FIA–FSP Forest Science Corner

The Cotton Creek Watershed Experiment

Investigating the effects of forest disturbance on watershed function

Reference

Jost, G., M. Weiler, D.R. Gluns, and Y. Alila. 2007. The influence of forest and topography on snow accumulation and melt at the watershed scale. Journal of Hydrology 347: 101–115.

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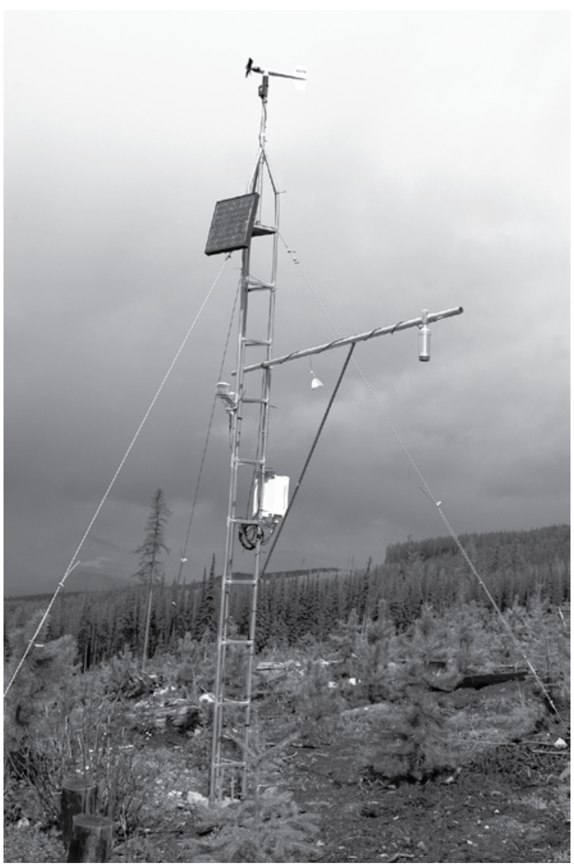
The Cotton Creek Experimental Watershed (CCEW) project is helping researchers understand the effects of large-scale forest disturbance on watershed function.

Understanding the effects of these disturbances, such as the mountain pine beetle (MPB) infestation and subsequent salvage harvesting, on watershed function is critical to ensuring water resources are managed sustainably and to protect downstream resource values. Assessing the effects of these episodic disturbances is often difficult because we cannot predict where and when they will occur. So, when existing research installations are threatened with MPB infestation, it creates an excellent opportunity to examine pre- and post-disturbance trends in watershed function.



High-elevation climate station for monitoring continuous air temperature, soil temperature, snow depth, wind speed/direction, and precipitation.

David Gluns photo

The Cotton Creek Experimental Watershed, a long-term experiment into the effects of forest management and forest disturbance on watershed function, presents just such an opportunity. This watershed has been extensively instrumented and monitored for four years, generating a set of high-quality baseline data which includes climate, streamflow, groundwater, soil moisture, channel morphology, water quality, and riparian processes.

Initiated in 2004, the Cotton Creek Experimental Watershed project is a collaborative effort between the University of British Columbia (UBC), Tembec, and the BC Ministry of Forests and Range (MOFR), with funding through the Forest Investment Account–Forest Science Program. The third major watershed experiment in the Southern Interior, this site complements ongoing research at Upper Penticton and Redfish Creeks in terms of climate and topographic differences. It is a 17.4 km^2-watershed situated 17 km south of the city of Cranbrook which drains into Moyie Lake to the west.

Cotton Creek watershed is one of several types of watersheds that are characteristic of the Southern Interior. Covering a wide range in elevation, it is underlain by sedimentary bedrock, and is completely forested up to the ridges as opposed to being alpine- or grassland-dominated. Over 50% of the watershed is covered with lodgepole pine, making the CCEW a high risk watershed for MPB infestation; indeed, patches of red trees were visible in the fall of 2006. Outbreaks of MPB in the watershed in the 1980s and 1990s resulted in salvage logging.

