Nechako IRC NEWSLETTER

September 2023 Volume 5 Issue 3


Image credit: Justin Kokoszka

Territorial Acknowledgement

Working on traditional First Nations territories in a scientific context is a humbling privilege, and we deeply appreciate it. Collaborating with Indigenous communities enriches scientific understanding and promotes mutual respect and cultural exchange. We are thankful for the trust and partnership extended to us and approach this work with utmost gratitude and responsibility. We acknowledge that our research and work take place within the unceded traditional lands of the following First Nations:

- *Binche Whut'en*
- *Cheslatta* Carrier Nation
- Lake Babine Nation
- *Lheildli T'enneh*
- *Nadleh-Whut'en*
- *Nak'azdli Whut'en*
- *Nee-Tahi-Buhn* Indian Band
- *Saik'uz*
- *Skin Tyee* Band
- *Stellat'en*
- *Takla* Lake
- *Tl'azt'en*
- *Ts'il Kaz Koh* (Burns Lake) Band
- *Wet'suwet'en* First Nation
- *Yekooche* First Nation

CONTENT

Welcome to the latest Nechako IRC newsletter! In this edition, you'll find updates about the research led by the Northern Hydrometeorology Group (NHG). We've had a busy summer in the field, and now our dedicated research team is looking forward to an exciting and productive fall, with more fascinating work and discoveries on the unceded lands of the Nechako.

On September 30th we celebrate the National Day for Truth and Reconciliation.

It’s Fall!

An introduction from the project leader

Yet another summer has zipped by and here we are at the start of another fall season and academic year at UNBC. The NSERC / Rio Tinto IRC team hopes you enjoyed this past summer’s warm weather despite the bouts of smoky air and the critical wildfire situation in our region. These extreme conditions affected some of our planned field work in the Nechako Watershed early in the summer. Despite the wildifres, we had an exceptionally busy and highly productive field season, visiting nearly all of our field sites to maintain equipment while doing data downloads.

As you will notice, this issue of the Nechako IRC Newsletter covers a broad range of topics ranging from field work updates to numerical modeling efforts and the production of a technical report on water temperature monitoring efforts in the Nechako Watershed. Of note, this summer marked the inception of the “Monitoring Extreme Climate and Hydrometeorological Events” Observatory, or MECHE. The MECHE Observatory comprises two main field sites, namely UNBC’s Northwest campus in Terrace and Huckleberry Mines, in the upper Nechako Watershed. Each site has been instrumented with a complete meteorological station, along with a laser-optical disdrometer and micro-rain radar. Read more on the MECHE Observatory in Kirsten Calder-Sutt’s contribution including the goals for this monitoring effort.

Our field crew also reports on the many field visits and reflections from their summer experiences. Post-doctoral fellow Jingwen Wu continues reporting on his modeling efforts including how climate change is affecting water resources across the Nechako Watershed. Master’s student Justin Kokoszka explores deviations in the summer 2023 streamflows for the Nechako River relative to historical conditions, including (near) record low flows in early summer. Ph.D student Bruno Sobral shows some interesting information on a notable atmospheric river that struck the Nechako in the last half of October 2017. You will also find my research update that covers the topic of the Nechako Reservoir’s water budget, which has been a frequent point of discussion during recent Water Engagement Initiative meetings.

As the summer field season comes to an end, several of our research team members have completed their positions at UNBC. As such, we sincerely thank Laura-Anne Browning and Jade Reynolds for their exceptional work and dedication this past summer to ensure our data collection, quality control, and management efforts proceeded smoothly and successfully. As well, we sincerely thank Dr. Jingwen Wu for his profound contributions to the IRC’s modelling efforts over the last two and a half years as he takes up a new position this fall at the Pacific Climate Impacts Consortium.

Stephen Déry

Dr. Wu's work generated terabytes of model output for future Nechako Watershed climate research. Research Manager transition: Justin Kokoszka's term ends in September, and Bruno Sobral, a PhD candidate, is the new part-time Research Manager. Dylan Broeke continues as a research assistant for fall field work. We welcome Meng Wang, a Master's student, to the IRC team in September.

As of July 2023, the NSERC/Rio Tinto IRC program of research is now already in its fifth, and potential final, year of operation. As the COVID-19 pandemic hindered some of our progress, we plan on requesting from NSERC (the funding agency) a one-year, no-cost extension so that the IRC position would end in June 2025. Regardless, the team continues to seek additional sources of funding to build on progress achieved so far through the IRC program of research. This summer, we have been notified that UNBC's Integrated Watershed Research Group (IWRG: Drs. Eduardo Martins, Phil Owens, Margot Parkes and I) was successful in securing funds from the Nechako Environmental Enhancement Fund (NEEF) for a 2-year project focusing on the impacts of the climate crisis on the Nechako Watershed. An event announcing the initiation of this project was held on August 31st at the UNBC campus (see the Outreach section for details). As well, Dr. Eduardo Martins and I are co-applicants on a newly-funded NSERC Alliance grant for a 4-year project that will look at thermal refugia in the Nechako River in the context of climate change. This project is led by Dr. André St-Hilaire at the Institut National de Recherche Scientifique (INRS) in Quebec City and includes Rio Tinto and Cheslatta Carrier Nation as collaborators.

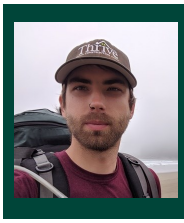
The IRC team takes this opportunity to thank many members of the communities across the Nechako Watershed that provided generous support and guidance during our summer field activities. Of note, we are especially grateful to Cheslatta Carrier Nation and the Tl'azt'en First Nation for providing boat support to reach remote field sites across the upper Nechako and Stuart river basins, respectively. The NSERC/Rio Tinto IRC team wishes everyone a most pleasant fall season.

The Team

Industrial Research Chair members of the NHG

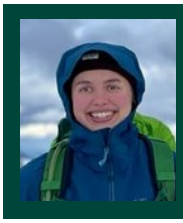
Stephen Déry

Project Leader



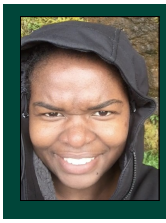
Justin Kokoszka

Project Manager
M.Sc. Candidate



Kirsten Calder-Sutt

Hydrometeorological Technician



Tamar Richards-Thomas

Research Skills Trainee

Dylan Broeke

Research Skills Trainee

Meng Wang

M.Sc. student

Bruno Sobral

Research Manager
Ph.D. Candidate

The Team

Recent changes

Justin Kokoszka starting as project manager

Bruno Sobral starting as the new research manager

Meng Wang starting M.Sc studies at UNBC and joining the IRC team

Farewell to Jade, Laura-Anne and Jingwen

As the summer field season draws to a close, we extend our heartfelt gratitude to our Research Skills Trainees, Laura-Anne Browning and Jade Reynolds, for their outstanding contributions.

