Summary of the presentation given at *Carbon Management in British Columbia Ecosystems*, Columbia Mountains Institute of Applied Ecology, 15-16 June 2011, Nelson BC

From Carbon to Conifers and Sawmills to Salmon: Climate Change and Forest Ecosystems in the Northwest Skeena Region

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Project funding
Future Forest Ecosystems Council of British Columbia (FFESC)
MITACS
ESSA
Coast Tsimshian Resources LP

Summary

The northwest Skeena region is among the world's most important commercial forest production areas, provides critical habitat for salmon and other wildlife, and is increasingly used as a key transport corridor and industrial area. Faced with accelerating climate change over the current century, communities and industry urgently need a local-scale scientific basis for strategic planning and eventual adaptation to changing environmental conditions. Under the aegis of the British Columbia Future Forests Ecosystem Council (FFESC) project *Climate Change Adaptation Planning for Northwest Skeena Communities*, and in cooperation with Coast Tsimishian Resources LLP and the Lax Kw'alaams First Nation, we are performing an interdisciplinary study of social and natural science issues surrounding environmental change in the northwest Skeena. Our sociological study assesses a spectrum of local residents to quantify perceptions of how environmental and socioeconomic issues have changed in the recent past, and the values placed on diverse natural resources at the present. The natural science component of our project applies a state-of-the-art dynamic vegetation model to simulate the potential future of forest ecosystems in the northwest Skeena, with a focus on how climate change and management strategy interact to influence forest productivity, species composition, and carbon storage.

The social science component of the project was initiated in 2010 through a series of interviews with community leaders and natural resource managers from both First Nations and settlers groups in Prince Rupert, Terrace and Lax Kw'alaams. The goal of these interviews was to gauge and understand the local populations' needs, desires, and perceptions with respect to environmental change. The interview process is ongoing, but based on the data we have collected to date we can highlight some of the preliminary findings. Over the past 20 years, the people we interviewed believe, on average, that their most important environmental resources and the way they have changed over the recent past are: the timber industry (declining); small business (improving), Salmon and Oolichan fisheries (declining), and water quality (improving). When asked about the drivers of these changes, the most important and influential of these were: "natural resource policies", "availability of natural resources", and "global economy". Climate change as a driver of economic and environmental change was perceived as being neither particularly influential at present nor very important for the future of the region.

Despite its perceived low importance for the people of the lower Skeena, we nevertheless attempted to quantify recent trends in climate change, and to understand how future climate could further impact the forests of the region. Analysis of weather station data collected at Prince Rupert and Terrace over the past century (Fig. 1) showed that, in particular, winters have become warmer, snowfall has decreased, and spring precipitation has increased, especially since about 1970.

To investigate future potential forest responses to climate change, including changes in disturbance frequency, hydrology, species composition, and carbon storage, we customized the LPJ-GUESS dynamic vegetation model with the physiological properties of 19 northwestern B.C. forest tree species. LPJ-GUESS is driven by monthly climate data, a soil map, an optional forest management scenario, and operates at a 30 arc second (~1km) spatial resolution. We collected data on individual species characteristics, including climatic preferences, morphology, and shade tolerance from a variety of sources in the silvics literature, and from other detailed forest models. We used the CGCM3 A2 future climate simulation as a first attempt scenario to look at forest responses to climate change. Compared to other GCMs, this scenario results in an increasingly warm and wet Skeena region over the next 100 years. For these first model runs, we did not use a management scenario, i.e., we considered potential changes in natural (unmanaged) vegetation.

We applied the model over the northwest Skeena region, roughly the lower watershed of the river, plus Prince Rupert and coastal areas to the north, an area of ca. 32,000 km^2 (Fig. 2). We evaluated the LPJ-GUESS simulations for the state of forests at the present day using the VRI and other forest inventory data. Our model evaluation was limited by reliable data on forest stand history and composition, especially dates of past harvest and replanting strategies. Nevertheless, preliminary results indicate that, in the absence of major disturbances such as fire or insect outbreak, changes in forest species composition over the next 100 years are likely to be small. Common tree taxa at the present day, especially western hemlock, may increase in their range, generally moving up mountainsides to higher elevation, and possibly further inland. The core habitat for western hemlock at present, in the valley bottom around Terrace, could see a slightly reduced concentration of these trees, in favor of more thermophilous taxa, including Douglas-fir. The area of alpine tundra is projected to shrink significantly in the futyre, especially over the 2060-2080 period of our future simulation.

