Natural Resources Canada | Ressources naturelles Canada

Canadian Forest Service

CANADIAN WOOD FIBRE CENTRE

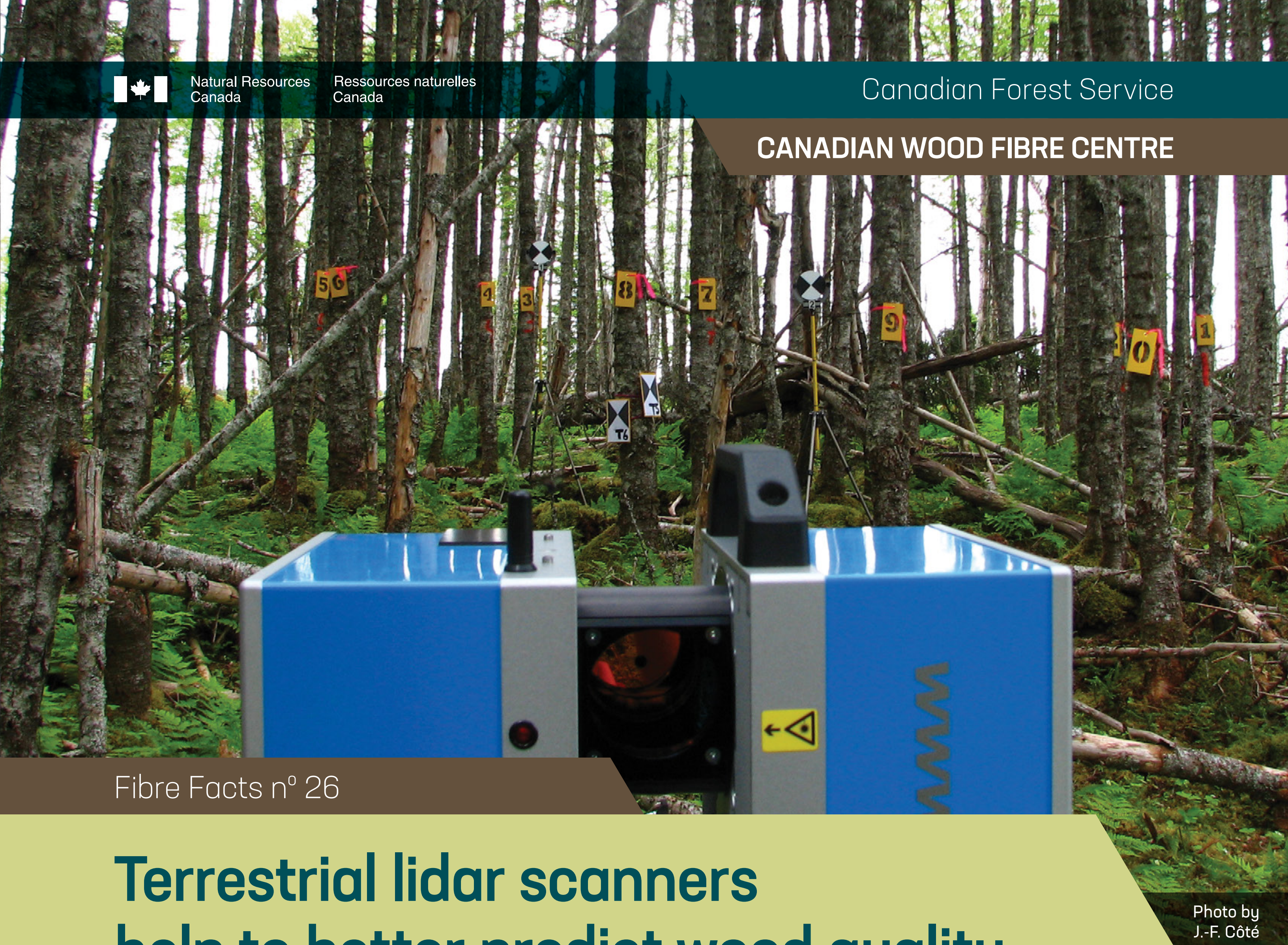

Photo by J.-F. Côté

Fibre Facts nº 26

Terrestrial lidar scanners help to better predict wood quality by using tree structure

Information regarding the quality of wood fibre optimizes resource allocation by matching the right fibre to the right end use and is needed to maximize the economic benefits from our fibre baskets. Wood fibre quality directly influences the processing, uniformity, and value of derived wood and fibre products, however, the supply is inconsistent as fibre quality varies across the landbase. To date, spatial modeling of wood fibre attributes (WFA) has been limited to using structural attributes describing a forest stand; commonly derived from photo-interpretation, and more recently through modeling with airborne light detection and ranging (a-lidar) data.

