

2021 CGU-HS Committees Annual Report

Committee name: Permafrost-Hydrogeology Interactions

1. Committee Description, Background and Objectives

Permafrost – Hydrogeology Interactions committee of the Canadian Geophysical Union - Hydrology Section facilitates scientific advancement, interdisciplinary collaboration and knowledge transfer with respect to the relations between permafrost and hydrogeology in varying circumpolar landscapes, and the responses with climate change. These poorly understood relations are critical knowledge gaps, as climate change impacts on permafrost are likely to alter hydrologic cycles, groundwater flow networks, and surface water supplies in Canada's North. Communities, governments, regulators, industry, and academics are noting process changes in northern Canada. Regulators need guidance on how to scope groundwater and permafrost issues as they affect economic development, and Northern capacity is needed to address issues facing Northern communities. The knowledge must come through extended collaborations and engagement. The committee was established according to consensus at a meeting of 27 government, academic, and industry researchers and practitioners held to address these issues in Yellowknife, NT, 14 November 2016 (Morse, 2017).

Objectives:

1. Establish a collaborative research and development network to improve knowledge transfer and educational opportunities by facilitating scientific sessions and short courses in association with the Canadian Geophysical Union annual meeting and other with other scientific societies.
2. Prepare a White Paper synthesizing pan-Canadian perspectives on the state of knowledge of permafrost-hydrogeology interactions. Use this White Paper to develop a conceptual framework to guide future Canadian research.
3. Collate this White Paper with case studies and process research to publish a special journal issue on permafrost – hydrogeology interactions.
4. Report annually on progress to the Canadian Geophysical Union – Hydrology Section.
5. Follow-up on the conceptual framework and special issue by facilitating subsequent scientific sessions in association with the Canadian Geophysical Union annual meeting and other with other scientific societies.

2. Committee Membership. Please list using the following format School/Institution: CRCs: #, Profs: #, PDFs: #, PhD: #, MSc #, HonBSc: #. e.g. Waterloo; CRC:1, Profs: 5, PDFs: 2, MSc: 4, HonBSc: 2, RAs: 1

Geological Survey of Canada: Research Scientist: 1

Environment and Climate Change Canada: Research Scientist: 1

3. Committee Activities

3a. Major areas of research

3ai. Permafrost control on hydrogeology;

3aii. Permafrost control on surface - subsurface linkages;

3aiii. Implications of climate change on permafrost extent and subsequent impacts on water resources;

3aiv. Implications for northern communities

3e. Summary of areas of challenges and achievements (progress on issues and objectives)

- 3ei. Members are Named Partners in the NSERC Permafrost Partnership Network for Canada (PermafrostNet) thaw was awarded 5-years of funding in 2019 and has a goal of boosting Canada's ability to adapt to permafrost thaw;
- 3eii. Members are involved in the secretariat of the Canadian Permafrost Association;
- 3eiii. Members are involved in the secretariat of the Federal Permafrost Network.

4. Major Publications. Please list by: Peer Reviewed Journals; Invited Commentaries; Technical Reports. Indicate student authors with bolded font

Ensom, T., Makarieva, O., Morse, P., Kane, D., Alekseev, V., Marsh, P., 2020. "The distribution and dynamics of aufeis in permafrost regions", *Permafrost and Periglacial Processes* 31: 383–395.

McKenzie, J.M., B.L. Kurylyk, M.A. Walvoord, V.F. Bense, D. Fortier, C. Spence and C. Grenier, 2021. "Invited perspective: What lies beneath a changing Arctic?", *The Cryosphere* 15: 479-484.

O'Neill, H.B., Burn, C.R., Allard, M., Arenson, L.U., Bunn, M.I., Connon, R.F., Kokelj, S.A, Kokelj, S.V., LeBlanc, A.-M., Morse, P.D. , Smith, S.L., 2020. "Permafrost thaw and northern development", *Nature Climate Change* 10: 722–723.

Spence, C., N. Hedstrom, S.E. Tank, W.L. Quinton, D. Olefeldt, S. Goodman and N. Dion, 2020. "Water budget resilience to forest fire in the subarctic Canadian Shield", *Hydrological Processes* 34: 4940-4958.

Spence, C., M. Norris, G. Bickerton, B. Bonsal, R. Brua, J. Culp, Y. Dibike, S. Gruber, P. Morse, D. Peters, R. Shrestha and S. Wolfe, 2020. "The Canadian Water Resource Vulnerability Index - Permafrost Thaw (CWRVI_{PT})", *Arctic Science* 6: 437–462.

5. Scientific conferences/workshops/sessions hosted by members; attended by members (in Canada, and abroad)

None in 2019 due to CGU-IUGG partnership. A session was planned for 2020. There is a dedicated permafrost hydrogeology session at the 2021 CGU annual general meeting.



Committee on River Ice Processes and the Environment (CGU-HS)

June 17, 2021

CRIPE OBJECTIVES

The main objectives of CRIPE are:

- To identify specific high-priority river ice topics for research and development and to undertake relevant research programs;
- To facilitate information dissemination and exchange of ideas on river ice among practitioners, researchers, and resource managers at a national and international scale; and
- To encourage the incorporation of pertinent river ice lectures or courses in undergraduate and graduate studies at Canadian Colleges and Universities.

