

Lessons learned from a long-term irrigation experiment in a dry Scots pine forest: Impacts on traits and functioning

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Beat Wermelinger¹ | **Thomas Wohlgemuth¹** | **Roman Zweifel¹** | **Marcus Schaub¹**

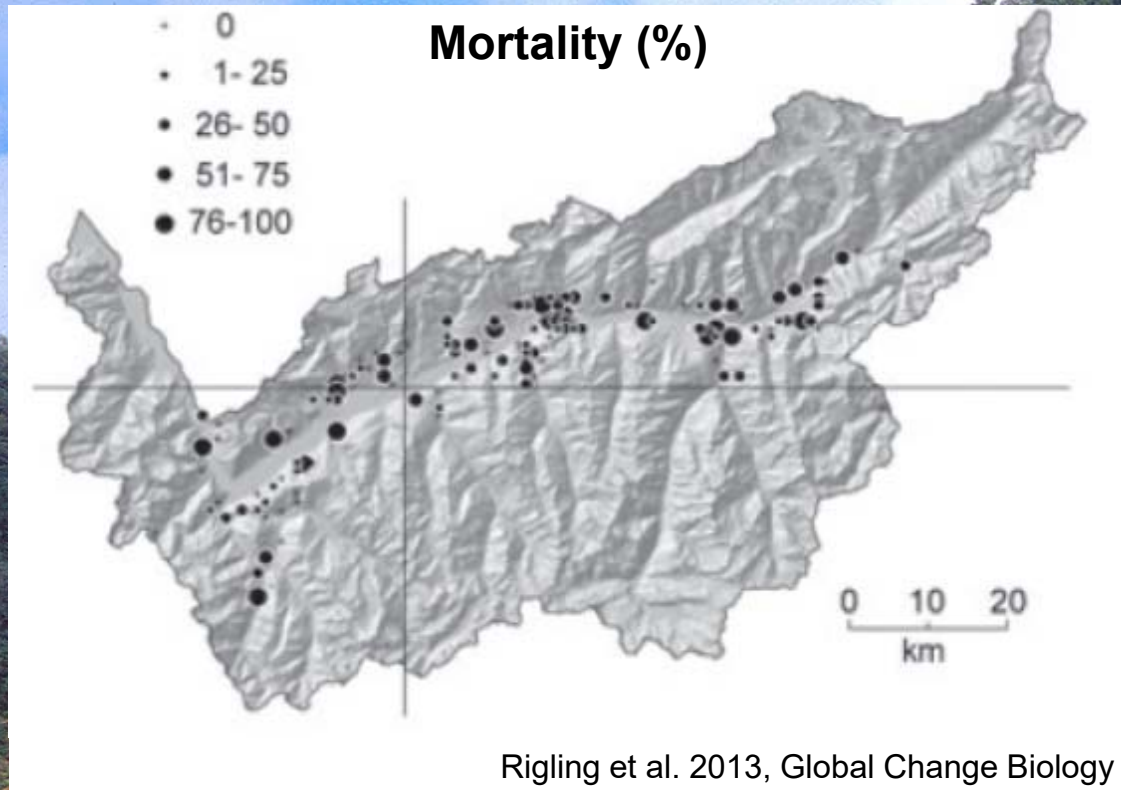
Arun K. Bose,
Pfynwald workshop, February 14th, 2022

Tree mortality (Switzerland – Visp, 1996)