Carbon storage in the Skeena forests is relatively insensitive to climate change over the past decades or projected into the near future in the scenario we used (Fig. 3). Modest decreases in dead organic matter mainly in litter and in the labile soil organic matter pool, caused by faster microbial decomposition under warmer temperatures, are offset by increases in living biomass, stimulated by longer growing seasons and CO_2 fertilization. On the other

hand, simulated winter runoff increases significantly into the future, related to decreases in wintertime snowfall, and autumn runoff decreases, caused by increases in summertime evapotranspiration as a result of increasing temperatures in all seasons (Fig. 4).

Forest management strategies to maximize carbon uptake include accelerated harvest cycles and replanting with appropriate species for changing climate. Future climate change in the northwest Skeena could have its greatest impact on hydrologic rather than carbon cycle, and management for optimal productivity would have important impacts on hydrology, ultimately affecting fisheries and other valuable natural resources.

Jed Kaplan background

Jed Kaplan is professor in environmental engineering at the Swiss Federal Technical University, Lausanne (EPFL). He is also adjunct professor in the School of Earth and Ocean Sciences, University of Victoria, Canada. Prof. Kaplan has been a primary developer of large-scale models of vegetation dynamics and biogeochemistry for the last 15 years, and has worked at leading universities and government laboratories in Europe, Canada, and the United States. The author of about 50 peer-reviewed scientific publications, Prof. Kaplan is an expert on the role of climate change in influencing global biogeochemical cycles, terrestrial carbon stocks, and greenhouse gas emissions.

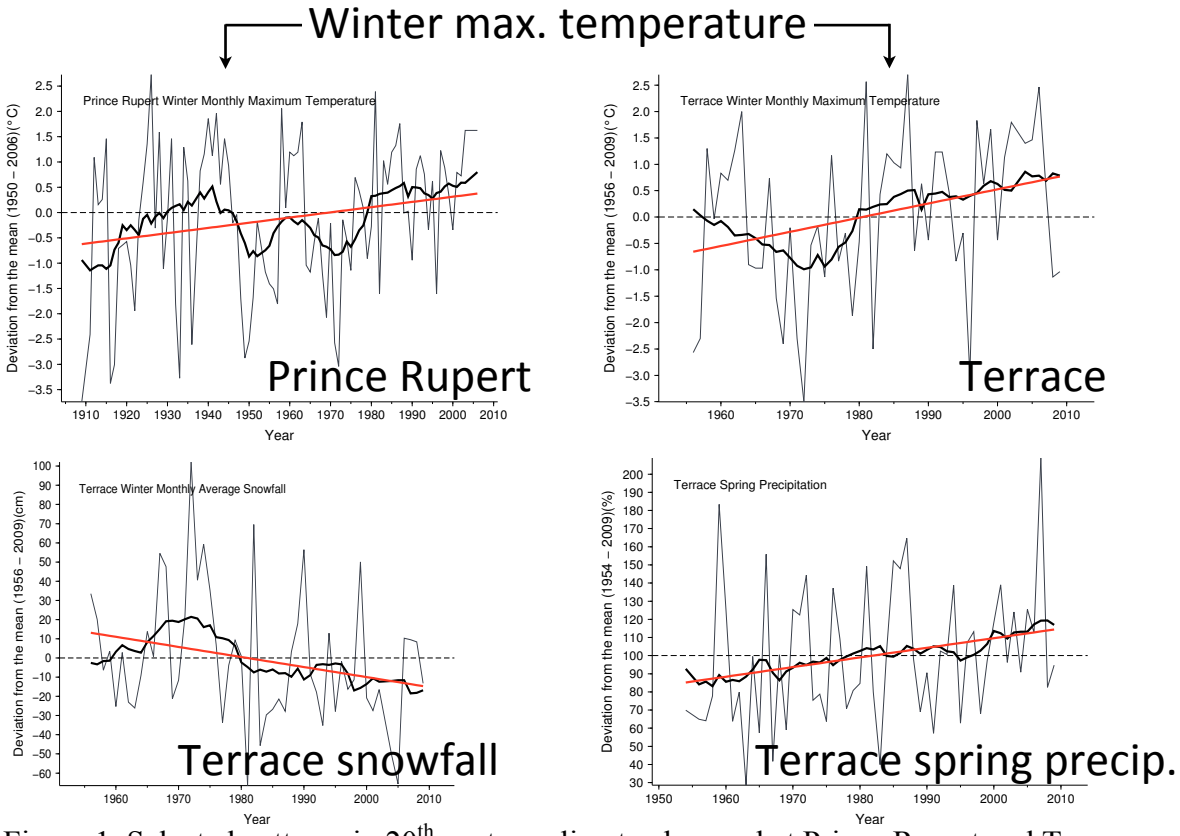

Figure 1. Selected patterns in 20th century climate observed at Prince Rupert and Terrace

