An Updated Forest Carbon Science Blueprint for Canada: Discussions on Priorities, Goals and Visions for the Coming Decade

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Forest Carbon Blueprint Update

The original Carbon Blueprint was published in 2012, and since then advances in forest carbon science have supported policy and forest management decisions.

The updated blueprint:
- Takes stock of progress over the past 10 years
- Identifies policy-relevant research priorities to orient activities of research organizations and guide research-funding decisions across the Canadian forest carbon science and policy communities.
Forest Carbon Blueprint Update Timeline

**Spring – Fall 2022:**
- Retrospective summary on progress since 2012

**Fall – Winter 2022:**
- Workshop #1: ~75 people CFS
- Drafted new science-policy themes

**Winter – Spring 2023:**
- Workshop #2: forest carbon community ~140 people
- Refined science-policy themes

**Summer 2023:**
- Draft distributed to >20 (external organizations and Government departments)
- Externally reviewed, revised draft

**Winter 2024:**
- Finalize and publish
- Launch updated Blueprint!
10-year progress on forest carbon research in Canada

**METHODS**
- Identify progress on 10 years of research to support policy
  - surveys
  - workshops
  - lit. review

**TOPICS**
1. Contemporary forest carbon emissions and removals
2. Effects of global changes on forest carbon
3. Forest sector climate change mitigation

**FINDINGS**
- Continuous improvement in nationally reported forest sector carbon
- Tools developed to assess climate change impacts on forest carbon, disturbances, growth, and mortality
- Projections developed for future GHG reductions and costs based on different climate mitigation scenarios

2012
- A blueprint for forest carbon science in Canada (2012-2020)
  - Identified forest carbon policy priorities and outlined associated Canadian research activities until 2020

2023
- Based on 10-year progress, blueprint will be updated with renewed priorities for the next decade
- 2023 blueprint for forest carbon science in Canada
Science-Policy Priorities for the Coming Decade

Through assessing progress-to-date, consultation with the forest carbon science and policy communities, and emerging topics in the discipline, five themes were drafted for the renewed Blueprint:

• Impact of human actions on forest sector carbon
• Impacts of environmental factors, climate change and natural disturbance on forest carbon dynamics
• Climate change mitigation measures in the forest sector
• Indigenous perspectives and traditional knowledge
• Connecting carbon to other values
Impact of human actions on forest sector carbon

Policy relevance:
Meeting Canada’s commitment to reporting on the impact of humans on forest GHG emissions and removals and continuous improvement of estimates

Research goals:
A. Continuous improvement of forest sector carbon estimates, projections, and uncertainties
B. Improved understanding of the impact of human activities on forest carbon at site- and landscape-level
C. Improved spatially explicit modelling and monitoring of forest carbon and comparisons to global forest carbon estimates
D. Expanded national forest sector carbon anthropogenic estimates
E. Continuous improvements in modelling and forecasting systems
Impacts of environmental factors, climate change and natural disturbance on forest carbon dynamics

Policy relevance:
Increasing need to understand how changing natural disturbances with climate change can impact forest carbon storage, sequestration and emissions. Enhancing foundational knowledge of forest carbon dynamics.

Research goals:
A. Advance understanding of the processes driving forest growth and productivity
B. Advance understanding of the processes driving biomass turnover and decomposition
C. Advance understanding of carbon cycling processes in peatland and permafrost soils
D. Advance understanding of carbon flows from terrestrial to aquatic systems
E. Understand and predict changes in natural disturbance regimes in a changing climate, and impacts on carbon pools, transfers, and fluxes
Climate change mitigation measures in the forest sector

Policy relevance:
Advancing the implementation of forest-related mitigation solutions to support GHG reduction efforts while achieving other environmental and societal co-benefits

Research goals:
Identify climate change mitigation opportunities involving:
- A. forest management, including adaptation measures and options for natural disturbance management
- B. afforestation, reduced deforestation, restoration and reclamation
- C. wood products
- D. bioenergy

Develop forecasting systems and model linkages that permit evaluation of baseline and scenarios of mitigation and adaptation
Indigenous perspectives and traditional knowledge

Policy relevance:
Advancing reconciliation and Indigenous co-management

Research goals:
Improve understanding of forest carbon through Indigenous-led research that is centered on Indigenous voices and experiences and application of Indigenous Knowledge systems.
Connecting Carbon to other values

