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Canadian Wood Fibre Centre

Fibre Facts

Modeling Wood Fibre Attributes Using Forest Inventory and Environmental Data

The Newfoundland Fibre Inventory Project is a multi-stakeholder initiative whose objective is to maximize the value of Newfoundland's fibre resources through the development of an enhanced inventory of forest fibre attributes. Researchers are using innovative approaches and developing new techniques that will enable woodland managers to better predict forest structure and fibre attributes. Knowledge gained from this research will improve the competitiveness of the forest industry.

Much of the effort in forest inventory over the past half century has focussed on improving our ability to predict wood volume. Although it is important to have accurate predictions on the volume of wood present, it is also increasingly important to know something about the quality of the wood that is available and where it is located on the landscape. Knowledge of wood fibre attributes while planning a forest operation could lead to improved fibre output, optimization of industrial processes, and to the development of new products that require unique attributes.

Research on modeling wood fibre attributes using forest inventory and environmental data was one component of a Natural Science and Engineering Research Council of Canada project led by Dr. Richard Fournier of the University of Sherbrooke and Joan Luther, Research Scientist with Natural Resources Canada's Canadian Forest Service. The modeling research was carried out by Ms. Emilie Lessard in partial fulfilment of a Master of Geographical Sciences Degree at the University of Sherbrooke.

The goal of Ms. Lessard's study was to model and map wood fibre attributes across the merchantable forest area of Newfoundland for the province's two major tree species: black spruce (*Picea mariana*) and balsam fir (*Abies balsamea*). Three key research questions were identified: (1) what are the relationships between fibre attributes and available forest inventory and environmental data? (2) to what extent can those relationships be used to predict fibre attributes across Newfoundland? and (3) what models can be used with the available spatial data to produce maps of fibre attributes for Newfoundland?

Obtaining information on fibre attributes is costly as it usually involves the collection and analysis of core samples from trees. The fibre attribute data used in this study was measured by FPInnovations and provided to the researchers through the Forest Inventory Competitive Advantage Project (FICAP) led by Corner Brook Pulp and Paper Limited. Close to 2000 wood cores were collected and analyzed representing 77 black spruce-dominated and 117 balsam fir-dominated plots distributed across the island. The measured attributes of interest included fibre length, wood density, radial and tangential diameter, coarseness, microfibril angle, modulus of elasticity, wall thickness and specific surface. Additional forest structural information associated with each plot was available from the permanent sample plots database developed and maintained by the Newfoundland Department of Natural Resources.

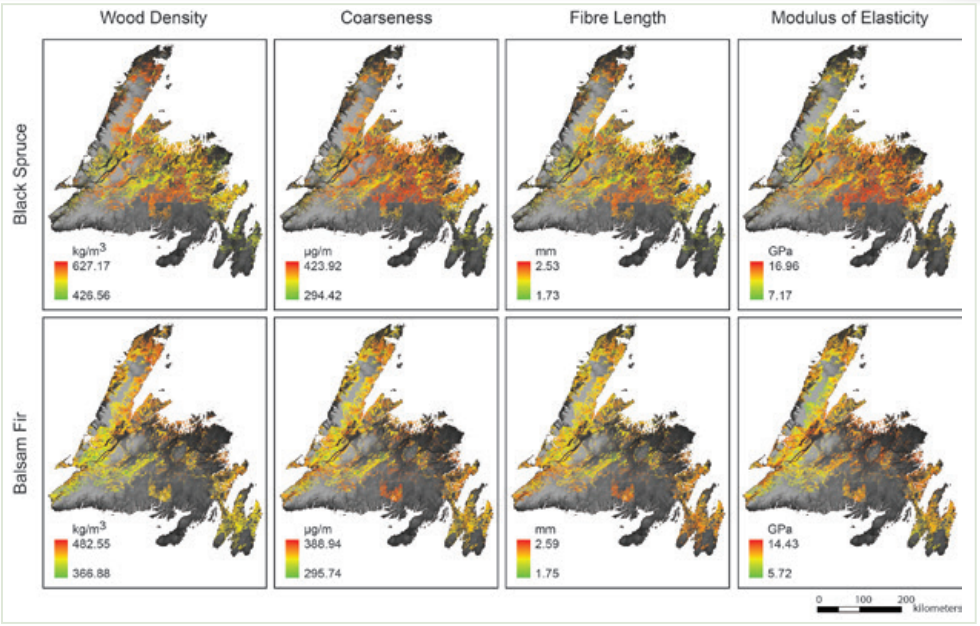

Figure 1. Predicted spatial distribution of fibre attributes across Newfoundland for stands containing black spruce and balsam fir.

Plot-level modeling: Plot-level models were developed using a set of four groups of explanatory variables: geography (elevation, latitude); climate (mean temperature of growing season, mean annual precipitation); vegetation structure (mean DBH, age, species composition, dominant height); and disturbance (Pre-Commercial Thinning). The variables were tested independently and in various combinations for their ability to predict the fibre attributes. The models were able to explain 35–48 % of the variation in fibre attributes for balsam fir and 52–61 % of the variation in those of black spruce.

Landscape-level modeling: Substituting some of the explanatory variables in the plot level-models allowed for producing landscape models that could be applied to generate continuous maps. For example crown closure was used instead of mean DBH to represent the vegetation structure and height was derived from the height class interpretation rather than from the measured heights of individual trees. The landscape-level models were able to explain 33–48 % of the fibre attribute variation in balsam fir and 51–59 % for black spruce.

The results confirmed that it was possible to model wood fibre attributes using explanatory variables contained in existing forest inventory systems combined with other environmental variables describing climate and geography. To the authors' knowledge, this study is the first to demonstrate the capability to predict and map wood fibre attributes for such a large land area (>100,000 km^2). The variables describing vegetation structure were found to be important explanatory variables in all models while environmental variables (elevation, latitude, annual precipitation, and mean temperature of the growing season) also influenced fibre attributes, but to a lesser degree. The importance of structural variables to predict wood fibre was an important finding such that further research is focused on improving the measurement capability for detailed structural variables. Spatially-explicit estimation of such variables is a challenge for large areas. However, the increasing availability of airborne LiDAR (Light Detection and Ranging) data allows for further development and application of predictive models such as those presented in this study.

Reference

Lessard, E.; Fournier, R.A.; Luther, J.E.; Mazerolle, M.J.; van Lier, O.R. 2014. Modeling wood fiber attributes using forest inventory and environmental data for Newfoundland's boreal forest. *Forest Ecology and Management* 313:307–318.

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Photos on front page, from left to right: Collecting stand data; black spruce.

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