

OUR VISION

Enabling water security by world-class research and training, science communication and science-informed policy. We define water security as the sustainable use and protection of water resources, the safeguarding of access to water functions and services for humans and the environment, and protection against water-related hazards (e.g. flooding, drought and contaminants).

OUR MISSION

- Create a focus and platform for interdisciplinary collaboration that recognizes the societal dimensions of water security, human impacts on the environment, and the linkages and feedbacks between atmosphere, land and water systems. This requires new integration of the relevant spectrum of natural, health and social sciences, public policy and engineering;
- Develop the knowledge, science and technologies needed to support integrated water quantity and quality management in the face of uncertain climate and water resource futures, and address local, regional and global water security agendas;
- Train the next generations of water security scholars and practitioners;
- Communicate key advances in water security research to government officials, environmental decision makers and the general public. Develop partnerships with key stakeholders to translate science into policy and management support to meet water security challenges, including interactions among water, food, energy and ecosystem services (i.e., benefits to human welfare), climate change adaptation and mitigation challenges, and the human health agenda;
- Understand the hydrological, social, economic and political factors that threaten water security in key regions globally. Engage in water diplomacy, collaborative network (e.g. government, civil society, NGO and universities) and capacity building in those regions; and
- Explore public-private partnership opportunities for strategic water security issues and regions.

EXECUTIVE DIRECTOR'S MESSAGE

Dear colleagues, members, and friends of GIWS,

It is hard to believe that one full term has passed since I took over the reins of GIWS from our esteemed colleague Prof. Howard Wheater. I have been using this time to become better acquainted with our institute, its faculty, staff and students. What a pleasure this has been! I have also spent considerable time reaching out to visit with the various unit heads on campus,

with a view towards how we can establish new collaborations. So far, so good!

I continue to be impressed by the impact that GIWS is having on research and teaching, and in particular, by our participation in Provincial and Federal government activities. Visits from the Lieutenant Governor of Ontario Elizabeth Dowdeswell, and by Minister of Fisheries, Oceans and the Canadian Coast Guard Jonathan Wilkinson, both of whom specifically visited the UofS this fall to learn about our programs in sustainability and in water security, underscore this point. Both the Lieutenant Governor and Minister Wilkinson explicitly requested that our graduate students be included in their visits, and I am pleased to report that our students made outstanding presentations. Earlier this



Dr. James Famiglietti, Executive Director GIWS and Canada 150 Research Chair in Hydrology and Water Security

fall, Global Water Futures Director Prof. John Pomeroy participated in discussions on revisions to the Canada Water Act. And just today, Prof. Pomeroy signed a Memorandum of Understanding in support of GWF collaborations in water security with Environment and Climate Change Canada and Natural Resources Canada.

We have a number of items to celebrate. We should take stock of these accomplishments and congratulate our colleagues for their fine work and for continuing to enhance the reputation of GIWS and the U of S. Here are just a few examples. Profs. Wheater and Pomeroy were recently inducted as Fellows of the Royal Society of Canada. Prof. Wheater was awarded the International Association of Hydrological Science's Dooge Medal, and Prof. Jeffrey McDonnell was this year's recipient of the U of S Distinguished Researcher Award. Graduate student Caroline Aubry-Wake was awarded the Natural Science and Engineering Research Council (NSERC) Vanier Scholarship, and graduate student Holly Annand was awarded the NSERC Postgraduate Scholarship-Doctoral Scholarship.

While it is important to celebrate and recognize our colleagues' achievements, it is also critical that we keep our eyes on the critical research that we have all devoted ourselves to conducting. The October 2018 report from the Intergovernmental Panel on Climate Change (IPCC) stressed the importance of limiting future global warming to 1.5°C, with the urgent warning that society has roughly ten years to the implement major changes required to achieve that target and avert climate catastrophe. The work that we all do at GIWS will have profound implications for how Canada responds to the climate crisis. Moreover, it positions our nation to be leaders in climate change mitigation and adaptation, in the Western Hemisphere and globally. Never forget the importance of the work that you do: much of what we will experience in climate change will come in the form of water...too much, too little or too dirty.

In light of the above, I expect to spend my spring setting priorities for supporting and growing our programs. I am currently planning some key international trips to establish strategic collaborations, at the University of Tokyo, at National Taiwan University, at the University of Virginia and at TU Delft. I also expect to begin making regular trips to Regina and to Ottawa to meet and form new relationships with our government officials and agency leaders.

As always, I will look forward to all of the great things we can accomplish together in the years ahead.

Best Regards,

Jay Famiglietti, FAGU, FGSA

Jay Tamigliette

Canada 150 Research Chair in Hydrology and Remote Sensing

Executive Director, Global Institute for Water Security

Professor, School of Environment and Sustainability, and

Department of Geography and Planning

ASSOCIATE DIRECTOR'S MESSAGE

Welcome to the 2018 University of Saskatchewan's Global Institute for Water Security report. The past year has witnessed many changes—most notably the retirement of Howard Wheater and the fantastic symposium held in his honor in March. We miss Howard! Of course we have a new, fearless leader in Jay Famiglietti and I could not be any happier with our choice. Welcome Jay! The past year has seen many other terrific new hires linked to the Global Water Futures (GWF) project—something that John Pomeroy leads with incredibly energy and enthusiasm.

We're very proud of our commitment to graduate student and postdoctoral training in water security. This past year we have led mentoring sessions through the Fall term linked to our Distinguished Lecture Series visitors. We have continued



In the field in Tasmania, Feb. 2018

(together with Maureen Reed), the annual Launching an Academic Career short course and led a mentoring day at the first annual GWF meeting at McMaster University. The CREATE Program in Water Security (led by Cherie Westbrook) continues to excel with a strong cohort of outstanding students. The new group of project-based Masters in Water Security (MWS) (led by Andrew Ireson) are thriving and we are tracking towards our joint MWS program delivery to Beijing Normal University students for next year. Our Distinguished Lecture Series continued in 2018 with visits from world leaders in water security research, including: Ciaran Harman (Johns Hopkins University), Martyn Clark (National Center for Atmospheric Research), Witold Krajewski (University of Iowa), Adam Ward (Indiana University), Barbara Sherwood-Lollar (University of Toronto), Steven Loheide (University of Wiscosin-Madison), Andras Bardossy (University of Stuttgart), Alex Konings (Stanford University), and Jennifer McIntosh (University of Arizona). These lectures are viewable at https://www.usask.ca/water/lecture-series.php.

