2019 Annual Report

from the

Integrated Watershed Research Group

at the

University of Northern British Columbia

submitted to

Nechako Environmental Enhancement Fund
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in conjunction with
Drs. Déry, Owens, Parkes and Petticrew

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General Project Introduction

The University of Northern British Columbia (UNBC) houses an Integrated Watershed Research Group (IWRG) comprising: Stephen Déry (NSERC/Rio Tinto Industrial Research Chair on Climate Change and Water Security), Philip Owens (Forest Renewal BC Chair in Landscape Ecology), Ellen Petticrew (Forest Renewal BC Chair in Landscape Ecology), and Margot Parkes (Associate Professor, School of Health Sciences). These researchers have worked collaboratively for several years on integrated watershed-based research with an emphasis on the Fraser River Basin and other northern BC watersheds including the Nechako River Basin (NRB). The researchers view integrated watershed research as linking biophysical, chemical, social, and human-health processes to address important environmental, landscape ecology, and community issues. This group is working on Phase 2 of a five-year research program in the NRB comprised of three foci that address specific questions.

1 – Water security and climate change (Déry and students): Is a warming climate leading to more or less surface water availability in the NRB? What is the impact of anthropogenic versus natural influences on the basin's water resources, including streamflow amounts and timing?

2 – Sediment sources and dynamics (Owens, Petticrew and students): Fine-grained sediment has been identified as one of the main concerns within the NRB, and some key questions are: Where is the sediment coming from? If we identify the sources of the sediment, can we implement watershed management strategies to help control these sources and limit their detrimental effects? Given anticipated future changes in climate and land use in the watershed, how might sediment sources respond to these changes?

3 – Tools for integration in watershed management and governance (Parkes and students): How do decision support tools such as watershed report cards, indicator frameworks, and tools to integrate spatially referenced watershed information feed into broader processes of watershed management and governance? How do we build capacity for developing, managing and maintaining decision-support tools that integrate health, ecological and socio-economic parameters to inform watershed management and governance? How do we better understand the relationship between these decision-support tools and ongoing watershed-based science, given their different timelines, orientations and processes?

Timeline

The IWRG at the University of Northern British Columbia was awarded a $499,950 contract from the Nechako Environmental Enhancement Fund Society (NEEFs) in December of 2017 to continue Phase 2 of the IWRG research project in the NRB. This contract allowed for the seamless continuation of the initial Phase of the NEEF funded research that terminated on December 31, 2017. The following text in this report represents the work that was accomplished in the second year of Phase 2 of the project (2019).

Overall Project Management

Presentations, meetings, and extension:

- The IWRG team gave a presentation on their research to date at the UNBC NRESi Colloquium series, a forum for sharing information and facilitating discussion on a wide range of perspectives on natural resource management issues. These colloquia are also livestreamed in order for people in remote locations to view these presentations in real time. An archived version of the presentation can be found here: https://bit.ly/2Ke1ODG. This presentation acted as our annual outreach event for 2019 as invitations were sent to our regional partners.

- As part of the collective contributions of the IWRG, we also continued our collaborative work with the Nechako Watershed Roundtable (NWR) partners, both from a project and a governance perspective, in ways that complement efforts across all three themes. Our work in this area included the following:

    - Margot Parkes remains as co-chair of the Core Committee of the NWR, and Barry Booth, research manager, continues as part of the Technical Advisory Committee;
    - Margot chaired the NWR Technical Advisory Committee meeting on May 22nd. Barry and Siraj Ul Islam (Theme 1) also attended this meeting;
    - Margot co-chaired the NWR Annual meeting on October 30th, 2019. Ella Parker, UNBC Masters student, was part of the organizing committee and was also a note taker. Ella also facilitated a youth engagement component of the meeting (see Theme 3 below for more details related to Theme 3's work on the NWR). Barry Booth, IWRG Research Manager, attended this meeting as did UNBC Masters Students Meg Lebron and Kate Van Dam.

- Stephen Déry attended Rio Tinto's Water Engagement Initiative meeting in Vanderhoof on March 14th, October 8th, and November 20th, 2019. Stephen has also been participating in the monthly Technical Working Group meetings since the fall of 2019.

Research maintenance:

- We continue to collate documents and existing knowledge (published reports, journal articles, books, etc.) pertaining to work in the Nechako River Basin. These documents will continue to inform and feed directly into activities and collaborations associated with Theme 3;
- We continue to refine the IWRG website that features work done under the auspices of this research program/grant. Phase 2 webpages are now active (https://www.unbc.ca/integrated-watershed-research-group/research/nechako-river-basin).