Postdoctoral Fellow, Jingwen Wu, is embarking on a new scientific journey in the Pacific Climate Impacts Consortium (PCIC), at the University of Victoria (UVIC).

We sincerely thank them for their dedication to the NHG and wish every success in their exciting new endeavors.

Jade Reynolds

Jingwen Wu

Laura-Anne Browning

Research Chair

Water budget of the Nechako

Stephen Déry

A central objective of the NSERC/Rio Tinto IRC program of research on climate change and water security is to quantify the water budget of the entire Nechako Watershed in the context of a changing climate and human interventions. Of particular interest, however, is the water budget of the Nechako Reservoir itself, given it forms the source of water diverted towards the Kemano Powerhouse for hydroelectricity production in support of Rio Tinto's BC Works aluminum smelter in Kitimat. The Nechako Reservoir also has an outlet at the Skins Lake Spillway that provides the source of the Cheslatta and Nechako Rivers.

Here, the term water budget refers to all inputs and outputs of water to a watershed or a reservoir plus any changes in storage. For the Nechako Reservoir, there are two main inputs of water: inflows from rivers and creeks (Q_{in}) and net precipitation (P_{net}). The latter term represents the difference between precipitation and evaporation from the Nechako Reservoir. River discharge (Q_{out}) is the sole output of water from the Nechako Reservoir, which includes water diverted towards the Kemano Powerhouse (Q_{KP}) and released at the Skins Lake Spillway (Q_{SLS}). The final term in the water budget is a change in storage (ΔS), here represented by a change in reservoir volume (V) over time (t), i.e. $\Delta S = \Delta V/\Delta t$ where the Greek letter delta (Δ) represents a change in either quantity. If we assume the surface area (A) of the Nechako Reservoir remains constant over time (at ~922 km^2), then a change in water storage equates to a change in water elevation (h) times area over time: $\Delta S = A\Delta h/\Delta t$. Then by the principle of mass (or water) conservation, all terms affecting the Nechako Reservoir's water budget can be assembled into the following equation:

$$\frac{A\Delta h}{\Delta t} = P_{net} + Q_{in} - Q_{out} \qquad [1]$$

Based on this equation it is possible to quantify all principal terms influencing the Nechako Reservoir's water budget. Indeed, the Water Survey of Canada, in collaboration with Rio Tinto, provide daily water elevations for the Nechako Reservoir and daily outflows at both the Kemano Powerhouse and at the Skins Lake Spillway. Daily net precipitation can also be obtained readily from a climate dataset such as the fifth-generation European Centre for Medium Range Weather Forecasts reanalysis product (ERA5) or its land surface component (ERA5-Land). The ERA5-Land product derives from a coupled atmospheric-land surface model run over a historical period (1940 to present) providing various surface meteorological fields at ~9 km spatial resolution including daily precipitation and evaporation. Not directly measured by the Water Survey of Canada or Rio Tinto are the inflows (Q_{in}) to the Nechako Reservoir. Rearranging Equation [1] we can then obtain the term Q_{in} as follows:

$$Q_{in} = \frac{A\Delta h}{\Delta t} - P_{net} + Q_{out} \qquad [2]$$

Using a reference period spanning from 1991 to 2021 (31 years), we then obtain the following values for the water inputs and outputs (expressed in m^3/s) to the Nechako Reservoir:

Inputs	Value (m^3/s)	Value (%)	Outputs	Value (m^3/s)	Value (%)
Inflows (Q_{in})	178	90	Kemano Powerhouse (Q_{KP})	121	61
Net Precipitation (P_{net})	20	10	Skins Lake Spillway (Q_{SLS})	77	39
Total	**198**	**100**	**Total**	**198**	**100**

Therefore, over the 31-year period, inflows from rivers and creeks to the Nechako Reservoir dominated its inputs (90%) with net precipitation only a secondary term (10%). Water turbined at the Kemano Powerhouse dominated the outputs at 61% with water releases at the Skins Lake Spillway accounting for 39% of the water budget. A net change in storage of -0.1 m^3/s arises from the imbalance of total inflows and outflows. Additional ongoing work at UNBC involves assessing how the water budget terms are evolving over time in response to historical and potential future climate change and alterations in water management practices for the Nechako Reservoir. This is to establish the future water security of the Nechako Reservoir and Watershed in a rapidly changing climate.

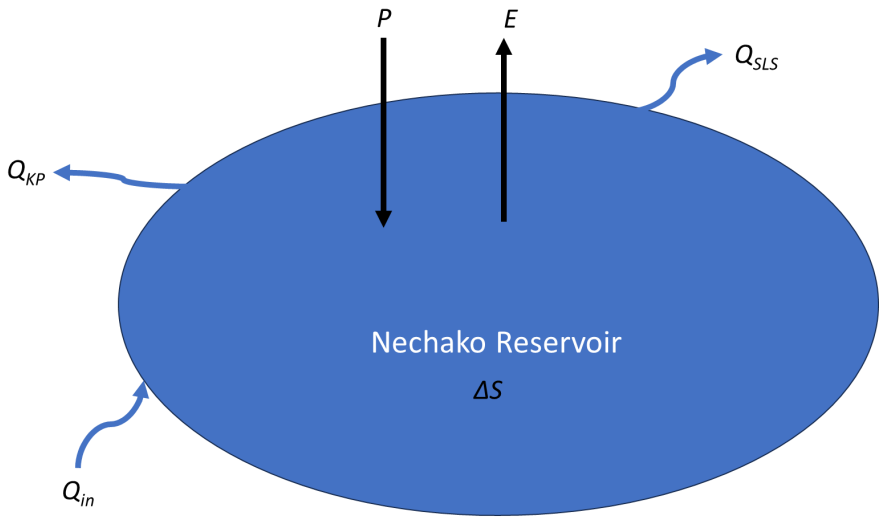


Figure 1: Schematic diagram illustrating the water budget of a basin such as the Nechako Reservoir.

Youth Engagement on the Nechako River

Justin Kokoszka

A series of water science demonstrations

In a bid to inspire and educate local youth about the natural environment, The Nechako Watershed Roundtable (NWR) recently held their annual youth canoe trip down a picturesque stretch of the Nechako River. We're delighted to share that the Northern Hydrometeorology Group (NHG) played a role in making this event a success.

On August 12th and 13th, the NHG team, alongside other experts, hosted engaging demonstrations related to water science (Figure 1). Kirsti Fairweather, a Hydrometric Technician from the Water Survey of Canada, wowed youth with her streamflow measurement demonstration using a remote-controlled boat with an acoustic doppler current profiler. Jeremy Morris, a Water Resources Scientist representing Environmental Dynamics Inc. and former NHG member, dove deep into water quality measurements.

