UNBC UNIVERSITY OF NORTHERN BRITISH COLUMBIA

RioTinto

The Nechako IRC Newsletter

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An update from Dr. Stephen Déry, Project Leader

Happy spring, everyone!

We are in the midst of a busy winter semester at UNBC as we rapidly approach the spring season. It certainly has been an unusual winter, not only because of the COVID-19 pandemic but also with our abnormally warm conditions. In December, for instance, air temperatures were about 5°C warmer than average leading to some early snow melt. With the warm temperatures, streamflow in December reached record volumes in parts of the Nechako Watershed while snowpacks attained average levels by the end of January. As of 16 March, the basin-wide average snow water equivalent (or SWE, the water content held within the snowpack) attained 127% in the upper Fraser West (the Stuart Watershed) and 117% in the upper Nechako. This implies that snowpacks at mid- to high elevations in the Nechako are slightly above average for this time of year.

In this issue of the Nechako IRC Newsletter you will find more information on the unusually warm temperatures and associated high flows observed in the Nechako Watershed this past winter. You will also find an update on the preparations and planning process for the Tahtsa Ranges Atmospheric River Experiment (TRARE) field campaign to be held in the upper reaches of the Nechako Watershed in September and October 2021. As well, the newsletter includes an introduction to the intensity scale of atmospheric rivers, perhaps better known as Pineapple Express storms, and their role on the hydrology of the Nechako Watershed. Finally, you will also be able to read the regular updates from the Research Manager and Outreach Coordinator for the IRC program of research.

Spring does mark a transition period and our team is also in a state of metamorphosis. We are saddened to hear of Barry Booth's decision to leave his position as Outreach Coordinator for the NSERC / Rio Tinto IRC program of research. While Barry is stepping down from this role, he remains fully engaged with research activities in the Nechako Watershed, in part as the Research Manager of UNBC's Integrated Watershed Research Group (IWRG). We are pleased to report that Kelly Hurley will step in as the Outreach Coordinator for a 3-month period while we find an individual to fill in that role on a longer term basis. Kelly has now been in the IRC team since last fall and is leading the preparation of this issue of the Nechako IRC Newsletter with support from Barry. We are also pleased to report the recruitment of two summer undergraduate students, Derek Gilbert and Spencer Woyke, who will lead our summer field activities across the Nechako Watershed. As well, given the expansion and the increasing complexity of the logistics of our field work across the Nechako Watershed, the position of Research Manager held by Jeremy Morris will transition to a full-time one this summer. This will also allow us to better prepare for and engage in the TRARE field campaign.

The Science Advisory Board of the NSERC / Rio Tinto IRC is also undergoing a transition due to the retirement of Justus Benckhuysen from Rio Tinto. The IRC team extends its most sincere thanks to Justus for all of his support, starting with the early discussions about a possible research chair position at UNBC in partnership with Rio Tinto in 2017/2018. Justus provided ardent support during the development of the funding application to NSERC and in the initiation of the IRC 5-year program of research. We therefore wish Justus all the best as he embarks on this next stage of his life and will miss his most notable contributions to the SAB and the IRC.

In the coming months we will begin preparations for the summer field season and once the snow melts we will start visiting our field sites across the Nechako Watershed. We hope to interact with you then, all in a safe manner as we continue to observe COVID-19 safety protocols. We wish you good health and look forward to a busy summer of activity across the spectacular landscapes and waterscapes of the Nechako!

Stephen

Northern Hydrometeorology Group (NHG), UNBC

Inside this issue

Special points of interest

- On Feb. 23rd, 40 participants joined Stephen and the IWRG for a virtual presentation on their research in the Nechako.
- Stephen was interviewed for CKPG News about high streamflows in the Nechako
- We are currently recruiting for an MSc position that will employ model simulations to explore the changing hydrology of BC coastal watersheds.

Some Very Welcome Winter Sun During Fieldwork at Ancient Forest / Chun T'oh Whudujut Provincial Park

Research Manager update

Jeremy Morris

Winter is flying by and, as such, we are beginning to plan upcoming field work. Two new summer students are hired on to maintain our network of climate stations, as well as collect data from the new instrumentation deployed throughout the Nechako watershed. Time will be spent in the coming months training our newcomers and preparing gear as the planning process unfolds. I look forward to reconnecting with our collaborators throughout the Nechako Watershed (including the great folks up the Stuart!) to continue working together on this project. Once we have collected our first datasets from the region, we will seek to share our results with the region through outreach opportunities.

