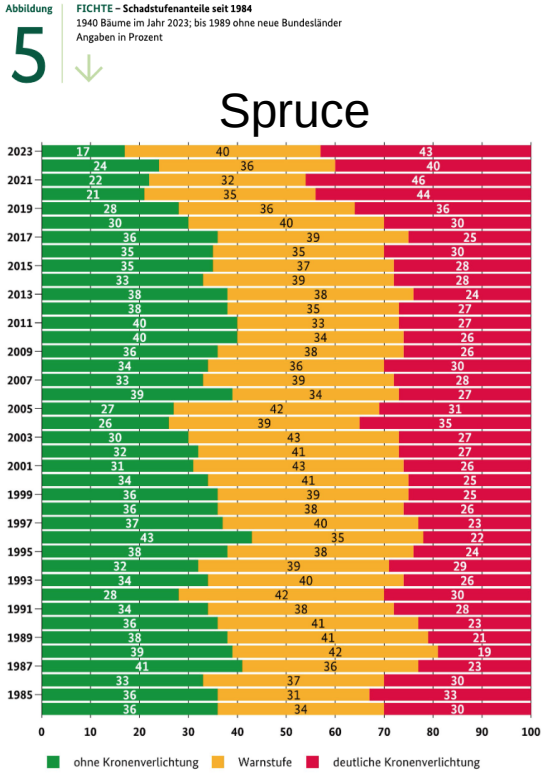
Climate Trends for Basel, Switzerland



modified after Kahmen et al. 2022, *Plant Biology*

Trends in Tree Health



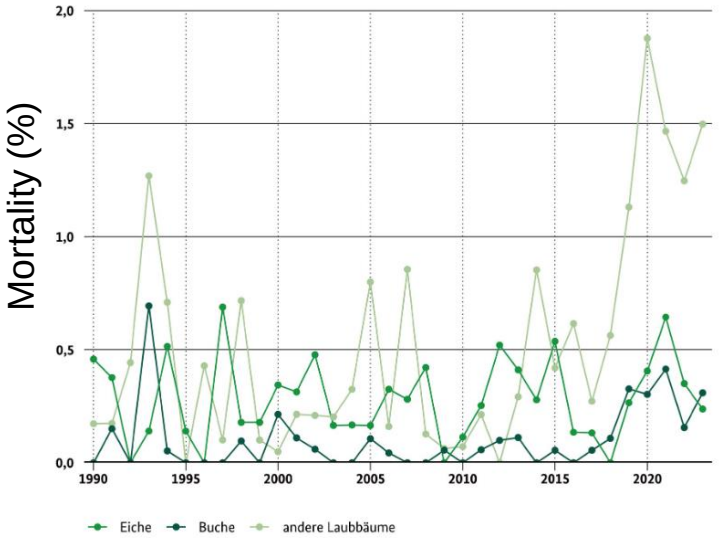


Waldzustandserhebung 2023, BMEL

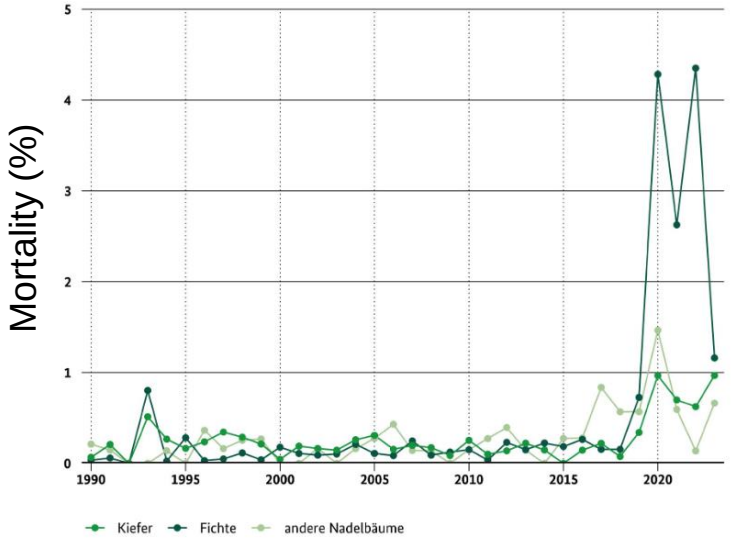
Trends in Tree Mortality

Mortality in Beech and Spruce in Germany 1990 - 2023

Beech



Spruce



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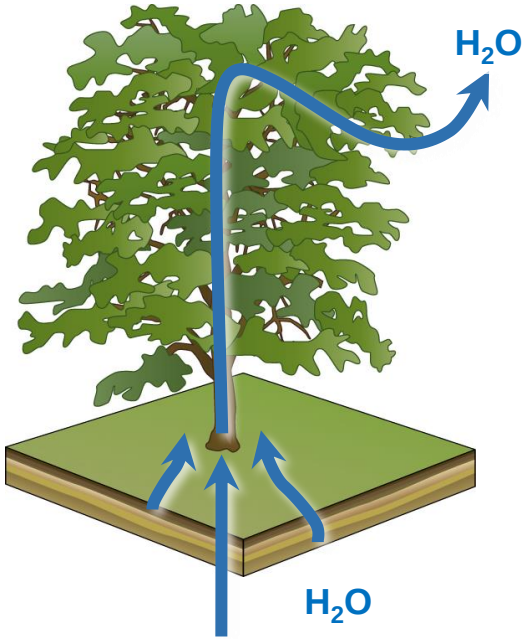
Mechanisms of Drought-Induced Tree Mortality

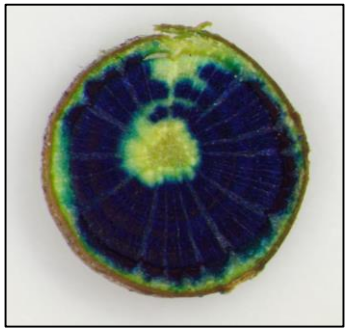
Water loss leads to tension (Ψ) in the xylem