Meanwhile, Justin Kokoszka, Research Manager with the NHG, led a demonstration on the collection of stream temperature data and demonstrated the effects of snowmelt input into streams and lakes.

But that's not all – these three demonstrations also gave youth an engaging showcase into the potential careers within the Nechako Watershed in all three major sectors: government, private, and academic. We hope these demonstrations not only fostered a deeper understanding of our local water ecosystems but also showcased the diverse paths within the field of water science. Kudos to the Nechako Watershed Roundtable for their fantastic initiative and for supporting the NHG's demonstrations. A special thanks to the Water Survey of Canada and Environmental Dynamics Inc. for the supporting the involvement of Kirsti and Jeremy. It's events like these that help nurture the curiosity of youth within the community!

Figure 2: A demonstration of streamflow measurement using a remote-controlled boat (yellow boat in the river) hosted by Kirsti Fairweather from the Water Survey of Canada (left). Water quality demonstration hosted by Jeremy Morris (center), and a demonstration on stream temperature hosted by Justin Kokoszka (right).

Summer 2023 field work

The summer truly flew by for the NHG field crew. This summer's successes also came with its challenges, wildfire prominent among them. Our hearts go out to all those impacted by BC wildfires this season. Despite having to postpone some mid-summer field work, the team has now visited nearly all of our field sites in the Nechako Basin, as shown in Figure 6 below. We will finish off the season with no remaining sites and some site re-visits.

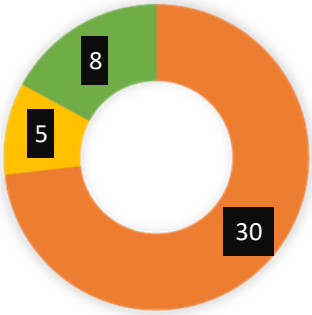


Figure 6: Fieldwork progress this summer. Orange, yellow and green represent stream temperature loggers, meteorological stations, and rain gauges (tipping bucket).

Figure 3: Tipping Bucket Rain Gauges

- Relocated Sather Ck TBRG nearer our Cheslatta Lake ST site
- Decommissioned our Laventie Ck TBRG site (knocked down by grizzlies 3 years in a row!)

Figure 4: Meteorological Stations

- Successful deployments of Cheslatta Lake and Huckleberry Mines weather stations!

Figure 5: Stream Temperature Loggers

- Visit to Nechako River at Cluculz Creek planned for this September
- All other sites complete, including very successful boat trip to sites around the Tahtsa Narrows in late August

Kirsten Calder-Sutt

Figure 7: NHG field crew setting up meteorological station at Huckleberry Mines, Upper Nechako.

This summer, we were able to obtain a brand new field truck! The truck arrived at the end of August and will be taken out for the remainder of our site visits this fall.

MECHE Observatory

A glimpse into specialized data collection

What is MECHE?

The overarching goal of MECHE (Monitoring Extreme Climate and Hydrometeorological Events) is to better quantify and comprehend extreme climate and weather events in western Canada. This goal is to be accomplished by setting up a variety of specialized meteorological equipment across two primary sites and analyzing the resulting data.

Figure 8: Deployed meteorological station.

Meteorological Stations

Our meteorological stations typically measure parameters such as wind speed, wind direction, air temperature, solar radiation, snow depth, and relative humidity. We are using a brand new ClimaVUE50 all-in-one weather sensor to capture much of this data at one primary site.

Figure 9: Deployed MRR-2

Micro Rain Radar (MRR-2)

The MRR-2 is a highly specialized meteorological radar that measures particle size and velocity of falling precipitation. Incredibly, the MRR-2 is able to provide data on what is happening in the lower atmosphere from 15 m up to a maximum of 6,000 m above the earth's surface. The data captured by the MRR-2 are particularly interesting because they tell us at what height above ground surface precipitation is melting (or freezing!) at any given minute.

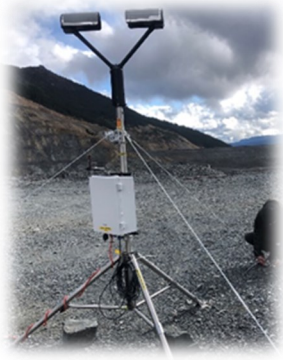


Figure 10: Deployed Parsivel2

Parsivel2 disdrometer

The Parsivel2 disdrometer is a state-of-the-art precipitation sensor that senses and classifies different types of precipitation such as rain, ice pellets and snow right at ground level. It gives us an accurate picture of the type of precipitation that is reaching the ground during precipitation events, which is all the more useful when used with MRR-2 data.

MECHE Observatory

The deployment

The MECHE Observatory was deployed in mid-August across two sites: Huckleberry Mines south of Houston and the UNBC Northwest campus in Terrace. On August 14, a team of 6 packed up a tremendous amount of tools and equipment and travelled out to Houston. On site, the crew got to work digging, levelling, wiring, and programming. After an extremely productive (and hot!) 3 days at Huckleberry Mines followed by 2 busy days at UNBC Northwest campus, the deployment was largely complete. Well done, team!

Figure 11: The MECHE Observatory team. From left to right, top to bottom: Hadleigh Thompson, Jade Reynolds, Laura-Anne Browning, Stephen Dery, Kirsten Calder-Sutt and Dylan Broeke.

Next steps

Most MECHE Observatory instruments are now up and running. They are set up to continue recording data over the course of the winter. Next on the to-do list is working with colleagues to set up a live feed of the data from our two primary sites as well as prioritizing data management activities to ensure all data collected are organized and accessible.

A special shout out and sincerest thanks to Hadleigh Thompson of *Université du Québec à Montréal* for making the journey out to BC to support the MECHE field campaign.

Figure 12: Meteorological station, Parsivel, and MRR deployed at Huckleberry Mines.

Figure 13: Terrace roof top set-up, including Hotplate, icing detector, MRR, and meteorological station.

Fall Reflections

Thoughts and reflections from our field staff

Jade Reynolds, B.Sc.

This summer has come with many adventures for me, from the Nechako Reservoir to the Stuart Basin. Exploring northern BC with my partners, Laura-Anne and Dylan, has been absolutely amazing. I have learned so much more from last year since signing back on with the NHG in February, gaining knowledge about our new site deployments as well as data base work and management through Justin. I have had such a wonderful summer with everyone and will look back on all the experiences that we have had with gratitude! I'd like to thank everyone at the NHG for a great summer and especially my partners for making this feel less like a job and more like a continuous adventure.

Jade Reynolds

Laura-Anne Browning, B.Sc.