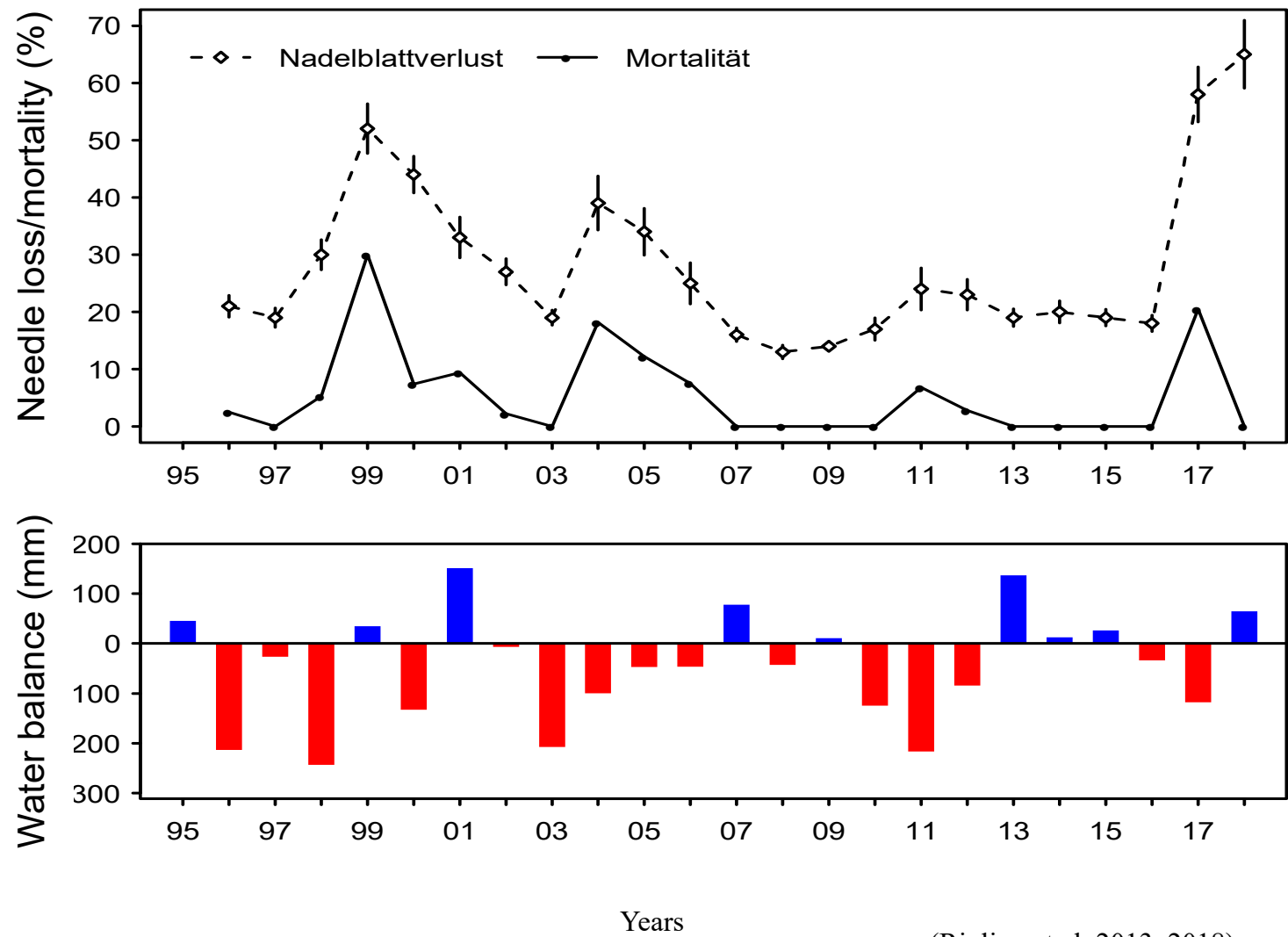


Foto: B. Wermelinger

Tree mortality (Switzerland – Visp, 1996)

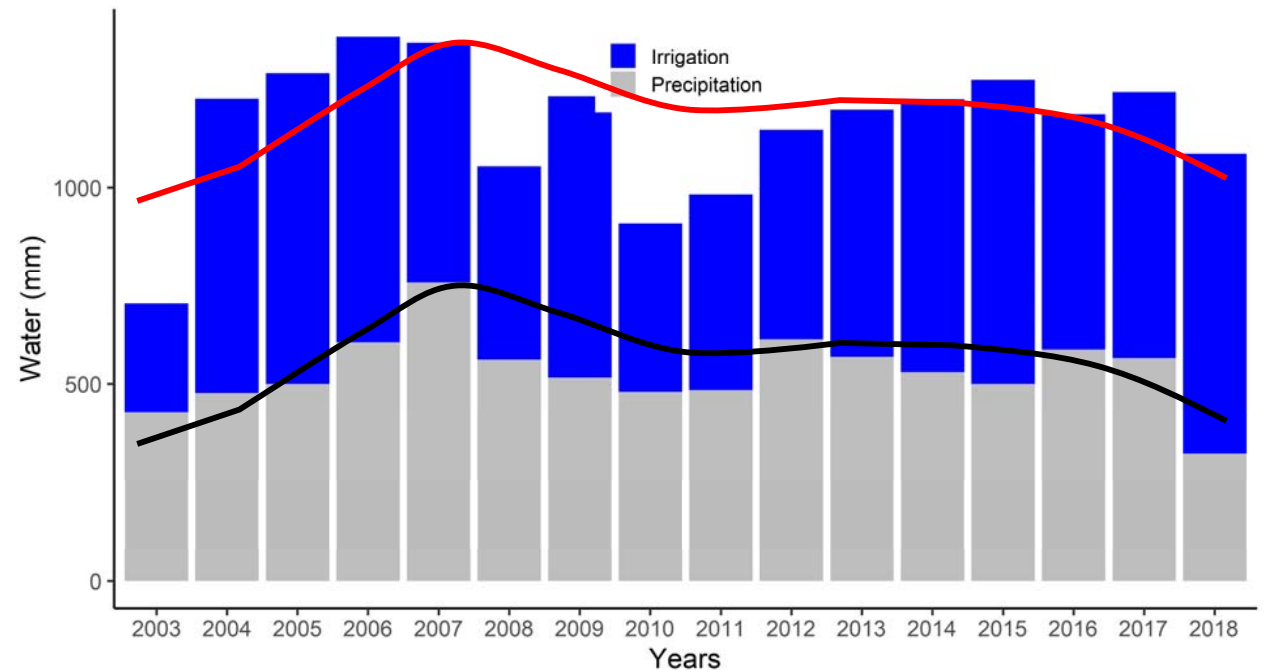
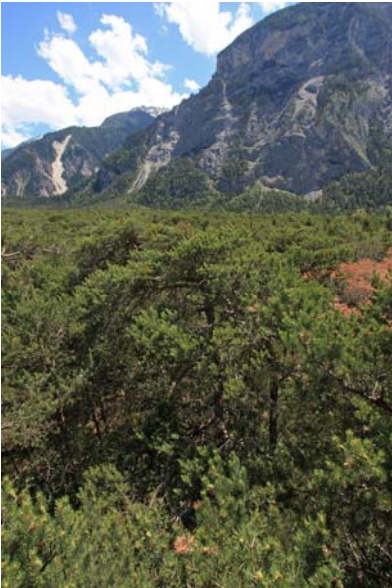


Drought-induced tree mortality

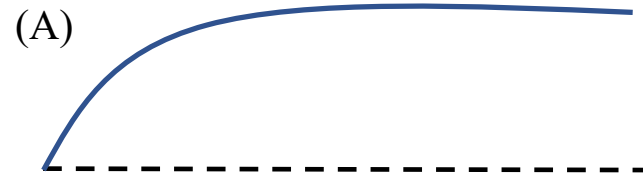
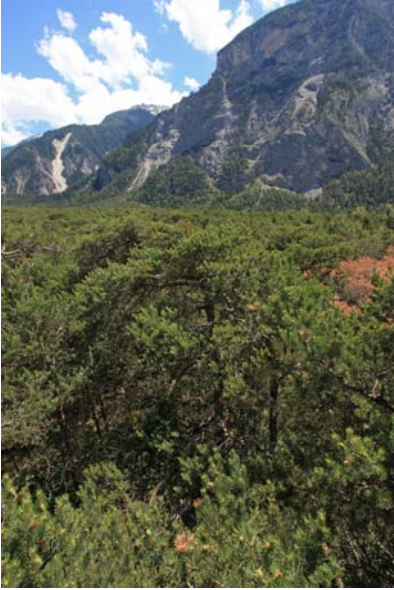


(Rigling et al. 2013, 2018)

