Stephen C. Zoltai
Research Scientist
CFS, Northern Forestry Centre
5320 - 122nd Street, Edmonton, Alberta
Canada T6H 3S5
Tel. (403) 435-7210
Fax (403) 435-7359

GLOBAL CHANGE AND FORESTS: AN OVERVIEW OF RESEARCH BY CANADIAN FOREST SERVICE

The overall objective of this research is to provide reliable answers to questions concerning the impact of climate change on forest ecosystems which can be used as predictive tools to support decisions by forest managers and policy makers at all levels.

The specific objectives are:

1. Develop a set of models which predict the changes in forest ecosystem components, ecosystem disturbance regimes and successional patterns under a changing climate.

2. Develop a carbon budget model for the Canadian forest sector by calibrating and validating a model that is sensitive to changes in climate.

3. Develop climate-sensitive models of forest productivity, tree decline, insect infestations and other disturbances which can be linked to the main ecosystem models.

4. Cooperate with major international and national initiatives to investigate ecophysiological functions in the boreal forest.

In order to deliver this program, the thrust of research was concentrated on three general subject areas, in cooperation with various regional and national institutions of CFS:

1. Intensive study of forest physiology and ecology along a climatic gradient from the semi-arid Aspen Parklands to the Subarctic Woodlands (Boreal Forest Transect Case Study, BFTCS). The ecophysiological and climatic processes are concurrently measured at two sites near the southern end of BFTCS, where transpiration rates, sap flow, and soil moisture levels are measured and related to solar radiation, precipitation, relative humidity, wind, etc. Microsites are monitored to indicate the variations within the studied forests. Related

physiological studies measure the effects of various climatic parameters on the rate of respiration in various tree species. The allocation of energy require to maintain the life functions of the trees and energy available for additional growth will be determined. This information is used to construct reliable models of the ecosystem carbon balance.

The processes affecting the boreal forest succession is investigated by relating successional trends to present and past climates, fires and other disturbances. Past climates and corresponding vegetation changes and productivity levels are determined by pollen analysis and dendrochronology. This information will be used to construct a computer simulation model of successional processes in the boreal forest, with specific reference to changing climate.

Other studies are carried out in support of the boreal forest succession Model. Historical records of infestations by important insects are being related to climate parameters to construct models which predict insect development rates as functions of climatic variables. The soil microflora and fauna is examined in different climatic zones to determine the sensitivity of the forest soil biota to climatic parameters. The frequency of forest fire occurrences will be related to past climatic events to create a predictive computer model.

2. The carbon budget model of Canadian forest sector (CBM-CFS) is being developed to show much carbon is currently stored in Canadian forests, how much do they currently contribute to the atmospheric carbon budget, and finally, how will these carbon pools and exchanges be influence by climate change and forest management. Current work is concentrating on (1) developing, testing and applying a comprehensive CBM-CFS which includes the carbon status of forest biomass, detritus, soil and peat, forest products and forest sector energy use. (2) A retrospective analysis of change in the carbon budget of Canadian forest sector during 1920-1944 was made to test the sensitivity of the CBM-CFS. (3) Projective analyses are being made to simulate effects of the influence of alternative forest management practices, but will consider land use changes and the use of energy and bio-energy. (4) In order to support the CBM-CFS, process level submodels of boreal forest responses to global change as a result of changes in the carbon cycle.

   Supporting research includes the determination of short- and long-term rate of carbon sequestration in different kinds of peatlands. This information will be used to construct models of carbon sequestration in peatlands and to forecast the possible effects of climate change on the functioning of peatlands, especially the change caused by massive thawing of permafrost in the peatlands.

In another experiment over 10 000 litterbags have been placed at 21 different forests in various climatic regions. The decomposition rate will be calculated from annual collection of the bags for ten years to determine and model the influence of climate and stand conditions on decomposition rates.

3. Tree decline studies are conducted in eastern Canada, to examine specific damage of forest trees induced by climate. The maple die-back has been linked to climatic extremes, such as deep soil freezing and low snow cover, during the winter before the die-back. Such conditions were artificially induced to test the limits that have a direct impact on sugar maple health. growth, and metabolism. In another study the die-back of different birch species was experimentally linked to damage caused by a mid-winter thaw, followed by r-freezing. Such studies will provide information to predict future impacts of global change on the broad-leaved forests.

The research by Canadian Forest Service is being carried out in cooperation with international agencies both at the science planning and technical levels. Such collaboration has been initiated with the European Forest Institute on the carbon budget of European forests. We are actively involved in the Global Change and Forest Ecosystem working groups of the International Boreal Forest Research Association. We are an integral part of the Boreal Ecosystem Atmospheric Study (BOREAS) presently being conducted in Canada in cooperation with US scientists.

FINNISH-CANADIAN FORESTRY SEMINAR

Gustavelund, Tuusula, Finland, May 16–18, 1994

Edited by Eero Paavilainen and Leena Halko

Metsäntutkimuslaitoksen tiedonantoja 512
The Finnish Forest Research Institute, Research Papers 512