Laura-Anne Browning

After nearly seven months working with the NHG, I have gained a wealth of knowledge into the various procedures and techniques associated with climatology work. I have also gained much experience in creating maps, which I found incredibly interesting and rewarding! I have seen many beautiful regions of the Nechako Basin and I am very grateful to have learned so much about the history of numerous industries and their impacts on the environment and the people in this area. I have also been lucky enough to see so much wildlife in the basin including black bears, moose, river otters and so many cool birds! By far the best experience I had while at the NHG has been meeting and collaborating with so many wonderful colleagues, I truly had an amazing time with all of you! Huge thanks to the field crew including Jade, Dylan, Kirsten and Justin, who made the summer so memorable, informative and fun!

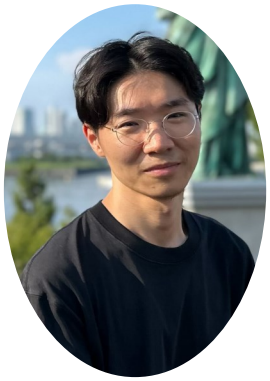
Dylan Broeke, B.Sc

During this summer I have learned a great deal about the managing, deployment, collection, and care of both weather stations and stream temperature loggers. I have been tasked with several different problems on how to best deploy a sensor and it has allowed me to critically think about how the sensor works and how best to deploy it in a specific and special situation. It has been incredibly interesting to learn how each sensor works and is wired to loggers and I look forward to continuing my learning and to passing this knowledge on.

Dylan Broeke

Welcome to our newest NHG member!

The IRC proudly announces and welcomes UNBC's Masters student Meng Wang. Meng's research project will focus on an analysis of the water temperature data collected across the Nechako Watershed. We wish you a pleasant start this Fall and count on the team for whatever you need towards accomplishing your research.



Meng Wang

"*Hello everyone, I am Meng from China. I graduated from Shanghai University and Imperial College London before that. I undertook a research on the relationship between plant growth promoting rhizobacteria with plant and its ability to adsorb heavy metals before. I worked in Unilever North Asia R&D center for nearly three years responsible for Dove cosmetics formulation development. I am very interested in watching films and I really enjoy watching films from different countries. I also like travelling*."

Nechako Research

Explore some of our research!

17 - Notable AR Event

PhD candidate Bruno Sobral highlights notable atmospheric river conditions that impacted the Nechako for over two weeks in 2017.

Research Skills Trainee, Tamar Richards-Thomas, reviews the weather in Prince George during the months of summer season

19 - Summer Weather in PG

20-21

Summer streamflow

MSc student Justin Kokoszka analyses 2023 summer streamflow at Vanderhoof and compares to historical values.

Post-doctoral Fellow, Jingwen Wu, shares his findings on future summer streamflow trends in the Nechako Reservoir between 2021 and 2100.

Research Skills Trainees, Laura-Anne Browning and Jade Reynolds, provide a step-to-step wiki on how to collect data from our stream temperature loggers.

23 - Stream temperature

Prominent Atmospheric River in the Nechako

Bruno Sobral

In 2017, a two-week streak of favorable AR conditions impacted the Nechako

In this edition, I will show you what I have been up to moving forward with my studies on the influence of atmospheric rivers (ARs) on the Nechako River Basin (NRB). More than anything, I've been working on computational scripts to help me analyze notable AR events that will make chapter 4 of my PhD dissertation. Here I will share partial results about a prominent AR event from 14-28 October 2017, which impacted the NRB and surrounding regions. This meteorological phenomenon lasted an impressive 15 days and brought over 100 mm of precipitation on average to the NRB. Despite not being so intense, considering accumulated totals, it is the most prominent AR event in the SIO-R1 AR catalogue (1950-2021) to have impacted the NRB.