The GIWS continues to be a hub for researchers internationally—in 2018 we hosted visits from Joshua Olowoyo (Sefako Makgatho University), Leo Peskett (University of Edinburg) and Drs. Zengchao Hao, Litang Hu, Haijun Liu, Chengzhong Pan, Wenchao Sun, Shengrui Wang and Yanguo Teng (Beijing Normal University). We are tackling some of the world's biggest water security challenges. Together with our research staff and our many international partners, we invite you to come and be a part of our team—as a visiting scientist, sabbatical visitor, graduate student, post doc or student intern.

Professor Jeffrey J. McDonnell, FRSC

1 M M well

Associate Director (International), Global Institute for Water Security

MESSAGE - DIRECTOR OF THE GLOBAL WATER FUTURES PROGRAM

It is with great applause that we thank Professor Howard Wheater for his enlightened leadership of GIWS and Global Water Futures program (GWF) since their inception to this past year, and welcome Canada 150 Chair Professor Jay Famiglietti as the new Executive Director of GIWS and

a key appointment for GWF. Dr. Famiglietti joins other exceptional new GWF-funded faculty - Drs. Martyn Clark, Corinne Schuster-Wallace, Patrick Lloyd-Smith, Markus Brinkmann, Colin Whitfield, and Simon Papalexiou who contribute to GIWS with appointments from departments such as Geography & Planning, Sustainability & Environment, Environmental & Geological Engineering, and Agricultural & Resource Economics. The new water faculty for GIWS greatly increase our capacity to deliver the ambitious GWF research program.



Photo Courtesy of Erin Collins, CBC Reporter

GWF is now the largest, most highly funded, most comprehensive and most cited university-led freshwater research project in the world. As such it makes a substantial contribution to GIWS and the University of Saskatchewan. It has been a wonderful and exciting two years for GWF with tremendous advances as the program has established 6 core teams and 39 transformative science and user-question led projects and set up new facilities in the Canadian Centre for Water Forecasting and Prediction at Innovation Place in Saskatoon and the Coldwater Laboratory in Canmore, AB. GWF shares much of its secretariat staff with GIWS and we are particularly grateful for the contributions of Dr. Phani Adapa, Director of Operations, Kelly McShane, Director of Finance, Michelle Martel-Andre, Director of Human Resources and Facilities, and Dr. Chris DeBeer, GWF Science Manager amongst many others. With support from Western Economic Diversification Canada, GWF has jointly created the Smart Water Systems Laboratory with Environment and Climate Change Canada. This lab is developing novel water and snow sensors and sophisticated Unmanned Aerial Vehicle remote sensing platforms. The coordination of our research in delivering a national water observation and prediction program with Environment and Climate Change Canada is critical to our success and we are delighted to be co-located with them in the National Hydrology Research Centre in Saskatoon. We have recently signed an overarching research agreement with Natural Resources Canada that will lead to new joint research opportunities in the water geosciences. GWF held the largest water science meeting in Canada in 2018 and this was co-hosted by a First Nation for the first time in Canada's history. We are appreciative for our support from the Canada First Excellence Research Fund and from many public and private sources, and for the remarkable team of 650 researchers and 350 partners that power the research forward. We are particularly grateful for the support and guidance from

Dr. Karen Chad, Vice-President Research, University of Saskatchewan, and the Vice-Presidents of research at the University of Waterloo, Wilfrid Laurier University and McMaster University, who have worked so well together. This partnership, totaling 18 universities, is critical to GWF.

We live in a time when dramatic climate change and increased development are threatening our water security, livelihoods and the environmental health of our planet. The extreme events of this year with record flooding, heat, wildfires, thaw and drought around the world help remind us to keep a steely resolve and to redouble our efforts. We will be surmounting great challenges in solving complex and unprecedented water issues over the next five years as we address GWF's objectives, to improve disaster warning, better predict water futures and inform adaptation and risk management. GWF has committed to contribute to the de-colonialization of Canada's water management through partnering with Indigenous communities in co-developing solutions for water problems. Internationally, we are a regional hydroclimate project of the World Climate Research Program, and contribute to UNESCO and to the Future Earth Program. With such core strengths and connexions, this program is making significant scientific contributions nationally and globally that are essential for protecting our civilisation and for preserving our planet.

The scope is massive and the task is grand, but this is the best of times to be a water scientist in Canada and particularly one at the University of Saskatchewan. With GWF, we can offer substantial new scientific knowledge and capability to humanity as we all work to better predict and manage our common water futures.

Dr. John Pomeroy, FRSC, FRGS

Canada Research Chair in Water Resources and Climate Change

Director, Global Water Futures Program

Director, Centre for Hydrology

Associate Director, Global Institute for Water Security

Distinguished Professor, Geography and Planning

TABLE OF CONTENTS

Vision	
Mission	
Director's Message	i
Associate Director's Message	i\
Message - Director Global Water Futures Program	٠١
Executive Summary	i
1. Global Institute for Water Security	01
2. Canada 150 Research Chair in Hydrology and Remote Sensing	05
2.1 Developing excellence in hydrologic remote sensing	05
2.2 Hydrological modeling and data assimilation	06
2.3 The role of water in global environmental and human security	07
2.4 Can Better Science Communication Impact Water and Environmental Policy?	07
3. GIWS Research Themes	09
3.1 Climate Change and Water Security	09
3.2 Land-Water Management and Environmental Change	09
3.3 Sustainable Development of Natural Resources	09
3.4 Socio-Hydrology	09
3.5 Water and Health	10
3.6 Water and Wastewater Treatment Technologies	10
3.7 Groundwater and Hydrogeology	10
4. Saskatchewan River Basin – A Large-Scale Observatory	11
4.1 Canadian Rockies Hydrological Observatory	11
4.2 Boreal Forest	12
4.3 Prairies	12
4.4 River Deltas	15
5. Changing Cold Regions Network	17
6. Major Research Facilities	20
6.1 Mine Overlay Site Testing Facility	20
6.2 Green Roof Environmental and Engineering Facility	20
6.3 Smart Water Systems Laboratory	21
6.4 Cold Water Laboratory	21
6.5 Centre for Hydrology	21
6.6 Canadian Centre for Water Forecasting and Prediction	22
6.7 Environmental DNA Analytical Laboratory	22
6.8 Aquatic Toxicology Research Facility	23
6.9 Toxicology Research Centre	23
6.10 Aqueous Geochemistry Laboratory	23

