Doctoral dissertation abstract

Environmental factors shaping the annual increment of Scots pine (*Pinus sylvestris* L.) on selected sites in northern Poland.

The climatic changes observed in recent decades are manifested by a global increase in temperatures, a shift in precipitation regimes, both spatially and in their intensity, and an increase in extreme events, which all significantly impact forest ecosystems. Investigating the relationships between tree growth, climatic variables and anthropogenic impacts on forest stands can be vital in predicting their future responses. Analysis of the growth patterns of Scots pine (*Pinus sylvestris* L.), the dominant forest-forming species in northern Poland, provides a basis for better understanding its possible responses to projected climate change.

The primary aim of the dissertation was to investigate the effects of observed climate change and human activities on annual increments of Scots pine trees, both at the macroscopic level (analysis of annual tree rings) and microscopic level (analysis of cell parameters based on microscope slides), using daily and monthly resolution climate data from 23 forest sites located in northern Poland. The results were presented in the form of three thematically coherent scientific papers, consisting of two articles published in international high-impact journals and a manuscript submitted for review in a scientific journal.

The first study, conducted on a stand of trees growing near Toruń city, concerned the analysis of the relationship between the width of annual tree rings and climatic variables. The results showed that both precipitation and temperature significantly impact the width of tree rings, especially in the spring months (March, April) and during the summer. Precipitation appeared to have the most significant effect on growth in June, while temperatures significantly affected tree growth in February and March. Daily data proved to be a more precise indicator of extreme weather events than monthly data, thus more accurately reflecting the influence of climate on the formation of annual tree ring widths. The study also identified years of exceptionally narrow annual rings due to climatic extremes. The second study analysed the effect of forest floor fertilisation with post-production wastewater on the anatomical structure of annual increments of trees growing near a potato starch factory in Iława city. The study aimed to understand how different fertilisation intensities affect the cellular parameters of pine trees. In years characterised by low nutrient concentrations in the effluent mixture, a positive effect on the width of annual rings and the diameter of cells in the wood was observed, while in the period with high nutrient concentrations, a reduction in cell wall thickness and ring width was observed. Excessive nutrient concentrations, especially of potassium, contributed to a decrease in wood quality, indicating the possibility of physiological drought and a reduction in the trees' ability to take up water, despite its sufficient availability in the soil. The third study focused on analysing climatic parameters and determining their influence on Scots pine growth in different parts of northern Poland. The eastern regions of the country, characterised by continental climate features, showed a negative response to high summer temperatures; at the same time, June precipitation had a positive effect on tree growth, suggesting that summer droughts may limit tree growth; however, higher summer precipitation totals can mitigate the impact of droughts. In western Poland, which is influenced by a transitional oceanic climate, pine trees were characterised by wider annual rings due to higher temperatures in winter and early spring, indicating that warmer winters positively accelerate the growing season.

These studies highlight the multifaceted dynamics of tree growth, which depends on both natural and anthropogenic factors. These analyses provide valuable information on the impact of climate change and human activities on forest health and growth, indicating the need for further research in forest adaptation to changing environmental conditions.

Nella Waszak

17.12.2024