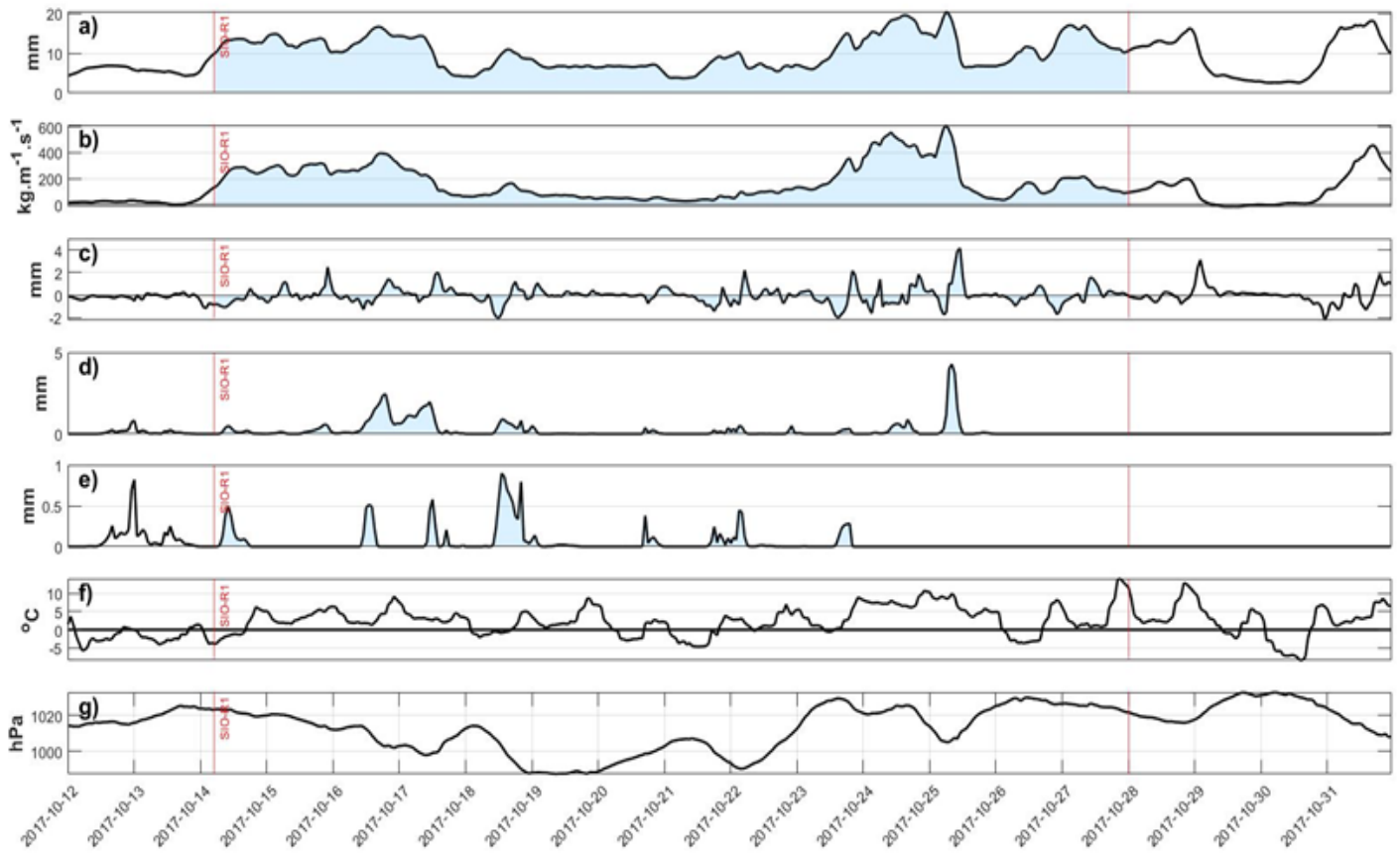


Figure 14 – Climograph of the 14-28 October 2017 AR event using ERA5 data in position (53°N, 125°W) within the Nechako Reservoir and showing a) total column of water vapour (mm), b) integrated water vapour transport ($kg.m^{-1}s^{-1}$), c) vertically-integrated moisture divergence (negative values represent convergence) (mm), d) total precipitation (mm), e) snowfall (mm), f) 2-metre temperature (°C), and g) mean sea-level pressure (hPa). The red bars represent the start and end of the AR event according to the SIO-R1 catalogue.

This notable AR event started at coordinates (52.5°N, 127.5°W) on October 14th at 06:00 UTC. It moved south the same day and reappeared in the north the following day, showing a non-ordinary pattern and suggesting that more than one AR occurred. It was registered at position (55°N, 130°W) by 06:00 UTC on the 15th and continued to move southward until the 21st. It is worth noting that this very long AR event seems to have been formed by two sequential ARs (Figure 1b), which were tracked as a single event by the tracking algorithm of the AR catalogue. A chronological representation of the event is shown in the climograph of Figure 1, using data for the position (53°N, 125°W) within the Nechako Reservoir, while Figure 2 (a-c) shows maps of accumulated variables of the ERA5 product for the southwestern BC region.

During the first AR (figure 1b), precipitation (Figure 1d) occurred intermittently, although the 16th, 17th and 25th registered greater precipitation totals. The majority of the precipitation was conveyed to the NRB as rainfall, reflecting typical AR precipitation. The AR also influenced regional temperature profiles (Figure 1f) with warm moisture from the Pacific Ocean, predominantly staying above 0°C until the 20th. The second AR started on the 23rd and intensified over time, reaching its maximum precipitation intensity on the 25th. Within the NRB, the highest accumulated precipitation totals were registered near the SkinsLake Spillway (Figure 2a), reaching ~600 mm in some locations.

The total average precipitation in the NRB during the event was 101.42 mm, with the Upper Nechako (156.49 mm) and Stellako (132.60 mm) being the most affected sub-basins. The eastern and northern parts of the watershed received more snowfall (Figure 2b), while the Upper Nechako sub-basin received only traces. Accumulated runoff (Figure 2c) reached >600 mm south of the NRB, in the same region where accumulated precipitation was maximum throughout the period. This AR event significantly impacted the Nechako River Basin and surrounding areas by bringing substantial precipitation and runoff to southwestern BC.

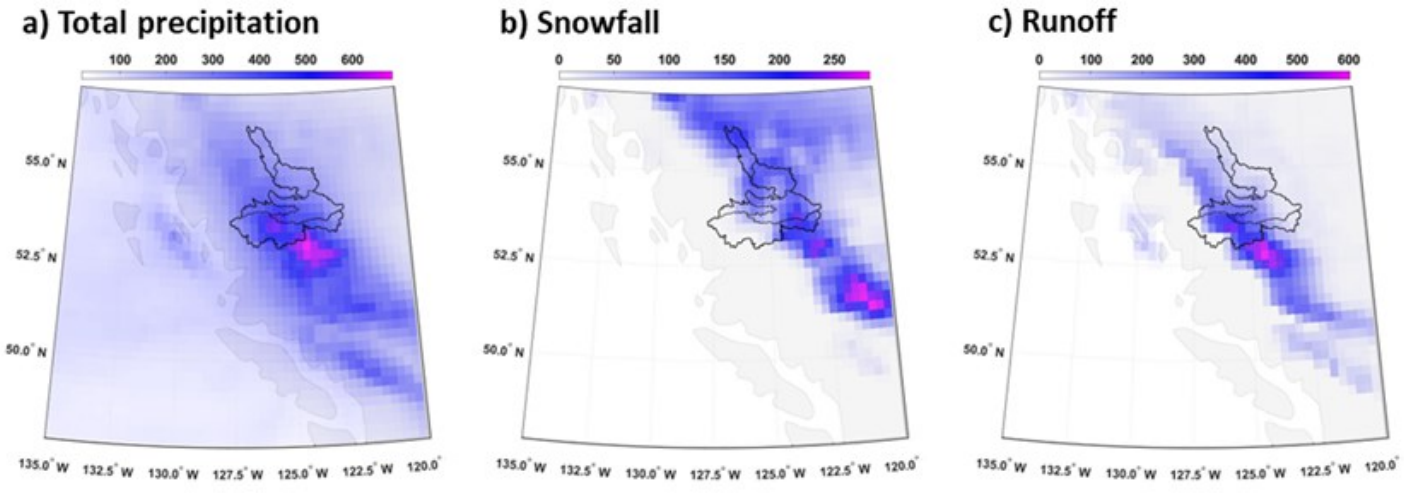


Figure 15 – Accumulation maps during the 14-28 October 2017 AR event for ERA5 variables a) total precipitation (mm), b) snowfall (mm), and c) runoff (mm).

The following steps in my PhD dissertation are to select and thoroughly describe other notable but more intense AR events using these scripts and methodology. Likely, I will choose ARs based on duration intervals and precipitation intensities, to represent different types of notable ARs that have impacted the Nechako watershed. If you want to learn more about this or other AR events, please feel free to contact me. See you in the December 2023 Newsletter.

Weather in Prince George

A Review of Prince George's Weather in Summer 2023

The mean temperature (Tmean) recorded at Prince George Airport Auto station was 12.9 °C in June to August 2023 (Fig. 1a). The monthly values of Tmean recorded were slightly different for June (14.7 °C), July (16.3 °C), and August (16.0 °C). Missing values of Tmean were reported on 19, 20, and 27 June 2023. The lowest and highest temperatures recorded were 7.7 °C in June and 21.1 °C in July, respectively, over the past three months. There were no recorded-breaking temperatures in August, but the temperature was slightly ≥ 30.0 °C on 6, 13, and 28 August 2023 at Prince George Airport Auto station (Fig. 1c). Typically, Prince George experiences temperature ≥ 30.0 °C once in August.