6.11 Saskatchewan Water Chemistry and Ecology Lab	24
7. Global Water Futures	
7.1 Transformative and Transdisciplinary Science Pillars	26
7.1.1 Core Modelling and Technical Support	26
7.1.2 Transformative Science, Big Data and Decision Tools	26
7.1.3 User Questions-Led Projects	27
7.1.4 Indigenous Community Water Research	27
7.2 Science Inception Meeting	29
7.3 1st Annual Science Meeting	30
8. International Engagement and Aspirations	32
8.1 Leadership of International Programs	32
8.1.1 World Climate Research Program	32
8.1.2 UNESCO & World Climate Research program	33
8.1.3 Future Earth – Sustainable Water Future Program	33
8.2 Howard Wheater Symposium	
8.3 Training	34
8.3.1 Notable Short Courses	34
8.3.2 Career and professional Development	36
8.4 Major Conferences Hosted by GIWS Members	37
8.4.1 International Commissions on Irrigation and Drainage	37
8.4.2 39 th Canadian Symposium on Remote Sensing	38
9. Performance Indicators	39
9.1 Membership	39
9.2 Support Staff	39
9.3 Highly Qualified Personnel	39
9.4 Research Funding	39
9.5 Research Publications	40
9.6 Awards and Honours	40
10. Student Corner	44
11. Concluding Remarks	48
Appendix A – Current Membership	49
Appendix B – GIWS Employees and Students 2016-17	65
Appendix C – Students and Highly Qualified Personnel not Funded by GIWS	70
Appendix D – Grants 2016-17	74
Appendix E – Publications, Conference Proceedings and Presentations	83
Appendix F – Collaborations and Outreach	114

EXECUTIVE SUMMARY

This report marks the beginning of a new era and welcomes Dr. James Famiglietti as the new Executive Director for the Global Institute for Water Security (GIWS), University of Saskatchewan (USask) and also as the Canada 150 Research Chair in Hydrology and Remote Sensing (2018-2025).

GIWS was formed in March 2011 with support from the Canada Excellence Research Chair (CERC) in Water Security funding to Prof. Howard Wheater - a federal-provincial-university partnership with base funding of \$30 million to ensure that society has the understanding and the tools to sustainably manage and protect the world's water resources and ensure that Canada, and the world, has the research and expertise needed to understand our water systems in an era of rapid societal and environmental change. In seven year of its existence, the GIWS has established itself as one of the premier research-intensive institutions locally (ranked #1 in Canada) and globally (ranked #18) in the field of Water Resources.

GIWS was created to provide: a) a vehicle for the new disciplinary and trans-disciplinary science needed to address the local, regional and global challenges of water security (and specifically the CERC program), and b) a platform and focus for the USask signature area of water. The institute combines expertise in natural, health and social sciences, public policy and engineering, recognizing that people and their activities are of critical importance for water science and management.

GIWS is the home of the Global Water Futures (GWF) program funded by the Canada First Research Excellence Fund (CFREF), Government of Canada, which is the largest university-based fresh-water research program in the world. GWF is led by the USask, in partnership with University of Waterloo, McMaster University and Wilfrid Laurier University and has 335 partners and 388 researchers from 18 Canadian academic institutions. The goal of the program is to deliver risk management solutions - informed by leading-edge water science and supported by innovative decision-making tools - to manage water futures in Canada and other cold regions where global warming is changing landscapes, ecosystems, and the water environment.

On its way to this remarkable achievements, the GIWS has become the host to the World Climate Research Program's (WCRP) only *Regional Hydroclimate Project* in North America — Changing Cold Regions Network (CCRN; program ended March 2018) and also host to the WCRP's *Global Hydroclimate Project* & UNESCO's International Hydrological Program - International Network for Alpine Research Catchment Hydrology (INARCH). In addition, GIWS/GWF is the Canadian node for the Sustainable Water Future Program with the Future Earth.

GIWS aims to be a global leader in Cold Region water science and focuses its efforts through seven research themes: Climate Change and Water Security; Land-Water Management and

Environmental Change; Sustainable Development of Natural Resources; Socio-hydrology, Water and health, Water and Wastewater Treatment Technologies, and Groundwater and Hydrogeology. We have developed new, internationally recognized research facilities, have taken on important national and international science leadership roles, attracted substantial additional research funding, and are beginning to deliver the exciting science that was foreseen at the program outset.

GIWS has developed two important strategic educational initiatives in graduate education and training: 1) The NSERC *Collaborative Research and Training Experience (CREATE) Program in Water Security*, which commenced in September 2015 stimulates research Masters and PhD students to integrate science, engineering, and policy as they address current and future challenges in complex water systems. 2) Beginning in 2016, we are offering an innovative one-year professional Master of Water Security graduate program that provides intensive cross-training to build disciplinary and interdisciplinary expertise for research and practice.

GIWS by the numbers in 2017-18

GIWS core faculty and its members have financially supported 114 graduate students (52 PhD and 62 Masters), 37 postdoctoral fellows, 94 research assistants, 17 research associates and scientists, and 17 research technicians and support personnel.

GIWS faculty members have secured a total of \$13.9 million (64% federal sources, 16% provincial, 15% industry and 5% from international and USask sources). Since March 2011, GIWS has secured a total funding of \$263.5 million (including the CFREF \$77.8 million) on top of the original \$30 million CERC investment.

GIWS members have published 244 journal articles, including papers in Science and Nature, published and presented 184 papers in proceedings and at conferences, delivered 130 plenary, key note and invited lectures, and published 10 book chapters and books.

In 2018, Dr. Jeffrey McDonnell, School of Environment and Sustainability (SENS) and Dr. Carl Gutwin, Computer Science have been awarded the Distinguished Researcher Award, while Dr. Tim Jardine, SENS/Toxicology was awarded the News Researcher Award.

For an institution of only 7 years in existence, it is unprecedented to have five Royal Society of Canada (RSC) Fellows, five American Geophysical Union Fellows, two Prince Sultan Bin Abdulaziz International Prize for Water winners, one Einstein Professor Chinese Academy of Science, and president of the 7500-member Hydrology Section of the AGU.