Unfortunately, it is looking like we will all be continuing to operate under the dark cloud of COVID-19; however, we will be conducting our research under strict health protocols. Though we will likely be minimizing our presence within local communities we will still strive to maintain and develop relationships across the area, albeit through masks or virtual platforms.

Future endeavors aside, there was an attempt by the team from Avison Management Services Ltd. to visit our Mt Sweeney climate station in early February while conducting snow surveys in the region. Upon reaching the site they encountered nearly 3 m deep hardpack drifted snow caused by high winds at the site. The team was able to service the Pluvio2 precipitation gauge, which needed some TLC from the violent winds on site. Unfortunately, the hardpack snow prevented them from reaching the data logger before weather closed in, but our remote connection to the site indicates the station is operating properly. The trip revealed that the site might be challenging for our precipitation measurements, but it can sure capture some heavy wind patterns there!

Mt Sweeney weather station covered in snow, 8 February 2021
Photo courtesy of Scott Klassen

In the meantime, we will be busy here at UNBC getting ready to go. I will also be scrambling to finish my Master's thesis on wetlands within Ancient Forest/Chun T'Oh Whudujut Provincial Park before the busy summer in the Nechako begins! Until then, best wishes to the communities of the Nechako Watershed, and I look forward to connecting after ice off.

Current and Historical Streamflows: Nechako Watershed

Rajtantra Lilhare & Justin Kokoszka

The 2020-2021 winter season (December-February) was both warm and mild with above normal air temperatures across the Nechako Watershed. Such warm conditions may have influenced the Nechako River's 2020-2021 winter streamflow. As part of the quarterly investigation of streamflow in the Nechako River, we looked at the 30-year average of winter flows (1981-2010) and compared those against streamflow for the current winter season at five locations within the Nechako Watershed. Three locations were in unregulated areas of the Nechako Watershed: the Stellako, Nautley, and Stuart Rivers. The remaining two locations were situated along the regulated Nechako River at Vanderhoof and Isle Pierre (Figure 1). We also compared the 30-year (1981-2010) average air temperature against those for this year's winter season at Prince George, Vanderhoof, Fort St. James, Skins Lake/Ootsa Lake, and Kemano (Figure 2). Our investigation highlights the influence of this year's mild winter on streamflow across the Nechako Watershed.

Streamflow for the 2020-2021 winter season was well above the 30-year normal at each location (Figure 1). Of the unregulated sites, the Nautley River had the largest difference with an average winter flow 82% above the normal average. Overall, the regulated site at Vanderhoof saw the largest change with an average winter streamflow 118% above normal. A similar pattern was revealed for air temperatures within the Nechako Watershed and west of the watershed at Kemano. At all five locations, winter air temperatures were above the 30-year average by about 1-2°C (Figure 2). For example, in Prince George the 2020-2021 winter average was about -4.5°C; a 2°C increase compared to the 30-year average of about -6.5°C. Clearly, these warm conditions have influenced the Nechako River's 2020 -2021 winter streamflow.

Above normal air temperatures across the Nechako Watershed may have led to periods of snowmelt during the winter season as well as greater groundwater movement due to warm soils. Both snowmelt during the winter season and increased groundwater movement may have accentuated winter baseflow. In addition, release of water from the Skins Lake Spillway was above average for the 2020-2021 winter season (https://nechako.riotintoflowfacts.com/#reservoir) and may have accentuated the above normal streamflow conditions seen at both Vanderhoof and Isle Pierre. As snow continues to melt in the Nechako Watershed, we should expect to see a continued increase in streamflow as the freshet approaches. Stay tuned as we investigate!