A total precipitation (Ptotal) of 78.3 mm was recorded at the Prince George Airport Auto station over the past three months (June to August, Fig. 1b). Ptotal in August (21.5 mm) was lower than Ptotal in June (33.3 mm) but slightly lower than Ptotal in July (23.5 mm). In addition, Ptotal in August was extremely lower than normal, representing < 50 % of the average 51.5 mm for this month over several years. In summer 2014, Prince George Airport Auto station recorded 68.40 mm of moisture as the only drier summer (not shown), and the second driest summer ever occurred in Prince George. The Northern hydrometeorology Group (NHG) continues to track and monitor these unique conditions in our region.

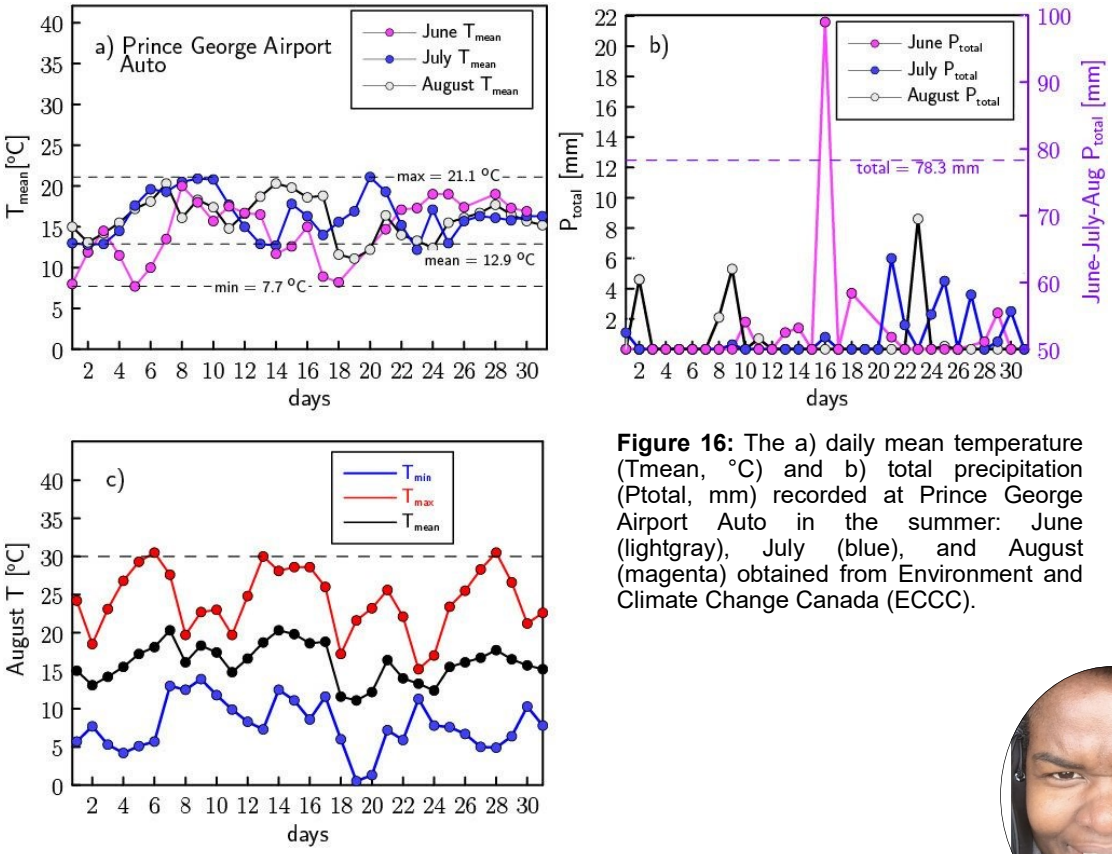


Figure 16: The a) daily mean temperature (Tmean, °C) and b) total precipitation (Ptotal, mm) recorded at Prince George Airport Auto in the summer: June (lightgray), July (blue), and August (magenta) obtained from Environment and Climate Change Canada (ECCC).

Tamar Richards-Thomas

Summer streamflow

A review of the summer flow conditions at Vanderhoof

Justin Kokoszka

In the summer of 2023, the Nechako River Basin experienced some notable differences in streamflow compared to the 1980-2020 summer averages. Here, we investigate these differences along the Nechako River at Vanderhoof (Figure 17). Streamflow was significantly lower during the early summer months compared to the historical averages during this summer. Additionally, we can see a series of ups and downs (three peaks and two troughs) during late summer compared to the smooth decline in the historical record.

While the historical maximum flow was 287.8 m^3/s on July 7th, this year's summer maximum flow was 302.7 m^3/s, but it occurred later on August 15th, representing a 3.4% decrease in flow and a 22-day delay. Meanwhile, the minimum flow in 2023 was 77.1 m^3/s on July 9th, significantly lower than the historical minimum flow of 92.0 m^3/s on August 31st, a decrease of 11.4% and a 53-day difference in occurrence. Additionally, we see that the total volume of water flowing at Vanderhoof was significantly lower than the historical record (Figure 17). The total volume of water during the summer of 2023 was 1.3 cubic kilometres, which is 18.6% lower than the historical average of 1.7 cubic kilometres. Overall, the summer of 2023 exhibited a small increase in maximum flow, significantly lower minimum flow, and a considerable reduction in the total volume of water compared to the historical averages from 1980-2020.