Since 2011, GIWS has recruited 15 core faculty members (7 faculty via the Canada Excellence Research Chair program and 8 faculty via the Global Water Futures Program), which is almost equivalent to creation of a new department.

1. Global Institute for Water Security

With recruitment of Prof. James (Jay) Famiglietti as the new Executive Director of the Global Institute for Water Security (GIWS), this report marks the beginning of a new era and the inception of a 7-year (2018-2025) Canada 150 Research Chair in Hydrology and Remote Sensing. Before joining GIWS, Dr.

Famiglietti served as the Senior Water Scientist at the NASA Jet Propulsion Laboratory (JPL) at the California Institute of Technology. Prior to working at JPL, he was a faculty member at the University of California, Irvine, and at the University of Texas at Austin. Famiglietti's research group uses satellites and develops advanced computer models to track how freshwater availability is changing around the globe. A fellow of the American Geophysical Union and of the Geological Society of America, he is a frequent speaker, an avid writer, and he is committed to science communication. Prof. Famiglietti is a regular advisor to state, provincial and federal government officials on water availability and water security issues, and his work is often featured in the international news media.



Dr. Jay Famiglietti , Canada 150 Research Chair in Hydrology and Remote Sensing and Executive Director GIWS

Since its inception in March 2011, the GIWS has established itself as one of the premier research-intensive institutions locally (ranked #1 in Canada) and globally (ranked #18) in the field of Water Resources as per the 2018 Academic Ranking of World Universities and in InCites. GIWS is a one-stop-shop for water security research at the University of Saskatchewan (USask) and manages individual research programs of more than 86 faculty members from 21 academic units. It is also the home of the Global Water Futures (GWF) program funded by the Canada First Research Excellence Fund (CFREF), Government of Canada, which is the largest university-based freshwater research program in the world. Since 2011, GIWS has recruited 15 core faculty members (7 faculty via the Canada Excellence Research Chair program and 8 faculty via the Global Water Futures Program), which is roughly equivalent to creation of a new department. The 7 CERC faculty are:



Howard Wheater



Jeffrey McDonnell



Karl-Erich Lindenschmidt



Yanping Li



Andrew Ireson







Saman Razavi

The 8 GWF faculty are (the 8th faculty position of Human Dimension of Water Security is still open):



James Famiglietti



Martyn Clark



Corinne Schuster-Wallace



Colin Whitfield



Patrick Lloyd-Smith



Simon Papalexiou



Markus Brinkmann

In last 7 years, GIWS has secured \$263.5 million research grants and contracts, and witnessed an exponential growth in its stature, and in the recruitment and training of highly qualified personnel including 477 graduate students, 136 postdoctoral fellows, 114 research associates and scientists, and 432 research assistants.

For an institution of only 7 years in existence, it is unprecedented to have five Royal Society of Canada (RSC) Fellows, five American Geophysical Union (AGU) Fellows, two Prince Sultan Bin Abdulaziz International Prize for Water (PSBAIPW) winners, one Einstein Professor Chinese Academy of Science (CAS), and president of the 7500-member Hydrology Section of the AGU.

RSC Fellows are men and women from all branches of learning who have made remarkable contributions in the arts, the humanities and the sciences, as well as in Canadian public life.







Jeffrey McDonnell



Ingrid Pickering



John Pomeroy



Howard Wheater

The AGU Fellows recognizes members who have made exceptional contributions to Earth and space sciences (only 0.01% recognized as fellows).



Martyn Clark



Jay Famiglietti



Jeffrey McDonnell



John Pomeroy



Howard Wheater

The PSBAIPW is a scientific prize with a focus on innovation and rewards the efforts made by scientists around the world towards sustainable availability of potable water and the alleviation of the escalating global problem of water scarcity. Dr. John Giesy is the Einstein Professor, which is awarded by CAS each year to only 20 distinguished international scientists actively working at the frontiers of science and technology. Dr. Jeffrey McDonnell is the president of the AGU Hydrology Section.



Patricia Gober



Howard Wheater

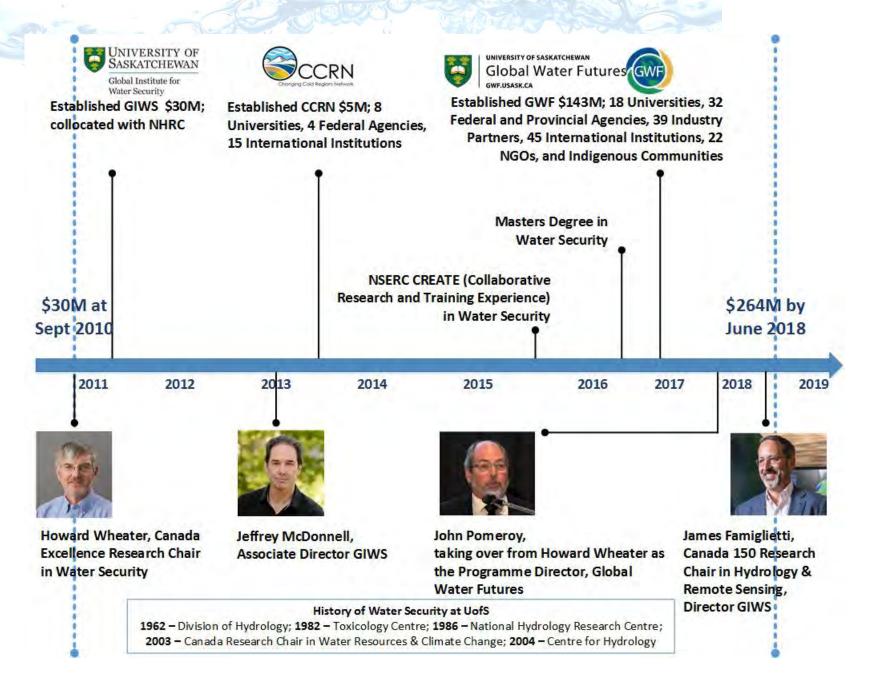


John Giesy



Jeffrey McDonnell

The following timeline chart shows the sequence of achievements of the GIWS since September 2010 to-date.



