EGU23-6143, updated on 23 Feb 2024
https://doi.org/10.5194/egusphere-egu23-6143
EGU General Assembly 2023

Dieback events of Scots pines caused by lack of rain in mid and late summer

Stefan Hunziker[1], Michael Begert[2], Simon C. Scherrer[2], Andreas Rigling[3], and Arthur Gessler[1,3]
[1]Swiss Federal Institute for Forest, Snow and Landscape Research (WSL), Forest Dynamics, Birmensdorf, Switzerland (stefan.hunziker@wsl.ch)
[2]Federal Office of Meteorology and Climatology MeteoSwiss, Climate Division, Zurich, Switzerland
[3]ETH Zurich, Institute of Terrestrial Ecosystems, Zurich, Switzerland

Same as other parts of Europe, the inner-Alpine Swiss Rhône valley has been increasingly affected by Scots pine (*Pinus sylvestris* L.) dieback events since the 1990s. Such events were not confined to years of extreme heat and drought across Switzerland and Europe such as 2003 or 2018, and the severity and frequency of sudden tree mortality varied on relatively small spatial scales. Which are the relevant parameters that changed in time and which factors triggered these dieback events?

We found that sudden mortality events occurred exclusively after periods of below average precipitation between July and September. During this time of the year, soil moisture regularly drops to a minimum while the atmospheric water demand is high. Further factors such as insect infestation or spring frost may increase the magnitude of tree mortality, but they were neither a required contributor nor were they found to trigger dieback events. Consequently, the region with lowest summer precipitation within the Swiss Rhône valley outlines the area most affected by Scots pine dieback.

However, the amount and frequency of the highly variable summer precipitation did not decrease since the 1980s, but the atmospheric water demand in spring and summer increased continuously. As a result of the higher water loss to the atmosphere, the period of low soil moisture has been prolongated and intensified. Therefore, Scots pines have become more dependent on (temporary) water stress relief by precipitation events during mid and late summer.

Many Scots pine died (most likely due to hydraulic failure) within months following severe summer water stress. The effects of such periods appeared faster on tree crown defoliation (i.e., the proportion of needles that should be present on a tree, but which have been lost) than on mortality, as some trees died only after a year or two. We found that these Scots pines exceeded a defoliation threshold of about 75 % and were unable to recover. In such strongly defoliated trees, stress-related metabolites increase in needles, but get depleted in roots, indicating that mortality is linked to belowground carbon starvation negatively affecting functions central for tree survival.