→Embolism can form and result in a collapse of the hydraulic system



Mechanisms of Drought-Induced Tree Mortality

Measuring the loss of hydraulic conductivity

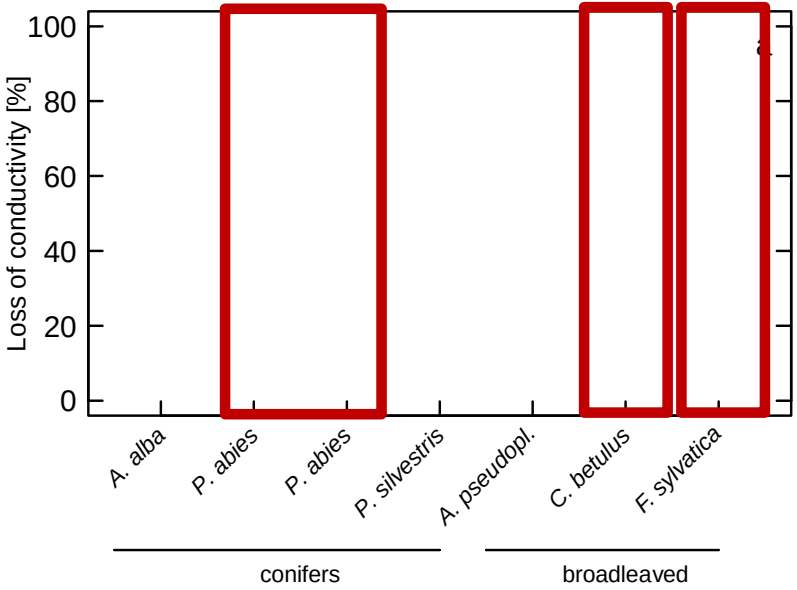


Intact hydraulic conductivity

Impaired hydraulic conductivity

Mechanisms of Drought-Induced Tree Mortality

Loss of hydraulic conductivity during the 2018 drought

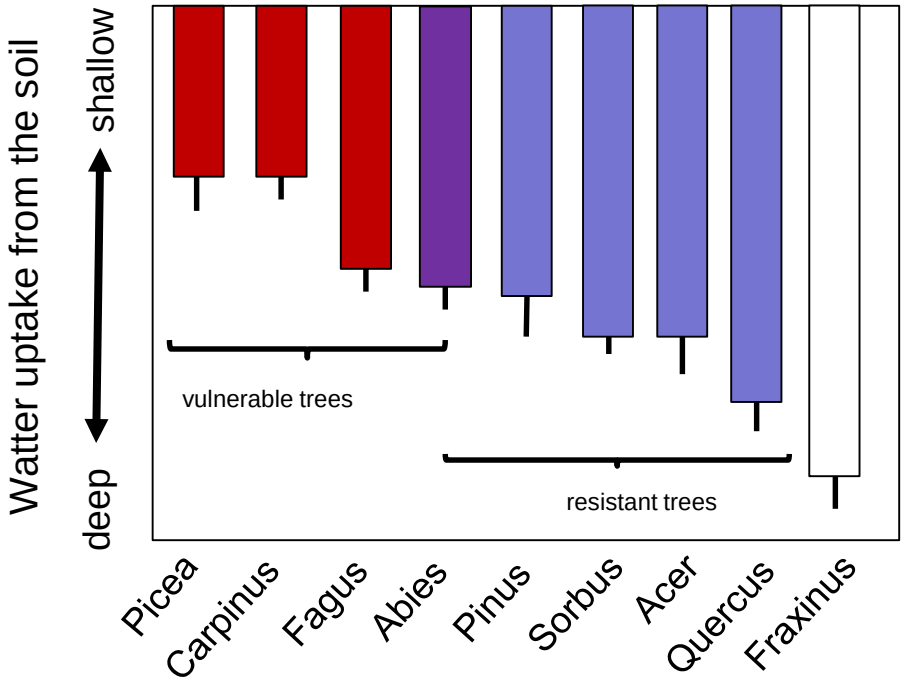


→ Drought vulnerability of different tree species differs

Arend et al. 2021, *PNAS*; Kahmen et al. 2022, *Plant Biol.*

Mechanisms of Drought-Induced Tree Mortality

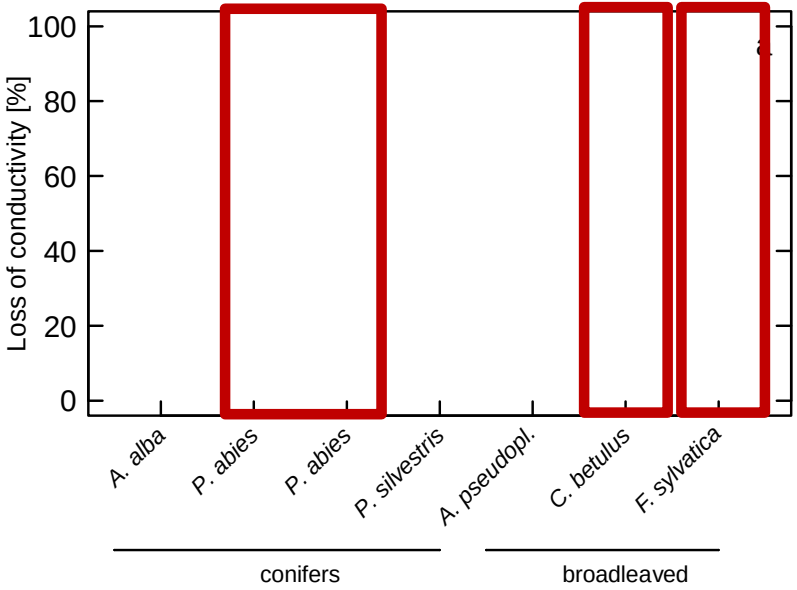
Rooting depth determines differences in drought vulnerability



