

Forest sector strategies for climate change mitigation

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Scientists examine how forests and wood products can reduce emissions to the atmosphere.

Pacific Forestry Centre research scientists Carolyn Smyth and Werner Kurz model the impact of various strategies on the greenhouse gas balance of Canada's forest sector. Modeling several decades into the future allows scientists to ask, "What mitigation actions will work best for each region?" and assess how changes in activities or technology can reduce future emissions or enhance removals of greenhouse gases from the atmosphere.

Forests play an important role in the carbon cycle (Figure 1). The carbon cycle is the movement

of carbon from land and water through the atmosphere and all living things. Carbon in the atmosphere exists as CO_2 , a greenhouse gas. Trees absorb carbon during photosynthesis and store it in their stems, branches and roots, removing large amounts of carbon from the atmosphere. A large proportion of this stored carbon also ends up in forest soil through natural processes such as annual turnover and tree death. Trees release carbon back into the atmosphere during respiration, when they die and decay, or if they are burned in a forest fire. This dynamic process of absorbing and releasing carbon constantly affects the global carbon balance.

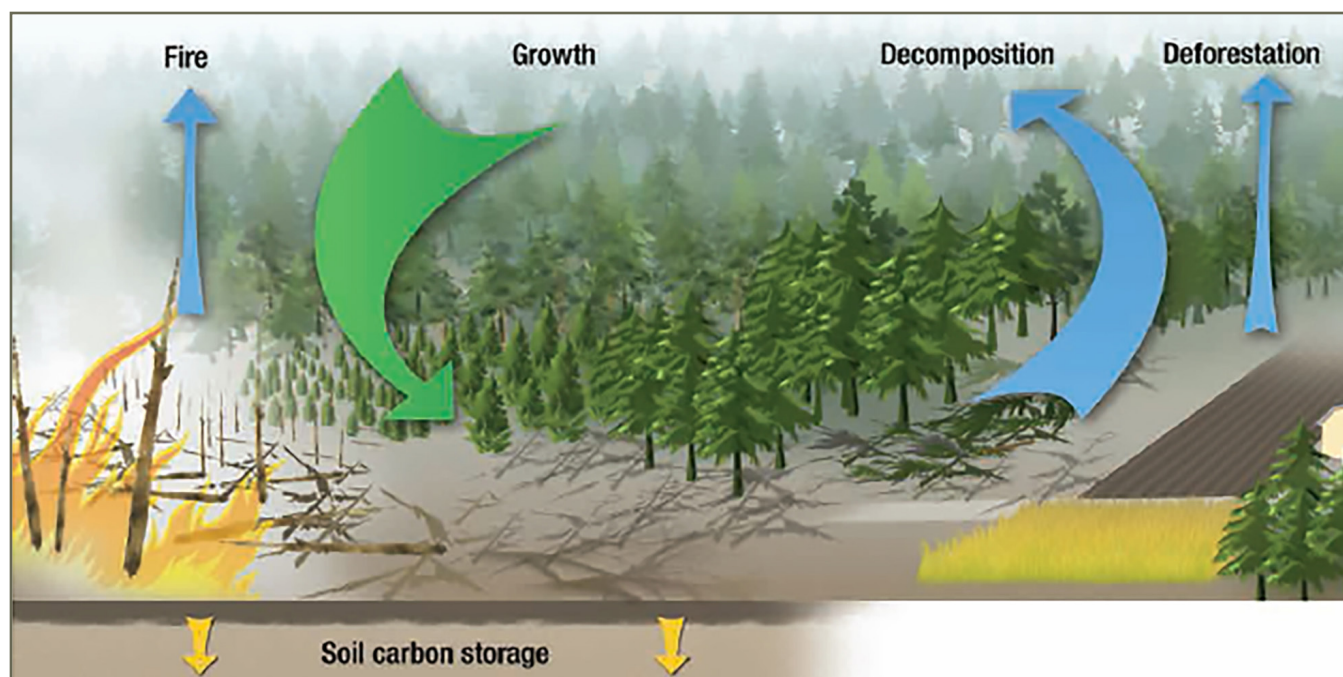


Figure 1 - The role of forests in the carbon cycle

As they grow, forests absorb large amounts of carbon from the atmosphere. Other natural forest processes, such as decomposition and fire, release carbon back into the atmosphere. This dynamic process of absorbing and releasing carbon constantly affects Earth's carbon balance. How humans manage forests and use wood also affects this balance.

Harvesting of trees transfers carbon into wood products to meet society's demands for building materials, furniture, other wood products, and energy. Carbon is released back into the atmosphere when a product is disposed of or burned as a source of energy.

Scientists at the Pacific Forestry Centre, model Canada's forest sector to understand how we can increase the amount of carbon absorbed by our forests or reduce emissions of carbon to the atmosphere. Changes in how forests are managed and how we use wood products can provide substantial opportunities to mitigate climate change. Several forest management activities were studied to see how much more forests could contribute to reducing emissions to the atmosphere or taking up more carbon out of the atmosphere (*Figure 2*).