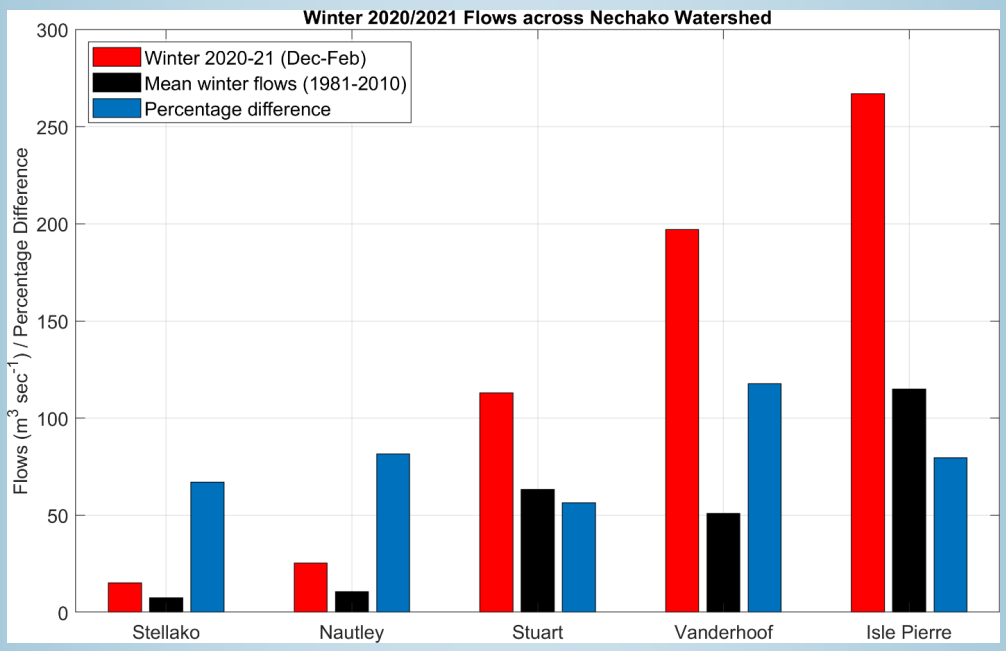


Figure 1: Climate normal winter (December-February) average streamflow (1981 to 2010; black bars) and current average winter streamflow (2020-2021; red bars) at five locations within the Nechako Watershed. The Stellako, Nautley, and Stuart Rivers are in unregulated areas of the watershed, while the Nechako River at Vanderhoof and Isle Pierre are influenced by streamflow regulation. The difference between current and normal streamflow (blue bars) was determined as the absolute difference in current and normal streamflow divided by the average of current and normal streamflow, multiplied by 100%.