CRIPE MEMBERSHIP

CRIPE currently has 20 Canadian members from various universities, hydro-electric facilities and government organizations, as well as 4 international members and 7 affiliate members.

Members

Shawn Clark, (Chair) University of Manitoba
Martin Jasek, (Vice-Chair) BC Hydro
Joel Evans, (Treasurer) BC Hydro
Benoit Turcotte, (Secretary) Yukon University
Robyn Andrishak, (Webmaster) NHC
Karen Dow, (Awards Coordinator) UManitoba
Brian Burrell, R.V. Anderson Associates Limited
Yves Gauthier, INRS-ETE, Quebec
Nadia Kovachis, Government of Alberta
Karl-Erich Lindenschmidt, Univ. of Saskatchewan
Mark Loewen, University of Alberta
Joe Groeneveld, Hatch Energy
Yuntong She, University of Alberta
Jennifer Nafziger, Alberta Environment
Jarrod Malenchak, Manitoba Hydro
Soheil Zare, Hatch
Colin Rennie, University of Ottawa
Dan Healy, Northwest Hydraulic Consultants
Tadros Ghobrial, Université Laval
Fuad Curi, KGS Group

International Members

Knut Alfredsen, Norwegian Univ. of Science and Tech.
Mikko Huokuna, Finnish Environment Institute
Edward Kempema, University of Wyoming
Ian Knack, Clarkson University

Affiliate Members

Spyros Beltaos, Environment Canada
Rick Carson, KGS Group
Steven Daly, retired from ERDC/CRREL
Evan Friesenhan, Government of Alberta
Brian Morse, Université Laval
Terry Prowse, Environment Canada
Hung Tao Shen, Clarkson University

RECENT ACTIVITIES

CRIPE held its Annual Meeting remotely, via WebEX, on September 22, 2022. Of importance during this meeting was the discussion and acceptance of a Terms of Reference document for CRIPE. Within this document we formally established the following for CRIPE:

- Purpose and Goals
- Membership categories, expectations, procedures, voting privileges
- Meeting procedures
- Executive positions
- Working groups

New members were also officially added as they are active in river ice sciences and research in Canada.

FUTURE ACTIVITIES

CRIPE will hold its bi-annual workshop in Saskatoon from Aug. 29-Sept. 1, 2021. The conference is being organized by Dr. Karl-Erich Lindenschmidt and others. The annual meeting will take place immediately before or after the workshop. Scientific papers have already been submitted and are being reviewed by different members.

CRIPE submitted a bid to host the 2022 IAHR International Symposium on Ice, which was accepted. We have established a General Organizing Committee with several subcommittees to assist with the conference organization. The conference will be held from June 20 – 23 in Montreal.

CGU-HS Committee on Isotopic Tracers Annual Report (2020-21)

Committee Directorship

Trish Stadnyk (Chair), University of Calgary

Jean Birks (past Chair), Alberta Innovates- Technology Futures, University of Waterloo

John Gibson, Alberta Innovates- Technology Futures, University of Victoria

Claude Hillaire-Marcel, GEOTOP-UQAM

Bernhard Mayer, University of Calgary

Fred Michel, Carleton University

Brent Wolfe, Wilfrid Laurier University

Background:

The CGU - HS Committee on Isotopic Tracers was originally established in 1997 to support and facilitate information exchange between isotope specialists and hydrologists both within Canada and internationally, and to address issues of importance to isotopic investigations including integration within broadly-based hydroscience research programs. In 2014, CGU Hydrology Section dissolved all sub-committees, and re-established only those who were active, including the Isotope Tracer Committee. Recognizing and supporting promising applications of isotopic tracers, promoting cooperative research, providing information resources, and articulating research and educational needs to government agencies, universities, and the general hydrology community are the fundamental aims of the Committee.

Objectives and Activities:

The long-term objectives of the committee are to:

- promote and advance the understanding and application of isotopic tracer techniques in hydrology and related sciences
- initiate and participate in research and education programs, maintain contact with relevant organizations, report on national and international research activities, information sources, isotope monitoring networks, and databases
- establish working groups and/or subcommittees to assess specific, high-priority topics for research, monitoring and/or development, and
- disseminate current research and important findings to the scientific community via discussion, meetings and conferences, and publications

Progress on Issues and Objectives:

Tracer committee members are active in the promotion and advancement of the understanding and application of isotopic tracer techniques in hydrology and related sciences. Two key initiatives have helped to promote the application and use of isotope tracers in Canada, which committee Directors and membership have been involved in:

National: Water Survey of Canada Isotope Network

The Water Survey of Canada, in cooperation with the University of Manitoba, University of Victoria, and Innotech Alberta, continues to support the national pilot of an operational isotope network in conjunction with their hydrometric network, similar the existing isotope-hydrometric network in the United States. The goal is to demonstrate the value in systematic collection of river discharge in tandem with analysis for oxygen-18 and deuterium across Canada.

