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Biomass inventory tools to support the Canadian forest bioeconomy

There is growing interest across the world in low carbon fuels as well as bioproducts and biomaterials. Canada is working towards sustainable energy and production goals and has renewed focus on the forest bioeconomy, aiming to become a world leader. The Forest Bioeconomy Framework for Canada, adopted by the Canadian Council of Forest Ministers (CCFM) in 2017, seeks to maximize the economic potential of the forest resource in support of a green economy.

Biomass is plant or animal material while forest biomass refers to woody material. It can be collected from various points along the supply chain, from the point of harvest (in forest), to processing facilities or recycling centres, including from abandoned mills and demolition sites. Forest biomass can be utilized for fuel or as a material input, either raw or as value-added products.

Biomass type	Description
Primary	Forest biomass harvested directly from forests (e.g. roundwood, harvest residues)
Secondary	By-products or residues (e.g. wood chips) from primary processing facilities (e.g. sawmills)
Tertiary	Used wood (e.g. reclaimed wood from demolition)

Canadian Forest Service biomass inventory tools

Forest inventories are commonly used to inform plans for the harvest of merchantable trees for conventional wood products such as lumber or structural panels. However, it is becoming ever more important to understand the availability and quality of other forest biomass resources that exist elsewhere in the supply chain to support the manufacturing of emerging bioproducts and biomaterials. For that purpose, research scientists at Natural Resources Canada (NRCan) - Canadian Forest Service (CFS) have developed several tools available to public and private sectors. A concise comparison of the different available inventory tools is presented in Table 1.

Biomass Inventory Mapping and Analysis Tool (BIMAT)

BIMAT provides a national and publically accessible inventory of biomass residues from agricultural and forestry sectors, including biomass distribution and availability. The tool was developed through a collaboration between Agriculture and Agri-food Canada (AAFC) and the CFS-Canadian Wood Fibre Centre (CWFC). The tool is housed on the AAFC website.

The forest sector component estimates harvest residues available at roadside and mill residues based on mill feedstock requirements, mill efficiencies, harvesting practices, present forest distributions, and projected forest yields and rotation lengths. The resulting inventory is of a national scale that provides estimates of forest biomass quantity, distribution and form (e.g. hardwood/softwood, stem wood/bark, tops/branches, chips/dust/shavings) based on activities occurring at large primary industrial facilities (annual consumption greater than 100,000 m^3 of wood).

BIMAT also provides an estimate of urban wood biomass. This portion of the waste stream includes discarded wood products, whole trees, pruned branches or stumps generated during street and park maintenance, used lumber, trim, shipping pallets and crates, and other wood debris from recreational/landscape management, construction, demolition and land clearing activities. Estimates of the urban wood biomass are provided for communities with populations greater than 1,000 persons according to the 2011 Canadian census.

Carbon Budget Model of the Canadian Forest Sector (CBM-CFS3)

The Carbon Budget Model (CBM-CFS3) was developed through collaboration between the CFS Carbon Accounting Team (comprising CFS staff from the Pacific and Northern Forestry Centres) and Canada's Model Forest Network. The model provides stand- and landscape-level estimates of carbon dynamics including stocks, stock changes, and greenhouse gas emissions. Forest product carbon outputs from the model are used in the CFS's Carbon Budget Modeling Framework for Harvested Wood Products (CBM-FHWP). This model tracks the flux of carbon in solid wood product commodities, (including wood use and post-consumer waste treatment), as well as fluxes from bioenergy. Together, CBM-CFS3 and CBM-FHWP enable investigation of the potential use of harvested wood products for climate change mitigation. In Canada, they have been applied to estimate the spatial distribution of harvest residues that could be used to produce bioenergy on a national scale. The models are critical for reporting for criteria and indicators of sustainable forest management, for certification or carbon offsets, and for international agreements.

Remote Sensing Estimate (RSe)

The remote sensing estimate provides a map that forecasts the availability of logging residue across Canada for the next few decades on a 10 km by 10 km grid. It was developed using two remote sensing products: 1) 30 years of satellite information on forest harvest (30m resolution) to derive a local harvest rate (CanlaD) and 2) forest attributes derived from MODIS imagery (250m resolution) together with the national forest inventory (NFI) dataset to derive biomass stocks. Results were evaluated using a large compilation of field assessments from post-harvest biomass residue measurements. The forecasting approach uses a forest management unit-level harvest rate over the last 30 years to locate future harvests in forest stands that are close to or at maturity. RSe developed through a national CFS collaboration was published by CFS researchers from the Laurentian and Pacific Forestry Centres.

Conclusion: future of biomass inventory Tools

The biomass inventory tools summarized in this note cover a number of areas: carbon emissions and climate change mitigation potential, biomass location and quantity, and proximity of source to mills. The tools support well-informed decisions related to forest biomass. The CFS is working to make more data on forest biomass accessible to public and private parties, lending strength to the CCFM position that Canada can and will become a world leader in the forest bioeconomy.

One area for improvement in forest biomass inventory tools is in the acquisition of data from remote sensing photo plots. Boundaries of such plots are often difficult to establish in images, requiring much time and effort by interpreters. Furthermore, image quality presents interpretation problems, often a result of weather and other factors typically over coastal areas. Images that are frequently updated and at higher resolution would overcome this problem, enabling better interpretation and data capture. A solution may be forthcoming with the recent launch of RADARSAT.

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Table 1. A concise comparison of the different inventory tools available

	BIMAT	CBM-CFS3	RSe
Biomass type	Primary, Secondary, and Tertiary	Primary and Secondary	Primary
Data source	Mill survey, land cover, forest attribute data, national/ regional waste statistics, population statistics	Harvest statistics, forest inventory, climate and disturbance data	Historical survey data, imagery, photo plots, climate and topographical variables
Time coverage	**Version 1:** circa 2003-2004 **Version 2:** circa 2013-2014	From 1990 to 2050	From 2015 to 2045
Geographic coverage	National	National	National
Spatial resolution	**Version 1:** 1 km; **Version 2:** 250 m; **Public (Versions 1 &2):** 10 km	Varies – based on administrative forest units	Final estimates on a 10 km grid. Maps of mature forest and biomass on a 250 m grid as intermediate products
Access to data	**Public (via BIMAT platform)** http://www.agr.gc.ca/atlas/bimat	**By request** https://www.nrcan.gc.ca/climate-change/impacts-adaptations/climate-change-impacts-forests/carbon-accounting/carbon-budget-model/13107	**Public** https://www.nrcresearchpress.com/doi/10.1139/cjfr-2018-0080.
Other	Includes Urban Wood Biomass estimates (Residential and Non-Residential) for places with populations greater than 1,000 (circa 2011 census).	Used for bioenergy facility selection https://cfs.nrcan.gc.ca/publications?id=38881	Provides spatial forecasts of future availability of forest harvest residues

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