Theme Updates

Theme 1: Water security and climate change (Déry, staff and students)

We continue our work on climate research in the NRB. Our progress so far is summarized below.

Field work, data collection and analysis:

We continue to work on research related to climate change and resource development in the NRB. This included:

- Analyzing Air2Stream water temperature model outputs for 17 river sites in the Fraser River basin (including 7 sites in the NRB);
- Initiating a pilot study to monitor water temperature. We have installed 8 HOBO UA-001-64 data loggers in the following locations:

    - Nechako main stem (5)
        - Upstream and downstream of the Sinkut River
        - Upstream and downstream of Clucluz Creek.
        - Wilson Park, Prince George.

- Nechako tributaries and reservoir (3)
    - Nadina River
    - Tatsha Reach, Nechako Reservoir
    - Immediately downstream of Skins Lake spillway*

These loggers were deployed at various times during the summer of 2019. Data were retrieved in June, October and November and have been summarized to determine efficacy of equipment and sampling locations. A brief summary of data can be found on the NSERC/Rio Tinto IRC website: https://bit.ly/36nmamS. Three loggers have been left in their respective locations for the duration of the winter and data will be retrieved after break up.

Reports published, in press, and in preparation:

- In 2019 we published three papers.

Papers published:

Islam, S. U., Curry, C. L., Déry, S. J. and Zwiers, F. W. (2019). Quantifying projected changes in runoff variability and flow regimes of the Fraser River Basin, British Columbia, *Hydrology and Earth System Sciences*, 23, 811-828, doi: 10.5194/hess-23-1-2019.

Islam, S. U., Hay, R. W., Déry S. J. and Booth, B. P. (2019). Modeling the impacts of climate change on riverine thermal regimes in western Canada's largest Pacific watershed, *Scientific Reports 9*, 11398. https://www.nature.com/articles/s41598-019-47804-2

Sharma, A. R. and Déry, S. J. (2020). Variability and trends of landfalling atmospheric rivers along the Pacific Coast of northwestern North America, *International Journal of Climatology*, 40(1), 544-558[1].

Stephen and Siraj provided information to local media relating to their research (Appendix 1).

Outreach, knowledge exchange and extension:

- Stephen attended Rio Tinto's Water Engagement Initiative meetings on: March 14th, July 16, October 8th, and November 20th, 2019;
- Siraj Ul Islam, Research Associate, participated in the Nechako Watershed Roundtable Technical Working Group meeting, May 22, Prince George;
- Siraj presented a paper that the IUGG General Assembly Meeting in Montreal. The title of the presentation was :

Modelling the impacts of climate change on riverine thermal regimes in western Canada's largest Pacific watershed. 27th IUGG General Assembly, Montréal, Québec, Canada, July 8-18, 2019.

[1] This paper was initially published online in July and was just assigned to the January 2020 issue of the journal.

Theme 2: Sediment sources and dynamics (Owens, Petticrew, staff and students)

Field work, data collection and analysis:

- Kristen Kieta, PhD student, and Barry continued work that was begun in the fall of 2018 on using sediment fingerprinting methods to track the signal of the 2018 wildfires. They sampled sediment in Ormond, 9 Mile, and Tatsutnai creeks as well as three sites on the Nechako main stem (near Dog Creek, Highway 27, and the Vanderhoof town site). Sampling extended until November 1, 2019;
- From the 2018 field season, six suspended sediment samples from the tributaries and main stem and 24 source soil samples within burned and unburned areas were sent to SGS/AXYS Labs for analysis of polycyclic aromatic hydrocarbons (PAHs). Results from 2018 sediment samples show the wildfire signal moving into the tributaries and the main stem of the Nechako;
- Rainfall simulation experiments were undertaken in low, moderate, and high severity burn areas by Emma Burak, a visiting scholar from Lancaster University in the UK. The goal of these experiments was to determine if the volume of erosion and the size of the particles mobilized change based on burn severity, and will help inform the suspended sediment work associate with the wildfires;
- In 2019, two samples of fly ash[2] and 12 sediment samples from the tributaries and main stem sites, taken during the spring snowmelt period, were also analyzed for PAHs;
- Kristen completed her field campaign using compound specific stable isotopes to differentiate sediment sources in the Murray Creek watershed. The field and lab campaign included:

    - Obtaining approximately 50 source samples taken from forested, riparian, and agricultural land and from streambanks;
    - Sediment samples taken from 3 sites on the west arm of Murray Creek, 1 site on the east arm, and 1 site below their confluence;
    - Samples are currently being analysed for very long chain fatty acids of CSSIs, mineral magnetism and particle size.