Canada

As fibre quality varies within a stand, these models can have lower predictive capabilities compared to more contemporary approaches which incorporate structural attributes describing individual trees. Researchers developed an innovative approach which uses terrestrial light detection and ranging (t-lidar) with an architectural model to measure and reconstruct fine-scale structural attributes of trees. The approach has shown to improve the accuracy of WFA model predictions and can be incorporated into a framework for large-scale applications using a-lidar, which is likely to become ubiquitous in forest operations and inventories (Figure 1).

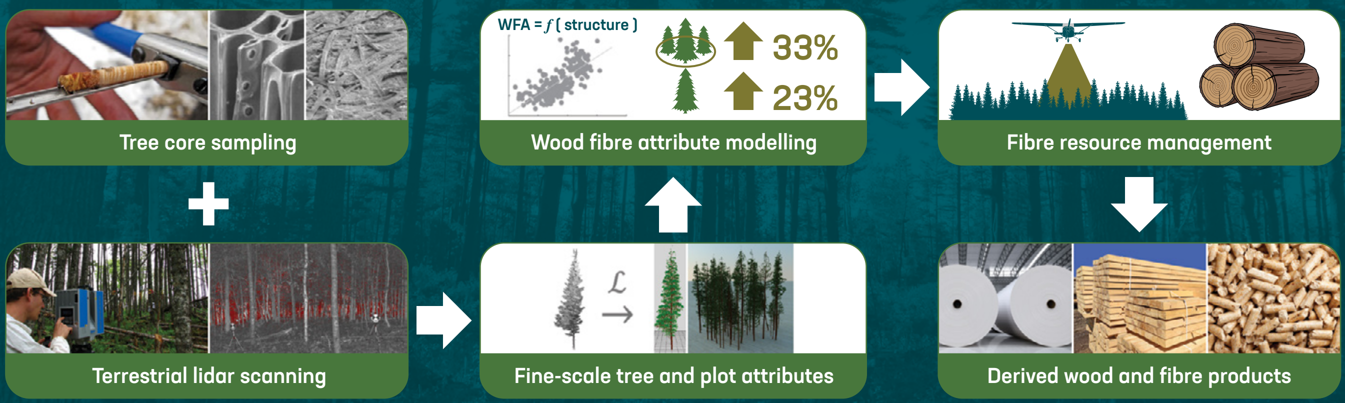

Figure 1: Schematic illustrating the framework that utilizes terrestrial lidar to collect fine-scale structural information from trees. By training the ℒ-Architect model with the collected data, fine-scale structural attributes are obtained for reconstructed trees and plots. Relationships linking tree and plot structure with wood fibre attributes are then developed and similarly linked with airborne lidar data for large-scale applications. The information products support informed descision making with respect to fibre resource managememt and associated end use.

Modelling Wood Fibre Attributes

Obtaining information on fibre attributes is time-consuming and costly. Direct measurements require either the collection of tree core samples or discs taken in the longitudinal direction of the stem followed by analysis with specialized measurement systems. Historically, two methods have been used to spatially predict WFA. The first consists of developing relationships with forest inventory and tree growth data, which typically includes attributes related to stand structure and composition, as well as climate variables. For the second method, additional tree sampling data is combined with the previous method to increase prediction strength. This method is time-consuming and often involves destructive sampling.

Over the past few years, new technologies and modeling techniques have evolved which enable improved WFA predictions without the need for destructive sampling. This is achieved by incorporating fine-scale structural attributes of trees and forest plots as new predictors in the models. These attributes provide a level of structural detail that is much finer than what is currently available through traditional forest mensuration. Unfortunately, these new methodologies have been relatively untested in a forestry context.

Researchers from the Canadian Wood Fibre Centre conducted a study using t-lidar and a novel modeling tool called ℒ-Architect to generate fine-scale structure datasets (Figure 2). Using 227 scanned trees across 68 balsam fir and black spruce plots in Newfoundland, Canada, researchers developed predictive WFA models with the inclusion of this fine-scale structure data (Figure 3). The goal was to study the impact of fine-scale structure variables of trees and forest plots derived from t-lidar using the software ℒ-Architect on the predictive capacity of WFA models.

The reconstructed structure of trees and plots demonstrated that detailed structure derived from ℒ-Architect was highly important to explain variance of the WFA. The addition of fine-scale structure improved prediction of WFA models, built only with traditional inventory attributes, by 23% and 33% at tree- and plot-levels, respectively.

