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Predisposition of European beech to drought-induced die-off along a climate gradient in Northern Bavaria

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Climate change is strongly influencing global shifts in forest ecosystem dynamics. There has been a twofold increase in canopy mortality within the temperate forests of Europe in the past thirty years. The trend has been further intensified by recent drought episodes occurring between 2018 and 2020, leading to increased instances of die-offs and reduced vitality among key tree species.

In central Europe, notably in Germany, European beech (*Fagus sylvatica* L.) stands out as a tree species with high ecological and economic significance. Recent severe drought conditions led to substantial vitality loss and mortality. Nevertheless, there was considerable diversity in how individual beech trees responded to drought, with some trees in the same location being heavily impacted while others remained seemingly unaffected. Factors influencing this uneven response are still not fully understood.

In this study, we gathered 600 beech tree-ring width series from 13 sites located across Northern Bavaria, along a climatic gradient. We explore the differences in growth between two groups of trees (damaged/vital) using a dendroecological approach. We evaluated loss of vitality through the implementation of mortality and critical slowdown indicators such as long-term growth decline or changes in climate memory, as well as climate/growth relations and growth synchrony indicative of changing growth limitations.

While we did not find significant differences between groups in terms of climate memory and drought sensitivity, our results showed a divergence in the growth patterns of vital and damaged trees following repetitive exposure to drought events. We detected higher growth rates of damaged trees prior to the last three decades, after which their growth rates declined stronger than vital trees. Our results suggest that faster-growing beech trees may be more susceptible to drought-induced mortality, which is in line with findings of higher vulnerability of faster-growing trees to environmental stressors.