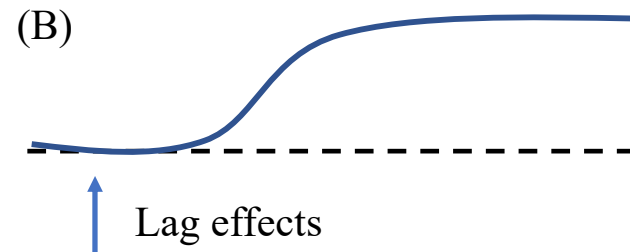
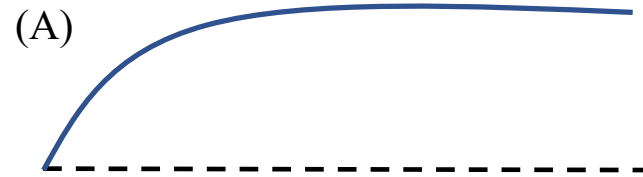
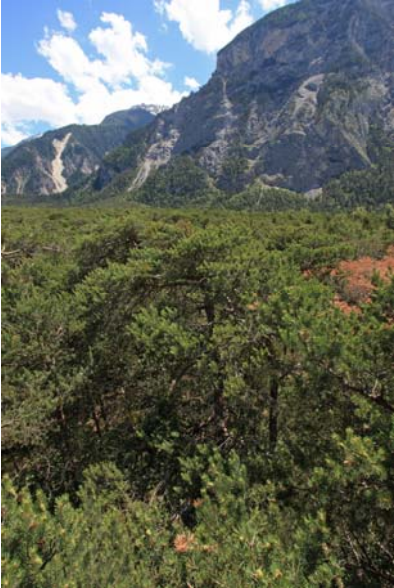
Irrigation experiment in a dry Scots pine forest



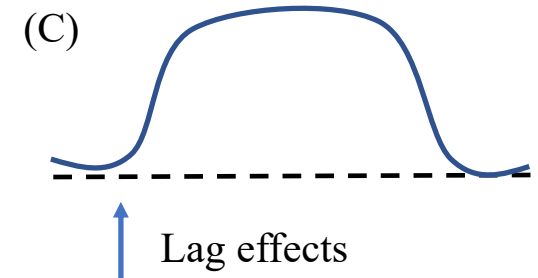
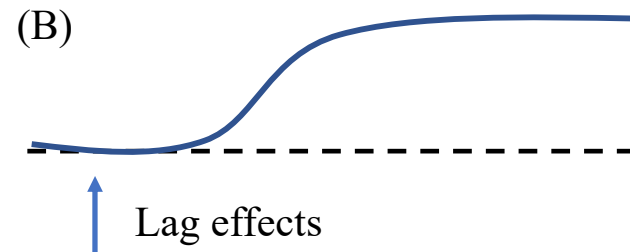
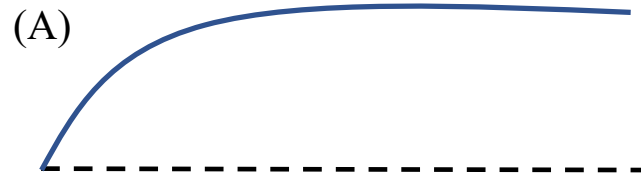
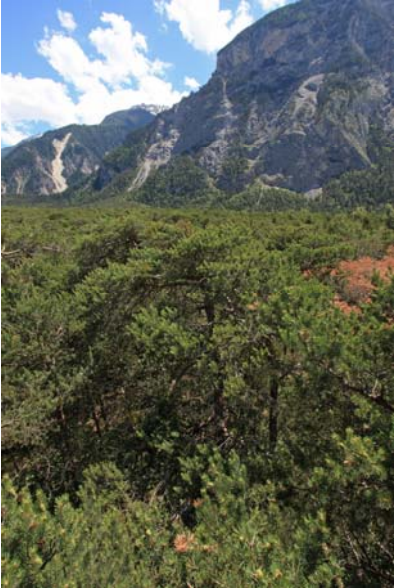
Long-term response patterns



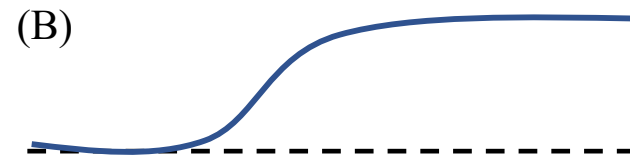
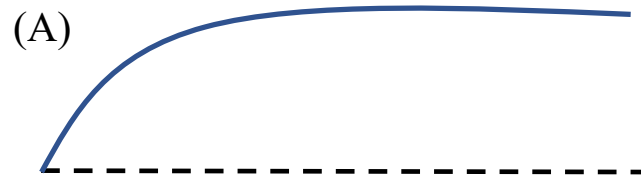
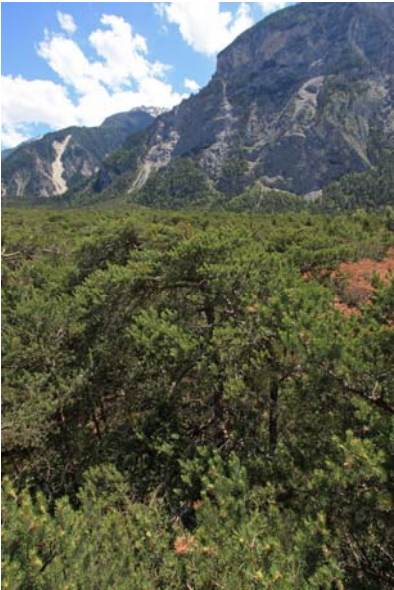
Long-term response patterns



