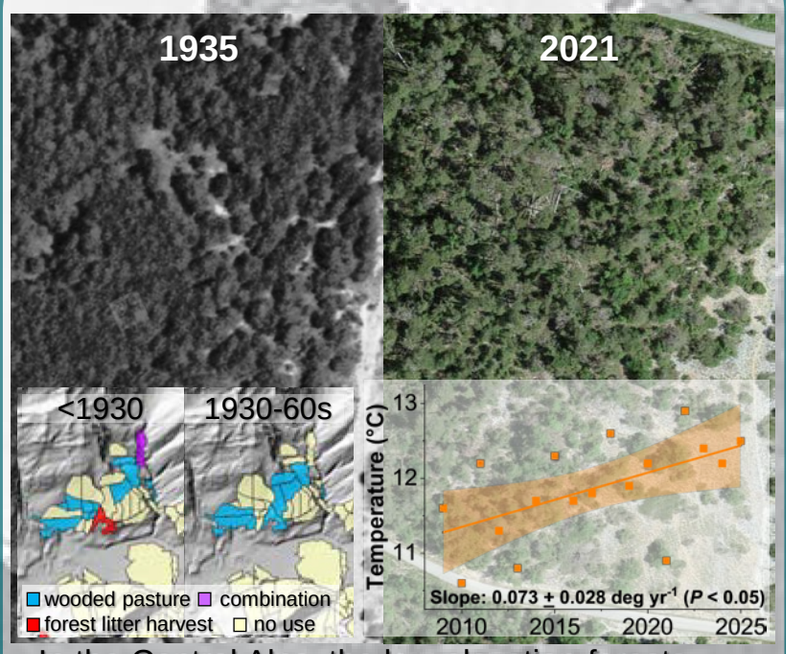
From an overexploited wooded pasture to a climate-resilient forest: ecological trajectories aboveground and belowground in a low elevation pinewood from the driest region of Switzerland

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Global change in the low-elevation forests of Swiss Alps



- In the Central Alps, the low-elevation forests were overexploited for millennia through the harvesting of forest litter and cattle grazing.
- Since abandonment in the 1960s, reclamation by mixed-woody species has been underway.
- Steadily rising temperatures have increased environmental stress..

Gimmi and Bürgi (2007) environ. hist. **13**, 211-46

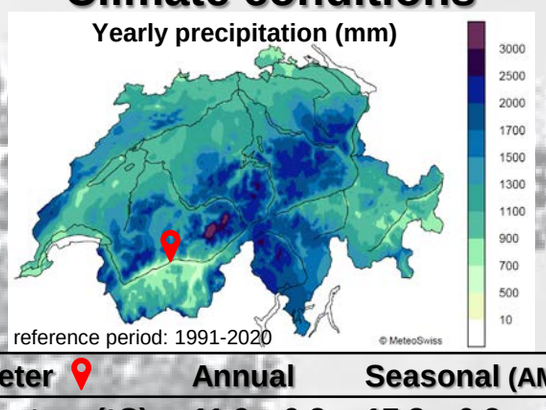
Study objectives and experimental design

Objectives: In light of repeated episodes of forest decline, the Salgesch experiment has aimed to improve our understanding of the impact of past land use on the current forest dynamics observed in a former pine-wooded pasture in Switzerland's driest region.



- **Design:** In a communal forest above Salgesch (Valais, 440 ha), 2x6 circular plots 5 m in diameter centered on an older pine were established in 2010, with the reclaiming woody vegetation either cleared (**RM**) or left as control (**CO**) In 2021, 12 supplementary plots centered on a youger pine from the reclaiming vegetation (**Y**) were selected.
- **Monitoring:** Soil water content and temperature (3 depths, 6 plots) / monthly tree growth (band dendrometers).
- **Assessments:** Soil properties, carbon stocks, soil biological activity / plant communities ecology and functional traits / tree growth, foliar functional traits.

