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Dependence of climate-growth correlations on nutrient provision - a dendroecological study on German oak and spruce trees

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Forest growth and vitality are threatened in Central Europe by climate change. Especially the higher frequency and intensity of drought events lead to growth reductions and increased tree mortality. Site properties could mitigate negative effects of climate change on forest growth and tree vitality. This is well known for soils with a high water storage capacity. The question, however, is whether and to which extend, other factors like nutrient supply could compensate for drier conditions.
Our work aims to quantify climatic effects on tree growth on a wide range of sites and to estimate the effects of site properties on the climate impact on growth focusing on Pinus sylvestris, Quercus petraea and Quercus robur. These species are regarded to be more drought tolerant compared to other main tree species in Central Europe.
We took tree ring cores at several German oak and pine sites of the ICP Forest Level II intensive monitoring network. Here we have a wide range of environmental data, including soil, climate, and foliar nutrition data. Standard methods of dendroecology are used for tree ring measurements and data procession including the identification of pointer years and calculation of indices of resilience.
Climate-growth relationships are analysed using a moving-window regression and the software CLIMTREG (Beck et al., 2013). To estimate soil water content and evapotranspiration we use the soil water balance model LWF-Brook90 (Hammel & Kennel, 2001). Furthermore, we give a projection of future growth of the stands under different climate change scenarios.
In a second step we estimate the influence of soil fertility (C/N-ratio, base saturation), soil water storage capacity, and average climatic conditions on the climate-growth relationship.
We found no general links between fluctuations in nutrient concentrations, marked by decreasing foliar nutrient content, and a decrease in radial stem increments. Regarding climate-growth the results indicate that Scots pine possess higher synchronism on a cross-regional scale compared to the oak species. Early year temperature and summer precipitation influences pine growth on nearly all sites. Summer precipitation has partly opposite effects on oak. Previous year climatic conditions influence growth of Scots pine as well as oak.
Soils of oak sites show a wider range of base saturation and C/N-ratio. The effect of soil base saturation and C/N-ratio on the climate impact on growth is weak compared to the effect of water supply.

Beck W, et al. 2013. Dendrochronologia 31: 232-241.
Hammel, K. & Kennel, M. 2001. Forstliche Forschungsberichte, Munich 185p.