MONITORING WATER RESOURCES IN BC TO HELP UNDERSTAND THE EFFECTS OF CLIMATE CHANGE

The entire planet is impacted by climate change, whether it's believed to be a natural cycle or human-induced. Lakes, rivers, streams, oceans, and the entire water cycle are affected. From heavier rainfalls to less snow in some areas and extreme droughts in others.

In this article, we showcase two different monitoring programs in British Columbia, Canada, that share the goal of further understanding how climate change affects the water resources they rely on and are passionate about.

We highlight how environmental data, specifically water level and temperature data, are being used to track changes in rivers, streams, and lakes to help predict and prepare for the changes brought on by a warming atmosphere.

Community Based Water Monitoring

Detailed water monitoring and planning are required to ensure that communities relying on surface water resources are protected from future climate change impacts.

Significant weather and hydrologic events in the north Kootenay Lake area of British Columbia, Canada spurred citizens in the region to start taking an active role in preparing for a changing climate.

This community concern led to the establishment of Kootenay Watershed Science (KWS) – a community-driven project that has taken the lead in understanding how climate change will impact the small and medium-sized watersheds in their region.

The monitoring activities now championed by KWS began as an initiative of the Kaslo and District Community Forest Society in 2007. The program has since changed hands a few times and in early 2020 KWS found its new home as part of the Living Lakes Canada portfolio of projects.

Living Lakes Canada is a national non-profit organization based in the Canadian Columbia Basin that is working towards the long-term protection of Canada's fresh water with the mission to normalize water stewardship through community-based water monitoring.

Much of their work has become a grassroots template for aquatic ecosystem monitoring across BC and Canada, and they are affiliated with Living Lakes International, a global network of over 120 non-governmental organizations and stewardship practitioners who share best practices in efforts to protect lakes, rivers, wetlands, and watersheds world-wide.

The KWS project focuses on collecting and sharing important data on which to base future decisions in land use and development, conservation, emergency preparedness, water supply allocation, and more. To date, the program has established two high-elevation snow course sites, three climate stations, and seven hydrometric stations. Data is collected on snowpack, precipitation, temperature, water quantity, and more.

Solinst Leveloggers are Installed in PVC or Steel Pipe in Streams to Record Water Levels

KWS datasets now include five continuous streamflow records of around ten years and two more of four and five-year durations. Dedicated volunteers, citizen scientists, and professional hydrologists perform the data collection, sampling, and monitoring.

In 2012, Solinst Leveloggers were installed in five KWS hydrometric stations and two more were added at stations in 2017.

A Levelogger is an instrument that automatically and continuously records accurate fluctuations in water level, temperature, and optionally, conductivity.

The Leveloggers are deployed in streams in either a perforated PVC or steel pipe, combined with a staff gauge. Barologgers are installed nearby to record atmospheric pressure (used to barometrically compensate Levelogger data) as well as air temperature.

KWS has also recently installed Leveloggers in two alpine lakes to help assess the health and function of these systems, and to determine how they may play a role in moderating the flow in the smaller waterways in the region.

The Leveloggers are set to log water level and temperature every 15 minutes, providing a detailed record of water level fluctuations. The frequency allows them to download the data just twice a year.

Paul Saso, Hydrologist with Kootenay Watershed Science, says the original decision to go with Solinst Leveloggers was based on reputation, good accuracy, reasonable price, and reliability. "They have a great reputation and have definitely lived up to it" Paul noted.

Solinst recently donated Leveloggers and Barologgers to replace the dataloggers that have been recording for almost 10 years.

The Levelogger water level data (stage data) is used to calculate discharge in the streams. Water level data is converted to discharge (streamflow) by determining the relationship between stage and discharge, using streamflow measured at several different stages through time to create the Stage Discharge rating curve.

The air temperature data from the Barologgers are stored. They may be able to provide information towards future modelling work for low-elevation areas around the hydrometric stations.

The data collected by KWS is made available on the Columbia Basin Water Hub, which provides quality-controlled water-related data via an open-source database developed and formally launched in 2021 by Living Lakes Canada. The Columbia Basin Water Hub can be accessed here: https://data.cbwaterhub.ca/

KWS also has a partnership with Aquatic Informatics for processing, storing, and distributing data online. Data can be accessed and viewed on their Web portal: https://mission.aquaticinformatics.net/AQWebPortal/

The data collected will ultimately help evaluate how the watersheds in the region will respond to different hydrological flows– especially in times of high precipitation and low water supply. The data will help predict the risk, frequency and outcome of more catastrophic events brought on by climate change, such as flooding and landslides.

Map of Watershed Monitoring Station Locations in Kootenay British Columbia

Research Based Water Monitoring

The Canadian Rocky Mountain Parks are designated as UNESCO World Heritage Sites for their "exceptional natural beauty".

