Tree-ring growth of Scots pine, Common beech and Pedunculate oak under future climate in northeastern Germany

Gerald Jurasinski (1), Tobias Scharnweber (2), Christian Schröder (2), Bernd Lennartz (3), and Andreas Bauwe (3)

(1) Landscape Ecology, University of Rostock, Rostock, Germany, (2) Institute of Botany and Landscape Ecology, University of Greifswald, Greifswald, Germany, (3) Soil physics, University of Rostock, Rostock, Germany

Tree growth depends, among other factors, largely on the prevailing climatic conditions. Therefore, tree growth patterns are to be expected under climate change. Here, we analyze the tree-ring growth response of three major European tree species to projected future climate across a climatic (mostly precipitation) gradient in northeastern Germany. \newline

We used monthly data for temperature, precipitation, and the standardized precipitation evapotranspiration index (SPEI) over multiple time scales (1, 3, 6, 12, and 24 months) to construct models of tree-ring growth for Scots pine (Pinus syl- vestris L.) at three pure stands, and for Common beech (Fagus sylvatica L.) and Pedunculate oak (Quercus robur L.) at three mature mixed stands. The regression models were derived using a two-step approach based on partial least squares regression (PLSR) to extract potentially well explaining variables followed by ordinary least squares regression (OLSR) to consolidate the models to the least number of variables while retaining high explanatory power. The stability of the models was tested with a comprehensive calibration-verification scheme.\newline

All models were successfully verified with R2s ranging from 0.21 for the western pine stand to 0.62 for the beech stand in the east. For growth prediction, climate data forecasted until 2100 by the regional climate model WETTREG2010 based on the A1B Intergovernmental Panel on Climate Change (IPCC) emission scenario was used. For beech and oak, growth rates will likely decrease until the end of the 21st century. For pine, modeled growth trends vary and range from a slight growth increase to a weak decrease in growth rates depending on the position along the climatic gradient. The climatic gradient across the study area will possibly affect the future growth of oak with larger growth reductions towards the drier east. For beech, site-specific adaptations seem to override the influence of the climatic gradient.\newline

We conclude that in Northeastern Germany Scots pine has great potential to remain resilient to projected climate change without any greater impairment, whereas Common beech and Pedunculate oak will likely face lesser growth under the expected warmer and dryer climate conditions. The results call for an adaptation of forest management to mitigate the negative effects of climate change for beech and oak in the region.