

Effects of climate and forest cover change on snowmelt dominated water supplies in the Okanagan

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The overall project goal was to quantify the effects of climate and forest cover change on snow accumulation and melt processes in a forested high-elevation watershed at Upper Penticton Creek. We used the Cold Regions Hydrological Model (CRHM), developed at the University of Saskatchewan, in combination with the long-term (>10 y) dataset collected by Dr. Winkler at Upper Penticton Creek, to model basin-scale snow response to climate and forest cover change. We modelled snowpack response first to iterative changes in air temperature and precipitation, and then to changes in forest structure that would result from mountain pine beetle infestation, moderately severe wildfire and clearcutting.

This research aimed to resolve high priority issues in water management identified by the project clients (Ministry of FLNRO, Okanagan Basin Water Board, Ministry of HLS, Ministry of Environment, Okanagan Nation Alliance). Throughout the project, we collaborated with these clients to interpret research results in the broader context of potential community impacts and adaptations under predicted future water supply scenarios. Project results provide forest and water resource professionals with key information required to begin to assess the hydrologic consequences of forest response to climate change, and to make scientifically defensible water and timber management decisions.

Application of the CRHModel at Upper Penticton Creek suggests that increasing air temperature and precipitation will result in the following general snowpack responses across Okanagan headwater basins:

- a decrease in maximum snow accumulation (SWE) and shorter snow season at high elevations
- greater reductions in both maximum SWE and snowpack duration in response to smaller temperature increases at low than high elevations in headwater catchments
- a greater proportion of precipitation falling as rain
- an increase in mid-winter melt events, particularly in clearcuts
- greater snow sensitivity to climate change in clearcuts than mature forests
- similar snow sensitivity to climate change in stands killed by MPB to that in mature green forests, while those in moderately severe burns will respond similar to clearcuts
- a decrease in SWE at low elevations in headwater basins, and a reduction in snow duration at high elevations, suggesting earlier and more rapid increases in streamflow in spring, as well as an earlier return to baseflow.

These results have implications for both forest and water management including:

- reduced high elevation over-winter water storage
- compressed snowmelt runoff seasons
- changes in winter wildlife habitat

- reductions in ski and snowmobile season duration
- more frequent occurrence of flashier high flow events in small headwater streams, and an associated potential increase in erosion risk
- increased stress on road drainage structures
- added complexity in management of water storage facilities
- earlier reductions in available moisture for tree growth, particularly at lower elevations
- potential risk of early season desiccation damage to trees no longer protected by snow
- longer growing seasons but with greater chance of late season drought stress
- earlier and longer low flow seasons
- increased frequency of low flows below minimums for aquatic habitat

The modelling work completed at Upper Penticton Creek is a first step towards understanding how upland watersheds are likely to respond to climate and forest cover change. Although this project focuses on only two small upland basins and several selected disturbances, it provides a strong indication of the direction of expected change across Okanagan headwater basins, and points to the need for continuing research to confirm and expand upon these initial results. Reductions in and earlier delivery of snowmelt runoff will require adaptations in forest and aquatic resource management, water storage, delivery and allocation and in community development, to ensure continued security of water supplies. Actions that should be taken in preparation for future climate- and forest-related changes in the hydrologic regime include:

- a critical review of water flows and licenses in the Okanagan Valley to ensure that streamflow is not currently over-allocated
- where streams are over-allocated, or approaching the limit required to protect aquatic habitat, no new water licenses should be issued until such time as a detailed watershed-specific evaluation of current and future water supply potential has been completed
- forest management should maintain diversity in stand composition and age classes across watersheds to vary snow accumulation and ablation rates, summer evaporative losses, and water uptake by forest cover, and to desynchronize runoff
- water storage and delivery infrastructure should be assessed to ensure sufficient capacity to withstand higher short-duration flows in spring, rapid response to summer storms and reduced late season flows. This will minimize the risk of breaching and flooding in spring, while maintaining a sufficient water supply for the prolonged low flow season
- manage water use, whether by agriculture, industry or communities, as a finite rather than an infinite resource
- consider future water supplies when approving expansion of communities throughout the Okanagan Valley
- continue to fund and support long-term hydrometric monitoring in the Okanagan Basin
- continue research into hydrologic processes on forest and agricultural land, and into climate change and water supply management, including innovations in water engineering, home appliances, landscaping, and irrigation.