A wrap up report for the pilot phase was submitted to Environment and Climate change Canada in September 2018, and a recent set of publications was submitted to the *Journal of Hydrology: Regional Studies*¹ and *Data in Brief*² to publish these data and provide a preliminary analysis. Efforts are on-going to secure a permanent network, as part of the hydrometric database and

¹ Gibson, J.J., Gibson, J.J., Holmes, T., Stadnyk, T.A., Birks, Pietroniro, A. ¹⁸O and ²H in streamflow across Canada. Submitted to *J. Hydrol.: Regional Studies*. EJRHS-20-00128

² Gibson, J.J., Eby, P., Stadnyk, T.A., Pietroniro, A. Surveys of ¹⁸O and ²H in streamflow across Canada: a national resource for tracing water sources, water balance and predictive modelling. Submitted to *Data in Brief*.

CGU-HS Committee on Isotopic Tracers Annual Report (2020-21)

hydrologic services. The activities form part of Canada's contribution to the Global Network of Isotopes in Rivers, a network coordinated by the International Atomic Energy Agency.

Also on-going are efforts to re-establish the Canadian Network for Isotopes in Precipitation. For the past three years, the network has been run through a pilot program with the IAEA and Health Canada's radiation network. The goal is to find a permanent program to support the CNIP network since it is a valuable part of the IAEA's GNIP program. For further information please contact John Gibson, jjgibson@uvic.ca

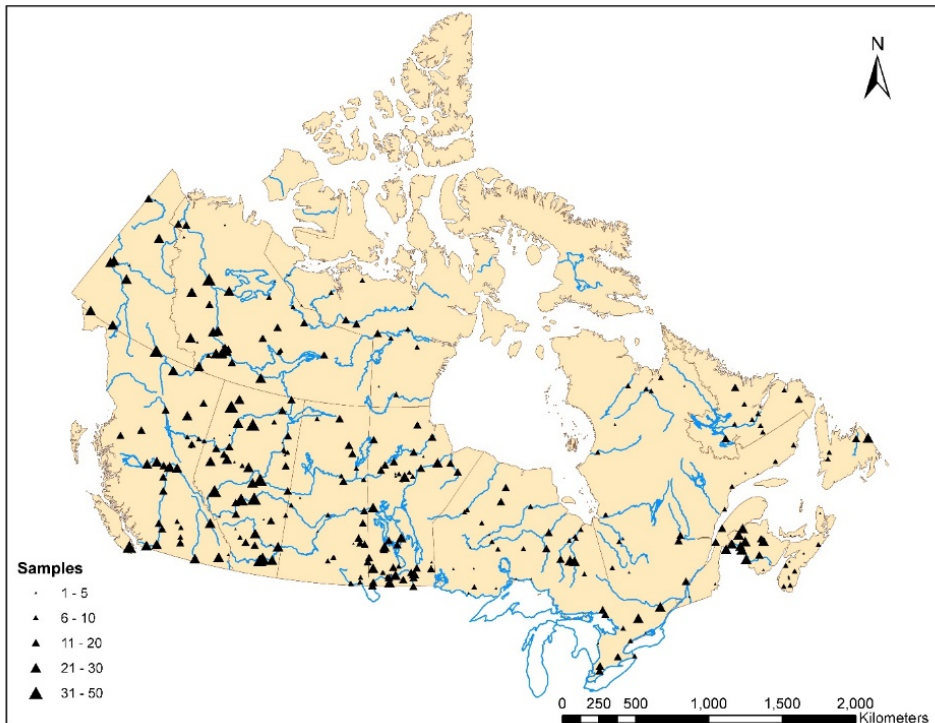


Figure 1. CNIP and CNIR network, indicating number of samples at various locations in Canada

International: Isotope Tracing of Human Impacts on Water Balance and Nutrient Dynamics of Large Canadian River Basins

A team of members of the Isotope Tracer Committee of the Canadian Geophysical Union is participating in an International Atomic Energy Agency (IAEA) Coordinated Research Project (CRP F33021) entitled: Application and Development of Isotope Techniques to Evaluate Human Impacts on Water balance and Nutrient Dynamics of Large River Basins. The Canadian project, initiated in April 2014 and entitled *Isotope Tracing of Human Impacts on Water Balance and Nutrient Dynamics of Large Canadian River Basins*, is Coordinated by Jean-François Hélie (Geotop-UQAM) and supported by John Gibson (University of Victoria & AITF). Six teams from across Canada support this Canadian CRP and are led respectively by Jean-François Hélie (Eastern), John Gibson (Western), Trish Stadnyk (Prairies), Ian Clark (Northern), Fred Longstaffe (Great Lakes) and David Soto (Maritimes). The CRP aims at coordinating Canadian efforts in assessing human impacts on large river systems using isotope tracers. Now that almost all the respective networks are operational, we hope to expand from tier 1 to tier 2 sampling in the coming months for some targeted sites. We also hope to strengthen the interactions between the teams by organizing an informal meeting and create a database of published Canadian river isotopic data.

For information contact Jean Francois Hélie (helie.jean-francois@uqam.ca).