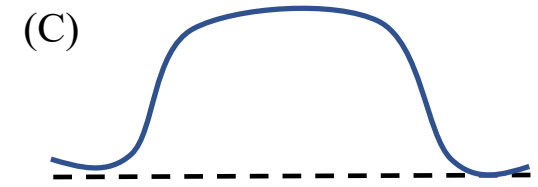
Long-term response patterns



Long-term response patterns



↑
Lag effects



↑
Lag effects



Data

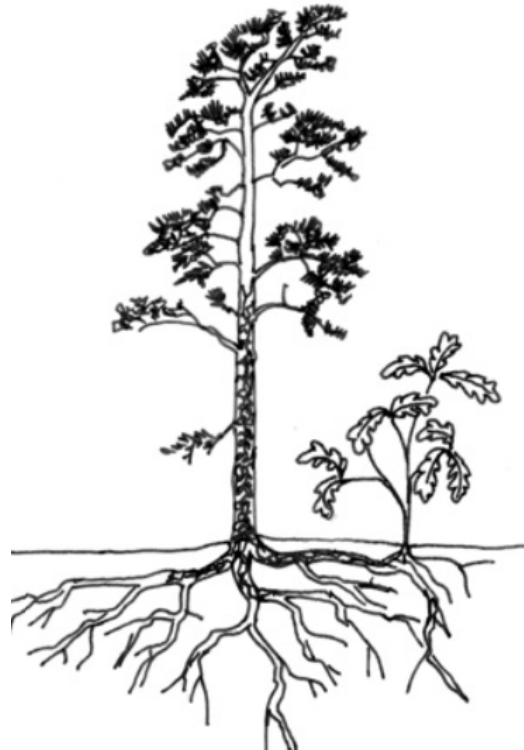
Tree-level

- ✓ Needle length
- ✓ Shoot length
- ✓ Leaf area index
- ✓ Crown transparency
- ✓ Radial growth
- ✓ $\delta^{13}\text{C}$ in tree ring
- ✓ Fine root biomass
- ✓ Tree survival

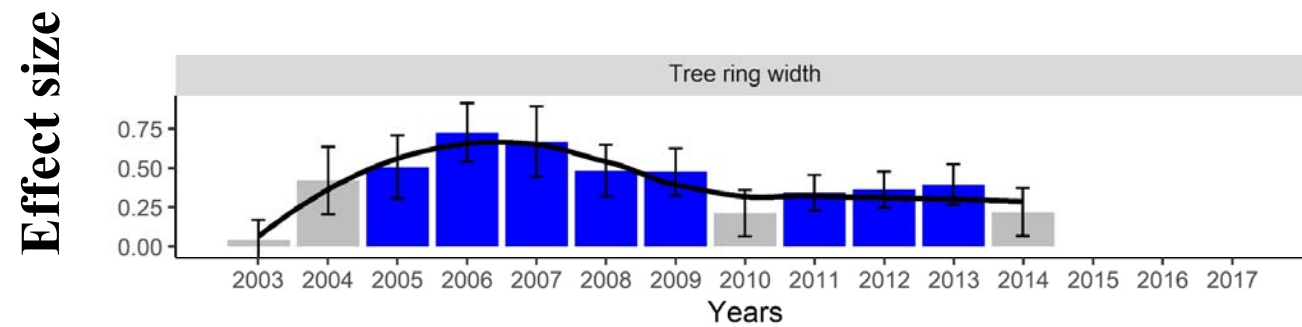


Ecosystem-level

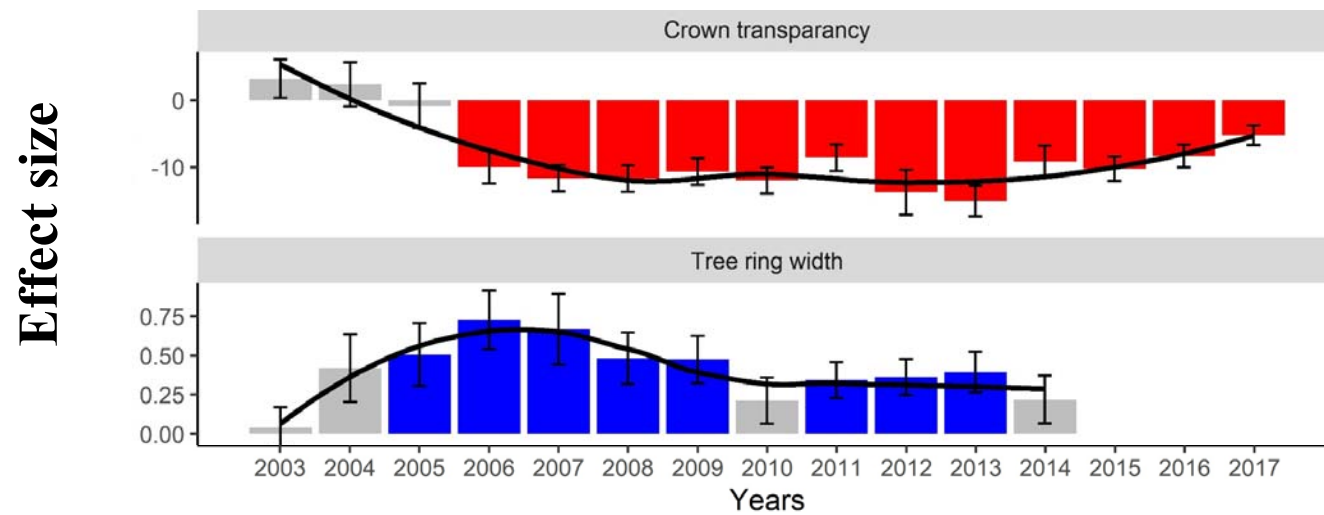
- ✓ Volumetric soil water
- ✓ Stand-level basal area of live trees
- ✓ Regeneration abundances
- ✓ Litterfall
- ✓ Litter decomposition rate
- ✓ *Tomicus* abundances
- ✓ Fungal fruit body abundances