2. Canada 150 Research Chair in Hydrology and Remote Sensing

Prof. James (Jay) Famiglietti is a leading-edge senior water scientist who has contributed to the growth and success of hydrologic remote sensing for over three decades. He regularly publishes in the upper echelon of his discipline, including in the journals Science and Nature, and has earned a Web of Science Highly Cited designation- indicating a paper is in the top 1% for citations received in a particular field- for 10 of his journal articles in the fields of Geosciences and Environment/ Ecology. His models are used by several of the major climate modeling labs in North America to track how freshwater availability is changing around the world and, in combination with his pioneering work on satellite studies of groundwater depletion- including SMOS (soil moisture and ocean salinity), SMAP (for soil moisture) and GRACE satellites (for groundwater)-, has influenced water management decisions around the world, either through direct testimony to governing bodies, or through influential commentary in high-impact journals.

Through high-profile transformative initiatives, Prof. Famiglietti has rapidly advanced the scientific field and made a lasting impact on global policy. He is a pioneer in the application of GRACE gravity satellite data, which revolutionized global monitoring of water storage, and later, an integral part of the team that launched SMAP (for soil moisture) and SWOT (for surface water; planned) satellite missions. These world-leading initiatives build on a long-standing track-record of advancing the capabilities of hydrological models to evaluate global climate change impacts on water availability. Prof. Famiglietti also spearheaded the Community Hydrologic Modeling Platform (CHyMP) to accelerate the development of hydrologic modeling assets in support of advancing the water sciences and to address key water-related questions of societal relevance, and which also laid the groundwork for the National Water Model initiative in the United States. These programs continue today at NASA JPL, where he led the agency's strategic initiatives on regional-to-global water and sustainability issues.

Expected Contributions of the Canada 150 Research Chair: With his experience in hydrological remote sensing, large-scale modelling and data assimilation research, Dr. Famiglietti will address environmental security (including water, food and energy security) and provide the basis for his extensive abilities in public communication for influencing policy. These areas fill a critical void in current Canadian hydrological expertise, in particular in remote sensing and data assimilation, and would contribute greatly towards advancing Canada's, reputation as a global centre of expertise in water resources and prediction.

2.1 Developing excellence in hydrologic remote sensing

A current member of the NASA Science Teams for GRACE, GRACE-FO, SMAP, the Precipitation Measurement Mission (PMM), and the Surface Water and Ocean Topography Mission (SWOT), Prof. Famiglietti will bring thirty years of expertise and leadership to help place Canada in a position of prominence in global research and development of remote hydrological sensing.

His work based on pioneering efforts with GRACE, will embrace current and planned missions, and will develop the capability to lead new missions from within the USask. Areas of importance for Canada include remote sensing of snow, surface waters, soil moisture and groundwater, of fluxes including precipitation, river discharge and evapotranspiration, and of related, ground-deformation phenomena that are in part driven by the storage and movement of water.

Prof. Famiglietti's leadership in GRACE hydrology research will continue to be a focal point of his research. Having developed the GRACE-based methods for groundwater remote sensing (as well as for drought and flooding, for evapotranspiration and for river discharge), research will now turn to planning for future GRACE missions. These include the follow-on to GRACE-FO (GRACE-FOFO), and importantly, to the next-generation GRACE mission (currently unnamed, but formerly GRACE-2). Specifically, research will focus on the GRACE-2 mission specifications required to monitor variables such as total water storage, icefield water storage, groundwater storage changes, regional flood potential, drought severity, river discharge and evapotranspiration, at varied space-time resolutions and with varying levels of uncertainty.

2.2 Hydrological modeling and data assimilation

Prof. Famiglietti has devoted much of his career towards the continued development of large-scale hydrologic and land surface (i.e. the land component of global climate models) models, with three main thrusts.

The first has been to make the models progressively more realistic by including missing components such as rivers, lakes, alpine glaciers, groundwater and water management (e.g. irrigation). The second has been to assimilate satellite mission data, such as that from GRACE and SMAP, and to prepare models to assimilate new satellite observations, like those from SWOT. The third thrust has been to run science experiments with the improved models, for example, to characterize how irrigation in California influences regional and perhaps global climate.

Work at JPL, which will continue at the USask, includes the continued development of a very high-resolution model (3 km²) and data integration platform (i.e. the Western States Water Mission) for the western U.S., that simulates all major components of the natural (snow, surface water, soil moisture and groundwater storage; runoff, snowmelt, river discharge, evapotranspiration, and groundwater recharge) and managed (irrigation, groundwater pumping, conveyances) water cycles. Current work is also focused on GRACE assimilation, and the addition of rivers to better simulate surface water dynamics and to prepare to assimilate SWOT observations.

This work would continue at the USask, but, integrated and coupled with the Core Modelling of the Global Water Futures (GWF) Program, it will provide new insights into high-resolution hydrological modeling and data assimilation for Canada. As such it will contribute to the GWF development and running cold regions hydrological land surface models through the new USask Canadian Centre for Water Forecasting and Prediction. Ultimately these models will be extended

across Canada, North America, and eventually, across the globe. Higher resolution versions (< 1 km²) of the model could be implemented for studies of the Saskatchewan River basin, with the potential for assimilation of current and new satellite, drone and aircraft observations and to support regional field experiments. Science studies in changing flooding and drought frequency, how global change may impact Canada's water resources, and water management impacts on climate would be key priorities. Developed models could also be linked to those of water quality, of food production, or economic models, to provide science-based information to other sectors, including to government officials and environmental decision makers.

2.3 The role of water in global environmental and human security

Links between water availability, food and energy production, the 'food-energy-water nexus,' define environmental security, but are only a fledgling area of research. However, true environmental security, and thus human security, depends on this understanding. Prof. Famiglietti's research at the USask will address key aspects at this interface. For example, food modeling studies often do not use decreasing groundwater availability in their forecasts for future food production, yet groundwater provides almost 50% of the water used for irrigation around the world. Likewise, little work has linked increasing energy costs due to greater pumping costs in falling water tables environments. Internationally, what role does water scarcity play in triggering violent conflict; how are upstream policies of building dams (e.g. in Turkey and China) along international waters affecting relations across borders? Earlier studies have yet to use best available observations, such as those from the satellites listed above. At the USask, Prof. Famiglietti and colleagues would strive to utilize state-of-the-art observations to better characterize water's role in environmental and human security.