Reports published and/or submitted:

- In 2019, we had the following papers accepted for publication:

    Paper published in print form[3]:

    Philip N. Owens, David J. Gateuille, Ellen L. Petticrew, Barry P. Booth and Todd D. French (2019). Sediment-associated organopollutants, metals and nutrients in the Nechako River, British Columbia: a current study with a synthesis of historical data. Canadian Water Resources Journal / Revue canadienne des ressources hydriques, 44:1, 42-64. Abstract available here: https://doi.org/10.1080/07011784.2018.1531063

    Paper published online in an open access format:

    David Gateuille, Philip N. Owens, Ellen L. Petticrew, Barry P. Booth, Todd D. French, and Stephen J. Déry (2019). Determining contemporary and historical sediment sources in a large drainage basin impacted by cumulative effects: the regulated Nechako River, British Columbia, Canada. Journal of Soils and Sediments, 19, 3357-3373. https://doi.org/10.1007/s11368-019-02299-2.

[2] Fly ash is being used as a fertilizer on agricultural fields in the Nechako River Basin

[3] Please note that this paper was published online in November 2018 and we made note of this in our 2018 Annual Report. The paper was published in print form in January 2019.

Outreach, knowledge exchange and extension:

- Kristen spoke about her PhD research to EBus grade 10 science students as part of the UNBC Research Ambassadors program on February 27, 2019;
- Kristen, Barry, and Phil Owens set up an interactive display about sediment transport and storage in the Nechako River Basin at the White Sturgeon Release Event in Vanderhoof on May 3rd;
- Kristen attended and spoke to the members of the Fraser Basin Council about her ongoing work in the NRB during their field day to visit the sturgeon hatchery on June 12th, 2019;
- Phil and Ellen Petticrew were invited to Environment and Climate Change Canada (ECCC) in Vancouver on 19th June to discuss work on contaminants in the Nechako watershed. This ECCC team are assembling information on contaminants in the Fraser basin and BC coast in order to protect the southern resident killer whale population, including their main food source, salmon;
- Phil gave two presentations at conferences where he presented some of the research findings on the sediment work in the Nechako. These presentations were as follows:

  Sources of fine-grained sediment in a large regulated watershed in BC using the sediment fingerprinting technique. European Geosciences Union annual meeting, Vienna, Austria, 7-12 April 2019.

  Sources of fine-grained sediment in a large regulated watershed in BC using the sediment fingerprinting technique. Western Division of the Canadian Association of Geographers, Victoria, Canada, 8-9 March 2019.

- Kristen gave one presentation at a conference and a further presentation to a professional working group where she presented some of the research findings on the sediment work in the Nechako. These presentations were as follows:

  Determining sources of sediment in the Nechako River Basin in British Columbia: present and future work using sediment fingerprinting. International Union of Geodesy and Geophysics Conference – Montreal, QC (July 2019).

  Determining sources of sediment in response to landscape changes in the Nechako river basin using the sediment fingerprinting approach. Presentation to the Nechako White Sturgeon Working Group at the Ministry of Forests, Lands, Natural Resource Operations and Rural Development, Prince George, BC – (November 2019).

Theme 3: Tools for integration in watershed management and governance (Parkes, staff and students)

We continue to develop and trial a spatially referenced watershed portal tool to create a platform to bring together, share and profile existing knowledge and new watershed research. Progress for this theme continued to focus on design and collaborative activities required to develop and test new tools to integrate and share information in the watershed. The development of this theme has been directly informed by the projects described in Theme 1 relating to climate change and resource development in the Nechako and will continue to be informed by the research and results emerging from Theme 2.

In 2019 we continued our efforts on strengthening the application of our 'tools for integration' in conjunction with an expanding collaboration with School District 91 (SD91), including their engagement with the development of the Pacific Streamkeepers (PSK) waterway monitoring, and links with other aspects of the SD91 curriculum, including the First Nations Principles of Learning. This work has been supported almost exclusively by the successful securement of a three-year, Systems Change Test Grant from the Vancouver Foundation. The intent of the grant is to help facilitate an experiential, place-based

learning program entitled "Koh-Learning in Our Watersheds: Transforming learning in Nechako region by connecting students, communities and waterways". The proposal was fully funded, and work began on this project in July of 2019. Given the overlap between the SD91 area and the Nechako watershed, this collaboration is proving to be very productive in terms of delivering, expanding on, and providing new audiences for Theme 3 objectives. Ella Parker, former MITACs intern who worked with IWRG Theme 3 objectives between Sept 2018 and March 2019, began her Masters research into the topic of school-based monitoring and water resources decision making in September of 2019.