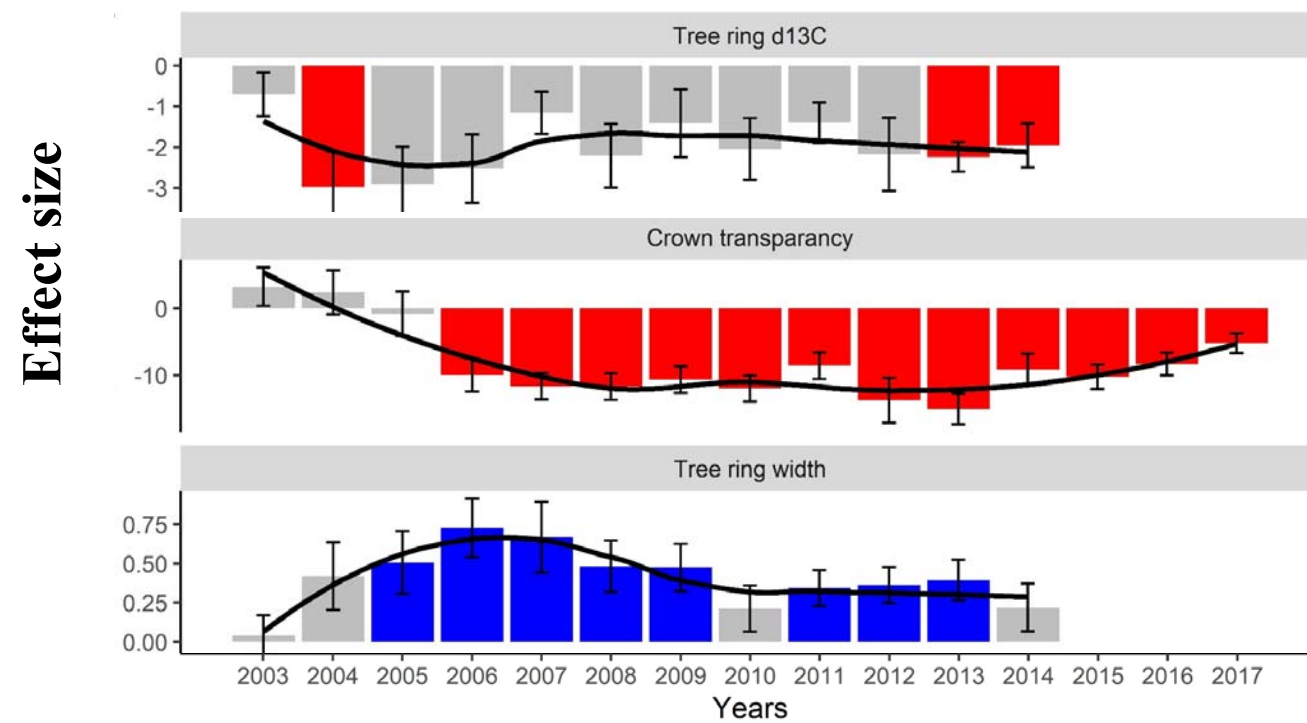
Results, Tree-level



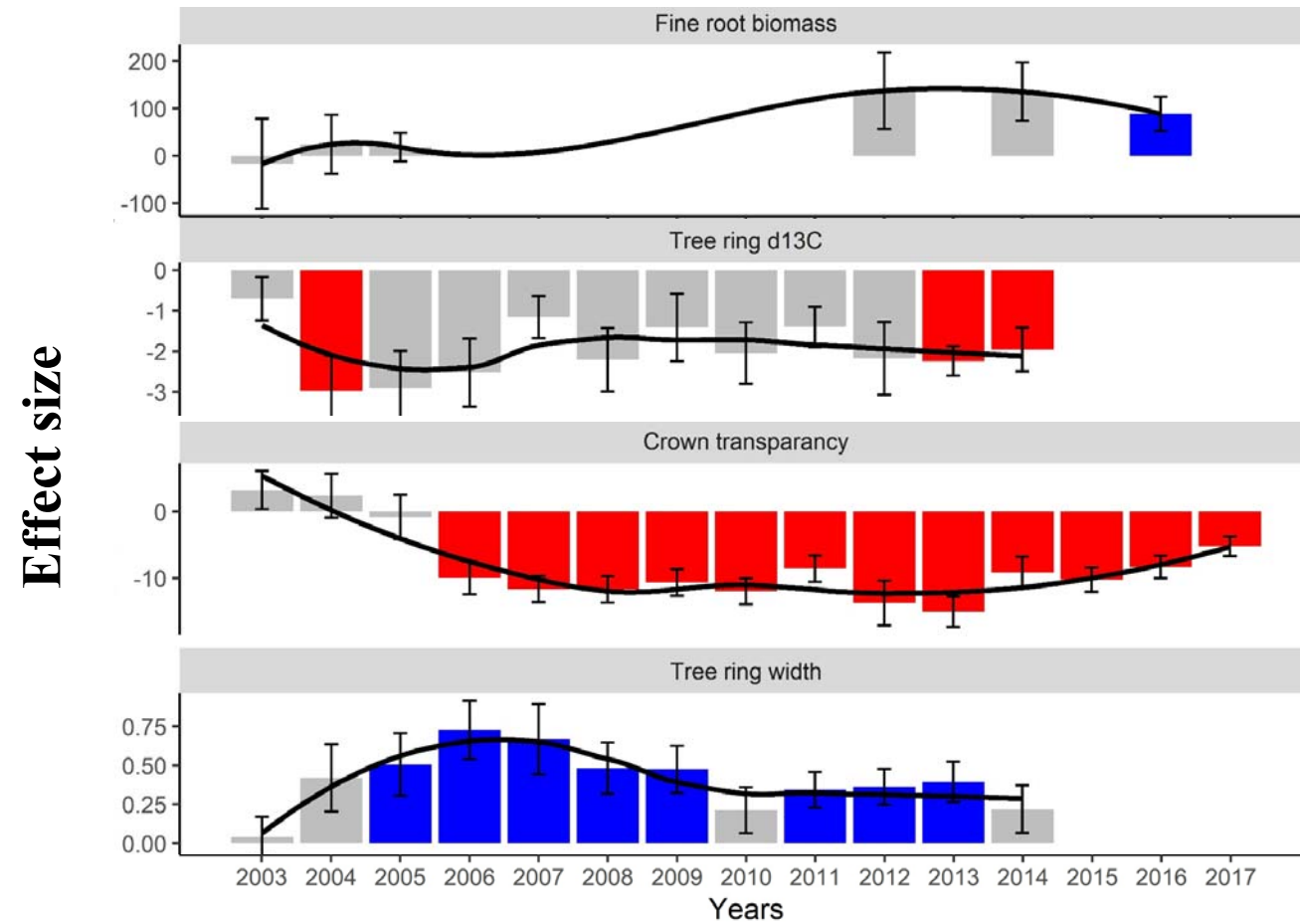
Results, Tree-level