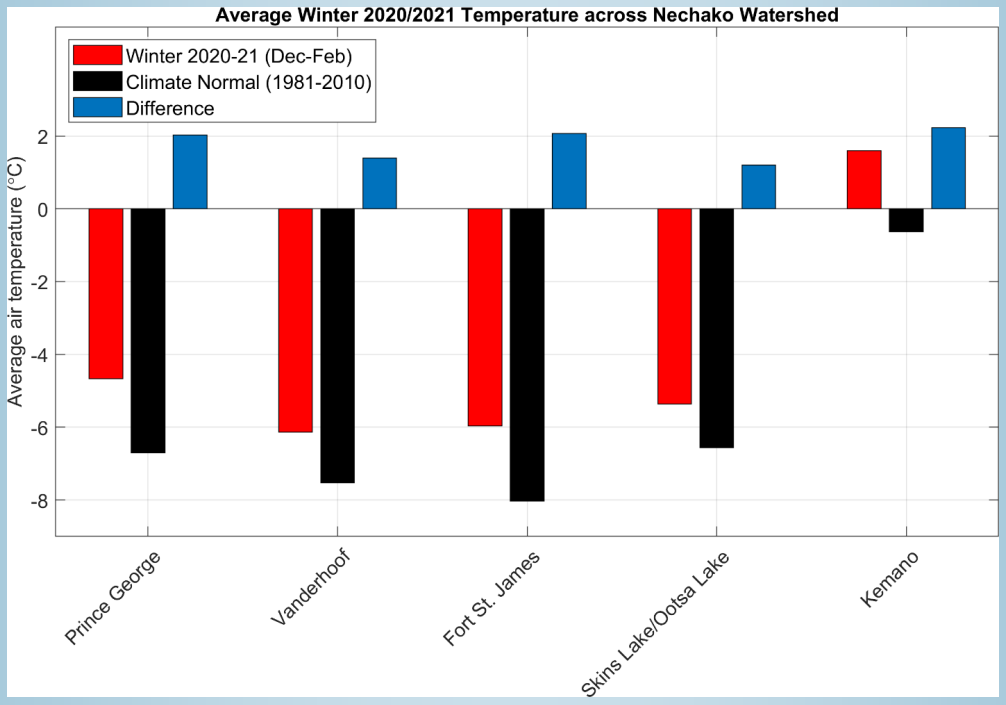


Figure 2: Climate normal winter (December-February) average air temperature (1981 to 2010; black bars) and current average winter air temperature (2020-2021; red bars) at four locations within the Nechako Watershed and west of the watershed at Kemano. The difference between current and normal air temperatures (blue bars) was determined as the difference in the current and normal air temperature.

Summer Fieldwork Plans for Gathering Stream Temperature Data in the Nechako

Adam MacDonald

As we move into the New Year, I am currently working on finishing up two more classes this semester, as well as working on my master's project. Current work will be to catalogue all of the different temperature data available to the IRC and then determine new sources of data to complement our database of water temperature data.

Stuart Lake, Upper Stuart Watershed
Photo by Adam MacDonald

Moving ahead towards summer, there will be a large field season to prepare for. This will involve collecting all of our own data from the water temperature loggers that have been deployed by IRC staff over the past 3 years (now up to 28 loggers!) This field work will begin following the spring freshet when river discharge has reduced to safe levels for us to get into the water and download the water temperature data.

Our goal for the upcoming field work will be to:

- Download data from all 28 temperature loggers spread within the Nechako watershed,
- Train any new field staff on how these downloads take place and how to safely work around fast moving water,
- Replace any temperature loggers we lost during the winter season with new loggers,
- Replace batteries in the temperature loggers,
- Ensure that the current deployment is sound and we are not at risk of losing the logger.

With so many loggers deployed and such a large area to cover from north of Stuart Lake, all the way west to the Coast Mountains, this will require a lot of work, including help from a couple of summer research assistants. Once we have finished collecting the data, we can download and finally analyze them. We will repeat all of these steps in the fall before the winter of 2021 hits, and the rivers freeze up!

With this field component coming up quick, I am looking forward to being able to get away from my computer and head out to collect this data and have the opportunity to see the more remote parts of the Nechako watershed.

An Update on the TRARE Field Campaign

Kelly Hurley

As we welcome in the spring, preparations are ramping up for our upcoming autumn field campaign, the Tahtsa Ranges Atmospheric Rivers Experiment (TRARE). We have been having regular virtual meetings with our collaborators across the country, at both McGill University and the Université du Québec à Montréal (UQAM). Together, we have been planning what meteorological and hydrological equipment will be deployed and where. The following map shows the complexity and diversity of the prospective field sites for TRARE. Our field data will be primarily collected at three main sites: The Upper Mount Sweeney Weather Station, the Huckleberry Mine Site, and the Nadina River Spawning Channel.

As you can see from the map on the next page, the Nadina Spawning Channel field site is approximately 30 km northeast of the Huckleberry Mine Site. The reason for positioning our weather stations and observation points far from each other is because it allows us to compare and contrast weather variables as an Atmospheric River (AR) moves eastward, across the basin. There is also approximately 700 meters of elevation difference between the Upper Mount Sweeney Weather Station and the Huckleberry Mine Site, allowing us to quantify meteorological differences across an elevational transect.