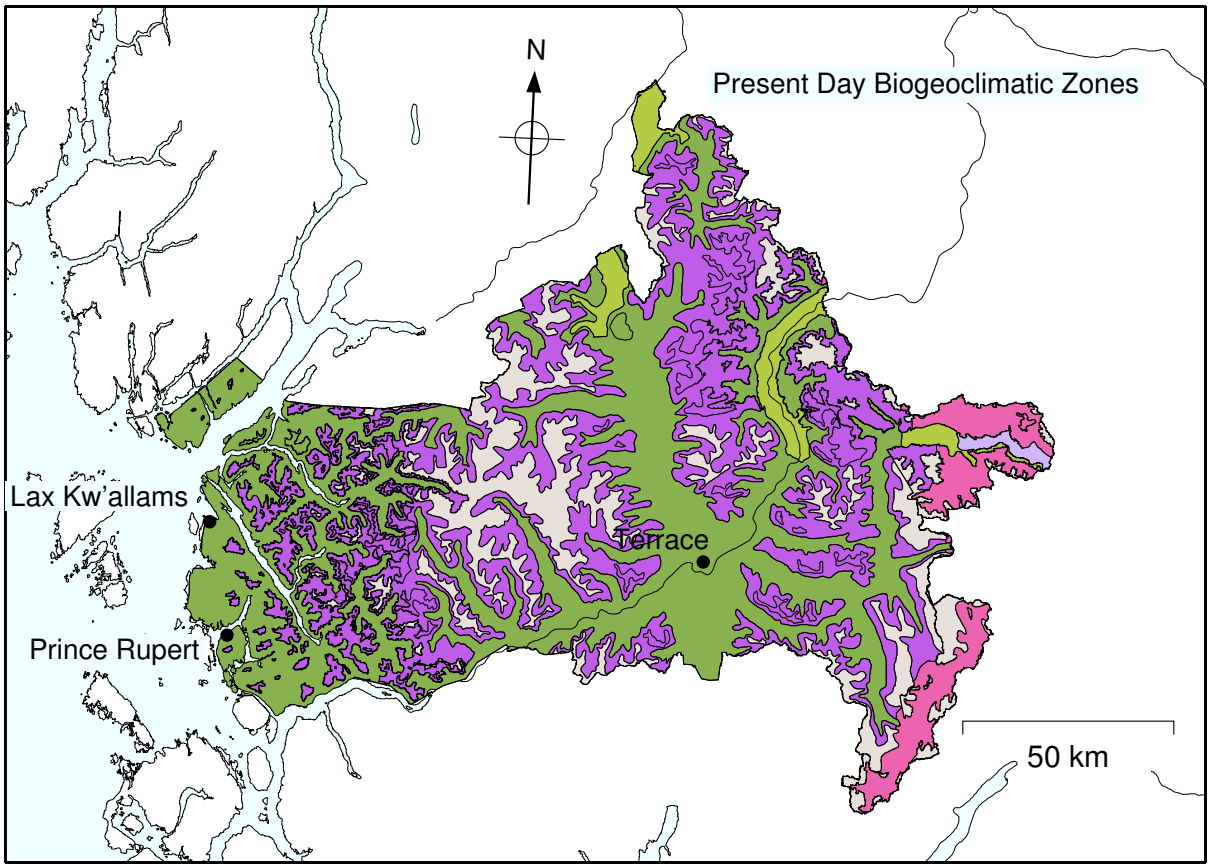

Figure 2. Biogeoclimatic zones map of the lower Skeena study area

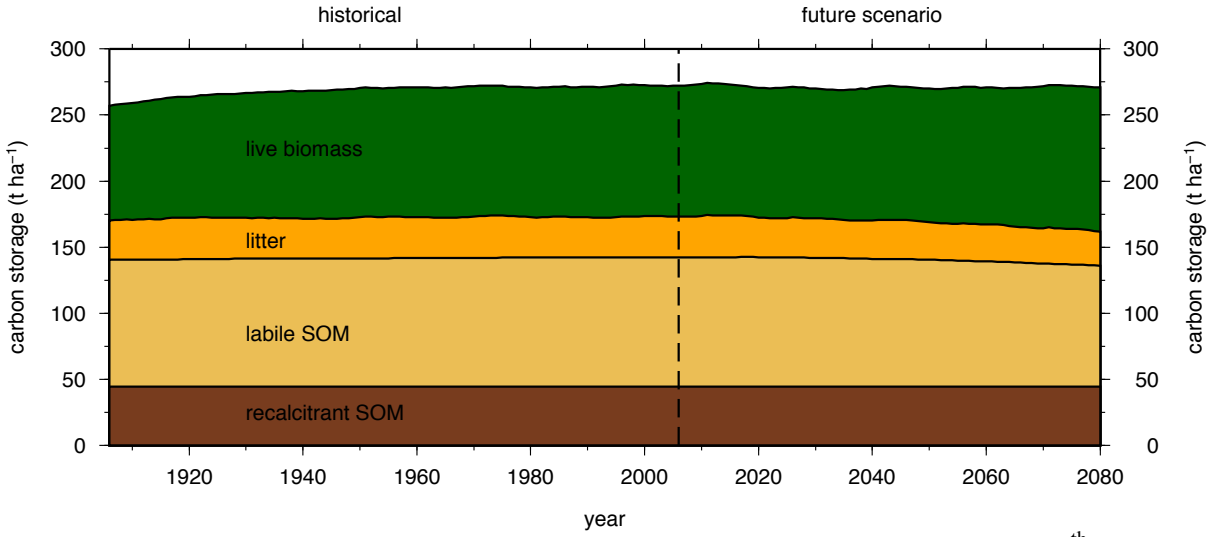

Figure 3. Changes in terrestrial carbon storage simulated by LPJ-GUESS for the 