CGU-HS Committee on Isotopic Tracers Annual Report (2020-21)

ENVS 898 – Isotope Tracers in Catchment Hydrology Graduate Course

The course once again ran successfully from May 9-13, 2020 in a totally online, live format. With more than 150 participants world-wide (20 of which were registered students), the course format was successfully migrated to online only format during COVID19. Talks with the Canadian Society for Hydrological Sciences and the Canadian Water Resource Association are on-going to consider adding this course to their core National courses and professional certifications. The course remains available to graduate students from outside U of S via the Western Canadian Dean's Agreement (<http://wcdgs.ca/western-deans-agreement.html>). For more information, or if you are interested, contact Jeff McDonnell (jeffrey.mcdonnell@usask.ca).

Conference Sessions

Due to COVID19, no formal sessions were held as part of national or international conferences. We will resume with special sessions when conference activity resumes.

Committee Coordination

Though progress is being made on National scale networks and collaborations, the committee would like to hold more formal activities beginning in 2020-21. Anyone interested in being a part of the executive should contact tricia.stadnyk@ucalgary.ca. The executive will reach out to committee membership in 2019-20 to decide what directions the membership would like to proceed in.

2021 CGU-HS CYHS annual report

1. Committee Description, Background and Objectives

The Canadian Young Hydrologic Society (CYHS), founded in 2015, aims to engage early career researchers by organizing workshops and activities to stimulate meaningful interaction and exchange between research groups across Canada. It is the Canadian branch of the wider Young Hydrologic Society (YHS), an international initiative that facilitates the interaction of young hydrologists within the hydrological community. These activities include pop-up sessions at large national conferences, seminars, workshops, and social nights.

2020-2021 was the sixth year of the Canadian Young Hydrologic Society (CYHS) being in operation. This year succeeded in further establishing the CYHS in the Canadian hydrology community as a national branch of the international YHS and as a staple of the CGU-HS by organizing a twitter symposium, and by financially supporting the ECR community with additional awards during challenging times where in-person engagement is prohibited. In the 2020-2021 year, the CYHS focused on two main events, our annual twitter symposium where we identified meaningful ways to engage with ECRs through online platforms using financial incentives. Additionally, the CYHS helped facilitate the CGU 2021 Student Conference that was hosted by the University of Waterloo and organized by the Basu Lab. For this event, the CYHS funded student awards and members of the CYHS Executive provided support in scheduling and facilitating an ECR-focused panel discussion.

The 2020-2021 CYHS committee is composed of 9 members:

Chair: Sarah Ariano, PhD Candidate, Department of Geography and Environmental Studies, Ryerson University

Secretary and CGU-HS representative: Cody Ross, Postdoctoral Fellow, Ryerson University

Treasurer and Social media/Communications: Arsh Grewal, PhD Candidate, McMaster University

ECR collaboration: Kelly Biagi, Postdoctoral Fellow, Ryerson University

External Liaison: Julia Cantelon, PhD Student, Centre for Water Resources Studies, Dalhousie University

Members at large:
Karl Friesen-Hughes, MSc Candidate, Dept. Biology, University of Winnipeg
Pierrick Lamontagne-Hallé, PhD Candidate, Dept. Earth and Planetary Sciences, McGill University
Caroline Aubry-Wake, PhD Candidate, Centre for Hydrology, University of Saskatchewan
Jason KarisAllen, MASc Candidate, Centre for Water Resources Studies, Dalhousie University

2. Committee Membership. Please list using the following format School/Institution:

CRCs:#, Profs: #, PDFs: #, PhD: #, MSc #, HonBSc: #. e.g. Waterloo; CRC:1, Profs: 5, PDFs: 2, MSc: 4, HonBSc: 2, RAs: 1

CYHS does not have an annual membership, but we do keep track of workshop/seminar attendees. Numbers for 2019-2020 early-career workshop organized ahead of the 2020 CGU meeting were as follows:

McGill University: 7
University of Alberta : 2
Simon Fraser University: 1
University of Saskatchewan: 3
University of Waterloo: 5
Ryerson University: 1
University of Calgary: 1
University of Toronto Mississauga: 1
Guelph University: 4
McMaster University: 3
University of Manitoba: 1
Dalhousie University: 1
Ecole de Technologie Supérieure: 2

PDF: 4
PhD: 17
MSc/MSA: 10
Professionals: 1
TOTAL: 32

3. Committee Activities

3a. Major areas of research

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3b. Science-industry collaborations

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3c. Training and networking initiatives geared towards young and emerging scientists

The main activity undertaken by the CYHS in 2020 was a Twitter Symposium. Held between October 5th and 7th, the symposium generated 22 external posts (excluding committee members), generating 252 likes, 6 retweets and 10 new followers. CYHS awarded four participants \$100.00 for engaging in the event and receiving the Award for Most Liked and Retweets Twitter Post. The most popular tweet was assessed through Twitter Analytics, identifying participants with the greatest number of retweets and highest engagement rate. The CYHS executive committee was excluded from competing.

The CYHS Twitter account is used as a platform to facilitate the distribution of information, news, resources, and support relevant to early career hydrologists. The account currently reaches 546 followers (an increase of 137 followers from May 2020 - May 2021) and averages 4,143 tweet impressions (viewership of our tweets and retweets) a month. From May 2020 - May 2021 the CYHS twitter account had 3476 profile visits, 93 mentions, and the tweets were viewed a total of 42,312 times. The month of October generated the most engagement from

our audience which was a result of the Twitter Symposium with over 10,800 members engaging with the CYHS and other ECR's.