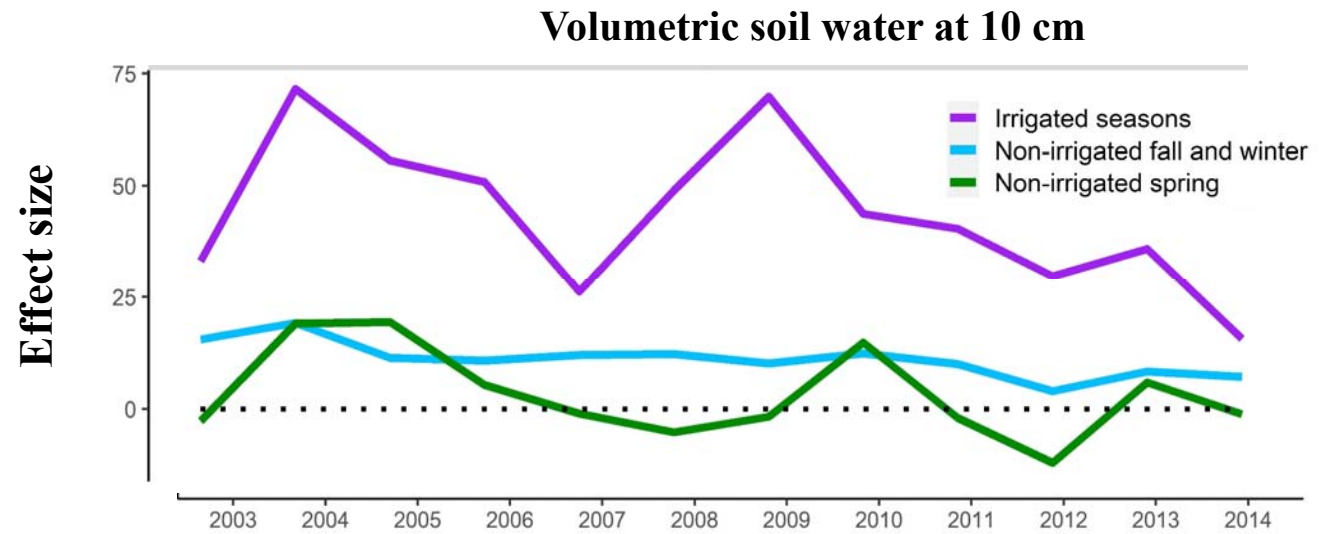
Results, Tree-level



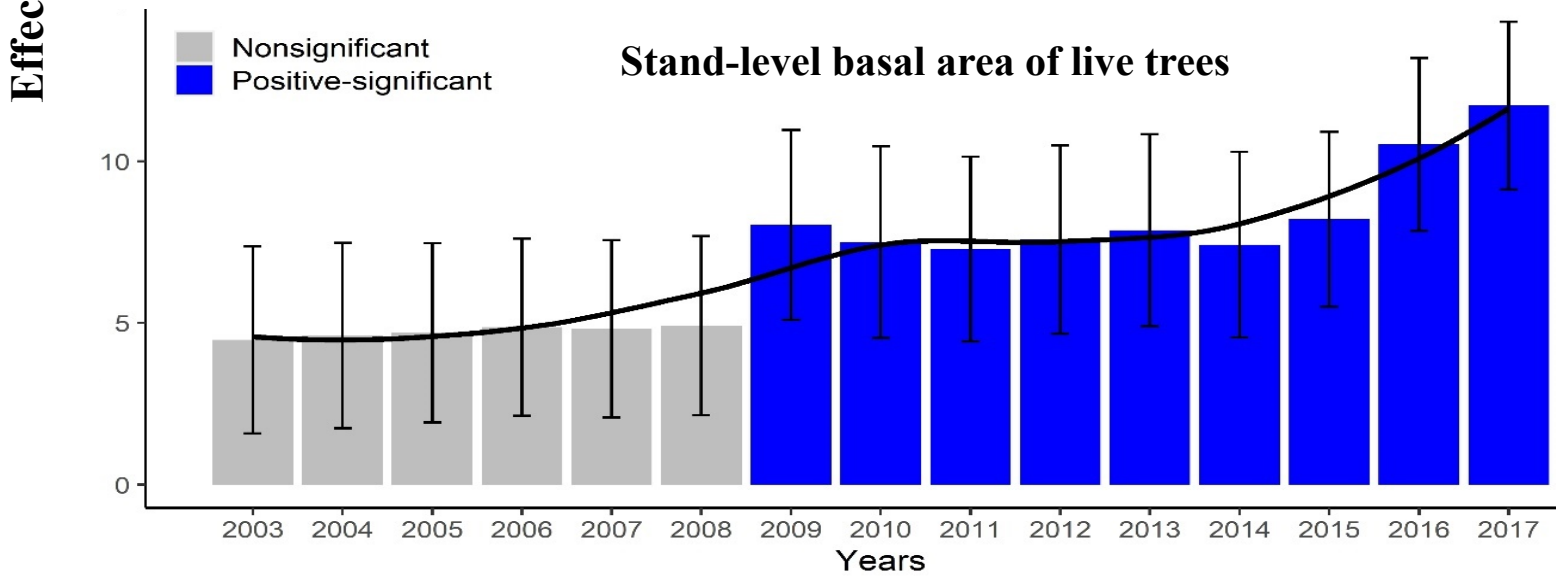
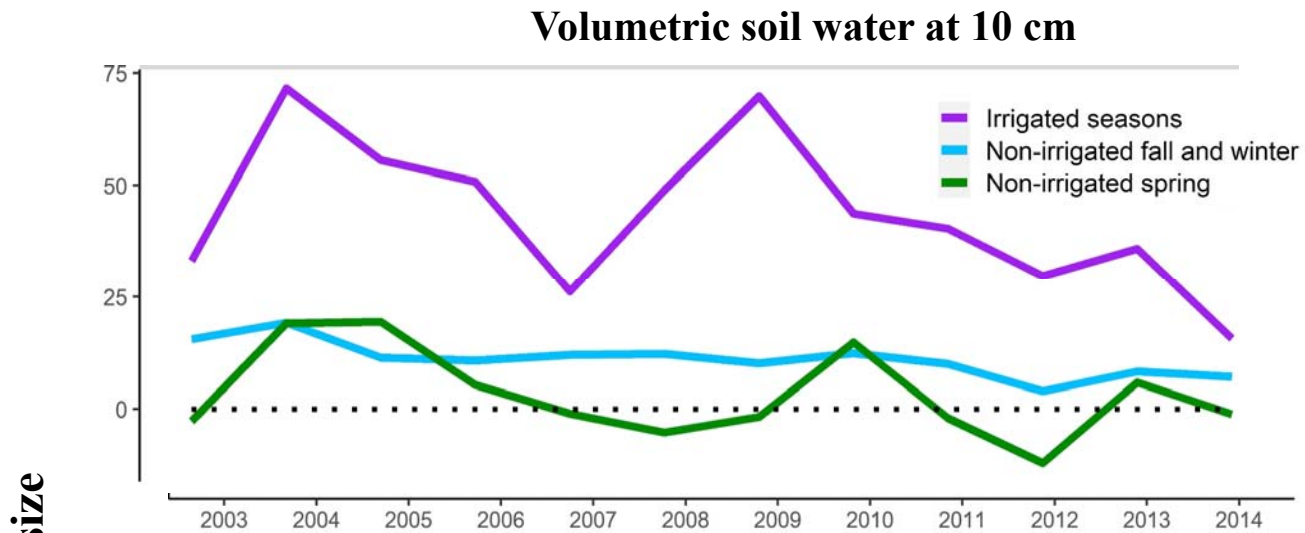
Results, Tree-level



