Advisory from the Forestier en chef

Research needs for forest carbon modelling adapted to the realities of Québec

Context

Within the ministère des Ressources naturelles et des Forêts, the Forestier en chef is responsible for accounting for the forest sector's mitigation potential, to support the provincial greenhouse gas inventory. This work relies on quantifying greenhouse gas stocks and fluxes in forest ecosystems using the Carbon Budget Model (CBM-CFS3)[1].

As part of this mandate, the Forestier en chef set out to build a map of research needs in forest carbon modelling, in order to identify current scientific limitations and define priority research areas. This work aims to strengthen scientific knowledge, in line with existing tools, to improve the modelling of carbon dynamics in Québec's forest ecosystems.

However, efforts to improve the modelling parameters so far have relied largely on work conducted at the Canadian scale, with measurements taken in Québec playing a limited role. Improving the representation of forest characteristics and management practices in Québec will therefore require collecting new data, analyzing existing data, and carrying out research projects at the provincial scale.

Approach

Four themes associated with this Advisory were identified to cover the initial research needs. Three concern some of the main carbon pools represented in the Carbon Budget Model (CBM-CFS3), and one deals with disturbance matrices, which determine carbon transfers between pools during a natural or human-caused disturbance. Each theme reviews the current state of the component in question, outlines the limitations of the model, and suggests ways to improve it along with directions for future research.

Findings and research needs

For several pools and components, modelled values can differ from data collected in the field, and these gaps are sometimes poorly documented. Recent changes to the Carbon Budget Model (CBM-CFS3) have not been enough to adapt its parameterization to Québec's territory, so the forest conditions and management practices observed in the province remain imperfectly represented.

The model also does not account for the effects of climate change, whether on carbon dynamics in the different pools or on how disturbance patterns will change in the future.

Bringing together the four themes attached to this Advisory highlights the following research directions:

Deadwood: Document natural tree mortality, the fall rate of dead trees, the decomposition of deadwood, and the fate of carbon in coarse roots.

Litter: Assess the amount of leaves and needles deposited on the soil each year, their decay rate by species and stand type, the carbon dynamics of fine and small woody debris, and the proportion of carbon that stabilizes in the organic horizons and can become incorporated into the soil.

Soil: Establish the residence time and stability of carbon in mineral soil, the influence of microbial activity and site conditions, and the mortality and decay of fine roots.

[1] Kurz, W. A., Dymond, C. C., White, T. M., Stinson, G., Shaw, C. H., Rampley, G. J., ... & Apps, M. J. (2009). CBM-CFS3: a model of carbon-dynamics in forestry and land-use change implementing IPCC standards. Ecological modelling, 220(4), 480-504.

Disturbance matrices: Revise the matrices using field data collected from managed forests in Québec, develop the missing matrices for site preparation, differentiate fire severity, calibrate insect epidemics to provincial conditions, and ensure this work remains valid under future disturbance regimes.

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Under section 47 of the Loi sur l'aménagement durable du territoire forestier, the Forestier en chef advises the minister on the direction and planning of forest research in Québec. This Advisory identifies the research needs in forest carbon modelling. Addressing these needs will help improve the accounting of the provincial forest sector's climate change mitigation potential and strengthen the reliability of the results produced.