RESEARCH HIGHLIGHT

The Pacific Forestry Centre

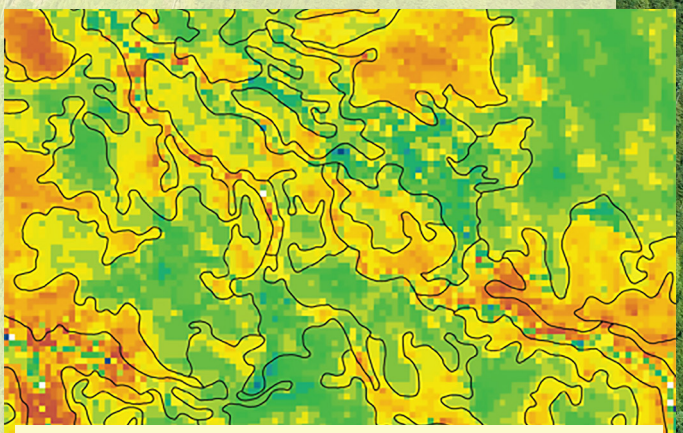
March 2022

EXPLORING THE APPLICATION OF REMOTE SENSING TO TRACK FOREST CARBON

Through carbon capture and sequestration, Canada's forests play a critical role in the fight against climate change. Carbon gains have been realized through world-class sustainable forest management while at the same time, insects, wildfire, and other natural disturbance impacts work to release carbon back into the atmosphere. To monitor and help manage forest carbon stocks, the Government of Canada has developed a sophisticated approach to carbon accounting and reporting.

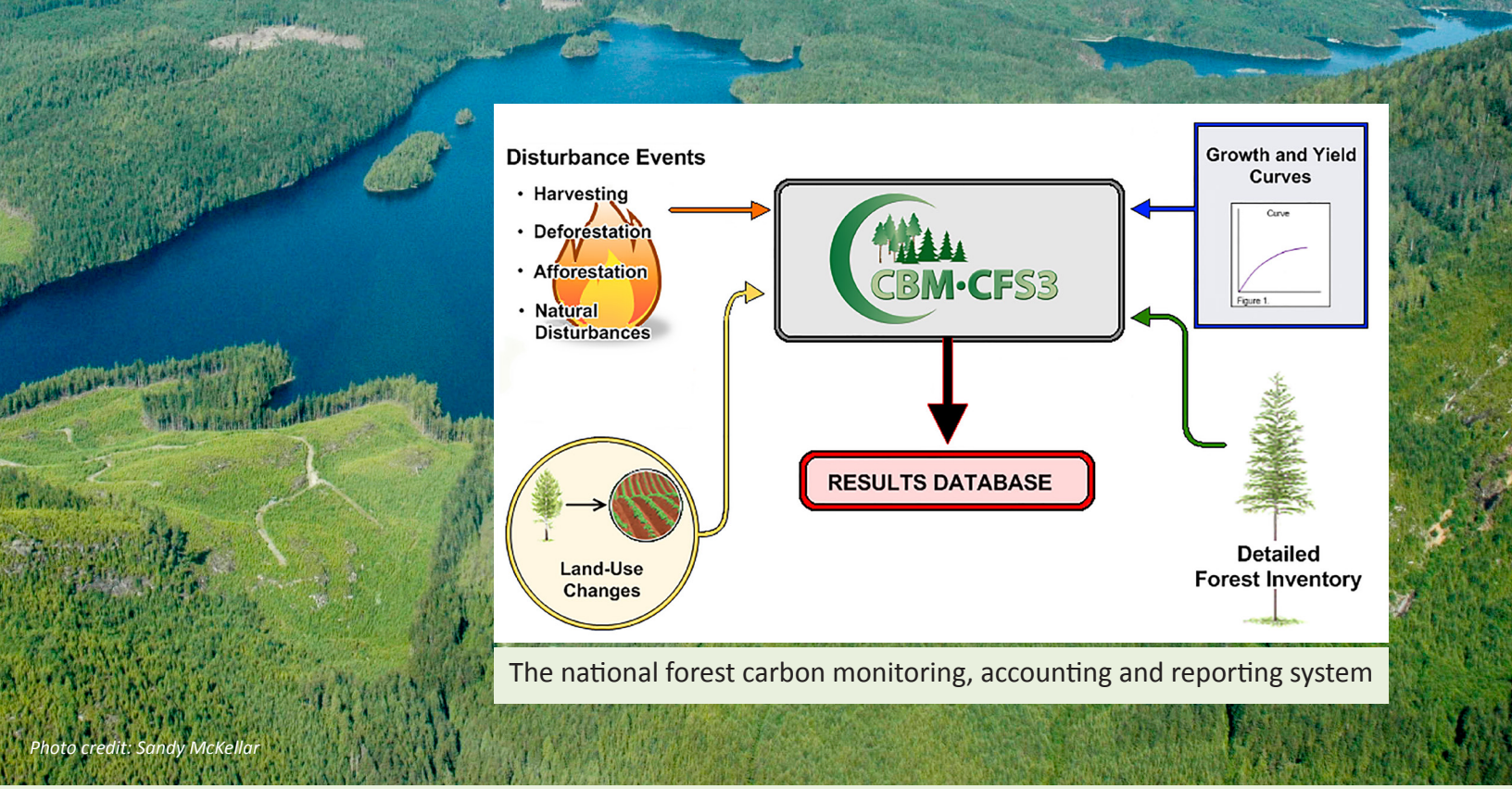
A highly specialized team of research scientists, programmers, analysts, and remote sensing specialists make up the Carbon Accounting Team in the Canadian Forest Service. To track the progress of Canada's forest sector in the fight against climate change, they developed the Carbon Budget Model of the Canadian Forest Sector (CBM-CFS3) — a tool for estimating forest carbon stocks. This model is used to meet the operational-scale forest carbon accounting needs of forest managers and analysts across Canada. Annually, the model is used to produce estimates of forest-related GHG emissions as part of NRCan's contribution to Canada's National Inventory Report for GHG emissions/removals – which Environment and Climate Change Canada submits to the United Nations Framework Convention on Climate Change Secretariat.

