SUMMARY REPORT

MEASURING FOREST MANAGEMENT FOR CLIMATE MITIGATION: RESEARCH-TO-PRACTICE DIALOGUE

By: Lauren T. Cooper (Sustainable Forestry Initiative) and Prof. Alemu Gonsamo (McMaster University), with contributions by Lindsay Douglas (SFI) and Dr. Francesco Cortini (SFI)

SUSTAINABLE FORESTRY INITIATIVE
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McMaster University

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Executive Summary

Sustainable Forestry Initiative (SFI) & McMaster University Remote Sensing Lab co-hosted a Measuring Forest Management for Climate Mitigation Research-to-Practice Dialogue at McMaster University in Ontario, Canada with the goal of better understanding current gaps and advancements in measuring practice-based forest management interventions (e.g., thinning, restoration), and their outcomes at multiple scales. A key focus was exploring the measurement and assessment of carbon and carbon equivalent outcomes in relation to benefits, uncertainties, and time scales. The dialogue aimed to enhance forest-based climate work across the nearly 120-million-hectare footprint of the Sustainable Forestry Initiative (SFI) in Canada. This work is advanced by the SFI Climate Smart Forestry Initiative, an effort supported by Environment and Climate Change Canada (ECCC).

Participants explored how effective forest greenhouse gas (GHG) accounting and climate-related decision-making are affected by fragmented, inconsistent, and insufficiently accessible forest data systems. Disparate data archives, lack of coordination in data collection, and high costs of acquiring and processing necessary information, especially in high-priority areas like southern Ontario and Quebec, pose significant barriers. Moreover, current tools often lack the resolution, accuracy, or annual reporting capabilities needed to fully capture forest dynamics at both local and national levels. These data and technological gaps limit the ability to train models, track the effectiveness of management interventions, and inform operational policy. This report distills these challenges into four dominant themes central to advancing the measurement and assessment of forest-based climate solutions:

- Data quality and availability
- Measurement gaps and scientific methodologies
- Policy alignment and implementation barriers
- Collaboration and communication

The workshop concluded by emphasizing the importance of working closely to address research and practice gaps in forest GHG measurements and monitoring. The report presents a series of recommendations for further action to improve forest GHG inventorying and assessment across multiple scales, including: 1) Collaborative forest carbon monitoring, 2) Enhance forest measurement to capture management and disturbance impacts, 3) Align measurement and reporting frameworks with international standards, 4) Strengthen inclusive partnerships with Indigenous and local communities, and 5) Enhance public communication and climate literacy on forest interventions.

Strengthening these frameworks will enable more precise monitoring, improve forest-based GHG accounting, and support more informed forest-climate decision-making.

Event Overview

This dialogue convened diverse professionals across academia, government, First Nations, and the private sector to present work on forest GHG measurement and monitoring practices for forest management intervention outcomes, and sustainable and Climate Smart Forestry practices. The group included experts who shared their work in research or practice in a series of short presentations. Facilitated by Dr. Alemu Gonsamo (McMaster University) and Lauren T. Cooper (Sustainable Forestry Initiative), the event featured presentations and discussions on forest carbon accounting, forest disturbance, and climate-resilient forest management.

The afternoon closed with a discussion of the overall challenges and opportunities facing the forestry sector and research communities in terms of measuring, assessing, and monitoring forest management outcomes and climate impacts of Canada's forests. There was a particular focus on forest management, while there was recognition that wildfire is often considered a natural disturbance despite the role that anthropogenic activities can have in reducing or exacerbating wildfire risks and impacts.

The discussion also addressed the significance of organic carbon stored in Canada's soils and peatlands, as well as the post-disturbance changes in land reflectivity (albedo) in forest carbon accounting. The audience acknowledged that post-fire landscapes dominated by snow and deciduous regrowth can increase surface reflectivity and partly offset carbon emissions, and that Canada has 15 times more organic carbon stored in soils than in vegetation, which should be considered in forest GHG accounting.