Results: Ecosystem-level



Results:
Ecosystem-level



Summary:

Tree-level responses	
a Crown transparency ^P	↓
b Tree survival ^P	↑
c Needle length ^P	↑
d Shoot length ^P	↑
e Radial growth ^P	↑
f Tree ring d13C ^P	↓
g NSC insoluble ^P	↓
h Fine root biomass ^P	↑
i Leaf area index ^P	↑

Summary:

Tree-level responses

- a** Crown transparency^P ↓
- b** Tree survival^P ↑
- c** Needle length^P ↑
- d** Shoot length^P ↑
- e** Radial growth^P ↑
- f** Tree ring $\delta^{13}C$ ^P ↓
- g** NSC insoluble^P ↓
- h** Fine root biomass^P ↑
- i** Leaf area index^P ↑

Ecosystem-level responses

- j** *Tomicus* abundance* ↓
- k** *Pinus*, *Quercus* & Shrubs' sapling abundance ↑
- l** Litter decomposition* ↑
- m** Fungal fruit bodies ↑
- n** Soil organic matter (SOM) stocks* ↑
- o** Soil moisture ↑
- p** Stand basal area ↑
- q** Litterfall* ↑

Summary:

Tree-level responses

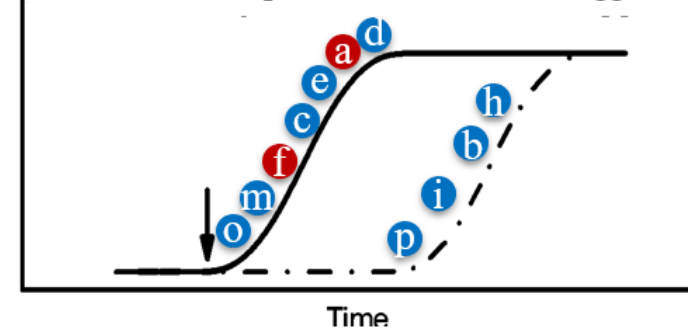
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Ecosystem-level responses

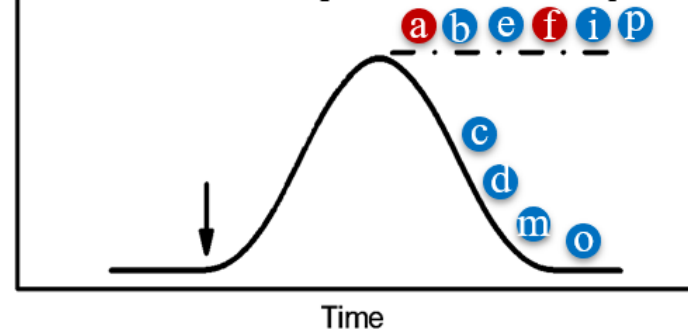
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Response patterns

Start of the responses: Immediate vs. lagged



Duration of the responses: Transient vs. persisting



Summary:

- ✓ Tree- and ecosystem-level **responses were pervasive** across a number of traits on long-term temporal scales
- ✓ However, after reaching a peak the magnitude of these responses either decreased or reached to a new **Dynamic Equilibrium**

Outlook



Experiments

➤ Pfywald, Switzerland

- Scots pine
- Established in 2003
- Precipitation 576 mm/yr
- Irrigated to double amount of precipitation

➤ Puechabon, France

- Holm oak
- Established in 2003
- Precipitation 910 mm/yr
- Excluded 27% of precipitation

➤ Prades, Spain

- Holm oak
- Established in 1999
- Precipitation 610 mm/yr
- Excluded 30% of precipitation