The CGU 2021 Student Conference was hosted by the University of Waterloo and organized by the Basu Lab. The event was held over two days (February 10th and 11th) and featured a keynote speaker (Dr. Nora Casson - *Warmer, wetter, wilder: impacts of winter weather whiplash events on ecosystems and communities*), oral presentations, poster presentations, and an ECR focused panel discussion (Dr. Sohom Mandal, Dr. Lauren Somers, and Dr. Michel Baraer - *Adapting to ongoing change as a natural scientist*). The CYHS supported this initiative through collaboration and funding. Two of the CYHS Executive members (Sarah Ariano and Cody Ross) served on the conference planning committee and assisted in planning, speaker scheduling, and panel discussion facilitation. The CYHS also supported the conference with advertising and student presenter awards. The event was well received by ECR participants, the Keynote speaker and the panelists. This event has been running for over a decade and the 2021 conference successfully fulfilled the conference mandate of showcasing and fostering student and early career research from Canada in a particularly disruptive and challenging year.

The CYHS has proposed a series of events for the CGU 2021 virtual meeting. The planned events feature two proposed workshops featuring talks and panel discussion on various ECR related topics. CYHS is planning to gauge student interest in virtual workshops via a survey prior to implementing these activities at the CGU 2021. A virtual social event was held June 22, 2021 before CGU conference sessions, using the online platform Gathertown as an opportunity to meet and engage with early career researchers.

3d. Regional, national and international advisory efforts

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3e. Summary of areas of challenges and achievements (progress on issues and objectives)

Challenge/Achievement 1: Funding

Funding has been the primary challenge to provide a high quality workshop in conference centres with high catering costs or in cities with expensive venues for social events, leading to concerns that CYHS workshops are not self-sufficient with costs fluctuating between years as the scope of workshops, venue/location and attendance varies. In past years, CYHS has kept workshops economical and has primarily relied on funding from CGU-HS, external funding from individual lab groups (2018), contributions from universities, or cooperation with other early career researcher (ECR) organizations (2018, 2019).

This changed in 2019, when CYHS secured \$12,000 in funding to support a 3-day workshop. Residual funds and workshop fees acquired from hosting the workshop in Montreal will be used to support future ECR initiatives. Future fundraising activities including workshops will promote CYHS to be self-sustaining. CYHS will likely require no support from CGU-HS for the 2020-2021 fiscal year. Additionally, the cancellation of in-person CGU-2020/2021, has preserved CYHS funds and will be used to support workshop and ECR activities in the future.

Challenge/Achievement 2: Wide-spread recruitment/advertisement in Canada

Ongoing goals are to recruit participants from a wider range of Canadian universities. The main advertisement of CYHS events seems to be from word-of-mouth. To this end, we compiled a list of all physical geography, hydrology, and engineering departments with graduate programs in Canada to build an email list to advertise events. This list was used to promote the 2019 ECR workshop and resulted in participants from universities which were previously not commonly present at CYHS events. This listserv will also be used to gauge interest in CYHS virtual workshops at the CGU 2021 annual meeting.

To achieve a more widespread presence across Canada, the CYHS is establishing collaborations with existing university water-focused networks; we also work to recruit annually, when possible, new committee members from a diverse range of universities.

Challenge/Achievement 3: Grow the reach of CYHS as an early career network

By publishing papers, the CYHS has expanded its audience by enhancing significance as an early career network. By participating in international ECR initiatives, we have enhanced the expertise of CYHS members and shared our experiences with other ECR organizations. The connections we have made during these last few years have been important for our personal and professional development and for the success of our organized workshops. We also realized that the challenges we are facing as ECRs and as members of an ECR organization are similar. This was one of the many motivations to organize and participate in ECR-centered symposiums and conferences.

Additionally, the CYHS is aiming to strengthen its presence as an active early-career network. To do so, the CYHS was involved with two main early-career workshops in the last 2 years. The first workshop was in Canmore, Alberta, was supported by the World Meteorological organization, The World Climate Research program and the Global Energy and water Exchange network, and it was organized in collaboration with the Young Earth System community (YESS). Similarly, the CYHS was involved in the organization of the AGU-WCRP Joint Early Career event, organized by APECS, YHS and YESS.

4. Major Publications. Please list by: Peer Reviewed Journals; Invited Commentaries; Technical Reports. Indicate student authors with bolded font.

Two publications emerged from early-career workshops organized and hosted by or in partnership with the CYHS.