Field work, data collection and analysis, and technical development of portal:

The spatially referenced watershed portal tool continues to be a focus for Theme 3: developing and expanding this as a key tool for integration in watershed management and governance, and creating a platform to bring together existing knowledge and new watershed research. Development of the watershed portal during 2019 included:

- Maintaining and expanding our Zotero library of material relating to the Nechako watershed. This includes regular searching for articles, reports, etc. through Google Scholar and other search tools. This library is the central storage place for managing items before they are submitted into the portal;
- Submitting all preliminary literature to the portal (300 + papers) and created shapefiles to provide a geospatial attribute for each article;
- We continue to build a repository of shapefiles available to support Nechako submission: this is being built through the spatial data associated with existing submissions and, where necessary, creating new shapefiles for submissions that do not have spatial attributes. Portal layers that have been recently added include School District 91 Science Fair booth poster boards. These photos and associated project information were entered into the portal to trial the bulk-loading feature. We are working with the GIS lab to generate layers that will be added in early 2020. These include: natural disturbance regimes, agricultural activities, locations of aquifers, biogeoclimatic zones, BC Enviro Screen scores, commercial forest activity, protected areas, locations of water monitoring sites, locations of health centres and, occurrence of featured wildlife species;
- Ella Parker (MITACS Intern and subsequent Masters student) has worked with Scott Emmons and Margot Parkes to develop a protocol for entering new documents into the portal, that includes assignment of a spatial attribute (generally a shapefile), and made accessible via search functions to portal users;
- Other activities and developments to improve portal functionality and accessibility for different portal user groups, include:

    - Trialing the use of the geo-paparazzi app (https://bit.ly/2JIT7Ba) for entering data into the portal;
    - Merging data layers from Nechako Watershed Health Atlas into the portal, including: Obstacles to Fish Passage, Fish Observation Points, First Nation Communities, BC Biogeoclimatic Ecological Classification Zones, Environmental Monitoring Locations;
    - Developing a series of spatial files to display Streamkeeper data in the portal in ways that effectively communicate learning outcomes and concepts. Some of these submissions will be used to provide examples in future portal training workshops;
    - Trialing different methods of uploading photo and video media into the portal so that it can be displayed and interacted with in a user-friendly manner;
    - Optimizing the GIS analysis tool to be used in the portal;
    - Developing customizable methods for sharing portal data.

- We continue documenting the process on the development of the portal and we are currently drafting a research article relating to this work. A draft of this article is expected in the spring of 2020.

- School District (SD) 91 and Nechako Environment and Water Stewardship Society (NEWSS).

  - We are continuing our work with SD 91 and NEWSS on how students from this district could work with UNBC and NEWSS on collecting ecological data (e.g., riparian health, water quality, etc.). This work was funded primarily by a grant from the NSERC Promoscience program, with contributions from Theme 3 team members to support the work.

    - Margot, Barry, Diana Kutzner, Ella Parker, Deborah Kohen (UNBC School of Education) and members of SD 91 administration and staff held meetings to help formalize the Koh-Learning project: a new education program that will combine integrative STEM science skills, indigenous education, and active collaboration with community and research partners. The program was launched in Vanderhoof at NVSS on February 25th https://bit.ly/2Lc1Rlw and https://bit.ly/2LDvift . On August 29th, we brought SD 91 administrators, staff and students together for a District-wide Koh-Learning Teacher orientation gathering that took place at the Nadleh Whut'en Yah Administration Building;
    - Ella worked with students from NVSS in the production of the student-produced short film: Stream Monitoring for Change. She also helped organize a community screening of the film in Prince George on March 15th. The film can be viewed here: https://bit.ly/2YUuuqn;
    - Barry, along with numerous SD 91 teachers, community members and a First Nations elder travelled by boat to the historic Dakelh village site of Chinlac on the Stuart River (September 7th) to explore the possibility of using this site as a Koh-Learning place of learning;
    - Ella travelled to the John Prince Research Forest, north of Ft. St. James on September 24th, to observe place-based learning programs that are being delivered to schools in the region and how these might be adapted/implemented in other district schools;
    - Barry and Ella met with NVSS staff on January 28, May 10, June 10, September 18, 19, 26, October 1, 3, and 15 to help with the development and the implementation of Koh-Learning program in the SD 91 region;
    - We continue to work closely with SD 91 to foster a variety of ways that students can engage with portal development. Currently, we have a successional plan in place whereby student administration of the portal has been transferred from a student who is graduating this year, to a new grade 11 student;
    - Barry, in conjunction with Wayne Salewski, NEWSS, secured funding in late December from Centerra Gold to purchase equipment for an eDNA project. Barry and other team members, as well as other UNBC Faculty will apply for additional funding in February 2020 to enable SD 91 students and others to engage in a pilot project focussing on using eDNA as a tool to examine of the distribution of juvenile salmon in the small streams of the Nechako Basin.