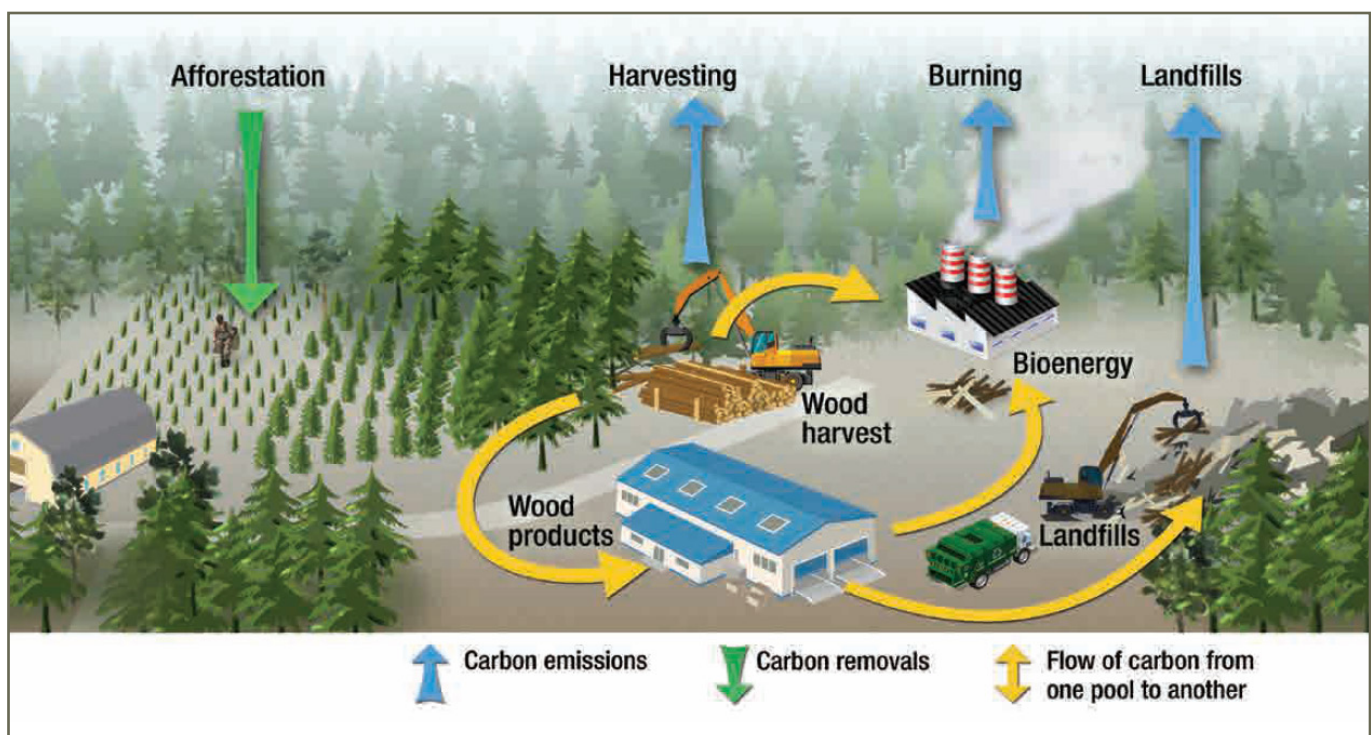


Figure 2 - The carbon cycle

The "carbon cycle" is the movement of carbon from land and water through the atmosphere and all living things. Carbon in the atmosphere exists as CO_2 , a GHG. Forests are an important part of the carbon cycle. Trees absorb carbon during photosynthesis and store it in their stems, branches and roots. A large proportion of this stored carbon also ends up in forest soil through natural processes such as annual leaf fall and tree death. Trees release carbon during respiration, when they die and decay and if they are burned in a forest fire. Forests are considered to be "carbon sinks" when they absorb more carbon than they release; and "carbon sources" when they release more carbon than they absorb.

Forest Sector Strategies to Mitigate Climate Change and their impacts in Canada

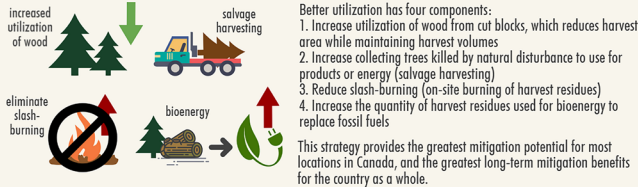
Mitigation Potential:

The Greenhouse Gas (GHG) emissions that are reduced and/or the carbon removals that are enhanced resulting from a mitigation activity, relative to a baseline.

Legend:
carbon emission ↑ carbon removal ↓

There is a significant opportunity to achieve large climate change mitigation benefits from the forest sector. Below are five options that may be effective in Canada:

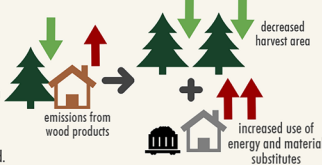
Better Utilization



Harvest Less

Reducing total harvest volumes and restricting forest area available for harvesting increases the area of growing stands, allowing carbon to accumulate in tree biomass, and reduces emissions from harvested products.

