CANADIAN MOUNTAIN NETWORK

RESEARCH PROJECT SUMMARY

Managing groundwater resources in mountainous areas: planning for and adapting to drought conditions

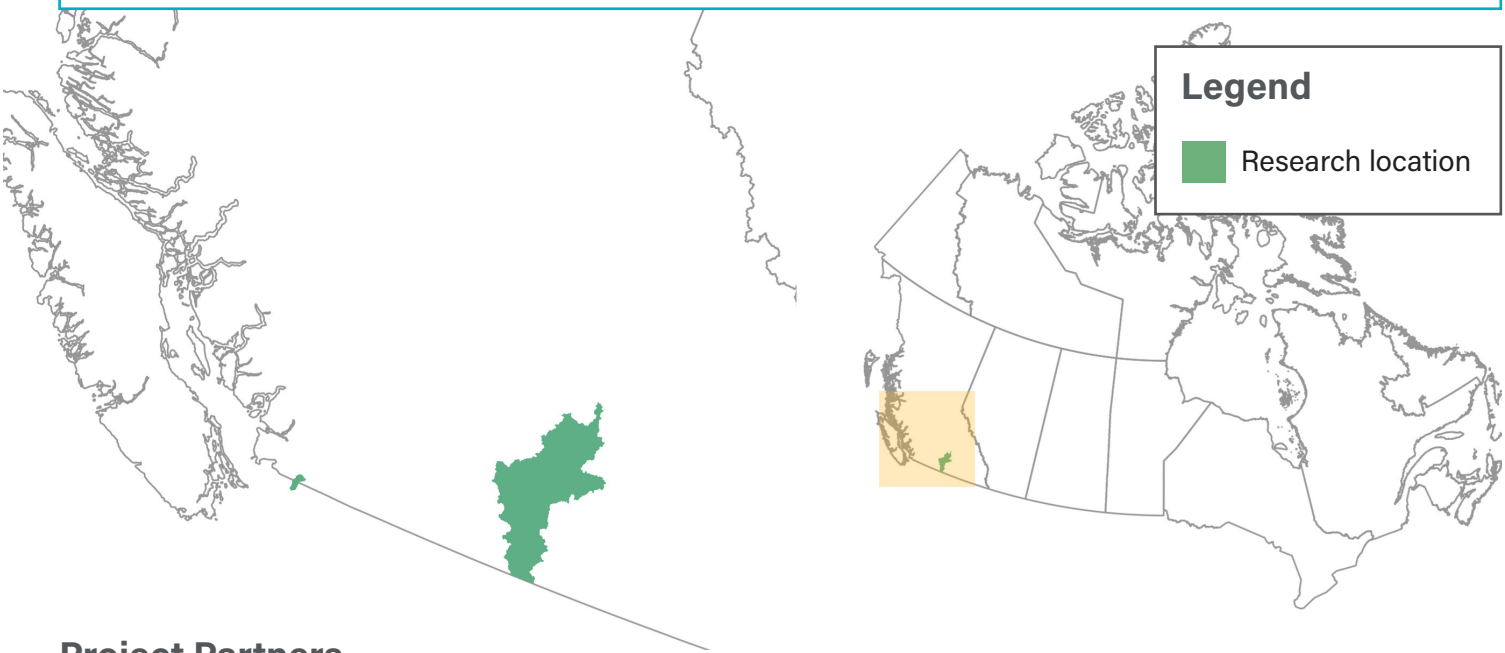
This project was driven by two key challenges encountered when managing groundwater resources in areas susceptible to drought. First, measuring drought is a complex process, particularly in mountain regions due to their geographic diversity and complex regional microclimates. Second, drought affects water allocation decision-making as the BC Water Sustainability Act requires that environmental flow needs be considered in water allocation decisions. This research addressed a number of research priorities and data gaps related to assessing groundwater responses to environmental conditions, developing drought indicators, and evaluating the ways in which water allocation decision-making occurs. Specific questions included determining the recharge source for specific aquifers and assessing the stability of those sources in terms of changing precipitation patterns, receding ice packs, etc., determining if it is possible to predict when critical water shortages will occur, and assessing the points at which further licenses for an aquifer would be allowed or denied for a particular basin.

