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Climate change and forest productivity: questions abound

Researchers at the Canadian Forest Service have been working for a long time on methods to estimate forest productivity at different levels. Variations in forest productivity can best be estimated at the tree and stand levels.

According to the simplest growth scenario, tree productivity depends on site fertility as well as on temperature and precipitation regimes. However, other factors complicate the picture, such as the capacity of trees to adapt to their environment, the increase in atmospheric CO_2, or extreme climatic events (frost, drought, ice storms).

An increase in temperature would result in accelerated tree growth because it would lengthen the growing season and reduce the frequency of summer frost in northern regions. For example, an early spring results in increased carbon accumulation at the stand level; summer drought, however, can cancel out this positive impact on tree growth.

Photo: SCF

Other factors contribute to the uncertainty associated with forecasting accelerated tree growth. First, soil fertility may not be sufficient to sustain the increasing need for nutrients. The capacity of trees to adapt to new climatic conditions also depends on their genetic characteristics. For example, trees of local provenance subjected to more favourable climatic conditions do not grow faster than trees that have adapted to the same conditions[1]. As for increased atmospheric CO_2, it could have a fertilizing effect on forests and promote tree growth.

1 Beaulieu, J. 2005. Climate change: predicting white spruce yield. Branching Out No. 20, Canadian Forest Service – Laurentian Forestry Centre.

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Once again, soil fertility, and the availability of nitrogen in particular, could limit the potential for improved growth rate due to CO_2.

Currently, forests show signs of increased productivity. In Europe, growth rates seem to have improved significantly during the 1970s and 1980s. This increase is attributed to both global warming and the fertilizing effect of nitrogen pollution. In North America, analyses conducted using traditional inventory systems have not revealed a similar change. However, recent growth analyses conducted on samples from sites located in forested areas across the country suggest a great deal of

Fir photosynthesis measurement.
Photo: SCF

variability in response to on-going climate change, both from one species to another and from one region to another with respect to a given species. This variability could explain, in part, the absence of any related signal in the analyses based on forest inventory data.

Photo: SCF

With global warming, the forest picture based on productivity models is quite different from that of today. A 2°C increase in average annual temperature is equivalent to a shift in climatic zones of 322 km to the north in less than 100 years. Forests, however, cannot change this rapidly. In all likelihood, the northern limits of forest ecosystems will shift very slowly while their southern limits will be subjected to increasing environmental constraints. These constraints could result from significant disturbances, increased competition from herbaceous species during the regeneration stage or other mechanisms which impact is currently marginal.

Our forests will change slowly in response to the accelerated change in their environment. The majority of these changes should result in a general improvement of growth conditions, but progress will not be steady. The main question that remains to be answered concerns the impact of natural disturbances on forests.

Root carbon flux measurement.
Photo: SCF

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Forest Ecosystems of Canada – Issues: Climatic Change
ecosys.cfl.scf.rncan.gc.ca/issues/clim_chg_e.asp

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