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How the Forest Sector Can Help Mitigate Climate Change

Patrick Lavoie, Senior Scientist

The Intergovernmental Panel on Climate Change (IPCC) states that land-use related solutions, including forestry, can play a crucial role in climate change mitigation. Among the high-potential forestry solutions identified by the IPCC are afforestation and reforestation practices, sustainable forest management and replacing high-intensity GHG products with wood products and forest biomass. These solutions can be applied in a Canadian context where deforestation is not an issue.

Thus, an **integrated approach** leveraging the synergy between forest management actions, carbon storage in long-lived forest products and substitution in the marketplace would enable the forest sector to play an important role in the fight against climate change over the coming decades.

It is in this context that the *Groupe de travail sur la forêt et les changements climatiques* (GTFCC - Working Group on Forests and Climate Change) examined how Québec's forest sector could help mitigate climate change. The working group's conclusions are relevant across Canada.

Leveraging the Forest Sector's Assets

For the purposes of the mandate, four mitigation scenarios that contain a collection of actions were identified by the GTFCC in consultation with the Scientific and Technical Committee consisting of representatives of ministries and agencies associated with the forest industry. The scenarios were modelled in the Carbon Budget Model of the Canadian Forest Sector (CBM-CFS3) in collaboration with the Canadian Forest Service's Pacific Forestry Centre in Victoria, B.C. The Université Laval and the Université du Québec à Chicoutimi (UQAC) also partnered with FPInnovations to fulfill the GTFCC's mandate.

The study area includes all commercial forest areas in Québec, both public and private. It should be noted that all actions comply with sustainable forest management principles and ecosystem-based management objectives that are at the heart of Québec's forest regime, such as preserving biodiversity, protecting old-growth forests, etc. Forest inventory data and yield curves used for forest modelling were obtained from Canada's 2018 National Inventory Report database.

All four scenarios are compared to the **business-as-usual scenario (BAU)** to assess their potential to mitigate GHG fluxes to the atmosphere. The BAU scenario has no additional policy and is based on future technological development aligned with past trends. This scenario is neither a prediction nor a forecast but rather a continuation of the current situation and trends.

Potential GHG emissions mitigation includes the sum of three effects:

- Carbon sequestration in forests
- Carbon storage in wood products
- Emission reduction resulting from the replacement of carbon intensive materials and energy with forest products or forest bioenergy

Scenario 1: Intensive Forest Management

In the forest management intensification scenario (INT), poorly regenerated areas and unused agricultural lands are afforested. For the period between 2021 and 2030, this represents a program of 50,000 ha per year, more than the BAU scenario, for a total of 500,000 ha. The INT scenario sees between 1.6 and 4.5 M m^3 more merchantable wood than the BAU scenario harvested. Also, a slightly higher-yield of long-lived products is produced from the wood harvested.

Scenario 2: Bioenergy Development

The bioenergy development scenario (BIO) focuses on the removal and use of harvest residues to supply heat for buildings and industrial processes. Between 2020 and 2050, 0.8 million oven dry metric tonnes (ODMt) will be harvested under the BIO scenario than under the BAU scenario; that number rises to 2 ODMg between 2051 and 2089.

Scenario 3: Intensive Management and Bioenergy Development

The third scenario (INT+BIO) combines the intensive forest management scenario (INT) with the bioenergy development scenario (BIO).

Scenario 4: Harvest and Use of Low-Value Stands

This final scenario combines the preceding scenarios with the harvesting of low-value stands (INT+BIO+HLVS) that is part of the annual allowable cut but that is not sold in the current industrial network. Every year, 8 to 10 M m^3 of this timber is not harvested in the BAU scenario but is planned for harvest in scenario 4.

Half of the hardwood harvested in low-value stands is used for bioenergy and the other half for sawmilling. Coproducts produced during the sawmilling process are used to manufacture panels, and pulp and paper, and to produce energy for sawmills, as is normally the case. Softwood harvested from low-value stands is sent to sawmills.

Results

A scenario's potential mitigation is calculated by subtracting the fluxes of the BAU scenario from the four scenarios. A positive flux means there is a net increase in GHG emissions to the atmosphere, while a negative flux means there is a reduction in GHG emissions. This decrease, or mitigation, can come from the various components of the **integrated approach**: The effect of a forest carbon sink (sequestration), temporary forest carbon storage in products or a substitution effect.

All flux and mitigation values are calculated in megatons CO_2 equivalent (Mt CO_2 eq.) for 2030, 2050, and 2089. This InfoNote only presents the results for 2089.

Two analyses are proposed: A **baseline analysis** and a sensitivity analysis. Both analyses assess the lower bounds (baseline analysis) and the upper bounds (sensitivity analysis) of mitigation of the four scenarios investigated: INT, BIO, INT+BIO, and INT+BIO+HLVS. The assessment of carbon sequestration in forests is the same in both analyses. Only carbon storage in forest products and the extent of substitution differ.

