

LIMITED REPORT

Forest Ecosystem Vulnerability to Climate: An Assessment of the Western Canadian Boreal Forest

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EXECUTIVE SUMMARY

The Canadian Boreal Forest is a mainstay of the Canadian economy, and it has immense social, environmental and intrinsic importance. Canada depends on the boreal forest for many essential products and services including forest products, wildlife habitat, recreation, research, and educational opportunities, and spiritual values. Forestry is an important primary goods-producing industry in the Prairie Provinces. Many of the communities and businesses in the north depend heavily on forest related activities. As the boreal forest is altered by climate change, these values will be compromised in important ways. Climate change is expected to affect boreal forests to a greater degree than other forest types because of its northern location and because boreal forests are more sensitive to temperature.

Currently available information on climate change impacts is presented at global or regional scales and does not provide adequate information for forest and other resource managers to make decisions on changing their management to adapt. Overall objectives of this project are to collect and synthesize information on climate change impacts on western Canada's boreal forest, and to present the information at spatial and temporal scales meaningful to forest management and planning. Specific objectives of this project are: 1) targeted literature review; 2) conceptual model; 3) sensitivity analyses of landscapes; 4) modelling approaches; 5) adaptation option identification; and 6) communication of results.

The Canada Country Study forest literature review by Wheaton (1997) was updated in several main topic areas including moisture and other climate variables, fire, insects, diseases, and economics. Interactions, knowledge gaps, adaptation options were discussed, and recommendations were developed. A very substantial gap in current boreal forest impacts, adaptations, and vulnerability work is that findings have not been drawn together in any comprehensive way. This is a serious obstacle to determining the vulnerability of the boreal forest and of those communities that rely on the forest. A conceptual model to accomplish this integration is essential and the foundation to further modelling (Figure 1).

We developed and presented a preliminary integrated conceptual model based on the findings from the literature review, meetings, workshops, and an assessment of existing models of various types.

The conceptual model highlighted and synthesized the impact of climate change on forest fire frequency and severity; moisture stress and productivity; and forest insect pest outbreaks. Also included is the recognition that climate-induced impacts will occur in association with other land use activities such as timber harvesting, mining development and road construction. These must also be taken into account when assessing the ecological and socio-economic impacts of climate change. Conceptual models were also created to advance research on the effect of climate change on the output of the forest sector and to estimate the economic impacts of climate change on the forest sector. A limitation to this entire work was the lack of published impacts and adaptations papers for this area and subject. This lack is being partly addressed, as additional work done for the Government of Canada's Climate Change Action Fund and for the Prairie Adaptation Research Collaborative (PARC) is being completed. However, socio-economic aspects, for example, may still be neglected.