Peer-reviewed Journals:

Langendijk, G., C. Aubry-Wake, M. Osman, C. Gulizia and 18 others (2019) Three Ways Forward to Improve Regional Information for Extreme Events: An Early Career Perspective. *Front. Environ. Sci.* 7:6. doi: 10.3389/fenvs.2019.00006

Invited Commentary:

Aubry-Wake, C., Somers, L.D., Alcock, H., Anderson, A.M., Azarkhish, A., Bansah, S., Bell, N.M., Biagi, K., Castaneda-Gonzalez, M., Champagne, O., Chesnokova, A., Coone, D., Gauthier, T.-L.J., Ghimire, U., Glas, N., Hrach, D.M., Lai, O.Y., Lamontagne-Hallé, P., Leroux, N.R., Lyon, L., Mandal, S., Nasri, B.R., Popović, N., Rankin, T.E., Rasouli, K., Robinson, A.,

Sanyal, P., Shatilla, N.J., Van Huizen, B., Wilkinson, S., Williamson, J. and Zaremehrijardy, M. (2020), A new flow for Canadian young hydrologists: Key scientific challenges addressed by research cultural shifts. *Hydrological Processes*, 34: 2001-2006. doi:[10.1002/hyp.13724](https://doi.org/10.1002/hyp.13724)

5. Scientific conferences/workshops/sessions hosted by members; attended by members (in Canada, and abroad).

A list of presentations, workshops and events organized by or in partnership with the CYHS is provided:

Conferences presentation:

2018:

Aubry-Wake, C., Biagi, K. M., Lamontagne-Hallé, P., Ross, C., Shatilla, N., Somers, L., & Wilkinson, S. (2018). The Canadian Young Hydrologic Society: the growth and development of a national YHS branch. AGU 2018: Washington D.C.

2019:

Participation in EGU Early Career Scientists' Forum, EGU General Assembly 2019, Vienna, April 10th 2019. Conveners: Stephanie Zihms, Raffaele Albano and Hazel Gibson.

Organized Workshops and Events:

2016:

1. Challenges and opportunities in Canadian hydrology” workshop, CGU Fredericton, NB
 - Invited Workshop Speakers: Dr. Genevieve Ali, Dr. Sean Carey, Dr. Merrin Macrae, Dr. Phil Marsh, Dr. Claire Oswald & Dr. Howard Wheeler (attendance: 50 ECRs)
 - Social event held after the workshop at a local pub where 75 ECRs attended.

2017:

1. “Progression of a scientific career in academia” seminar, CGU, Vancouver, BC
 - Invited Workshop Speakers: Dr. Nora Casson, Dr. Andrew Ireson, Nicola Jones, Dr. Barret Kurylyk, Dr. Jeff McKenzie & Dr. Ming-ko (Hok) Woo (attendance: 65 ECRs).
 - A social event was held in the evening after the workshop on the UBC campus where we had 100 attendees.

2018:

1. “Careers in hydrology: Options and insights” workshop and panel discussion, CGU, Niagara Falls, On
 - Invited Speakers: Simon Gautrey, Dr. Christa Kelleher, Dr. Joseph Shea & Dr. Chris Spence (attendance: 45 ECRs). A social event was held in the evening after the workshop in Niagara Falls where we had 100 attendees.
2. “Tips and tricks for publishing in hydrology” workshop.

- Invited Speakers: Dr. Laura Lautz & Dr. Mike Waddington (attendance: 47 ECRs)
- 3. Inaugural GWF Young Professionals workshop and social events (GWF Annual Science Meeting in collaboration with GWF YP group)
 - Invited Speaker: Dr. Jeff McDonnell ‘
- 4. Professional Development Workshop: ‘The Art of Scientific Investigation’ (attendance: ~80 ECRs).
 - Invited Speaker: Dr. John Pomeroy ‘Role of YPs Within Larger GWF Context’ (attendance: 90 ECRs)
- 5. Water Week Poster Session and award for “Most Innovative Research” awarded to Anjali Narayanan (Undergraduate student)
- 6. Joint YESS-YHS Early Career Researcher (ECR) Workshop. “Towards Regional Information to Improve Our Understanding on Weather, Water, and Climate Extreme Events” at the 2018 GEWEX Open Science Conference, 3-5 May, 2018.

2019:

1. “Opportunities and Challenges in Canadian hydrology: a early-career perspective” workshop at IUGG-CGU 2020. 32 participants.
 - Invited speakers: Professor Nigel Roulet, Prof. Jan Adamowski and Prof. April James.
2. Joint WCRP-AGU workshop, Water Cycle in a 1.5° Warmer World: Interdisciplinary Approaches, AGU Fall Meeting, Dec. 7, 2019. Co-organized by APECS, YESS and YHS/CYHS
3. McMaster Water Week, CYHS: McMaster Water Week Most Innovative Poster Award (1 ECR Awarded)
4. CYHS Twitter Symposium, Award for Most Liked and Retweets Twitter Post (4 ECR’s awarded)

2020 (Cancelled):

1. From failure to progress: lessons learned in hydrology, CGU meeting in Banff
2. Applied data management best practices for young hydrologists, CGU meeting in Banff
3. Python Hydrological Modeling Workshop, CGU meeting in Banff, on Thursday 7th May.

2021:

1. CYHS Twitter Symposium, Award for Most Liked and Retweets Twitter Post (4 ECR’s awarded)
2. CGU Student Conference , Grand prize (x2), Honourable mentions (x6) (8 ECR’s awarded)

6. Awards received by members

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7. Other major achievements (Complete and ongoing scientific projects; Institutional relations/cooperation)

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8. Budget/Finances

Previous years funding was secured from the Canadian Geophysical Union-Hydrology Section (\$5000), McGill Department of Earth and Planetary Sciences (\$3000), McGill Geography (\$2000) and McGill Science (\$2000), to support the 2019 CYHS workshop and amounted to \$12,000. \$5,095.55 remained in the McGill affiliated funds account after the 2019 CYHS workshop. These funds were planned to be used to support workshop activities for CGU 2020 and 2021. However, the reduction in costs associated with CGU 2020 and 2021 occurring via a virtual format preserved the remaining funds from the 2019 workshop.