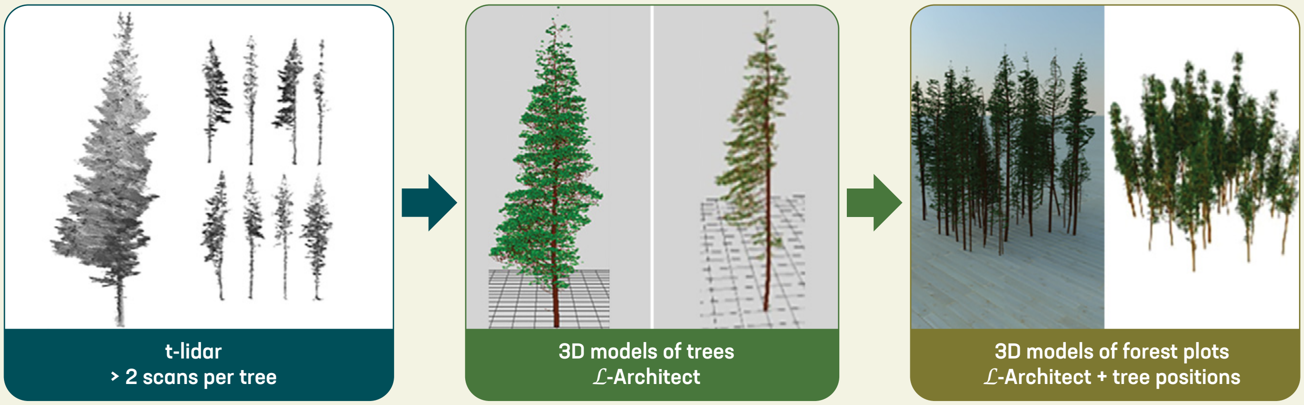

Figure 2: Schematic illustrating the $\mathcal{L}$-Architect model for generating 3D tree models to reconstruct trees and plots from the t-lidar data.

Forest Management Implications

The approach outlined by the researchers provides estimates at the same level of accuracy, or better, as traditional forest inventory-based approaches, while avoiding the need for destructive sampling. This saves up to four person-days per tree in a typical plot. This study not only demonstrates that fine-scale structural information derived from t-lidar and $\mathcal{L}$-Architect improves the accuracy of WFA model predictions, but also that these attributes are amongst the key factors in predicting WFA. The results indicate that fine-scale characterization of forest structure significantly improves wood quality prediction and opens opportunities to enhance forest inventories. In a previous study, the researchers demonstrated how the architectural model can be used to create forest plots with fine-scale structure and calibrate a-lidar for large-scale applications. The application of these newly developed WFA models within this large scale application framework will help forest professionals better quantify the quality of their resource and better match existing fibre to the end-user to maximize product value. Additionally, the information gained from this study can serve as a platform to catalyze additional lidar applications in forestry operations, including updating forest inventories.

Figure 3: A field interpreter uses the t-lidar unit to capture data in a sample plot. (Photos by Olivier van Lier)

Photo by Michael Hoepting

For more information (references):

Côté, J-F., Luther, J.E., Lenz, P., Fournier, R.A., and van Lier, O.R. (2021). Assessing the impact of fine-scale structure on predicting wood fibre attributes of boreal conifer trees and forest plots. Forest Ecology and Management (479): 118624.

Côté, J-F., Fournier, R.A., Luther, J.E., and van Lier, O.R. (2018). Fine-scale three-dimensional modeling of boreal forest plots to improve forest characterization with remote sensing. Remote Sensing of Environment (219): pp. 99-114

Available online at:
www.sciencedirect.com/science/article/pii/S0378112720313931
www.sciencedirect.com/science/article/pii/S0034425718304450

AUTHORS:

Jean-François Côté,
Canadian Wood Fibre Centre

Olivier van Lier,
Canadian Wood Fibre Centre

Dasvinder Kambo,
Canadian Wood Fibre Centre

CWFC CONTACT PERSON:

Anthony Bourgoin
Forest Program and Project Coordinator
Canadian Wood Fibre Centre
fibrecentre@nrcan-rncan.gc.ca

cwfc.nrcan.gc.ca

Aussi disponible en français sous le titre : Le lidar terrestre aide à mieux prédire la qualité du bois à l'aide de la structure des arbres.

Canadian Wood Fibre Centre – Fibre Fact: 026. ISSN 1918-2562-PDF-E