Measuring and monitoring carbon stocks in Canadian forests can utilize a number of different inputs. Some of the required information can be estimated with remote sensing data including time series of satellite images, laser scanning, or drone imagery, to create realistic 3D models that are similar to computer games.



Aboveground biomass estimated at 20 x 20 m pixel level using airborne lidar. Black lines depict existing forest inventory polygons.

Photo credit: Sandy McKellar



The national forest carbon monitoring, accounting and reporting system

Photo credit: Sandy McKellar

The remote sensing data are complemented by plot measurements (collected manually) to develop links between forest conditions in the field and forest characteristics observed with remote sensing. Dr. Piotr Tompalski, NRCan's newest research scientist in the Carbon Accounting Team, has been instrumental in implementing such an approach for estimating aboveground biomass. "Today, laser scanning (or LiDAR – Light Detection and Ranging) allows us to create accurate 3D models of a tree or a forest stand that can be measured automatically," Tompalski explained. "We have methods to accurately estimate forest height, basal area, biomass, or volume—on large areas at a very fine level of detail."

This sci-fi technology is what drew Tompalski to a career as a remote sensing specialist. He joined the CFS team just over a year ago. "I'm excited about how can I use this technology to help solve forest sector challenges", he said. "With our team's combined expertise, we hope to enhance the existing methods and tools by incorporating remote sensing data such as time series of satellite imagery and airborne laser scanning."

Tompalski is currently working on a project to understand the differences in biomass estimated using existing models vs. remote sensing data. It is an important step toward improving the integration of remote sensing data in forest carbon modelling by the Canadian Forest Service. The project uses remote sensing data in several forestry-related applications, mostly related to forest inventory (e.g. estimating forest stand attributes like height, basal area, volume). The data help answer targeted questions like: how did the above ground biomass change between 1990 and 2015 in white spruce-dominated stands in Alberta? Or how did the trajectory of above-ground biomass differ between stands disturbed by fire or by harvesting?

"By utilizing the remote sensing data, we aim to improve the accuracy of carbon modelling and reported greenhouse gas emission values." Tompalski explained, "Future decisions based on the reported data will therefore become more informed since the uncertainty in the carbon levels will be lower". But there are still a lot of issues related to forest inventory that cannot be easily solved with remote sensing. "We are still struggling to accurately classify species composition, estimate age, or quantify growth in remotely sensed data. The growth issue is of particular interest for me and I plan to continue my work on this subject," said Tompalski.

It was during his Masters in Forestry at the University of Agriculture in Krakow, Poland that Tompalski first became interested in GIS and remote sensing.

Piotr Tompalski shown in his workshop where he creates handmade wooden bowls, boxes and vessels.

Over his career, that interest has become focused on issues related to forest inventory and forest carbon. As part of the Pacific Forestry Centre in Victoria, he is grateful for the chance to improve existing methods of estimating forest carbon and contribute to enhancing the accuracy of reported forest greenhouse gas emissions.

With more remote sensing data becoming available every year, the opportunity to better manage and quantify forest resources increases. “As new sensors are developed and launched into orbit, our capacity to improve existing methods or develop new ones increases,” he enthused. With twin daughters at home, Tompalski is up at all hours of the night – which gives him plenty of time to work out coding issues and develop new technologies to aid in the science of Canada’s carbon sequestration!

Piotr Tompalski: *https://cfs.nrcan.gc.ca/employees/read/ptompals*

Pacific Forestry Centre: *www.nrcan.gc.ca/science-data/research-centres-labs/forestry-research-centres/pacific-forestry-centre/13489*