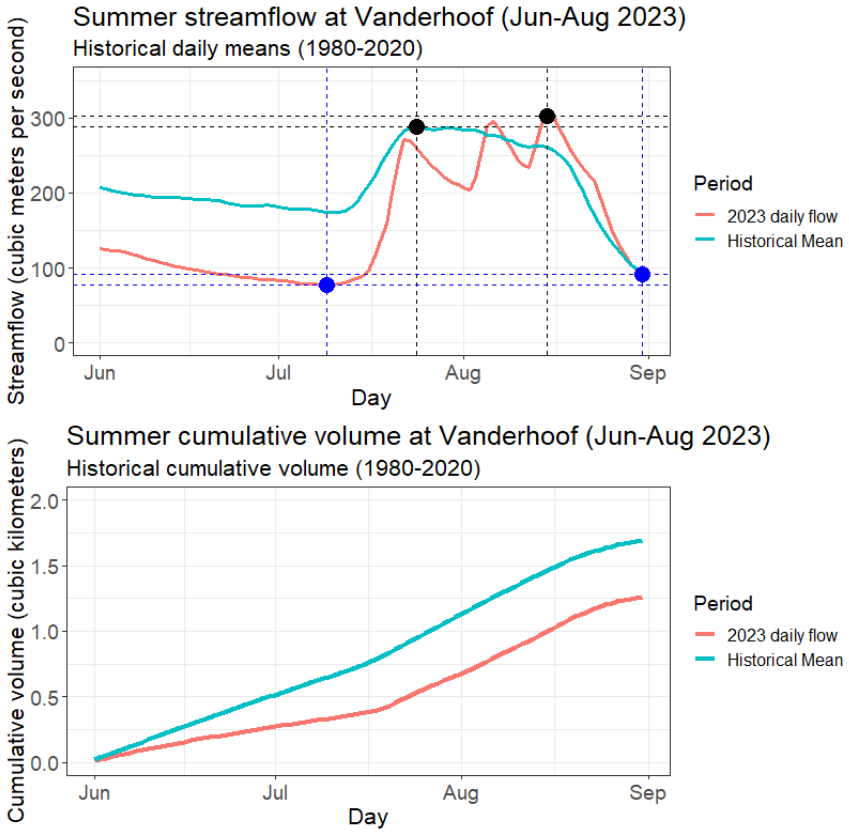


Figure 17: Summer streamflow and cumulative volume at Vanderhoof during the 2023 summer season (June to August) and historical summer average (1980-2020). Peak flows are indicated by the black-dots with peak flow dates and magnitudes shown by the black-dashed lines. Minimum flows are depicted by the blue-dots with minimum flow dates and magnitudes show by the blue-dashed lines.

The differences observed in the Nechako River Basin are likely due to ongoing drought conditions and periodic releases of water from the Skins Lake Spillway, aimed at keeping stream temperatures below 20°C for aquatic species. Drought leads to reduced precipitation, increased evapotranspiration, lower soil moisture, and decreased runoff. This explains the lower minimum flow and total water volume in summer. Skins Lake Spillway releases, part of the Summer Temperature Management Program, temporarily raise flow rates, causing periodic late-summer increases.

This underscores the importance of studying the Nechako River Basin's historical hydroclimate. Better understanding can inform water management to protect aquatic life during droughts. Investigating hydroclimate and stream temperature records is crucial for grasping regulation, climate change, and their impact on the Nechako River Basin's ecosystems and communities.

Future summer streamflow

Future changes in summer flow in the Nechako River Basin

Summer flow in rivers and water bodies holds paramount importance for the intricate balance between natural ecosystems and human societies. It serves as a linchpin for a multitude of vital processes. The flow ensures the continuity of surface water movement, nurturing and sustaining a rich tapestry of flora and fauna that depend on the rhythm of these waters. Moreover, this seasonal flow plays a pivotal role in maintaining water quality. By preventing stagnation and fostering the vital interplay of oxygen and nutrients, it acts as a natural purifier, preserving the delicate equilibrium of aquatic ecosystems. A significant function of summer flow is its role in sediment transport. It acts as a river's storyteller, carrying the tales of eroded landscapes downstream. This sediment movement sculpts riverbeds, rejuvenates floodplains, and shapes the very essence of river systems. In an era where our climate is shifting due to global warming, this dance of summer flow takes on even greater importance.

Jingwen Wu

In the Nechako River Basin, where rising temperatures and altered precipitation patterns are anticipated, understanding and monitoring these shifts become imperative. Assessing changes in summer flow patterns becomes a window into the evolving hydrological landscape. It unveils insights into the delicate intricacies of fish migration and spawning, foretelling potential repercussions of climate change and human activities on water quality.

This study delves into forthcoming shifts in the annual summer streamflow within the Nechako Reservoir, spanning the period from 2021 to 2100. To accomplish this analysis, we harnessed the predictive prowess of the VIC (Variable Infiltration Capacity) hydrological model alongside the Canadian Earth System Model version 5 (CanESM5) general circulation model. The findings notably showcase a diminishing trajectory in the mean spring flows (depicted in Figure (a)), reflecting a yearly deduction of approximately ~1.23 m^3/s. Equally noteworthy, the summer peak flow (illustrated in Figure (b)) similarly exhibits a downward trend, revealing an annual deduction of roughly ~3.32 m^3/s. The primary driving force behind this phenomenon is the pronounced escalation in summer air temperatures, indicating a yearly uptick of approximately 0.08 degrees Celsius.

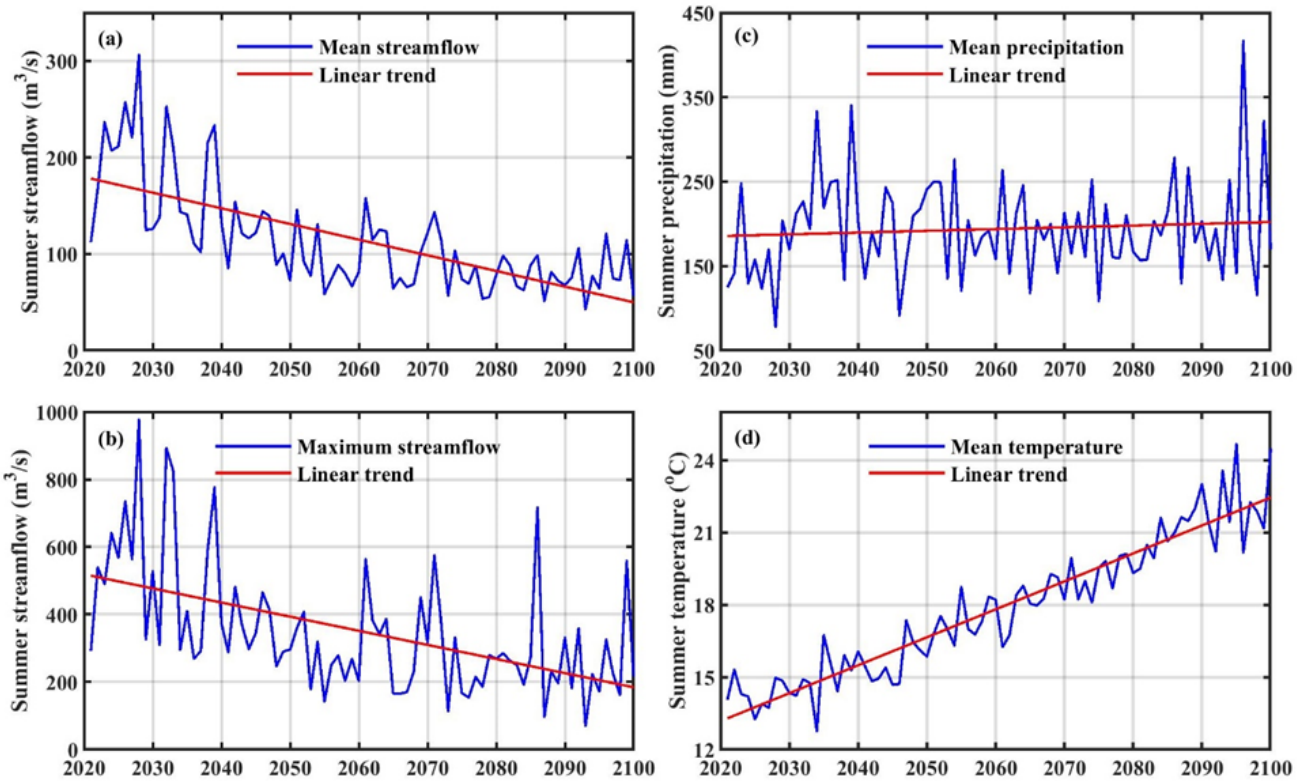


Figure 18: Future (2021–2100) annual changes in summer mean flow, peak flow, mean precipitation and mean temperature in the Nechako Reservoir.