20th century and future CGCM3 A2 scenario

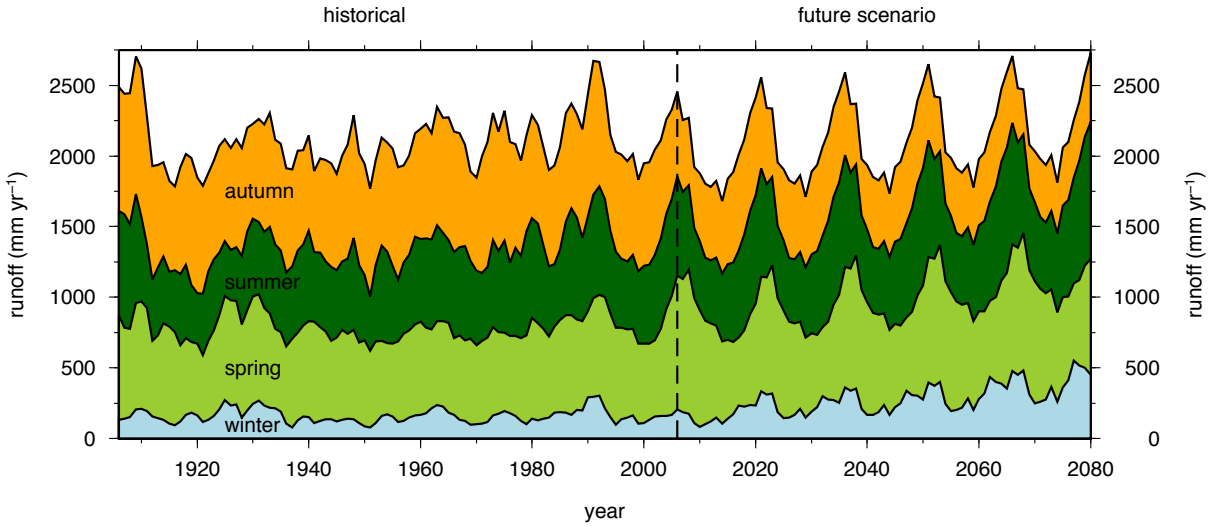

Figure 4. Average seasonal and annual changes in runoff for the lower Skeena region simulated for the 20th century and future CGCM3 A2 scenario