2.4 Can Better Science Communication Impact Water and Environmental Policy?

Public communication of science and influencing public policy have been strengths of hydrology at USask, and have shown the importance of engagement and the great need to supplement current efforts. Prof. Famiglietti's area of research will explore some key questions regarding how scientists, and science, can impact decision making. Some critical research questions will examine how scientists can enhance their environmental public communication in subjects on which they are experts; and how can scientists become more willing and skilled communicators. Public policy questions will examine how key science and engineering research results are used in decision making, and explore the differences between informing and advocating. At the global level, which governing bodies are important, and do such bodies exist, or should they be proposed? Are we, as a global community, prepared for the extremely challenging global water future that lies ahead, and what legal, political and civil infrastructure is required?

This work, in collaboration with GWF outreach strategies, will build on Prof. Famiglietti's last decade of interacting with state and federal officials in the United States. Both experiences point

to the need for hydrologists to join forces with social scientists, economists, policy and law scholars, to best understand how to listen, and to communicate and to educate, in order to achieve optimal societal outcomes.

3. GIWS Research Themes

The area of water security research is broad. To guide our efforts, and based on our current research strengths, we have identified a set of seven inter-disciplinary research themes, recognizing the need for deep disciplinary knowledge and the broader disciplinary dimensions of water security, and addressing challenges of local, regional and global significance.

These themes are supported by fully instrumented research observatories within Saskatchewan River Basin and Mackenzie River Basin providing data of regional and global significance. Due to the importance of, and diversity in, its cold region hydro-climate and ecological zones, the rapid rate of environmental change and the need for improved understanding, diagnosis and modelling of change, the basin also raises numerous globally-relevant science challenges.

3.1 Climate Change and Water Security

Developing sophisticated understanding and modelling of current and future effects of climate change on hydrology, ecology and water resource systems, and the associated land-atmosphere feedbacks.



Video File: Forecasting Extreme Weather Events http://www.usask.ca/water/publications/videos.php

3.2 Land-water Management and Environmental Change

Exploring the effects of agricultural and urban land and water management on water quality and water movement through a watershed, as well as the potential for agricultural beneficial management practices (BMPs) to mitigate adverse effects.

3.3 Sustainable Development of Natural Resources

Developing new science and management practices that could significantly change the way water is used, how land and water are managed, and how environmental risks are assessed and managed in natural resources development.

3.4 Socio-hydrology:

This program encompasses both the human drivers of hydrological change



Video File: Socio-Hydrology http://www.usask.ca/water/publications/videos.php

and the social processes through which hydrological science is translated and communicated to relevant decision-makers.

3.5 Water and Health

We are looking at issues that are critical to society, such as drinking water quality, water hygiene and sanitation, transmission of waterborne and water-related diseases in an ecosystem, aquatic pollution and effects on the food chain, wastewater re-use, extreme events such as flooding and drought, and health-based water quality standards.

3.6 Water and Wastewater Treatment Technologies

We are assessing impacts of contaminants on environmental and human health by addressing challenges that include appropriate technology for rural communities, development of advanced water treatment technologies to tackle emerging contaminants in our water systems, improved technologies for the treatment of industrial wastes, including those generated by natural resource extraction, and improved technologies for remediation of pollution.

3.7 Groundwater and Hydrogeology

This theme is exploring major challenges to quantify the extent of groundwater resources and their quality, the natural recharge, the long—term impacts of abstractions and waste disposals, the impact of resource development, and hence to provide the information needed for sustainable development.

4. Saskatchewan River Basin – A Large-Scale Observatory

With support from the Canada Foundation for Innovation (CFI), GIWS has established the Saskatchewan River Basin (SaskRB; 410,000 km²) as a large-scale observatory, which has come to be seen as an internationally-leading initiative. The multiple dimensions of water security and the accompanying science and management challenges, ranging from issues of water quality and quantity, anthropogenic activites, competing societal uses, industrialization, agricultural

intensification, extreme weather events (flooding and drought), etc. are all represented in the SaskRB. The basin, with area approximately half the size of France, spans Canada's three Prairie Provinces of Alberta. Saskatchewan and Manitoba and faces a climate characterized by and extremes climate change. Further, the basin encompasses



Saskatchewan River Basin

critical environments deemed significant both nationally and globally.

4.1 Canadian Rockies Hydrological Observatory: In Western Canada the availability of water is dependent upon cold water processes involving snow, glaciers, wetlands and frozen soils that control the storage and delivery of water to river systems. The CFI-funded Canadian Rockies Hydrological Observatory includes Marmot Creek in the sub-alpine and montain forested Saskatchewan River headwaters, Lake O'Hara alpine sites and the Natural Resources Canada (NRCan) -funded Columbia Icefield Glacier-Climate Observing System in the glaciated Athabasca headwaters, Alberta. This provides a cluster of >25 high elevation snow/ice and hydrometeorological stations in nested gauged catchments, which helps in improving understanding and description of governing processes for mountain water supply, improving modelling of mountain hydrological systems, and to improve prediction of mountain water supply. Unique observations of alpine and sub-alpine sub-surface storage and release are available from Lake O'Hara and Marmot Creek. Alpine treelines in this area are advancing in elevation where geomorphology and microclimate permit. Provincial, territorial and federal observation stations for flood forecasting, climate and fire prediction are clustered at both high and low elevations in

the region. The archive for Marmot Creek covers most of 50 years. Sibbald Wetlands is the focus of hydro-ecological research into Rocky Mountain wetlands and the effects of current and legacy beaver activity.

4.2 Boreal Forest: Key shortterm objectives of research conducted at Boreal Forest sites are to assess the vulnerability of



Video File: Canadian Rockies Hydrological Observatory http://www.usask.ca/water/publications/videos.php

ecosystem response to climate variability and change, and the performance of land surface schemes for simulating hydrological processes in the Boreal Forest. Longer-term objectives are to synthesize, integrate and upscale hydro-ecological understanding of stand-scale processes to

watershed scales. The western boreal forest study area traverses the latitudinal and altitudinal extents of boreal forests in Canada and the range permafrost conditions which these forests exist (nonpermafrost through to deep, continuous permafrost). Western permafrost-free boreal include the Boreal Ecosystem Research and Monitoring Sites (BERMS) in Saskatchewan that



Video File: Boreal Forest http://www.usask.ca/water/publications/videos.php

derive from the mid-1990s NASA-Canada Boreal Ecosystem-Atmosphere Study (BOREAS) and were subsequently expanded to the Environment Canada (EC) BERMS Programme. These sites in the Boreal Plains ecozone are characterized by heterogeneous forest types interspersed with wetlands and frequent wildfire disturbance, and include Black Spruce, Aspen, Jack Pine and Fen. Additional data sources in this region include Northern Alberta flux tower sites, developed in collaboration with the Oil Sands industry, as well as provincial and federal observation stations for climate and fire prediction.