The seven parks – Banff, Jasper, Kootenay, Yoho, Mount Robson, Mount Assiniboine, and Hamber – are known for their scenic mountain peaks, meadows, canyons, caves, hot springs, and glaciers.

Their pristine alpine lakes also draw millions of visitors to the parks each year. But, because of climate change, these spectacular alpine lakes are also changing.

Janet Fischer and Mark Olson, professors in the Biology Department at Franklin & Marshall College in Lancaster, Pennsylvania, are leading a research project that focuses on the causes and effects of changes in alpine lake transparency.

Paul Saso Hydrologist with KWS and Volunteer Ali Roux Download Water Level, Temperature and Barometric Data from Solinst Dataloggers

In general, water transparency is a measure of how deeply light penetrates and affects water temperature, algal growth, and exposure of organisms to potentially damaging UV radiation. These factors dictate what aquatic life is present. Water transparency depends on the number of particles in the water – the more particles, the less transparent.

In the alpine lakes of the Rocky Mountains, transparency is largely controlled by the amount of dissolved organic matter from alpine vegetation and inorganic material from glaciers.

Glacial melt, snow melt, and rainfall are responsible for how the particles reach the lakes. As climate changes, temperatures are rising and precipitation patterns are shifting, inevitably leading to altered rates of material inputs.

Climate change is accelerating glacial melt and vegetation advance, changing the alpine landscapes, and the types and amounts of transparency-regulating materials entering the lakes.

Their research aims to compare lake responses to these rain and snowmelt driven inputs and use the results to enable more accurate predictions of responses over time, as the climate changes.

Canadian Rocky Mountain Parks (Image source: Parks Canada)

Janet and Mark have been studying alpine lakes for the past 15 years. Through their research, they have observed the variation in lake transparency on an interannual scale (from one year to the next).

However, their latest research aims to observe seasonal and short-term changes in the factors regulating lake transparency.

They study a set of five lakes located in Banff and Yoho National Parks. The lakes share many attributes but represent different phases of glacial loss and vegetation advance, and therefore catchment material differences.

With the help of undergraduate field assistants from Franklin & Marshall College, sensors are deployed in the lakes during the ice-free season. They measure dissolved organic matter and turbidity on an hourly basis. The readings provide an idea of the changes in transparency-regulating materials throughout a season.

As part of the project, Leveloggers were placed in four of study lakes, with additional Leveloggers installed in the outflow streams of a subset of the lakes.

Janet and Mark are collaborating efforts with Masaki Hayashi of the University of Calgary. Masaki is an authority on alpine hydrology. He has previously used Leveloggers and had already deployed Leveloggers in one study lake, so recommended them for the remaining four.

Janet also notes, "The size, ease of deployment, durability, and logging capabilities matched our needs perfectly."

The Leveloggers are deployed in stilling wells in the lakes. A Barologger is also deployed at each site to provide data for barometrically compensating the water level data.

The Leveloggers are set to measure surface water levels over the course of a season, as well as short-term response to meteorological conditions (e.g., precipitation events and temperature changes).

Leveloggers record data every 30 minutes. After downloading data, the measurements are averaged to daily means to match the time scale of meteorological measurements. Data are stored in excel format and can be shared upon request.

In fact, data has been shared with Kootenay Watershed Science to help with their alpine lake studies!

Leveloggers help document lake level responses to rainfall events and warm spells that accelerate glacial melt. This allows the researchers to observe the connection between meteorological conditions and the changes in dissolved organic matter or turbidity.

As each of the five study lakes has different catchment characteristics, comparing this relationship among the lakes provides insight into potential changes over time.

Alpine lake research does bring its challenges!

The sites are remote and can only be accessed by foot; hikes can be up to two hours with elevation changes of more than 500 m. All equipment must be carried on their backs. The mountain terrain also brings unpredictable weather. Janet says, "We might start a hike in shorts, but it might be snowing at the lake."

Despite the challenges, Janet and Mark are committed and plan to expand their research.

Janet and Mark Taking Measurements for Alpine Lake Research Project

They recently purchased more Leveloggers and two Barologgers to add two more lakes to their study and have begun a new collaboration with Richelle Allen-King, a hydrogeochemist at the University at Buffalo.

Their research also has good backing, with a research permit from Parks Canada and funding from the National Science Foundation in the US.

Overall, their continued research will help provide a predictive understanding of the effects of climate change on alpine lakes. This will help give a picture of what these pristine lakes may look like in the future.

Solinst Levelogger Recording Water Levels in an Alpine Lake Stilling Well

Sharing Data and Monitoring Efforts

Both monitoring programs highlight how important it is to share data and work together to provide a better understanding on how water resources are affected by climate change.

Making the data available to decision-makers will allow for appropriate water budgeting and watershed management into the future, ensuring communities are supported and ecosystems remain functioning and enjoyed for future generations.

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