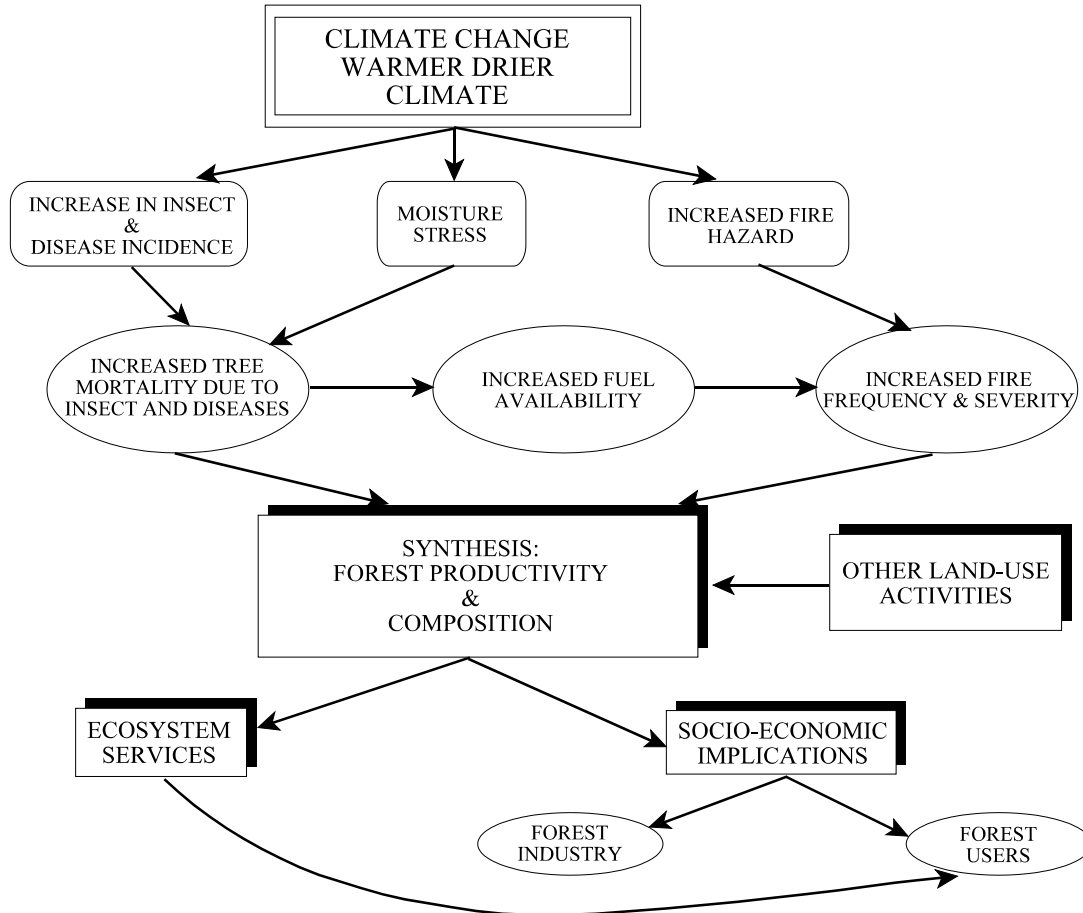


Figure 1 Forest ecosystem and socio-economic vulnerability to climate change (modified from Kulshreshtha et al. 2001)

Our results indicate that climatically-induced changes to the boreal forest in western Canada would likely occur through three principal mechanisms and their synergies: moisture availability, forest fires and insect outbreaks. By 2080, drought could reduce forest productivity by up to 50%, particularly at the southern margin of the existing forest and in locations where soil water-holding capacity is low. However, drought may improve growing conditions in locations where the water table is currently too high for forest growth. In areas where there is sufficient moisture, productivity could increase up to 40% due to higher temperatures.

Forest fires are likely to become more frequent, and fire severity could increase by 40-50% due to the warmer, drier conditions. Insect outbreaks are expected to increase due to higher temperatures, longer growing seasons, generally drier conditions, and the effects of forest fragmentation. In addition, it is important to recognize that these effects will interact with one another. For example, trees under moisture stress are more susceptible to insect attack, and the resulting dead trees will provide more fuel for forest fires. More forest fire activity will result in a generally younger forest, with consequent effects on wildlife species that prefer older forest.

Forest companies that depend on a particular species may have to seek wood supplies in new locations as forest species are re-distributed due to the impacts of changes to moisture availability and increased disturbance. These impacts will likely be most severe in the southern portions of the

boreal forest and most pronounced in areas with low soil water-holding capacity. In contrast, the northern boundary of the forest may shift northward, providing new opportunities for northern communities.

This project has advanced boreal forest impacts, adaptation, and vulnerability research and communications of this type of research. The project has filled gaps in several areas, including updating the literature review, developing conceptual models, applying a synthesis approach, and presenting information at scales meaningful to decision-makers. The project is documented in several papers (Appendix A), and has been discussed in several forums, including invited presentations listed in the Project Deliverables Section.

The boreal forest is affected by many variables, several of which act together to produce stronger changes than they would acting singly. This project is a first attempt to develop approaches to draw these various factors together. The synthesis process is not sufficiently mature to draw substantive conclusions, however the project does demonstrate the value of this approach.