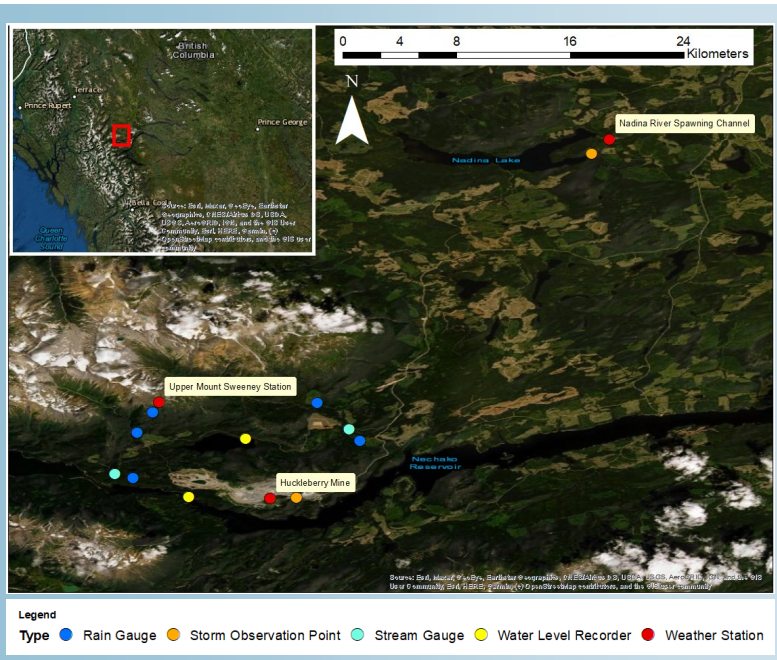


Figure 3: A map showing the prospective field sites for the TRARE Field Campaign. Map by Kelly Hurley

Aside from weather stations and storm observation points, we will also be deploying an array of rain gauges and water level recorders. The rain gauges will be installed along the slopes of Mount Sweeney in order to collect even more data on the differences in precipitation along an elevational transect. Although it is not possible to see from this map, there are two streams that drain Mount Sweeney. In each of these streams, we will install instruments that measure the volume of water moving through the stream (known as discharge). Data will also come from the water level recorders that will be placed in Sweeney Lake and Tahtsa Narrows. These data, along with the aforementioned discharge measurements, will help us better understand the terrestrial hydrological responses to these storms.

The TRARE campaign will be logistically complex. However, we are excited to take on this endeavor in order to collect meaningful data that will contribute to an enhanced understanding of the role ARs play in the hydrology of the Nechako.

A Scale for Landfalling Pineapple Express Storms

Bruno Sobral

Atmospheric rivers (Pineapple Expresses) are storms known for both their potential to induce precipitation-related hazards and also for the replenishment of water resources in British Columbia (BC). These narrow-shaped corridors of water flux in the atmosphere vary in length, width and height, which makes it a challenge to foresee their potential impacts on watersheds worldwide. This variability in their shape is linked to the volume of water vapour they carry from the tropics to the poles, which can be beneficial or hazardous to areas such as the Nechako. Many "Pineapple Express" hit the West Coast of BC every year, and satellite data can now aid scientists to provide an estimate of their magnitude and spatial position before they make landfall. This is of great importance for many reasons, but particularly for disaster planning and water management in areas of the province that have been affected by climate change. In light of this, researchers from the Scripps Institution of Oceanography at the University of California have developed a simple scale[1] that runs from 1 (Weak) to 5 (Exceptional) and allows the comparison of AR events based on the duration of the event[2] and the volume of water vapour they carry (also known as the integrated water vapour transport — IVT).

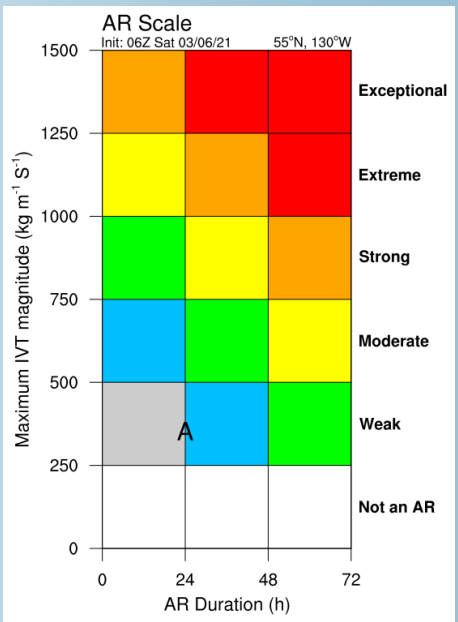


Figure 4: AR Scale created by Ralph et al. (2019)[2] characterizing the low probability of weak (blue) AR occurrence west of the Nechako for the second week of March 2021.

