The Carbon Budget of Canadian Forests in a Changing Climate: Can Forestry be Part of the Solution?

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A principal factor driving global warming projections is the influence of man on the natural greenhouse effect through changes in the atmospheric loading of radiatively active gases. Carbon dioxide (CO_2) is the main anthropogenetic greenhouse gas of concern and global forest ecosystems account for ~50% (100 Gt of C) of its annual exchange with the atmosphere. In addition to their significant and dynamic role in the annual C cycle, global forest ecosystems represent huge C pools in their soils (~1500 Gt of C) and standing biomass (~650 Gt of C).

Human activities are upsetting the C balance of the Earth by burning fossil fuels and by removing active biological sinks for CO_2 through deforestation and other land-use changes. An increasingly important question to Canadians is the extent to which our forests are part of the problem or can be part of the solution. This question has several parts: how much C is currently stored in Canadian forests?; how much do they currently contribute to the atmospheric budget?; and how will these C storage pools and exchanges change in the future as a consequence of climate change and forest management?

To address these questions, development of a C budget modelling framework for the Canadian Forest sector has been initiated as a team effort between Forestry Canada and ESSA (Environmental and Social Sciences Analysts Ltd). Supported by the Federal Panel on Energy R&D (PERD) through ENFOR (ENergy from the FORest program) of Forestry Canada, the project has three phases:

Phase 1: assessment of the current C budget using best available data;

Phase 2: future C budgets - the effect of alternative management strategies; and

Phase 3: future C budgets - the effect of alternative climate assumptions.

Preliminary Phase 1 results, for a reference year 1986, indicate that the forests of Canada acted as a net sink of atmospheric C of ~51 Mt with an additional net sink of ~26 Mt of C sequestered by Canadian peatlands. After accounting for disturbances (wildfire, insect-induced stand mortality, and harvesting) and decomposition processes across all the forest regions (ecoclimatic regions) of Canada, there was a net increase of ~27 Mt of C in standing forest biomass pools, ~2 Mt of C in the associated soils (including litter) and ~21 Mt of C remaining in forest products (including land-fills) derived from forest fibre harvested over the past 40 a. These 1986 budget figures should be considered in the context of the total pool sizes which have been estimated to be 12,000 Mt of C (biomass), 76,000 Mt of C (soils), 135,000 Mt of C (peatlands) and 600 Mt of C (forest products).

The sensitivity of these results to disturbance rates, model assumptions and data is currently being determined. It is clear that the 1986 rates will change if future conditions maintain the observed trend towards increased wildfire disturbance. Increased fire risk is expected for much of the forests of Canada under the projected changes in enhanced greenhouse climate and it is unlikely that increases in fire suppression could keep apace with these changes, should they occur. The biomass and soil pools may thus become significant net sources, and climate-induced changes in forest productivity do not appear to compensate for these losses, and in some areas, may even add to the problem.

Can alternative forest resource management strategies help to maintain a positive contribution by Canadian forests to the global CO_2 problem? The significant sink in forest products found in the Phase 1 analysis offers hope. Several resource management and forest product alternatives (including bioenergy substitution for fossil fuels) have been identified for evaluation in Phases 2 and 3, which are now underway.

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