The project team consists of four faculty members from UBC: **Dr. Dan Moore**, **Dr. Younes Alila**, **Dr. Markus Weiler**, and **Dr. Marwan Hassan**, along with **David Gluns** of the MOFR. A number of graduate students (**Kim Green**, **Pascal Szeftel**, and **Russell Smith**) and a post-doctoral fellow (**Dr. George Jost**) from UBC are also involved in the project.

The CCEW project's long-term objective is to improve the ability to predict, at multiple spatial and temporal scales, the cumulative influences of forest disturbance and of forest management responses to disturbance. This will enhance the ability of forest managers to assess the watershed-related risks associated with different management responses to disturbance (e.g., when to retain natural regeneration versus prompt harvesting and planting). The data-collection methods combine field-based research on watershed processes with spatially explicit modelling to improve our knowledge and ability to predict the effects of forest disturbance on watershed function.

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Currently, the project's hydrometric infrastructure consists of 12 climate stations, ranging from basic air temperature to a full suite of measurements, including air temperature, relative humidity, precipitation (both rain and snow), snow depth, wind speed and direction, temperatures at ground/snow interface and soil, solar radiation, and albedo. Streamflow is recorded at 10 sites within the watershed, and water temperature and specific conductance are also recorded at some sites. Data are collected on a continuous basis with hourly and daily outputs.

At the site scale, snow accumulation, snow melt, soil moisture, and groundwater levels are measured at 60 sites distributed through the watershed on the basis of a stratified sampling scheme designed to capture the variability in forest cover and topography. Some sites are in spruce-dominated stands that should not be significantly affected by MPB-related tree death, while others are in pine-dominated stands that should be affected by future MPB spread. This situation provides an opportunity to study the hydrologic effects of tree death (and ultimately salvage harvest) on sites with or without disturbance, and before and after disturbance.

Key research activities and outputs include the following:

- Monitoring groundwater, soil moisture, and streamflow continuously to investigate the effects of harvesting and roads on the processes governing runoff generation from hillslopes.
- Monitoring watershed climate variables continuously for input to hydrological models and evaluation of watershed processes.
- Examining the influence of canopy characteristics and regeneration on snow accumulation and melt processes, and subsequent streamflow responses.
- Monitoring bedload transport and streamflow continuously to understand the relationships with upstream disturbance (harvesting and roads). This data will be used to quantify the effects of disturbance-related changes in streamflow on bedload transport.
- Using channel surveys combined with Geographic Information Systems (GIS) analysis to produce maps of channel sensitivity to upstream disturbance and the capacity of the stream to transport wood and sediment to downstream reaches. The result will be a hazard rating system that can be applied to other watersheds.
- Applying high spatial and temporal intensity data for running a range of watershed models to predict the effects of disturbance on watershed functions such as streamflow, water quality, and sediment transport.
- Providing data to improve our understanding of the propagation of disturbance effects from headwaters to downstream reaches (i.e., cumulative effects).
- Linking hydrology and channel geomorphology to quantify relationships with the level of disturbance on the watershed (e.g., Equivalent Clearcut Area–ECA).

This research is designed to provide a sound scientific basis for defining disturbance thresholds (e.g., ECA) above which the risk of significant impacts becomes unacceptable. The nested stream gauging network will quantify streamflow at points having a range of upstream forest disturbances. The nested design will test the hypothesis that relative changes in the magnitude and timing of streamflow among stations should reflect the extent and spatial distribution of forest disturbance in the contributing areas. The spatially distributed measurements of snow accumulation and melt, soil moisture, and groundwater levels will allow site-scale impacts on surface and subsurface hydrology to be quantified, and the nested stream gauging network will capture the cumulative watershed-scale hydrologic effects. This study is unique in that it is the first to integrate hillslope and channel processes, both hydrologic and geomorphic, within a watershed context.

*For further information, please visit the CCEW Web site (**http://www.forestry.ubc.ca/cottoncreek/index.htm**) or contact Dr. Dan Moore, Departments of Geography and Forest Resource Management, UBC, **rdmoore@geog.ubc.ca***

David Gluns photo

Streamflow measurement site on Upper Elk Creek, tributary to Cotton Creek.

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