In 2020/2021, the CYHS awarded a total of \$1400.00 to students participating in CGU-HS 2020, the CYHS Twitter Symposium and CGU 2021 Student Conference. The current CYHS account balance held at McGill is \$3,695.55. The McGill-affiliated funders have agreed to have the leftover funds used for future CYHS events.

Current funds held by CGU-HS amounts to \$277.64. These funds will be used to support future CYHS award initiatives and CGU 2022.

9. Additional information the committee would like on file.

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Hydro-climatic Impacts and Adaptation Committee Report 2020-2021

Chairs:

Rajesh Shrestha, Yonas Dibike, Daniel Peters (Environment and Climate Change Canada, University of Victoria).

Background:

Established in May 2016 to provide a platform for researchers engaged in hydro-climatic, hydrologic and hydro-ecological impacts and adaptation, and promote the development of new methods and tools to address the challenges.

Objective:

To advance the development of methods and tools for better understanding of the hydrologic and aquatic ecosystem impacts of climate variability and change, and developing adaptation measures to mitigate the potential impacts.

Committee Memberships:

Government Scientists: 3, Profs. 1, PDFs: 1, Grad student 1.

Committee Activities:

The **Hydro-climatic Impacts and Adaptation** committee is active in the advancement of knowledge on the implications of climate variability/change on planning, allocation and operations of water resources, and adaptation/mitigation measures that address the potential impacts. Engagement of multidisciplinary scientists included organizing special sessions conferences, special issues for journals, and giving invited webinar presentations. These include:

- **IAGLR-2020 Session:** Climate Impacts on Great Lakes and Watersheds: Model Applications, International Association of Great Lakes Research Conference 2020, Conveners: **R. Shrestha, Y. Dibike**, Barrie Bonsal.
- **Water journal special issue 2020-2021: Hydrological Extremes in a Warming Climate: Nonstationarity, Uncertainties and Impacts**, Special issue editors: **R. Shrestha**, M. R. Najafi.: 9 articles published
- **Water journal special issue 2020-2021: Past and Future Trends and Variability in Hydro-Climatic Processes**, Special issue editors: B. Bonsal, **Y. Dibike, D. Peters, R. Shrestha.**: 9 articles published

Training/Supervisions:

- Trained 4 co-op students in geography and engineering departments, University of Victoria.
- Supervised 2 graduate students, University of Victoria.

Journal Publications

- Shrestha, R.R.**, B.R. Bonsal, J.M. Bonnyman, A.J. Cannon, M.R. Najafi. 2021. Heterogeneous snowpack response and snow drought occurrence across river basins of northwestern North America under 1.0°C to 4.0°C global warming, *Climatic Change* 164(40):1-21, doi:10.1007/s10584-021-02968-7.
- Shrestha, R.R.**, J. Pesklevits, D. Yang, **D.L. Peters**, **Y.B. Dibike**. 2021. Climatic controls on mean and extreme streamflow changes across the permafrost region of Canada, *Water* 13(5): 626, doi.org/10.3390/w13050626.
- Wong, J. S.**, X. Zhang, S. Gharari, **R.R. Shrestha**, H.S. Wheeler, J.S. Famiglietti. 2021. Assessing Water Balance Closure using Multiple Data Assimilation and Remote Sensing-Based Datasets for Canada, *Journal of Hydrometeorology* 22(6): 1569–1589 doi.org/10.1175/JHM-D-20-0131.1.
- Dibike, Y**, **R.R. Shrestha**, C. Johnson. B. Bonsal, P. Coulibaly. Assessing climatic drivers of spring mean and annual maximum flows in Western Canadian River basins, *Water* 13(12), 1617, doi.org/10.3390/w13121617.
- Siemens, K., **Dibike, Y**, **R.R. Shrestha**, T. Prowse. 2021. Runoff projection from an Alpine watershed in western Canada: application of a snowmelt runoff model, *Water* 13(9): 1199, doi.org/10.3390/w13091199.
- Shrestha, R.R.**, B. Bonsal, A. Kayastha, Y. Dibike, C. Spence. 2021. Snowpack response in the Assiniboine-Red River basin associated with projected global warming of 1.0°C to 3.0°C, *Journal of Great Lakes Research* 47(3), 677–689 doi:10.1016/j.jglr.2020.04.009.
- Dibike, Y.**, A. Muhammad, **R.R. Shrestha**, L. de Rham, J. Rowley, C. Spence, B. Bonsal, G. Evenson, T. A. Stadnyk, 2021. Variable contributing area dynamics for modelling the hydrologic response of the Assiniboine River basin to a Changing Climate, *Journal of Great Lakes Research*, 47(3), 663-676 doi.org/10.1016/j.jglr.2020.10.010.
- Bonsal, B, **R.R. Shrestha**, **Y.D. Dibike**, **D.L. Peters**, C. Spence, D. Yang, L. Mudryk, 2020. Western Canadian Water Resources: Current Status and Future Vulnerabilities, *Environmental Reviews* 28: 528–545, doi:10.1139/er-2020-0040.
- Ahmed, R. T Prowse, **Y Dibike**, B Bonsal: 2020. Effects of Climatic Drivers and Teleconnections on Late 20th Century Trends in Spring Freshet of Four Major Arctic-Draining Rivers, *Water* 13 (2), 179: doi.org/10.3390/w13020179.
- Eum, H.I. A Gupta, **Y Dibike**: 2020. Effects of univariate and multivariate statistical downscaling methods on climatic and hydrologic indicators for Alberta, Canada, *Journal of Hydrology* 588, 125065, doi.org/10.1016/j.jhydrol.2020.125065
- de Rham, L. **Y Dibike**, S Beltaos, D Peters, B Bonsal, T Prowse, 2020. A Canadian River Ice Database from the National Hydrometric Program Archives Earth System Science Data 12 (3), 1835-1860, doi.org/10.5194/essd-12-1835-2020
- Ahmed, R., T Prowse, **Y Dibike**, B Bonsal, H O'Neil. 2020. Recent trends in freshwater influx to the Arctic Ocean from four major arctic-draining rivers, *Water* 12 (4), 1189, doi.org/10.3390/w12041189