Policy relevance:
Advancing understanding of forest carbon issues, integrating multiple forest values, and improving collaboration

Research goals:
A. Advance understanding of opportunities for Nature-based Solutions involving forest carbon
B. Advance interdisciplinary approaches to forest carbon science
C. Improve communication of forest carbon modelling and research
Looking forward

- Periodic check-ins to evaluate progress, set milestones and adjust priorities.
- Knowledge exchange is key to ensuring forest carbon research effectively informs policy.
Thank you!
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- Estimating forest carbon emissions and removals
- Reporting Canada’s forest greenhouse gas emissions and removals
- Canada’s forest carbon reporting system

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## Impact of human actions on forest sector carbon

### Goal

1. Continuous improvement of national anthropogenic GHG estimates for the forest and associated harvested wood products, including historical and projected estimates, and uncertainties.

2. Improved understanding of the impacts of human activities such as forest management, land use change, and other industrial development on current and future carbon dynamics at site- and landscape-levels.

3. Improved spatially explicit modelling and monitoring to better estimate anthropogenic impacts on forest carbon and comparisons to global forest carbon estimates.

### Vision

1. To provide increasingly accurate estimates of anthropogenic forest and associated wood product emissions and their uncertainties that are accessible to the public, proactively communicated, and broadly accepted.

2. Continuous improvement in our estimates of the impacts of human activities on historical and projected forest carbon dynamics at a fine level of detail, which will improve forest sector GHG emission and mitigation estimates. Forest land managers and other stakeholders will have access to site- and landscape-level information on the impact of various human activities on current and future forest carbon dynamics.

3. Canada will have fully spatially explicit framework to better quantify anthropogenic impacts on forest carbon. A high spatial resolution will allow for increased accuracy of forest carbon estimates that are more easily verified and compared to global estimates.
4. Expanded knowledge on forest sector carbon estimates to meet evolving needs.

5. Continuous improvement in modelling and forecasting systems to estimate forest-related GHG emissions associated with anthropogenic activities.
Impacts of environmental factors, climate change and natural disturbance on forest carbon dynamics

Goal

6. Advance understanding of the processes driving forest growth and productivity.

7. Advance understanding of the processes driving biomass turnover and decomposition.

8. Advance understanding of carbon cycling processes in peatland and permafrost soils.

Vision

Large-scale observational datasets of forest growth and productivity components will be expanded across forest types and ecozones and include regular remeasurements. Models of annual forest growth will be developed that include biological factors integrated with environmental and climate drivers. Ensembles of models using different approaches (e.g., biometric, tree ring and flux towers) will be developed that better predict forest productivity at the landscape level, and climate-sensitive growth models will be developed that better predict tree mortality, survivor increment, and tree recruitment.

A curated database of collections and analyses of soils, dead organic matter composition, and degradability with sufficient representation across key factors (forest and soil type, parent material and climate) will be available. A thorough understanding will be developed of the role of soil composition, geochemistry, environmental controls, natural disturbances and soil community biodiversity in controlling biomass turnover, decomposition rates, and soil carbon stabilization processes.

Data for key model inputs and parameters (e.g. small-tree biomass growth, moss productivity, spatial extent of permafrost-affected organic and mineral soils) will be expanded, and methods will be available to estimate methane fluxes using refined spatial layers of peatland types and the water table. An improved understanding will be developed of environmental drivers and carbon cycling in peatland and permafrost affected soils, and their vulnerability to future climate.
9. Advance understanding of carbon flows from terrestrial to aquatic systems.

Monitoring at long-term forest watershed studies will provide decadal measurements of lateral (riverine and groundwater) carbon export. Frameworks will be developed to track lateral carbon flows from uplands to aquatic systems at catchment scales that incorporate high-resolution digital elevation models to estimate hydrologic flows and subsequent carbon loss or accumulation within the landscape.

10. Understand and predict changes in natural disturbance regimes in a changing climate, and impacts on carbon pools, transfers, and fluxes.

