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Projected changes in the future distribution and production of sessile oak forests near the xeric limit

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As a result of regional climate change, most European countries are experiencing an increase in mean annual temperature and CO_2 concentration and a decrease in mean annual precipitation. In low-elevation areas in Southeast Europe, where precipitation is a limiting factor, the projected climate change threatens the health, production, and potential distribution of forest ecosystems. The intensive summer droughts and commonly occurring extreme weather events create negative influences that cause health declines, changes in yield potential, and tree mortality. Due to the observed damages, attention has been focused on these problems.
The impacts of climatic extremes cause difficulties in forest management; these difficulties occur more frequently in Hungary, which is a region that is the most sensitive to climatic extremes. Regional climate model simulations project that the frequency of extremely high temperatures and long-term dry periods will increase; both of these factors have negative effects on future tree species distribution and production. Thus, the aim of our study is to utilize the sessile oak (Quercus petraea) as a climate indicator tree species to investigate potential future distribution and estimate changes in growth trends.
For future spatial distribution, we used the Fuzzy membership distribution model in a new Decision Support System (DSS) which was developed for the Hungarian forestry and agricultural sectors. Through study techniques we can employ DSS, which contains various environmental layers (topography, vegetation, past and projected future climate, soils, and hydrology), to create probability distribution maps. The results, based on 12 regional climate model simulations (www.ensembles-eu.org), show that the area of sessile oak forests is shrinking continuously and will continue to do so to the end of the 21st century.
For future production estimations, we analysed intensive long-term growth monitoring network plots that were established in 1993. We calculated production capacity on the basis of age and height; we then compared these to past climate conditions to discover connections between climate, site conditions, and production. We estimated future growth tendencies for three different time periods (2011-2040; 2041-2070; 2071-2100). Results show that the most vulnerable region is the south-western part of Hungary where the projected production capacity may decrease by 26% for the time period 2071-2100. The impacts of climate change may be milder in the north-eastern part of Hungary where a 19% decrease in the production capacity of sessile oak forests is estimated.
These investigations and results are important for sustainable forest management and help define climate change adaptation strategies in forestry.

Keywords: climate change impacts, distribution modelling, production capacity

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