- Nechako Watershed Roundtable (NWR)

  - Discussions are continuing with the NWR as to how the UNBC portal may be able to become an important tool for the roundtable. Specifically, moving the Nechako Watershed Atlas to the UNBC portal.

Outreach, knowledge exchange and extension:

The focus of Theme 3 on tools for integration in watershed management and governance, has facilitated a number of ongoing partnerships and collaborations for outreach and knowledge exchange including:

- Additional support work for the Nechako Watershed Roundtable (NWR), focused on developing tools and processes for watershed governance:
  - Ella's MITACs internship, which focused in part on acting as a liaison with the NWR and providing support as required, concluded on March 1, 2019. Since then, Ella has continued to provide secretariat functions using funds from Theme 3 and other sources.
- Our connections with ECHO Network partners in Canada and across the Oceania region are continuing to develop, including active engagement and exchange with the ECHO Network's "Team Watersheds", which includes involvement of watersheds across Canada and Oceania.
  - Scott Emmons attended the ECHO Network Annual Meeting in New Brunswick on behalf of the Theme 3 research team, making connections with other watershed partners (especially Cocagne and Battle River watersheds) for sharing the watershed portal to foster youth and student engagement in watersheds.
- Margot, Leona Prince (Principal of Aboriginal Education, SD 91), and Céline Surette and Annika Chiasson (members of the ECHO Network's New Brunswick Environmental Network Regional Case) attended a series of events in Aoteroa, New Zealand in 2019 that included the Oceania Regional Case. These were as follows:
  - Leona Prince (SD 91), Margot, Céline and Annika all participated in an Indigenous led environment, community, health workshop: 'Ma Uta Ki Tai' ("From the Oceans to the Sea") which was held in Auckland, NZ, April 4-5, 2019;
  - International Union for Health Promotion and Evaluation conference focused with the theme of "Promoting Planetary Health and Sustainable Development for All" at Rotorua (http://www.iuhpe2019.com/)

Contributions to publications and presentations

- The focus of Theme 3 on tools for integration in watershed management and governance, has informed a variety of related collaborative work (especially with the ECHO Network) and mean that Theme 3 insights have informed related publications and presentations, including open-access journal articles:

  Parkes, MW., Allison, S., Harder, HG., Hoogeveen, D., Kutzner, D., Aalhus, M et al. (2019) Addressing the environmental, community and health impacts of resource development: Challenges across scales, sectors and sites. *Challenges.* 10 (1) https://doi.org/10.3390/challe10010022

  Horwitz P and Parkes MW**.** (2019). Intertwined strands for ecology in planetary health. *Challenges.* 10 (1) https://doi.org/10.3390/challe10010020

- Tools and processes developed as part of Theme 3 have been profiled in the following presentations:

Parkes MW (on behalf of ECHO Network Team) *Visualization and analytic tools for community engagement on social-ecological health impacts of resource extraction.* IUHPE 23rd World Conference on Health Promotion. Rotorua, Aotearoa/NZ. April 7-11, 2019.

Parkes MW (2019) *Better Together for Health, Ecosystems & Society: Insights from a decade of collaborative, intersectoral engagements in Canada and Oceania.* Public Health Seminar Series, Department of Preventive and Social Medicine, University of Otago, NZ. April 18, 2019.

Parkes MW (2019) *"Communities, justice and living systems: connections for a healthy and thriving future".* Invited convenor and presenter, Breakout sub-plenary session: Planetary Health Annual Meeting. Co-hosted by Planetary Health Alliance, Harvard University and Standford University. Palo Alto, Sept 4-6, 2019.

Appendix 1

Media coverage related to Theme 1 Climate Change research

- CKPG:https://bit.ly/2L2vrd9 and https://bit.ly/36GmXPK
- UNBC Stories: https://bit.ly/2FXgZ1E
- Prince George Matters: https://bit.ly/2XplckB
- Prince George Citizen: https://bit.ly/2S7fRO9
- The Province: https://bit.ly/2XTDte6
- The Vancouver Sun: https://bit.ly/2FVSmSZ