Principal Investigator: Diana Allen, Simon Fraser University

Investigators: Tom Gleeson (University of Victoria); Carl Mendoza (University of Alberta), William (Jesse) Halm (Simon Fraser University)

Trainees: (Simon Fraser University) April Gullacher, Adam Mitton, Alexandre Nott, Kira Howe

Collaborators: Jillian Kelly (BC Observation Well Network) Julie-Ann Ishikawa, Robin Pike (BC Ministry of Environment and Climate Change Strategy), Jon Goetz (BC River Forecast Centre), David Campbell (BC Drought Response Team), Skye Tompson, Michele Lepitre (BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development), Anna Sears (Okanagan Basin Water Board) Tessa Terbasket (Okanagan Nation Alliance)



Project Partners

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Managing groundwater resources in mountainous areas: planning for and adapting to drought conditions

Objectives

This project explored groundwater drought in British Columbia (BC) through a combination of data analysis, field studies and modeling studies. The goals of the project were to (1) develop quantitative drought indicator thresholds for groundwater levels, (2) evaluate the performance of indicators and regulatory tools that are used during water scarcity in the Okanagan basin, and (3) identify which aquifers are susceptible to drought in the Okanagan basin. Specifically, this research evaluated how the groundwater level responses in different aquifers across the mountain regions of BC vary between drought and non-drought years. This research project developed quantitative drought indicator thresholds for groundwater levels in order to indicate the level of drought severity.

Research Plan

1) We co-analyzed historical data (snow, temperature, precipitation, streamflow) and groundwater level data from Provincial Observation Wells to classify the groundwater level responses in aquifers across the province. 2) We used Generalized Additive Models (GAMs) to identify climate variables that are associated with summer groundwater levels and that can be used as early indicators of summer groundwater drought in different regions. 3) We evaluated the Standardized Groundwater Level Index (SGI), developed in the UK, to characterize the magnitude of past drought conditions in aquifers. 4) We tested the aquifer-related drought indicators in the Okanagan Basin, one of BC's most water stressed regions, and evaluated the regulatory tools (analytical models and lag times) for assessing pumping impacts on Environmental Flow Needs (EFNs) for different drought scenarios. 5) Finally, we identified drought sensitive and drought resilient aquifers in the Okanagan Basin using the results of numerical watershed models under historic and future projected climate change.

Key Outcomes & Impact

- In total, 97 observation wells across the province were able to be classified based on their drought response mechanism, and 66% were found to be streamflow-driven and 34% were recharge-driven. The results of this classification were used to better understand the response of aquifers to drought.
- Predictor variables were identified for summer groundwater levels in South Central BC and the Fraser Valley. The findings showed that different regions are influenced uniquely by the different climate variables, and these variables can be used as early indicators of summer groundwater drought in the respective regions.
- The Standardized Groundwater Level Index (SGI), developed in the UK, was found to be effective at indicating which wells had pronounced responses to periods of drought in each region. Furthermore, we found that the SGI can be affected by water use in aquifers, so its usefulness as a tool needs to be assessed on a regional basis.
- Macroinvertebrate and habitat sampling data revealed important ecological consequences of the recurrence of flow cessation and drying and modelling of relationships (using GAMs) between benthic macroinvertebrate abundance and habitat variables suggested that dissolved oxygen and stream velocity were the significant drivers of spatial and temporal variability in benthic macroinvertebrate abundance.
- The final outcome was a rating scheme that incorporates aquifer hydraulic properties and degree of groundwater pumping (well density) and mapped the susceptibility of aquifers to drought. The map for the Okanagan Basin identified five highly susceptible aquifers and 23 moderately susceptible aquifers.

Contacts:

Project contact: Principal Investigator Diana Allen at dallen at sfu.ca

CMN contact: CMN Executive Director, Monique Dubé at monique@cmn-rcm.ca