modified afer Kahmen et al. 2022, *Plant Biol.*

Mechanisms of Drought-Induced Tree Mortality

Loss of hydraulic conductivity during the 2018 drought



→ Drought vulnerability of different tree species differs

→ Conifers and broadleaves show different response patterns

Arend et al. 2021, *PNAS*; Kahmen et al. 2022, *Plant Biol.*

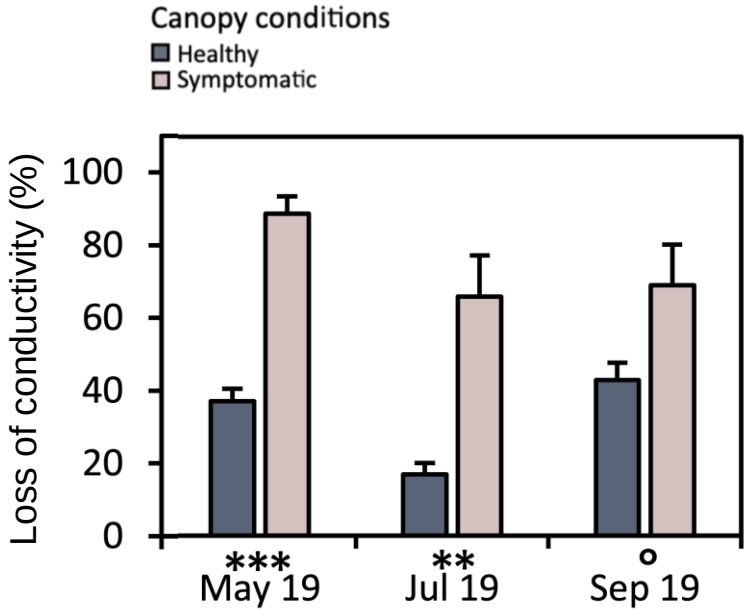

August 2018


June 2019

Recovery and Drought Legacy of Beech Trees

Loss of hydraulic conductivity does not recover after drought

→ No evience for xylem re-filling following wet winter and spring months.