Outlook

➤ Pfywald, Switzerland

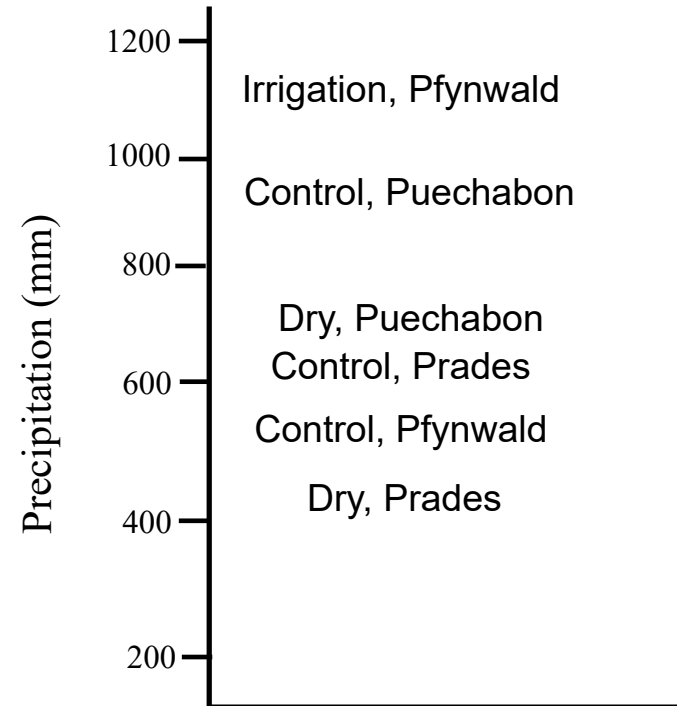
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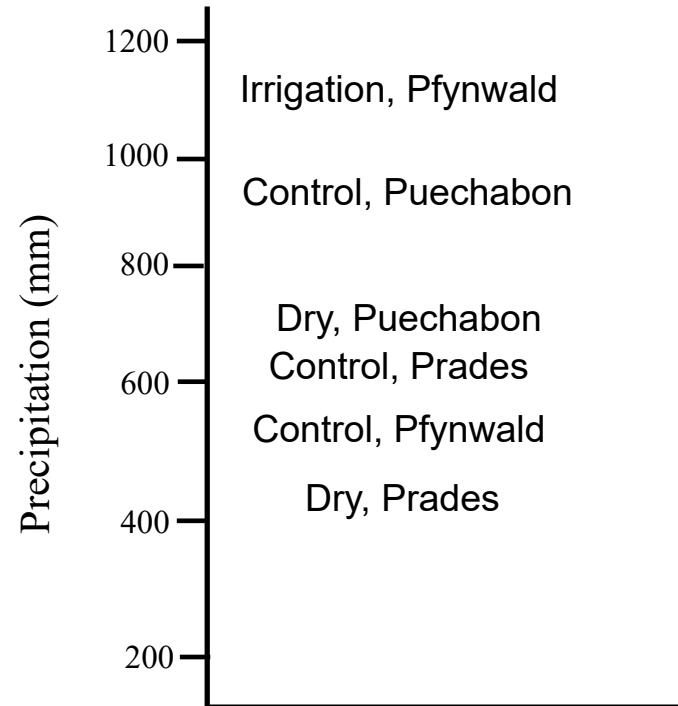
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Do we have a moisture gradient?

Outlook

➤ Pfywald, Switzerland

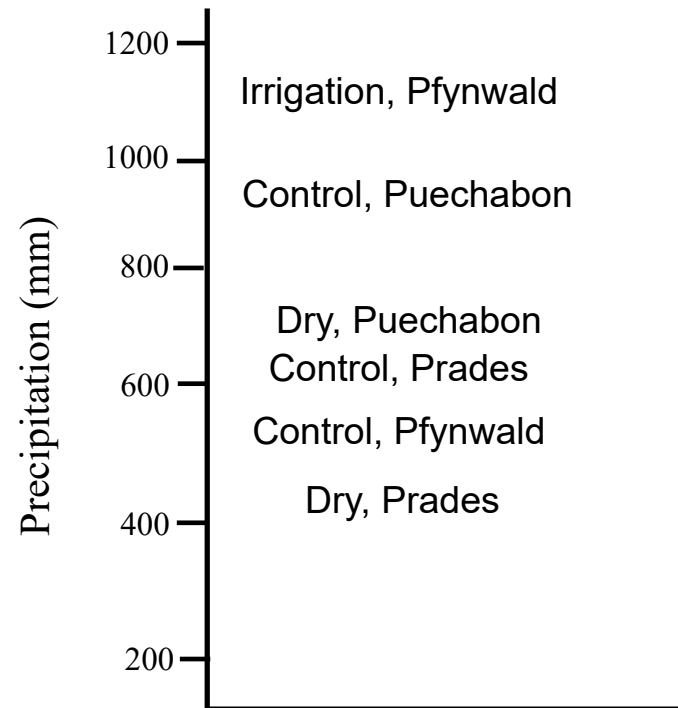
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Do we have a moisture gradient?

Local climate dynamics?

Outlook

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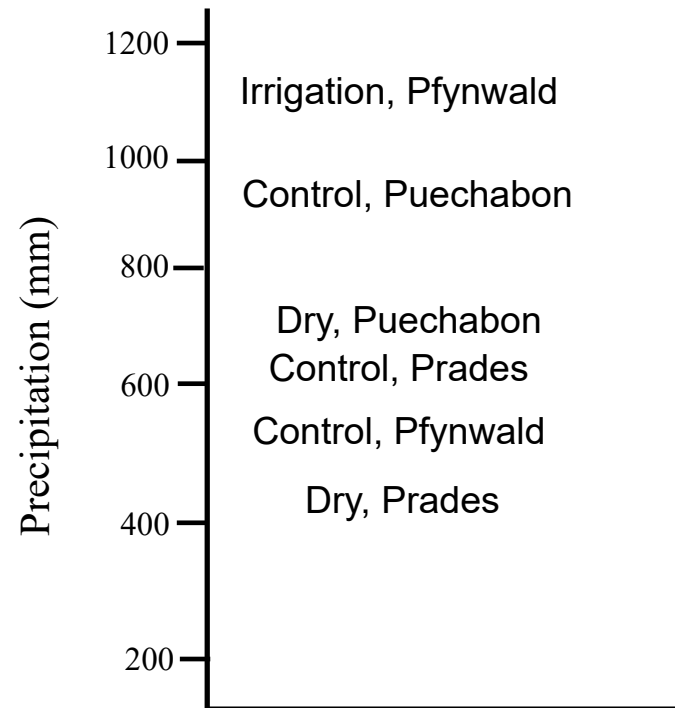
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Do we have a moisture gradient?

Local climate dynamics?

Can we generalize acclimation capacities in trees as a function of annual precipitation and/or the legacy of local climate?

A wide-angle landscape photograph of a mountain range. In the foreground, a valley with green fields and a small town is visible. The middle ground features steep, forested mountain slopes. In the background, a large, rugged mountain peak is partially covered in snow under a clear blue sky.

Thank you very much!

Acknowledgements:

The study is dedicated to Matthias Dobbertin, the visionary initiator of this long-term irrigation experiment, who passed away in 2012.

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