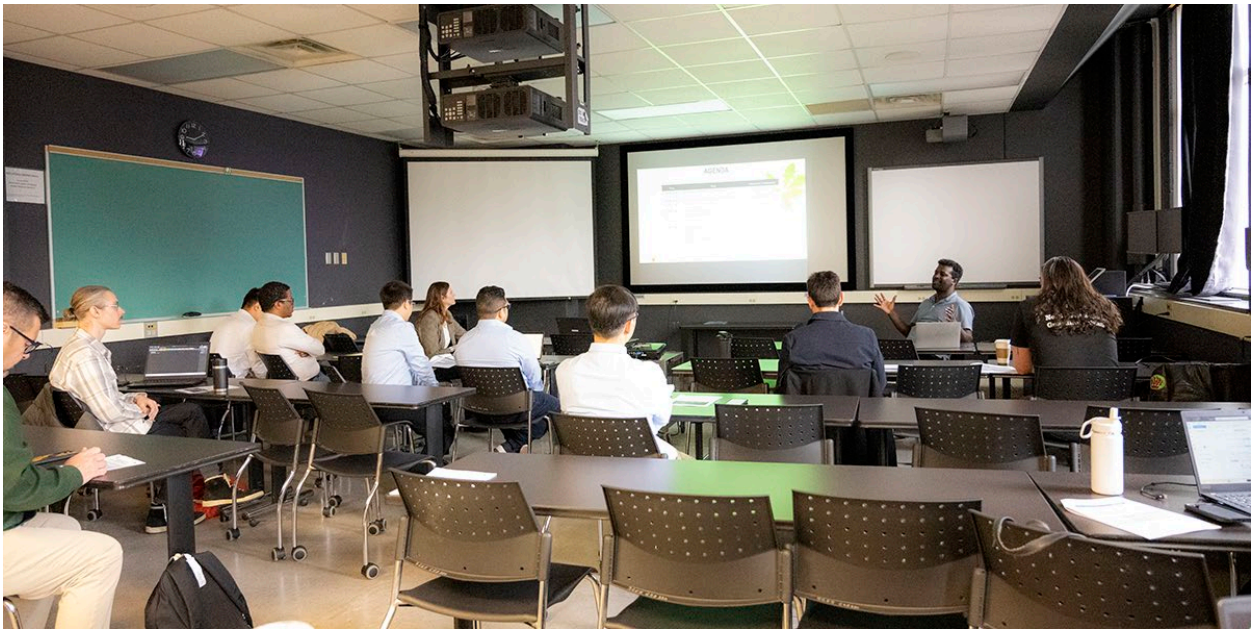

Figure 1: *Alemu Gonsamo (McMaster University) and Lauren T. Cooper (SFI) lead dialogue participants in a discussion about forest-based greenhouse gas measurement in Canada.*

Presentation briefs

The dialogue agenda was divided into two sections. In the morning, researchers presented on current research, methods, and data on forest carbon accounting. In the afternoon, six presenters from nonprofits, First Nations, and SFI certified organizations presented work on forestry planning and implementation. A more detailed summary of the presentations is available (please see contact information below).

Speaker	Organization	Title
Zilong Zhong	McMaster University	Burned area detection, carbon emissions estimation, and biomass budget modeling in forests
Jose Bermudez	McMaster University	Integrating multi-sensor data and deep learning for estimating canopy height, biomass, and uncertainty in managed southern and data-scarce northern forests
Tenaw Geremew	McMaster University	High-resolution space-based monitoring of large-scale tree planting initiatives for climate mitigation and environmental restoration
Kangyu So	McMaster University	Retention forestry: assessing biomass, soil carbon and albedo impacts with ground, UAV, and satellite observations
Dominic Cyr	Environment and Climate Change Canada (ECCC)	Uneven-aged stand dynamics, trees outside forests, and other opportunities to improve Canada's National GHG inventory carbon estimates
Sean Rudd and Vicky Chen	Korotu Technology	Towards a multi sensor, locally calibrated estimation of forest carbon stocks from space, aerial, and terrestrial data combined
Brennan Vogel	Chippewas of the Thames First Nation	Exploring collaboration & planning opportunities for sustainable forest stewardship, restoration & conservation
Caleb Rempel	First Nations' Emergency Services Society (FNESS)	First Nations' Emergency Services Society integrated fire management (IFM)
Leigh Fox	Wahkohtowin Development GP Inc.	Mycorrhizal inoculation of forest seedlings and connection to Indigenous forest stewardship values: measuring above ground biomass in below ground Improved Forest Management (IFM) silviculture interventions
Aidan O'Brien	Forests Canada	Challenges and opportunities to measuring forest carbon
Shannon Rawn	Miisun Integrated Resource Management Co.	Miisun's approach to achieving climate smart forestry

Findings

Through presentations and discussion, the dialogue captured diverse perspectives on forest GHG accounting across Canada. This report distills these into four dominant themes central to advancing measurements and assessment of forest-based climate solutions: 1) Data quality and availability, 2) Measurement gaps and scientific methodologies, 3) Policy alignment and implementation barriers, and 4) Collaboration and communication.