4.3 Prairies: The prairie hydrology is complex and presents a unique set of challenges including the effects of changing climate on agriculture, flood and drought risk, and water quality. In addition, land management practices, such as drainage and wetland removal, are changing the landscape and the ecological services that it provides.

The St. Denis National Wildlife Area site comprises internally drained wetlands, cultivated fields and pasture, and consists of numerous prairie pothole lakes of varying salinity. The focus is on runoff processes and pothole lake connectivity, surface-subsurface interactions and salinity dynamics. Brightwater Creek, near Kenaston, Saskatchewan, represents a mesonet site of lowland level pasture and cultivated grasslands. Multi-scale scale monitoring of spatial soil moisture, groundwater and land-atmosphere interactions is ongoing. Specialised soil moisture measurement arrays, cosmic ray soil moisture probes, a geological weighing lysimeter coupled to a network of groundwater observation wells, atmospheric measurements using large aperture scintillometer and Sonic Detection and Ranging (SODAR) and weather radar provide a unique concentration of measurements in a Canadian prairie environment. Hydrological connectivity and the effects of agricultural drainage on flows and water quality is the research focus at Smith Creek, Saskatchewan. The site has demonstrated the dramatic effects of inter-annual climate variability on water quality, and a complex response of flood generation and transmission to agricultural drainage¹. The effects of agricultural Beneficial Management Practices (BMPs) on flows and water quality, particularly those associated with changing tillage practices and on-farm reservoirs, are explored at Tobacco Creek, Manitoba. The Swift Current research site in Saskatchewan is home to AAFC agricultural research runoff plots. Thorough analysis of high frequency, long-term data, experimental monitoring of the surface hydrology and hydrological model building and testing are conducted at this site to improve understanding of the fundamental drivers of threshold-like hydrological runoff responses to snowmelt and rainfall events in a semi-arid, prairie landscape. Similarly, at semi-arid West Nose Creek site in Alberta, the studies are focused on groundwater recharge, groundwater hydraulics, surface- groundwater interaction, snow hydrology, and sustainable watershed management. At the Rosthern research site in Saskatchewan, the effect of agricultural practices such as stubble height on prairie snow dynamics, melting, and management is studied.







Video File: Brightwater Creek

¹ Shook and Pomeroy. 2011. Memory effects of depressional storage in Northern Prairie hydrology. Hydrological Processes, 26: 1752-1766







Video File: Rosethern Research Site – Prarie Hydrology

http://www.usask.ca/water/publications/videos.php

Research to explore water quality issues in the basin spans the study of the winter biogeochemistry of lakes to the monitoring of pharmaceutical products and heavy metals in urban wastewater and storm water. The first major study of pollutant loads and their ecological impacts for the South Saskatchewan River, Lake Diefenbaker and its tributary, Swift Current <u>Creek</u>, is underway. This project brings together researchers from the USask (Biology, Toxicology, Geography, Civil and Geological Engineering, the Schools of Environmental and Sustainability and Public Health), Environment and Climate Change Canada and the Saskatchewan Water Security Agency. Lake Diefenbaker is more than 200 kilometers long and plays a major role in the economic and social development of a large proportion of the province. However, the capability of the reservoir to continue to provide water of reasonable quality under rapid economic development and under a changing climate is unknown given nutrient loads and increasing evidence of eutrophication. A comprehensive evaluation of the sensitivity of the reservoir to current and future nutrient inputs includes limnology, paleo-limnology, toxicology and hydrodynamic water quality modelling. A similar study has been initiated for Buffalo Pound Lake, including real-time water quality monitoring to support treatment of this major source of drinking water for the cities of Regina and Moosejaw, Saskatchewan.



Video File: Lake Diefenbaker



Video File: Buffalo Pound



Video File: Lake Diefenbaker – Toxicology & Water Quality



Video File: Swift Current Creek – Urban Municipal Drainage



Video File: Sediment and Nutrient Transport Modelling



Video File: Modelling Riverine Processes

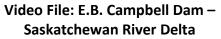
http://www.usask.ca/water/publications/videos.php

4.4 River Deltas: The Saskatchewan River, Peace-Athabasca, and Slave River deltas are biologically diverse and complex systems of rivers, lakes, and wetlands. These deltas support a range of fish, wildlife, bird, and plant species. The ecological changes in these deltas are often an indicator of issues arising in our river systems; if there are problems, people in the delta are often the first to notice. These deltas continue to play an important role in supporting traditional, subsistence, and cultural activities of the Indigenous peoples who have occupied these regions since time immemorial. Historically, inland deltas were also a central part of the fur trade industry.

Located near the Saskatchewan/ Manitoba border, the Saskatchewan River Delta is a complex series of abandoned and active river channels, lakes and wetlands. Home to Cumberland Marshes, which has been designated as an Important Bird Area, this region experiences the accumulated effects of upstream water use, including abstractions and power generation. Since the beginning of the last century, annual discharge has been reduced by approximately 30%. In addition, winter base-flow is now higher and spring freshets have been dampened due to storage in upstream reservoirs. Experts in climate, hydrology, ecology and social science are addressing the cumulative repercussions of these changes in flow for the production of fish, water-birds and mammals, and for the activities and livelihoods of local communities. The aim of this research is

to develop scenarios and an operational plan to provide for sustainable hydropower output without endangering the Delta habitat in the long-term.