The **sensitivity analysis** simulates the industry's **accelerated transition** to products that store carbon over a longer period (e.g., panels instead of paper products). It also considers the fact that the GHG emissions reduction potential stemming from the substitution of non-renewable products or energy is greater than that assessed in the baseline analysis. These are referred to as **targeted substitutions**.

Baseline analysis

Results from the **baseline analysis** show that the INT+BIO+HLVS scenario (160 Mt CO_2 eq.) offers the greatest mitigation, followed by the intensive management scenario (INT), with a cumulative mitigation of 127 Mt CO_2 eq. in 2089. In both scenarios the forest sink is reduced compared to the BAU scenario but is offset by a significant substitution effect and, in the INT scenario, by carbon storage in forest products.

The BIO scenario results in a positive emission flux (46 Mt CO_2 eq.) into the atmosphere by 2089. This is due to bioenergy emissions that are not fully offset by a substitution effect equal to or greater than that in the baseline analysis in which substitutions do not specifically target emission intensive energies. On the contrary, bioenergy replaces an average energy mix consisting largely of hydroelectricity and other renewable energies. Lastly, the INT+BIO scenario offers a compromise with a mitigation of 81 Mt CO_2 eq.

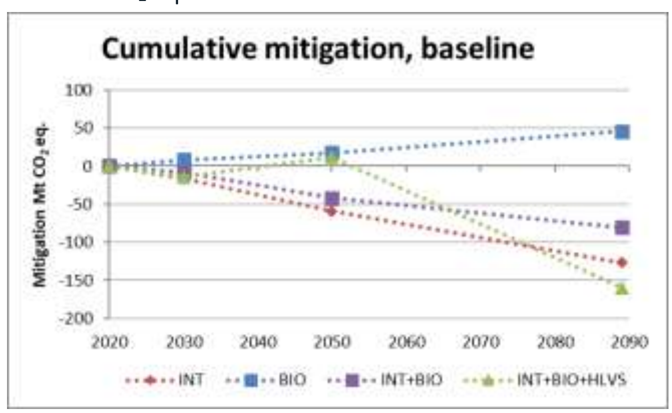

Figure 1. Climate change mitigation, baseline analysis.

Results from the baseline analysis provide a conservative outlook for the results of the four scenarios examined. The sensitivity analysis paints a more optimistic picture owing to a larger portion of the merchantable wood supply that is turned into long-lived forest products (e.g., construction) and medium-lived forest products (e.g., non-structural panels).

Sensitivity analysis

Results from the sensitivity analysis show that the intensification, bioenergy and harvesting of unsold timber scenario (INT+BIO+HLVS) results in a mitigation of

730 Mt CO_2 eq. As was the case in the baseline analysis, total mitigation comes primarily from substituting carbon intensive products and energy. Carbon sequestration in products is also slightly higher in this analysis when measured against the results of the baseline analysis of the same scenario.

A sensitivity analysis of the bioenergy development scenario (BIO) results in a mitigation of 102 Mt CO_2 eq. in 2089. In this scenario's analysis, the substitution effect is significantly greater, offsetting bioenergy carbon emissions. To summarize, in this analysis the carbon emitted by burning harvest residues is less than the equivalent amount of energy generated by fossil fuels.

The INT and INT+BIO scenarios result in a mitigation of 357 and 459 Mt CO_2 eq., respectively. In this analysis, both scenarios benefit from a higher substitution level that clearly illustrates the role of policies in ensuring that energy substitution and other substitutions are directed towards the highest GHG-emitting applications.

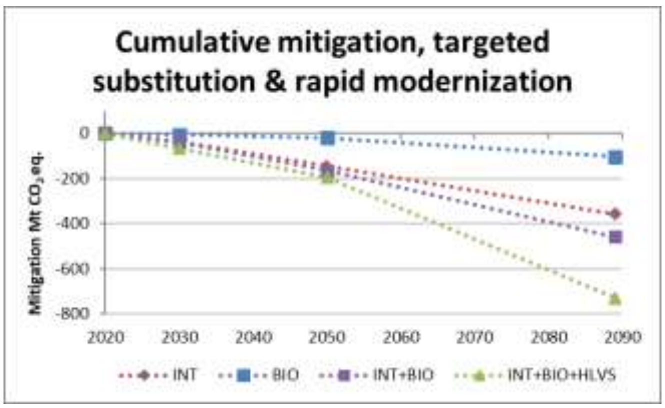

Figure 2. Climate change mitigation, sensitivity analysis.

Economic analysis

The costs of achieving the mitigation potential identified in both analyses have been assessed. They are estimated provincially based on the model of economic analysis (MEA) developed by the Canadian Forest Service (CFS). The mitigation costs for each scenario are calculated based on the average mitigation and the net revenue of each scenario which are discounted based on the time they occur.