Data quality and availability

High-quality, accessible, and consistent data are essential for operational policy decision-making. However, fragmented data systems and limitations in measurement tools hinder effective forest GHG accounting. Ongoing challenges include:

- Disparate data archives and uncoordinated collection methods reduce data usability
- Limited data in priority management areas (e.g., southern Ontario, Quebec) and high costs of data acquisition/processing
- Existing tools lack the accuracy, scale, and annual resolution needed for tracking forest GHG dynamics at stand and national scales
- Issues with data ownership, computational requirements, and integrating new technologies like LiDAR into growth models

Measurement gaps and scientific methodologies

Current measurement frameworks struggle to capture the full complexity of management and disturbance impacts across carbon pools of forest ecosystems. Scientific and technical measurement challenges further complicate efforts to quantify and manage forest-based climate outcomes. Additionally, current models and tools struggle to track scattered or small-scale interventions—such as tree planting programs—across diverse landscapes and time periods. Ongoing challenges include:

- Persistent gaps between remote sensing data and field observations
- Insufficient measurement of soil carbon responses to management and disturbance
- Underdeveloped methods to account for forest disturbances' biophysical climate effects (e.g., albedo, cooling)
- Insufficient integration of forest disturbance and management effects on climate feedbacks (e.g., albedo, cooling)
- Need for effective metrics to track forest management outcomes and their climate implications over time
- Difficulty in bridging gap between remote sensing data and ground observations

Policy alignment, tools, and implementation barriers

Another major barrier is the misalignment between current data, models, and policy frameworks with internationally accepted guidelines. Without this alignment, consistency and credibility at regional, national, and international levels are difficult to achieve. There is a pressing need for metrics and communication strategies that clearly articulate the climate outcomes of forest management practices over time. Ongoing challenges include:

- Lack of tools for stand-to-national scale GHG tracking on an annual basis
- Limited alignment across scales of data and methods with international best practices (e.g., IPCC guidelines) for consistency
- Resource constraints, including funding uncertainty, seed supply, and land ownership issues, challenge effective program delivery
- Limited awareness among policymakers of key scientific and operational forestry issues
- Uncertainty around land ownership (public vs. private) complicates implementation

Collaboration and communication

Effective forest GHG accounting requires strong collaboration across disciplines, jurisdictions, and stakeholder groups. However, inconsistent communication, unclear roles, and siloed data-sharing practices hinder coordination and limit the impact of scientific and policy efforts. A lack of shared language between technical experts, policymakers, and land managers also contributes to misalignment and reduced uptake of science-based recommendations. On going challenges include:

- Fragmented collaboration across federal, provincial, Indigenous, and private entities
- Limited platforms for transparent data sharing and cross-sector knowledge exchange
- Communication gaps between scientists, policymakers, and local practitioners
- Inconsistent messaging on climate outcomes of forest management undermines public understanding and trust

- Disconnect between researchers, policymakers, and operational forestry practitioners

Recommendations

The following recommendations address the ongoing challenges identified in the previous section:

1. Invest in Collaborative, Open Science for Forest Carbon Monitoring

Support cross-sector research partnerships that promote open data, co-development of methodologies, and interdisciplinary collaboration to improve the accuracy, transparency, and policy relevance of forest GHG inventories.

2. Enhance Forest Measurement to Improve Assessment of Management and Disturbance Impacts

Invest in the development and integration of advanced measurement methodologies that accurately reflect the complexity of forest ecosystem carbon dynamics, particularly in response to management practices and disturbances. Prioritize enhancing models for soil carbon and biophysical feedbacks can close pressing knowledge gaps. Approaches can include improving the alignment between remote sensing and field observations, including the integration of emerging tools such as LiDAR and AI-based modeling to improve spatial and temporal resolution. Models should be adapted to effectively track small-scale and dispersed interventions—such as afforestation and selective harvesting—across heterogeneous landscapes and timeframes.

3. Align Measurement and Reporting Frameworks with International Standards

Ensure Canada's forest GHG accounting systems at federal, provincial, and forest management unit levels are aligned with IPCC guidelines and other international best practices to enhance credibility, enable comparability, and support global climate commitments.

4. Strengthen Inclusive Partnerships with Indigenous and Local Communities

Expand and support initiatives like Indigenous Guardians programs to integrate Indigenous knowledges, leadership, and stewardship into forest monitoring and climate strategies. Clarify roles and foster shared accountability across all governance levels.

5. Enhance Public Communication and Climate Literacy on Forest Interventions

Develop and disseminate clear, consistent narratives that explain the climate benefits of forest management. Use traditional and digital media to build public understanding and support for reforestation, conservation, and sustainable forest practices.

Contact

Lauren T. Cooper
Sustainable Forestry Initiative
Lauren.cooper@forests.org

Alemu Gonsamo
McMaster University
gonsamoa@mcmaster.ca

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