National assessments of disturbed area and severity by disturbance type will be developed and combined with models and field studies to assess impacts on carbon pools, transfers, and fluxes. Models of climate-sensitive disturbance occurrence and intensity will be developed that support long-term (multi-decadal) forecasting, and integrated models will be developed that quantify the impacts of individual disturbances and cumulative effects of multiple disturbances on carbon dynamics.
Climate change mitigation opportunities in the forest sector

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<td>11. Identify climate change mitigation opportunities involving forest management, including adaptation measures and natural disturbance management options.</td>
<td>Canada’s climate change mitigation programs involving the forest sector will be supported by expanded comparative assessments of management options that are regionally differentiated, relative to a forward-looking baseline, and based on the best available data and methods for quantifying forest carbon at the tree, stand, and landscape level. Analyses will include impacts of climate change and future disturbance risks, sensitivity assessments, and adaptation and natural disturbance-based forest management.</td>
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<td>12. Identify climate change mitigation opportunities involving afforestation, reduced deforestation, restoration and reclamation.</td>
<td>Assessments with national coverage of climate change mitigation for afforestation and avoided deforestation opportunities will be developed based on the best methods available for quantifying carbon accumulation, will be regionally differentiated and include management to promote growth and mitigate loss and disturbance risk, and will include non-GHG impacts directly related to warming.</td>
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<tr>
<td>13. Identify climate change mitigation opportunities involving wood products.</td>
<td>Assessments with national coverage of the climate change mitigation potential for wood use will be regionally differentiated, consider all stages of a product’s life cycle and substitution benefits, and will address some of the barriers to implementation.</td>
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<td>14. Identify climate change mitigation opportunities involving bioenergy.</td>
<td>National bioenergy GHG estimates and costs will be developed for a range of feedstock selections and regionally differentiated fossil energy assumptions. New tools will become available that use simple and practical methods for managing bioenergy projects that contribute to net-zero commitments, based on the best-available data and methods.</td>
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<td>15. Develop forecasting systems and model linkages that permit evaluation of baseline and scenarios of mitigation and adaptation.</td>
<td>Progress towards mitigation and adaptation goals will be tracked using transparent, flexible and nimble modelling systems that provide iterative spatially explicit forecasts of mitigation scenarios. Forecasts will be constantly being updated and evaluated as new data and science become available and are integrated in the modelling system.</td>
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Indigenous perspectives and traditional knowledge


Goal

Vision

Truth and Reconciliation Calls to Action and Bill C-15 implementation will be reflected in forest carbon scientific research, bringing in Indigenous voices as an essential component and recognizing that Indigenous Knowledges and western approaches are both important, are both needed, and require significant changes to research practices and collaborations to be respectful to Indigenous Peoples and Indigenous methodologies. Understanding of Indigenous Methodologies, protocols and knowledge in forest carbon research priorities, goals and actions will be advanced through authentic and respectful Indigenous engagement with national Indigenous organizations, and under the guidance of Indigenous partners.
## Connecting forest carbon to other values

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<td>17. Advance understanding of the broader impacts of nature-based solutions to climate change.</td>
<td>Forest carbon science will be integrated into well-balanced qualitative and quantitative evidence to advance the full range of Nature-based Solutions benefits, including human well-being, clean water and biodiversity. Forest carbon science will better reflect links between forest carbon and human well-being through a reconciliation lens.</td>
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<td>18. Advance interdisciplinary and multi-disciplinary approaches to forest carbon science.</td>
<td>The forest carbon community will collaborate across disciplines to effectively and efficiently respond to emerging information needs and shifting expectations regarding other values, including commitments to Indigenous rights and reconciliation and biodiversity. Use of approaches that understand a range of values will enable multiple ways to implement forest carbon-based climate solutions.</td>
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<td>19. Improve communication of forest carbon modelling and research.</td>
<td>Forest carbon estimates and uncertainties, research findings and information will be communicated in a way that meets the needs of Indigenous knowledge keepers, scientists, policy makers, land managers, stakeholders, and the public.</td>
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10-year progress: Comparison of literature scan and workshop survey results

Research topics were based on those in the original Blueprint published in 2012.

Workshops participants were asked in their opinion, how much progress has been made on the blueprint themes (left).

Researchers categorized publications on Canadian forest carbon published since the Blueprint (right).

The figure shows alignment on progress and publication metrics, particularly for the first two research topics.