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PROJECT DELIVERABLES

Working Papers

- Johnston, M. 2001. *Impacts of Climate Change on Boreal Forest Insect Outbreaks*. Prepared for the Government of Canada's Climate Change Action Fund. Saskatchewan Research Council (SRC), Saskatoon, SK. SRC Publication No. 11341-6E01.
- Johnston, M. 2001. *Sensitivity of Boreal Forest Landscapes to Climate Change*. Prepared for the Government of Canada's Climate Change Action Fund. Saskatchewan Research Council (SRC), Saskatoon, SK. SRC Publication No. 11341-7E01.
- Kulshreshtha, S. 2001. *Forest Ecosystem Vulnerability to Climate: Economic Aspects*. Working Paper. Prepared for the Government of Canada's Climate Change Action Fund. University of Saskatchewan, Saskatoon, SK. SRC Publication No. 11341-5E01.
- Wheaton, E. 2001. *Changing Climates: Exploring Possible Future Climates of the Canadian Prairie Provinces*. Prepared for the Government of Canada's Climate Change Action Fund. Saskatchewan Research Council (SRC), Saskatoon, SK. SRC Publication No. 11341-3E01.
- Wheaton, E. 2001. *Changing Fire Risk in a Changing Climate: A Literature Review and Assessment*. Prepared for the Government of Canada's Climate Change Action Fund. Saskatchewan Research Council (SRC), Saskatoon, SK. SRC Publication No. 11341-2E01.
- Wheaton, E. 2001. *Past Climate Changes of the Canadian Prairie Provinces*. Prepared for the Government of Canada's Climate Change Action Fund. Saskatchewan Research Council (SRC), Saskatoon, SK. SRC Publication No. 11341-1E01.

Presentations

- Johnston, M. 2000. *Forest Sector Climate Change Impacts and Adaptations*. Prepared for the Government of Canada's Climate Change Action Fund. Presentation to Saskatchewan Environment and Resource Management (SERM) Directors meeting, February 2000, Regina, SK.
- Johnston, M. 2000. *Forest Sector Climate Change Impacts and Adaptations*. Prepared for the Government of Canada's Climate Change Action Fund. Presentation to SERM Climate Change Network (internal working group), March 2000, Regina, SK.
- Johnston, M. 2001. *Climate Change Impacts and Adaptation in the Forest Sector: A Provincial Perspective*. Prepared for the Government of Canada's Climate Change Action Fund. Presentation to the C-CIARN Forestry Node workshop, February 2001, Toronto, ON.
- Johnston, M. and S. O'Shaughnessy. 2000. *Sustainable Forest Management and Climate Change Impacts and Adaptation Options*. Prepared for the Government of Canada's Climate Change Action Fund. Presentation to the Network Centres of Excellence, Sustainable Forest Management, Manitoba Research Node, November 2000, Winnipeg, MB.

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- Johnston, M., E. Wheaton, and J. Thorpe. 2001. Forest Vulnerability to Climate: An Assessment of the Western Canadian Boreal Forest. Prepared for the Government of Canada's Climate Change Action Fund. Presentation to PARC-Prince Albert Model Forest Workshop *Climate Change Impacts and Adaptation Options for the Prairies' Forestry Sector*, January 2001, Prince Albert, SK.
- Johnston, M., E. Wheaton, J. Thorpe, S. Kulshreshtha, S. O'Shaughnessy. 2001. *Applying Climate Change Analysis to Forest Land Use Planning*. Prepared for the Government of Canada's Climate Change Action Fund. Presentation to the Fort a la Corne Forest Land Use Planning Team, June 2001, Tisdale, SK.
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- Wheaton, E. and V. Wittrock. 2001. *Prairie Climate Change: Past and Future Trends*. Presentation to EMAN National Science Conference, May 4, 2001, Calgary, Alberta. SRC Publication No. 11299-2D01.

Graduate Special Topics Course Outline

Johnston, M. and E. Wheaton. 2001. *Impacts of Climate Change and Associated Adaptation Options for the Forestry Sector in Western Canada*. Special topics graduate studies course outline and deliverables: Geography 898.3. Saskatchewan Research Council (SRC), Saskatoon, SK. SRC Publication No. 11341-9S01.

APPENDIX A

Working Papers