Developing efficient and accurate models for predicting tree growth is a fundamental tool in forestry sciences and plays a crucial role in forest management. To obtain the necessary data, research is conducted on permanent research plots, and measurements from the national forest inventory (NFI) are utilised. Both data sources have their advantages and disadvantages. Studies on permanent research plots are highly accurate, but there are few time series for such plots. On the other hand, measurements from the inventory are less accurate but cover large areas and often have several repetitions.

Many countries, especially in Asia, South America, and Africa, lack sufficient NFI data. In this situation, a one-time sampling combined with advanced statistical methods, such as Bayesian calibration, offers a promising alternative for predicting tree growth. The proposed project aligns with the concept of developing new methodologies to predict tree growth using limited data. It is one of the first projects to integrate whole stand models, diameter distribution models, and Bayesian calibration. This innovative approach will enhance the accuracy and reliability of forest growth forecasts, providing valuable information on tree growth patterns under different environmental conditions.

The primary objective of the proposed project is to develop a methodology for predicting individual tree growth (diameter and height), survival, and increment in the absence of time series data. The proposed methodology is based on one-time sampling and a priori information from areas with similar conditions and/or simulations.

The project will utilise data from research plots in the Świętokrzyskie Mountains and NFI data from Poland, the USA, and Canada. The methodology includes: (1) model development: the construction of stand models to estimate mean stand height, basal area, and mean quadratic diameter; (2) diameter distribution modelling: the formulation of models using Weibull functions, gamma distribution, two-component mixture models, and the Gamma Shape Mixture (GSM) model; (3) Bayesian calibration: the application of Bayesian techniques to improve diameter and height estimates for individual trees.

Within the framework of Bayesian calibration, Markov chain simulations using Monte Carlo methods (MCMC) will be performed with the DREAM algorithm, and calculations will be conducted in Python and R environments.

The innovative methodology of the project and its comprehensive approach will provide a robust framework for predicting tree growth in regions without time series data, ultimately contributing to improved forest management and environmental conservation. This is particularly important in countries lacking sufficient NFI data. The methodology will be tested using time series data from countries leading in systematic measurements (the USA, Canada). If the proposed methodology is successfully tested, its implementation, particularly in countries without sufficient NFI data, will be straightforward.