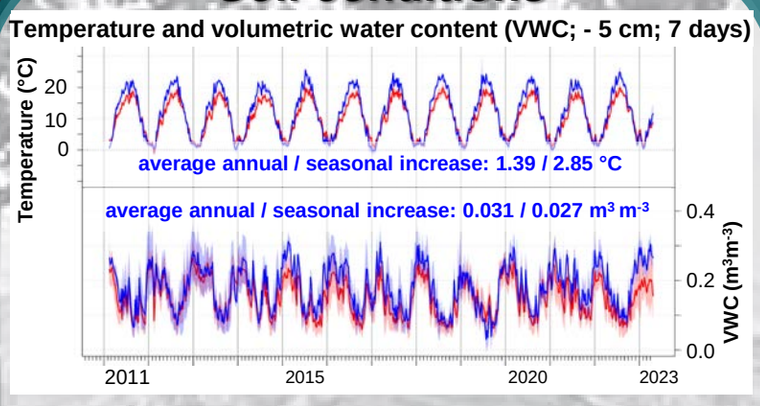
Climate conditions

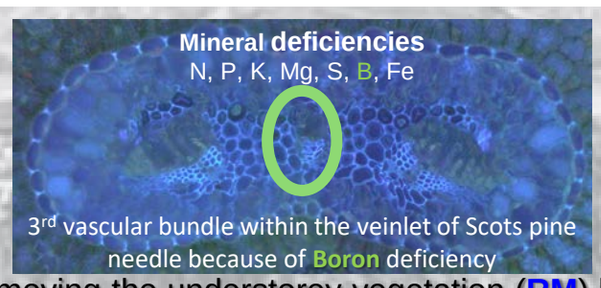


Parameter	Annual	Seasonal (AMJJAS)
Temperature (°C)	11.9 ± 0.2	17.8 ± 0.2
Precipitation (mm)	617 ± 23	298 ± 16
VPD (kPa)	0.83 ± 0.03	1.22 ± 0.05

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Soil conditions

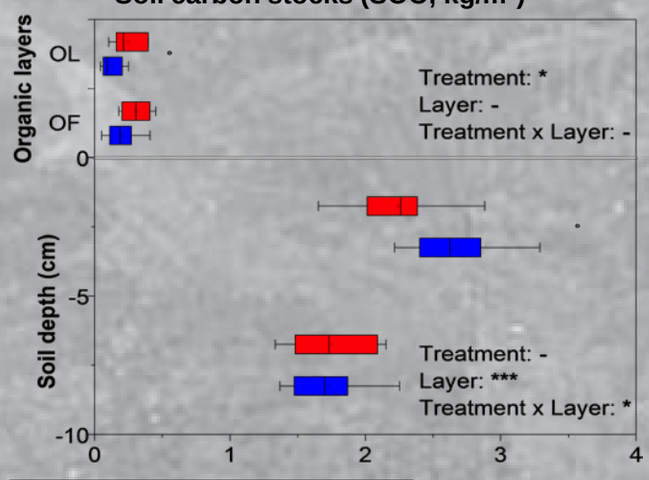




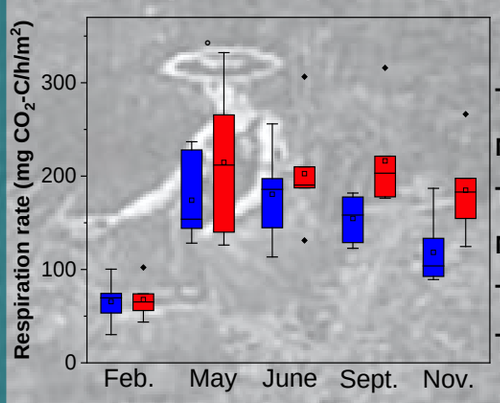
- Removing the understorey vegetation (**RM**) led to a stable increase in both soil temperature and volumetric water content.
- Important mineral deficiencies in pine foliage form a legacy of past land use.
- **Soil type:** 40 to 100 cm-deep dry, calcareous and polyphasic soils (Calcosols) derived from mostly colluvial material, with occasional occurrence of a 60-80 cm-deep loess horizon. Moder humus form, because of site xericity and low biological activity

Responses belowground

Soil carbon stocks (SOC; kg/m²)

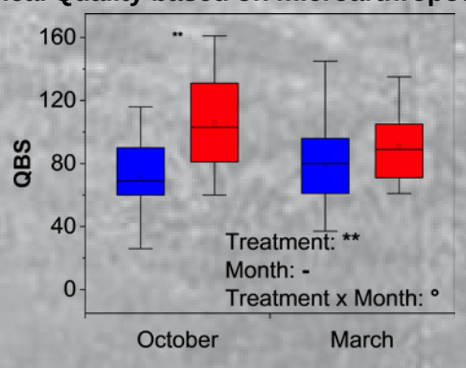


Soil respiration



Temperature	***
Moisture	
Treatment	***
Month	**
Temp. x treatment	*
Temp. x month	***

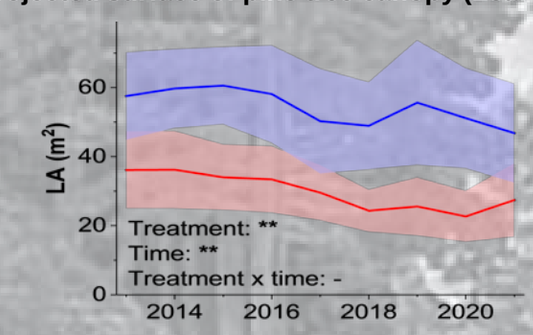
Soil Biological Quality based on microarthropods (QBS-ar)



