

WOVEN

Wood formation under varying environmental conditions

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Project Duration: 36 months

Project Consortium

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Project Objectives

This project aims to deepen our understanding of the factors affecting wood formation and the variation in wood properties of Norway spruce and Scots pine. We will study, with the help of empirical observations and mechanistic models, the production and the allocation of carbohydrates, and the dynamic interplay between environmental and genetic factors as they affect cambial activity.

Project Approach

To accomplish these objectives, we will:

(1) *analyse the effects of weather variables on wood formation, fibre characteristics, and chemistry.* The different phases of annual ring development will be characterized by following the development of cells from their division through enlargement to maturation by regularly extracting small increment cores during the growing season. Timing of cell division, enlargement and cell wall formation will be related to fluctuations in environmental factors.

(2) *analyse the effects of genetic origin on wood formation.* Several phenotypic traits have already been measured in the provenance, family and clonal trials, including measurements of frost hardness, timing and rate of shoot elongation, frequency of a second flush, wood density, tree height, and frequency and causes of damages reducing wood quality. The data will be used for quantitative genetic analyses including (i) phenological, growth, and survival data in relation to wood density data, (ii) family and provenance variation in wood density over a climate gradient, and (iii) clonal variation indicating random environmental (within clones) variation, among clonal (within family) variation, and among family component.

(3) *study the factors controlling the seasonality in carbon assimilation and availability of current and stored photosynthates during the growing season, and their relationship to nitrogen availability.* The seasonality in carbon assimilation will be estimated by means of parameterisation of process-based growth models with data from Scots pine and Norway spruce. The seasonality of carbohydrate allocation will be studied by puls labelling of trees, in non-fertilised and fertilised stands, with CO₂ enriched with C-13, followed by intensive sampling and analyses for determination of the fate of the labelled photosynthates.

(4) *analyse the effects of water relations and nutrient status on xylem and phloem transport and wood formation.* We focus on analysing the impacts of soil water availability, tree crown transpiration, and carbon assimilation on the turgor maintenance at different heights in tree stems, and how this is linked to local cambial growth. A model based on the Much hypothesis has been developed by the research team to describe the loading of sugars to the phloem from the sites of photosynthesis, and further, their translocation to the growth sites along the stem. Measurements will be conducted to further develop and parameterise the description of the environmental control of the phloem and xylem flow model.

(5) *formulate a dynamic process-based model describing wood formation in terms of whole-tree physiology.* A major advantage of this modelling approach is its explicit treatment of energy, water, carbon and nitrogen cycles within and through a given tree. The model can be used to assess the consequences of climate change on above and below-ground carbon sequestration, on nutrient gains and losses, and water regimes of a tree. The developed model will be used to predict the effects of alternative climate change scenarios on the future growth trends of trees and wood properties. The consequences of alternative silvicultural options will also be evaluated by simulations.

Expected Project Impact

The outcomes of the project will include new scientific knowledge on (A) wood formation, (B) tree physiology, (C) effects of climate change on tree growth and structure, (D) adaptation of different genotypes to meet the requirements of changing climate, (E) carbon sequestration, and (F) technical development of the simulation tools. Special emphasis will be put on the development of forests dominated by Norway spruce and Scots pine, which are the most common and also economically most important tree species in northern Europe.

Understanding of the link between environmental factors and tree growth will give guidance for more sustainable forest management strategies in terms of the management of wood properties. The applicability of growth models for predicting the effects of the environmental factors - such as climate change and forest management - will also improve. The results can be used for predicting radial increment and wood properties under a changing climate and/or new management regimes.

The results of the project will help forestry practices to favour genotypes with proper adaptation to the prevailing climatic and edaphic conditions. Genotypes with traits that make trees more fit to increasing temperature and prolonged growing season can be selected to maximise carbon fixation and storage, but avoiding genotypes with high risks to abiotic or biotic damages.

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