Net revenue considers implementation costs and the revenue generated by each scenario's silvicultural practices. Similarly, the costs of forest products from the supply harvested and the revenue from their sale were assessed. These cost and revenue data make it possible to evaluate each scenario's net revenue.

The results show that the INT and INT+BIO scenarios' mitigation costs are between \$10 and \$12/tonne CO_2 eq. As stipulated previously, mitigation under these scenarios is comparable, be it with the baseline analysis or the sensitivity analysis. Mitigation ranges from 3.5 to 4.0 Mt CO_2 eq./year over the 2020-2089 study period.

The INT+BIO+HLVS scenario's mitigation is much greater and is estimated at 6.5 Mt CO_2 eq/year. However, implementation costs are much higher, resulting in mitigation costs estimated at \$87/tonne CO_2 eq. The BIO scenario's mitigation costs are very low, or even negative, resulting in "mitigation revenue" of \$4/tonne CO_2 eq. It is important to point out that the mitigation level is uncertain, as it depends how efficient the energy substitutions are.

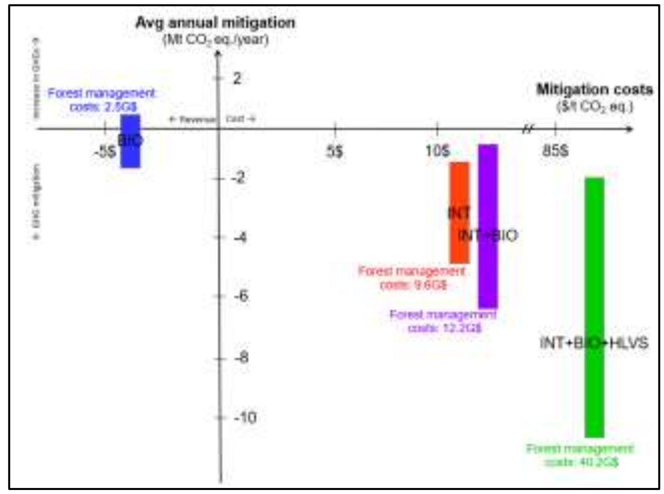

Figure 3. Scenarios' mitigation costs.

The study results provide conclusions and recommendations that could be further investigated. This particular study did not explore the optimal scenarios for specific forest management units or based on an optimal allocation of wood by stem quality in order to maximize the yield of long-lived products. Actions other than those included in the scenarios examined, such as commercial thinning and conservation could have also been studied.

Recommendations

Measures supporting the domestic use of long-lived wood products for construction and the development of domestic bioenergy markets would have a direct impact on Quebec's GHG inventory. In addition to lowering provincial GHG emissions, measures that have global positive impacts are proposed. They include:

- Increasing the yield of long-lived forest products by funding research and development focusing on the sawmill industry and the use of co-products in the production of panels and other bioproducts.
- Promoting the use of long-lived forest products through measures such as government exemplarity in construction and the development of policy and

regulatory frameworks that support the use of wood products in non-traditional applications.

- Promoting the development of biomaterials (bioplastics, biotextiles, wood chemistry), whose non-renewable equivalents depend largely on fossil energies through innovation support programs. These products can deliver substantial substitution effects.
- Developing a government project assessment mechanism based on GHG emissions accounting to identify and promote high emission reduction potential through product/energy substitution.
- Developing forest biomass supply chains and bioenergy production chains by targeting technical, legal and social barriers. Where possible, harmonize biomass procurement practices with other silvicultural practices – harvesting, site regeneration and stand tending – to reduce supply costs and increase overall profitability of forest operations.
- Identifying low-value stands that are included in the annual allowable cut and whose harvesting can be aligned with ecosystem-based management objectives. Analyze the climate impact and the ecological, economic and social constraints associated with the use of these wood volumes at the forest management unit level. Their harvest could facilitate the production of bioenergy, the mobilization of volumes of quality wood for long-lived wood products and the regeneration of low-productivity stands by replacing them with high-growth stands.
- Identifying unproductive sites and non-forest sites that could benefit from afforestation/reforestation and considering the introduction of an afforestation program that allows for a high growth rate and a high yield of long-lived wood products.

References

Beauregard, Robert, Patrick Lavoie, Évelyne Thiffault, Isabelle Ménard, Lucas Moreau, Jean-François Boucher, and François Robichaud. 2019. Report of the Working Group on forestry and Climate Change (WGFCC - Working Group on Forestry and Climate Change).

Web link: https://mffp.gouv.qc.ca/documents/forets/Rapport_final_GTFCC.pdf

For more information

Patrick Lavoie | (418) 781-6706
patrick.lavoie@fpinnovations.ca

Vincent Blanchard | (418) 781-6741
vincent.blanchard@fpinnovations.ca

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