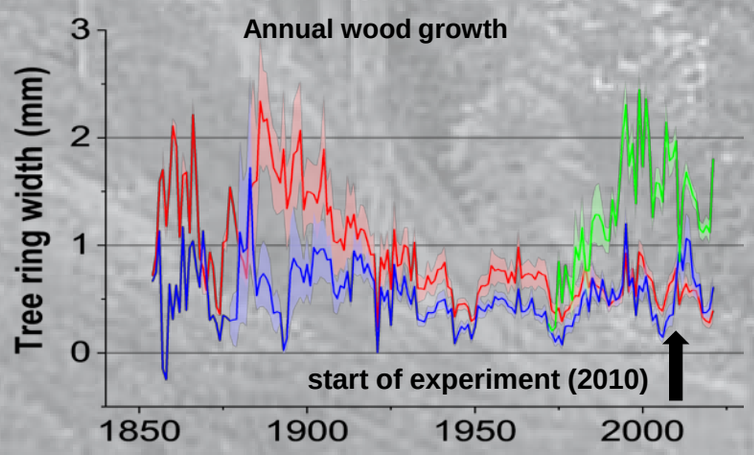
In response to treatment, the carbon stocks of organic layers were lowered, the soil biological activity and quality reduced.

Pine tree responses

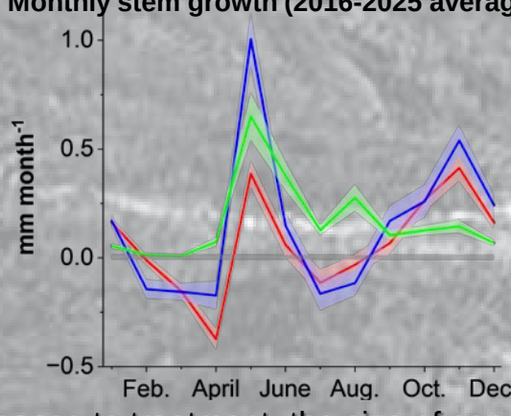
Projected surface of pine tree canopy (Leaf Area)



Annual wood growth



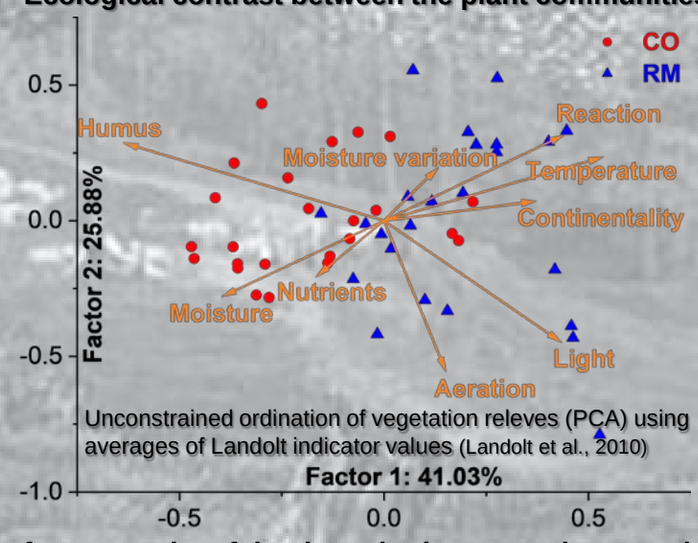
Monthly stem growth (2016-2025 averages)



In response to treatment, the size of canopy and width of tree rings of **RM** pine trees were increased. Older **CO** and **RM** *versus* younger **Y** pines showed bimodal stem growth, with periods of stem constriction.

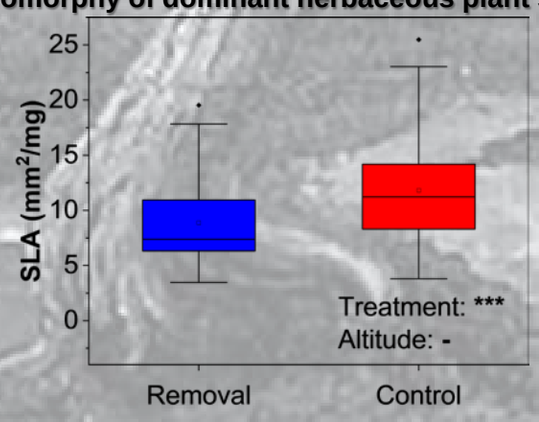
Vegetation responses

Ecological contrast between the plant communities



Unconstrained ordination of vegetation releves (PCA) using averages of Landolt indicator values (Landolt et al., 2010)

Leaf xeromorphy of dominant herbaceous plant species



In response to treatment, the leaf traits became more xeromorphic and the plant communities more xero-thermophilous.

A few conclusions

- As a legacy of millennia of overuse, soil carbon stocks, the macro- and several micronutrients were depleted.
- The RM treatment reversed the recovery of soil biological activity and quality that had been underway despite rising environmental stress, as indicated by *e.g.* the more xero-thermophilous ground vegetation.
- Older pines benefited from past wooded pasture conditions. However, they are now maladapted to the conditions of global change. Their offspring demonstrate greater tolerance and resilience to the warmer climate.