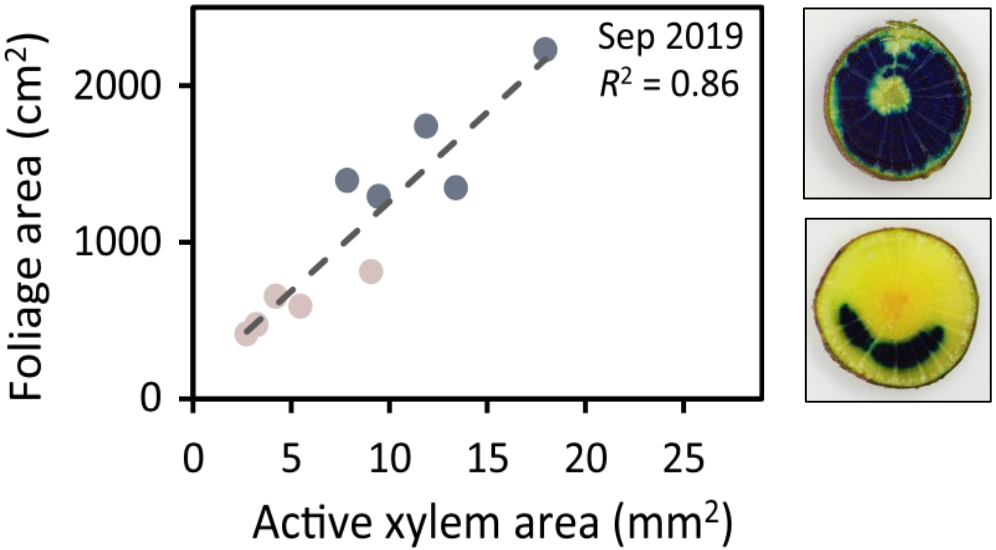


Arend et al. 2022, *New Phytologist*

Recovery and Drought Legacy of Beech Trees

Loss of hydraulic conductivity causes canopy decline and dieback

→ Reduced water supply to the canopy constrains canopy leaf area

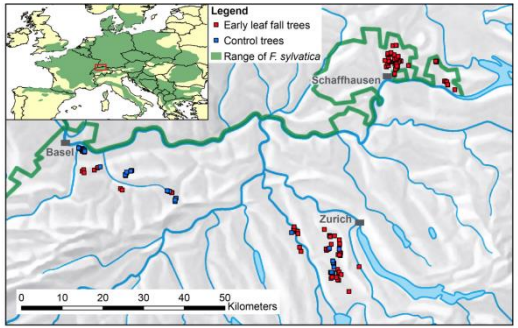


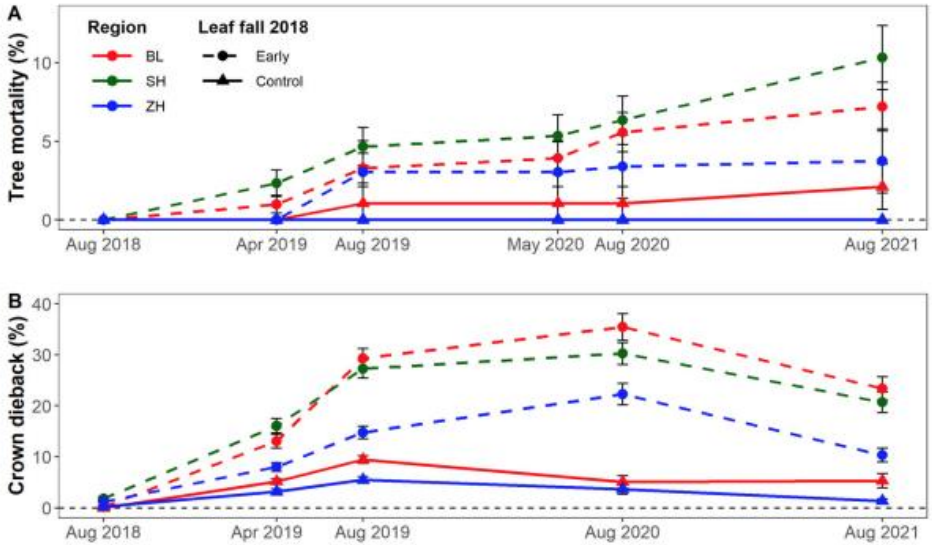
Arend et al. 2022, *New Phytologist*

Recovery and Drought Legacy of Beech Trees

Canopy decline and dieback increases mortality risk

→ Canopy decline during the 2018 drought increased the mortality risk of beech in the following years