A reanalysis of satellite data collected during the period from 1956 to 2018 from the SIO-R1-AR catalogue allows us to assess the intensity and duration of ARs that have reached the west region of the Nechako in the past. By applying the scale to these AR data, we find that the longest AR to make landfall near the Nechako was registered between the 23rd and 26th (over 72 hours) of July 1988, with maximum IVT value of 673 kg m^{-1} s^{-1} and reaching the Strong (yellow) classification. This AR event contributed to heavy rainfall during that month and caused widespread landslide events in the Northern Cordillera area[3], west of the Nechako. Later in the same year, an Extreme AR event west of the Nechako was registered between the 28th of September and the 1st of October. This event reached a maximum IVT value of 1123 kg m^{-1} s^{-1} (highest for the series), lasted almost 72 continuous hours, and helped to induce severe flooding in many watersheds located in the northwest of the province[3]. Intense and long-lasting events of lanfalling ARs such as these can impact the Nechako causing floods and landslides, which justifies the assessment of ARs before they make landfall and allows stakeholders to adopt mitigation measures before the events.

1 – CW3E website - https://cw3e.ucsd.edu/arscale/

2 – Ralph, F.M. et al. (2019). A scale to characterize the strength and impacts of atmospheric rivers. Bulletin of the American Meteorological Society, 100(2), 269-289. doi:10.1175/BAMS-D-18-0023.1

3 – BC Floods and Landslides (1820-2006) http://www.env.gov.bc.ca/wsd/public_safety/flood/pdfs_word/floods_landslides_north.pdf

Outreach Update

Kelly Hurley, Acting Outreach Coordinator

As Stephen announced in the Project Leader update, Barry Booth will be stepping down as the Outreach Coordinator for the NSERC / Rio Tinto IRC program of research. Barry has made many positive contributions to the IRC over the last few years, and we are very sad to see him go. While our group searches for a new person to fill this important role, I will be stepping in as the Acting Outreach Coordinator. I would like to thank Barry for his support and guidance through this transition. We wish you all the best in your future endeavours, Barry!

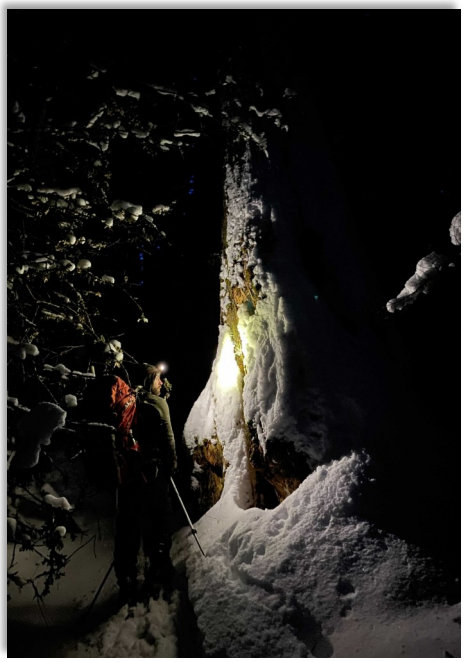
Despite the ongoing COVID-19 pandemic, the IRC team has continued to use virtual platforms for outreach:

- On January 8th, Stephen was interviewed by CKPG News to discuss the much above average air temperatures in December 2020 and concomitant high streamflows in the Nechako Watershed. Read the story here
- Stephen delivered a talk titled "Climate change and water security research at UNBC" to the Main Table of the Water Engagement Initiative on February 10th.
- On February 23rd, Stephen along with UNBC colleagues Drs. Phil Owens, Margot Parkes and Ellen Petticrew participated in a public presentation on integrated watershed research in the Nechako. This event was part of the "Koh-Learning in our Watersheds" project, created jointly by School District 91 and UNBC. The project aims to bring together learners, educators, and other local partners to learn about *Koh*, which means "waterway" is the Dakelh language. Watch the recorded presentation here

Scenes from the Field

A beautiful winter day at Ness Lake

Using our backcountry skis to move more efficiently during winter fieldwork



On our way back to the truck by headlamp after a long field day

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