This option results in the second highest cumulative mitigation potential for Canada in the short-term due to the increase in forest carbon stocks. However, in the long-term its benefits decrease as a reduction in wood products will likely increase the demand for of emission-intensive products to replace wood.



Planting



A planting strategy decreases the time required by a stand to regenerate after harvest.

The mitigation benefits possible with this strategy depend on the area planted. Benefits may increase in areas where stand regeneration has been impacted by disturbance.

Better Growth

Forest stand growth can be improved through various silviculture activities, such as fertilization, planting improved seeds, and reducing the abundance of competing vegetation.

This strategy does provide mitigation benefits, although the impacts are modest. Like Planting, Better Growth doesn't impact emissions associated with harvested wood products.



Longer-lived Wood Products (LLPs)



This strategy aims to produce less disposable products from pulp and paper production and instead increase the amount of wood used to make long-lived products, such as panels and sawnwood.

It has high mitigation potential in Canada, due to the ability of LLPs to store carbon for longer periods of time, and for them to substitute for more emission-intensive products (e.g. concrete) resulting in a net GHG emission reduction. In the long-term, this strategy has the second highest cumulative mitigation benefit of the options analysed.

Bioenergy Feedstock

A Bioenergy Feedstock strategy increases the proportion of harvest wood going towards bioenergy production at the expense of the production of other wood products.

This strategy does not provide a mitigation benefit at the national level, although opportunities may exist for some regions. Avoided emissions from replacing fossil fuels with bioenergy are not great enough to compensate for the increase in emissions caused by bioenergy production and shorter wood product lifetimes.



By choosing mitigation strategies that maximizes long-term mitigation benefits on a regional-basis, the Canadian forest sector could mitigate almost

50 MtCO₂e per year by 2050!



SOURCES:

- Environment and Climate Change Canada, <https://www.ec.gc.ca/ges-ghg/default.asp?lang=En&nav=6629C56-1#f=es-4>
- PICS, https://picas.sites.ualberta.ca/files/2012/01/Primer_Climate_Change_Mitigation_Options-in-BC.pdf
- Smith, S. and O'Connell, J. (2010). Meta-analysis of greenhouse gas displacement factors of wood product substitution. *Environmental Science & Policy*, 13, 104-114.
- Smyth, C.E., Sison, S., Neilson, E. et al. (2014). Quantifying the biophysical climate change mitigation potential of Canada's forest sector. *Biogeosciences*, 11, 3515-3529.
- Smyth, C.E., Rampley, G.J., Lempiäinen, T.C., Schwab, O., and Kurz, W.A. (2016). Estimating product and energy substitution benefits in national-scale mitigation analyses for Canada. *Global Change Biology Bioenergy*, 1-14.
- Xu, Z., Smyth, C.E., Lempiäinen, T.C., Rampley, G.J., and Kurz, W.A. (2017). Climate change mitigation strategies in the forest sector: biophysical impacts and economic implications in British Columbia, Canada. *Mitigation and Adaptation Strategies for Global Change*, 1-34. <https://link.springer.com/article/10.1007/s10271-016-9735-7>



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1. The first activity increased harvest efficiency which reduced the amount of wood which was cut but not used, and harvested more trees that have been killed by natural disturbances.
2. The second activity decreased harvest amounts, and assumed that more fossil fuels would be used for energy production and that steel, concrete and plastic would be used to meet society's demands instead of wood.
3. The third set of activities looked at increasing the carbon absorbed by planting seedlings and improving tree growth.
4. The fourth activity created more long-lived wood products such as timber and panels instead of short-lived products like paper.
5. The fifth activity used wood waste from harvesting operations for energy production in place of fossil fuels.

Modeling these activities out to 2050 showed that in each region there is the opportunity to reduce emissions through changes in forest management and wood use. The best activity or combinations of activities can be different for each region, and depend on forest characteristics, and the demand for wood products and energy. Research is continuing on additional regionally-differentiated scenarios of forest sector mitigation actions in collaboration with the Pacific Institute for Climate Solutions (PICS).

Overall there is great potential to achieving climate change mitigation benefits through changing forest management and the use of wood products, especially if the best strategies are selected for each region. If action is taken soon, significant long-term benefits of these mitigation strategies can be achieved.

Links

Links and Project Information:

Quantifying the biophysical climate change mitigation potential of Canada's forest sector

<http://www.biogeosciences.net/11/3515/2014/>

Climate change mitigation potential of local use of harvest residues for bioenergy in Canada

<http://onlinelibrary.wiley.com/doi/10.1111/gcbb.12387/full>

Climate change mitigation strategies in the forest sector: biophysical impacts and economic implications in British Columbia, Canada

<https://link.springer.com/article/10.1007/s11027-016-9735-7>

PICS Forest Carbon Management Project

<http://pics.uvic.ca/forest-carbon-management-project-potential-contribution-british-columbia%E2%80%99s-forest-sector-greenhouse>

For more details on research activities

https://www.researchgate.net/profile/Carolyn_Smyth



https://www.researchgate.net/profile/W_Kurz2