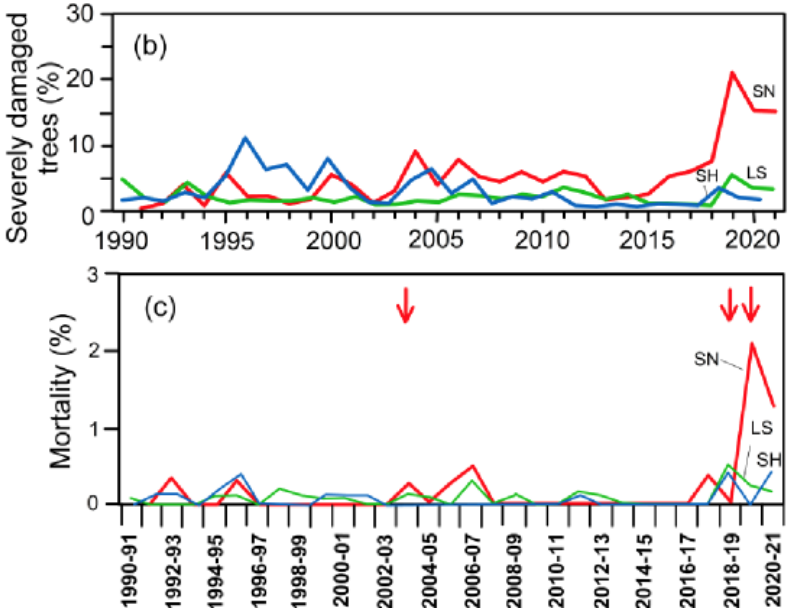


Frei et al. 2022, *Plant Biology*

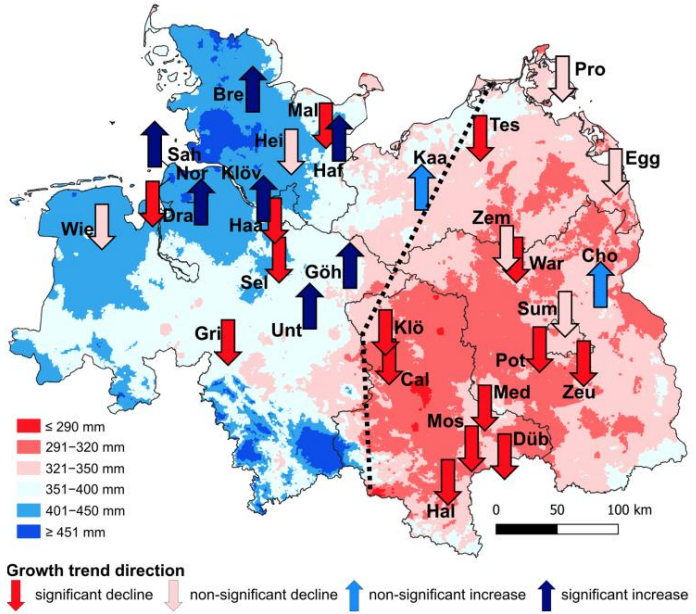
Spatial Variability of Climate Change Impacts

Drought responses of beech are spatially variable

e.g. case study from northern Germany



Growth trends 1983 - 2017



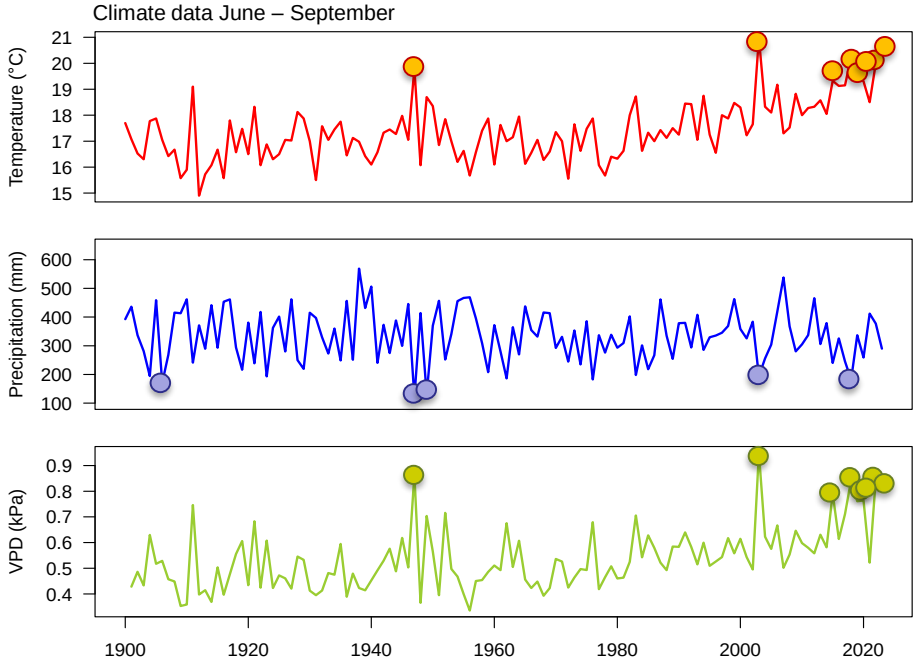
Leuschner et al. 2023, *Forests*

Summary

- → Temperature and VPD increases since the 1980ies have caused a decline in beech vitality across central Europe.
- → Drought events cause the partial and irreversible loss of hydraulic conductivity in the canopy of beech trees.
- → Beech (and spuce) are particularely vulnerable because of their shallow rooting system.
- → Loss of hydraulic conductivity causes canopy decline, canopy dieback and increases the risk of mortality of trees in beech stands.
- → Drought and climate chage responses of beech trees are spatially variable and depend on the amount of summer precipitation and soil edaphic factors.

Outlook and Open Questions

As climate change progresses, beech trees will be increasingly at risk



modified after Kahmen et al. 2022, *Plant Biology*

Outlook and Open Questions

Acclimation and adaptation potential:

- → What is the acclimation potential of established trees (phenotypic plasticity)?
- → How high is the adaptability of beech populations (population-level genetic diversity)?
- → How high is the genotypic diversity across different population (provenances)?