While summer precipitation is indeed on the rise, it's overshadowed by the substantial elevation in air temperatures during this season, subsequently amplifying evapotranspiration rates. Consequently, this intricate interplay culminates in a decline in the average summer streamflow. Furthermore, the temperature surge is not confined solely to the summer months; rather, it extends its influence into the winter and spring seasons. This extended warmth triggers accelerated snowmelt during these periods, precipitating a marked reduction in the summer's peak streamflow. These findings highlight the complex dynamics between summer precipitation, spring snowmelt, and summer flow in the Nechako Reservoir. The insights gleaned from our analysis serve as a compass for shaping sustainable water management strategies. In the ever-shifting landscape of hydrological conditions, these findings offer valuable guidance to ensure the preservation and responsible utilization of the Nechako Reservoir's precious water resources

Stream temperature monitoring

Learn the process with Jade and Laura-Anne

The Hoboware Bluetooth loggers are contained within a PVC pipe enclosure and zip tied to the cap. The pipe is then hose clamped to a cinderblock with tether fed through the block and the pipe, then attached to a piece of rebar or a tree to be used as an anchor.

Deployments tend to be done approximately two to four metres from shore targeting deepest parts of the river or creek that can be safely reached. The cinderblock logger assemblies are thrown in by the field crew while taking note to not snap the tether which is anchored to shore.

Figure 20: MX2201 bluetooth logger with equipment code sticker.

Figure 21: Logger in a PVC pipe that is secured to a cinderblock and tethered to an anchor.

Figure 19: Action shots from the summer 2023 field campaign

HoboConnect is used on a tablet to download the data from the loggers using Bluetooth. Pressing on the top of the logger allows connection through the app, where data can be collected, and the logger can then be reconfigured to start future data collection.

Data are transferred to our hard drive and our database. They undergo through quality analysis and control (QA/QC) to ensure that any errors or erroneous data are noticed and fixed.

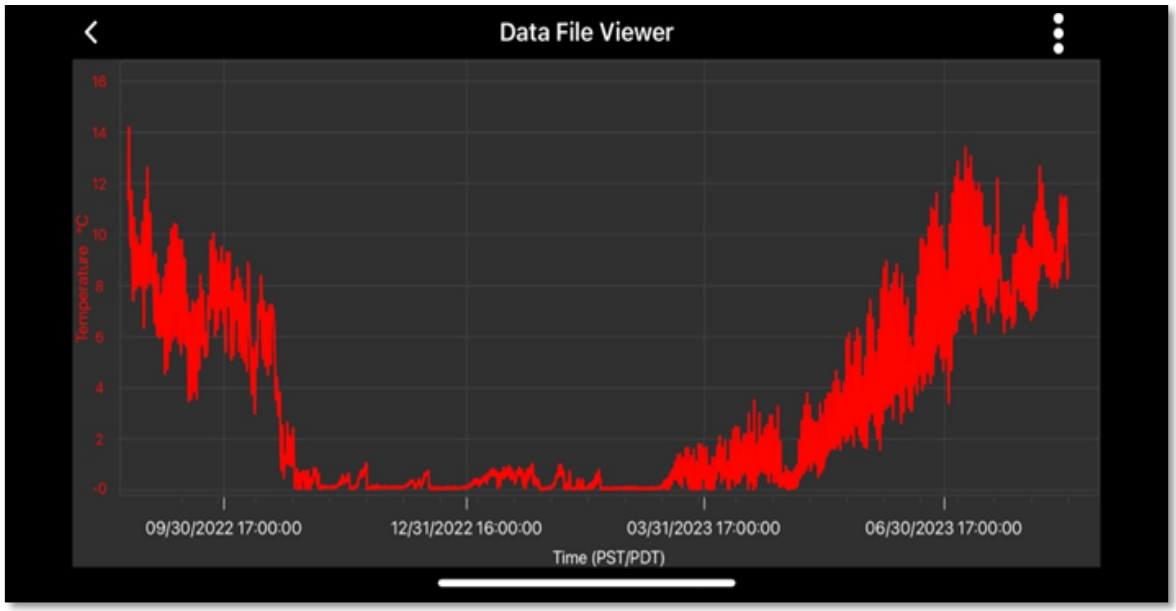


Figure 22: Plot of data from stream temperature logger at one of our sites.

Laura-Anne Browning

Jade Reynolds

Outreach

1. **2023/09/01** - UNBC research group launches third phase of Nechako River basin study, Daybreak North, CBC Radio
2. **2023/09/01** - UNBC research group gets $800k to continue Nechako River Basin study, Prince George Citizen - https://www.princegeorgecitizen.com/local-news/unbc-research-group-gets-800k-to-continue-nechako-river-basin-study-7484370?utm_source=Email_Share&utm_medium=Email_Share&utm_campaign=Email_Share
3. **2023/08/31** – UNBC research group launches third phase of Nechako River Basin study, UNBC media release—https://www2.unbc.ca/newsroom/unbc-stories/unbc-research-group-launches-third-phase-nechako-river-basin-study
4. **2023/08/31** - UNBC research group launces third phase of Nechako River Basin study, CKPG News, CKPG (Prince George, BC) - https://ckpgtoday.ca/2023/08/31/unbc-researchers-get-funding/

Stephen Déry

5. **2023/07/25** - Sediment loads and the different coloration of the Nechako and Fraser rivers, CKPG Today, CKPG (Prince George, BC)
6. **2023/06/30** - Drought conditions emerging across northern BC, CKPG News, CKPG (Prince George, BC)
7. **2023/06/27** - Ongoing, persistent warm, dry spell in northern BC, CKPG News, CKPG (Prince George, BC)
8. **2023/06/06** - Current warm, dry forecast for Prince George, CKPG News, CKPG (Prince George, BC)

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