- Beltaos, S. **DL Peters**: 2020. Naturalized flow regime of the regulated Peace River, Canada, during the spring breakup of the ice cover, *Cold Regions Science and Technology* 172, 103005, doi.org/10.1016/j.coldregions.2020.103005
- Rokaya, P. **DL Peters**, M Elshamy, S Budhathoki, KE Lindenschmidt, 2020. Impacts of future climate on the hydrology of a northern headwaters basin and its implications for a downstream deltaic ecosystem *Hydrological Processes* 34 (7), 1630-1646, doi.org/10.1002/hyp.13687

Book Chapters

- Shrestha, R.R.**, K.E. Bennett, **D.L. Peters**, D. Yang. 2020. Hydrologic extremes in Arctic Rivers and regions: historical variability and future perspectives, in: *Arctic hydrology, permafrost, and ecosystem: linkages and interactions*, D. Yang, D. Kane (eds.), Springer, doi:10.1007/978-3-030-50930-9_7.
- Zhenhua L., L. Yanping, D. Yang, **R.R. Shrestha**. 2020. Regional Climate Modeling in the Arctic and regions, in: *Arctic hydrology, permafrost, and ecosystem: linkages and interactions*, D. Yang, D. Kane (eds.), Springer, doi:10.1007/978-3-030-50930-9_27.
- Peters, D.L.**, D.J. Baird, J. Culp, J. Lento, W.A. Monk, **R.R. Shrestha**. 2020. Overview of Environmental Flows in the Arctic, in: *Arctic hydrology, permafrost, and ecosystem: linkages and interactions*, D. Yang, D. Kane (eds.), Springer, doi:10.1007/978-3-030-50930-9_8.
- Park, H., **Y Dibike**, F Su, JX Shi, 2021. Cold region hydrologic models and applications, *Arctic Hydrology, Permafrost and Ecosystems*, 763-794
- Ye, H. D Yang, A Behrangi, SL Stuefer, X Pan, E Mekis, **Y Dibike**, 2021. Precipitation Characteristics and Changes, *Arctic Hydrology, Permafrost and Ecosystems*, 25-59
- Young, KL, L Brown, **Y Dibike**, 2021. Arctic Wetlands and Lakes-Dynamics and Linkages, *Arctic Hydrology, Permafrost and Ecosystems*, 349-377

Conference Presentations

- Dibike, Y.**, **R.R. Shrestha**, C. Spence, B. Bonsal. 2021. Impacts of Beneficial Management Practices on Nutrient Loading in a North American Prairie Watershed, *International Association of Great Lakes Research Annual Conference, Winnipeg, MB*.
- Shrestha, R.R.**, B.R. Bonsal, J.M. Bonnyman, A.J. Cannon, M.R. Najafi 2020. Spatio-temporal variability of snowpack and runoff response over north-western North America Under global warming, AGU fall meeting 2020.
- Shrestha, R.R.**, B.R. Bonsal, J.M. Bonnyman, A.J. Cannon, M.R. Najafi 2020. Uncertainties in Snowpack Projections over North-Western North America from a Large-Ensemble RCM and a Hydrologic Model, *International Congress on Environmental Modelling and Software*, International Environmental Modelling and Software Society (iEMSs), Brussels, Belgium.

Shrestha, R.R., B. Bonsal, A. Kayastha, **Y. Dibike**, C. Spence, 2020. Projecting snowpack response in the Lake Winnipeg watersheds under global warming, *International Association of Great Lakes Research Annual Conference*, Winnipeg, MB.

Dibike, Y., A. Muhammad, **R.R. Shrestha**, L. de Rham, J. Rowley, C. Spence, B. Bonsal, G. Evenson, T. A. Stadnyk. 2020. Variable contributing area dynamics for modelling the hydrologic response of the Assiniboine River basin to a Changing Climate, *International Association of Great Lakes Research Annual Conference*, Winnipeg, MB.