# SUMMARY OF THE DOCTORAL DISSERTATION

## Investigation of tree sensitivity to drought and increased $CO_2$ concentration using stable carbon isotopes and intrinsic water-use efficiency

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The aim of the research work, the results of which are presented in the collection of thematically related articles, is to use stable carbon isotope ratios ($\delta^{13}C$) in tree ring increments, as well as the width of tree rings and anatomical features of wood to assess the impact of changing climate, particularly droughts, on trees growing in the same area but in varying health conditions. Based on the measured $\delta^{13}C$ values, intrinsic water use efficiency (iWUE) coefficients were determined and used to evaluate human impact on the environment. The scope of the research included comparative analyses of trees in different health conditions, conducted at two research sites: in the forests of the Świerklaniec Forest District and the forests of the Opole Forest District. Both research sites had numerous trees that were declining due to drought, as well as trees in good health. Additionally, the trees at the Świerklaniec site were exposed to pollution related to human activities, emitted by a nearby zinc smelter.

The conducted research demonstrated sensitivity of declining trees to emitted air pollutants, which was reflected in the reduction of $\delta^{13}C$ values in these trees during the years of highest emissions from the zinc smelter near the Świerklaniec site. Numerous significant correlations were also observed between $\delta^{13}C$ values of declining trees and average summer temperatures. Research conducted at the Opole site showed a significant impact of water deficiency on damaged trees, confirmed by numerous significant correlations between $\delta^{13}C$ values and meteorological parameters such as humidity and sum of precipitation, as well as SPEI (Standarised Precipitation Evapotranspiration Index) values. Additionally, there was a significant reduction in the width of annual increments and anatomical features, such as cell lumen area and cell wall thickness, in declining trees during the years 2010-2022, when the frequency of droughts in Opole was high. Declining trees also showed reduced values in resistance, resilience, and recovery indices for droughts occurring in the years 1975-2022.

This work may have practical applications, as it can help in the early diagnosis of deteriorating tree health in the face of progressing climate change.