Video File: Delta Dialogue Network

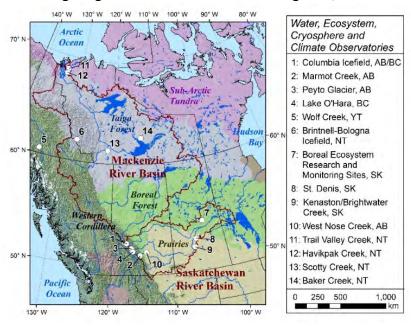
http://www.usask.ca/water/publications/videos.php

5. Changing Cold Regions Network

GIWS interdisciplinary research in the SaskRB was complemented by the <u>Changing Cold Regions Network</u> (CCRN) project, with a focus on changing climate, cryosphere, hydrology and ecosystems and expansion of geographical scope to include the Mackenzie River Basin (MRB; 1.8 million km²), which concluded in March 2018. The CCRN was led by Howard Wheater, Canada Excellence Research Chair in Water Security, and brings together 42 Canadian co-Investigators, 4 Federal

government agencies and 15 leading international researchers.

CCRN's overall aims were to integrate existing and new experimental data with modelling and remote sensing products to understand, diagnose, and predict changing land, ecosystems, water, and climate, and their interactions and feedbacks over western Canada's cold interior. A network of 14 intensely instrumented



Water, Ecosystem, Cryosphere, and Climate (WECC) observatories were used to study these detailed processes and connections in the permafrost regions of the Sub-Arctic, the Boreal Forest, the Western Cordillera, and the Prairies, and worked to better understand the changing regional climate and its effects on large-scale Earth system change and the region's major river basins: the Saskatchewan and the Mackenzie. The CCRN program and its objectives were organized based on five inter-related and inter-dependent Themes. Theme A, Observed Earth System Change in Cold Regions - Inventory and Statistical Evaluation, documented and evaluated observed change, including hydrological, ecological, cryospheric, and atmospheric components, in the cold regions of interior northwestern Canada over a range of scales. Theme B, Improved Under-standing and Diagnosis of Local-Scale Change, improved our knowledge of local-scale change by developing new and integrative knowledge of Earth system processes, incorporating these processes into a suite of process-based integrative models, and using the models to better understand Earth system change. Theme C, Upscaling for Improved Atmospheric Modelling and River Basin-Scale Prediction, improved large-scale atmospheric and hydrological models for weather, climate, and river basin-scale modelling and prediction of the changing Earth system and its feedbacks. Theme D, Analysis and Prediction of Regional and Large-Scale Variability and Change, focused on the driving factors for the observed trends and variability in large-scale aspects of the Earth system,

their representation in current models, and the projections of regional-scale effects of Earth system change on climate, ecology, land, and water resources. Theme E, Outreach and Engagement, engaged a community of partners and users, including local stakeholder groups, provincial and federal policy/decision makers, national and international research organizations, and other relevant groups, and disseminates the improved knowledge and tools within this extended community. Further details can be found at www.ccrnetwork.ca/science.

The CCRN was one of ten Regional Hydroclimate Projects of the World Climate Reasearch Programme's Global Energy and Water Exchanges (GEWEX) project — the only current one in North America. CCRN had an active research partnership with the US National Centers for Atmospheric Research (NCAR) and is also supported by and linked to Climate and Cryosphere (CliC) projects, to the Canadian High Arctic Research Station (CHARS) programme and integrated within NASA's Soil Moisture Active Passive (SMAP), Airborne Microwave Observatory of Subcanopy and Subsurface (AirMOSS), and Arctic Boreal Vulnerability Experiment (ABOVE) arctic programmes.

Key science and outreach highlights include:

- Improving our understanding of Earth system processes and their representation in hydrological, atmospheric and ecological models
 - Targeted process studies: This involved deployment of enhanced field instrumentation across a network on intensively studied and well-instrumented WECC Observatories; compilation of targeted process studies data; and the development of enhanced localscale process understanding.
 - Development of improved local-scale models, which consisted of both development and testing of improved local-scale models, primarily the continued development of the Cold Regions Hydrological Model (CRHM).
 - Algorithm development for weather and large-scale hydrological models, which included the activities of testing of existing land surface schemes using WECC data and development and testing of improved algorithms at WECC sites and at the mesoscale.
 - Large basin-scale application and testing of weather, climate and large-scale hydrological models, including verification and assimilation of ground-based observations and remotely sensed data. This involved development of the MESH modelling framework for the major basins, development and testing of assimilation methods, and testing of improved land surface schemes at large basin-scale.
- Advancing water, weather, climate and environmental prediction
 - Changing climate, changing land surface systems, and large-scale hydrology. This included assessment of large/regional circulation in models, MESH/GEM sensitivity/feedback simulations using the existing CLASS algorithms, MESH development to include largescale controls, and GEM sensitivity/feedback simulations using improved CLASS.

- Atmospheric circulations, temperature and precipitation. This included the establishment of large-scale controls on future climate, determination of role of regional circulations on future climate, and determination of future changes in precipitation and examination of future climate.
- Water resources, cryosphere and ecosystems. This included climate scenario selection for impacts assessment, determination of impacts on WECC observatories, determination of potential impacts on major river systems, and assessment of whether tipping points will occur.
- Improving our understanding of recent Earth system change in the cold interior of western and northern Canada
 - Assessing change at the local scale, including an inventory of observable local-scale change, statistical and meta-analysis of archived local data and environmental change, and dendrochronological examination of local change.
 - Assessing change at the biome and regional scales, including inventory of observable change at the regional/domain scales, and documentation of extreme events, in conjunction with Theme D.
 - Multi-disciplinary expert synthesis of conceptual understanding and scenarios of future
 Earth system change across western Canada for the purposes of informing model setup,
 parameterization, and application under future climates.

Over the five years of this network, CCRN has worked with government, industry, water managers, First Nations communities and other stakeholders to deliver the improved hydrological, ecological and climate modelling tools needed to understand, predict and manage uncertain climate and water futures. CCRN has addressed issues of importance not only to Canada, but also the world, and has contributed to the work of Canada's Federal, Provincial and Territorial governments, NASA and the Canadian Space Agency, the US National Center for Atmospheric Research (NCAR), and the World Climate Research Program (WCRP).

For additional information please contact Chris DeBeer, Science Manager at chris.debeer@usask.ca or visit: http://www.ccrnetwork.ca/index.php

6. Major Research Facilities

This section highlights a few of the major laboratory facilities that are part of the GIWS.

6.1 Mine Overlay Site Testing Facility

The Mine Overlay Site Testing Facility (MOST) bridges the critical gap between small scale lab experiments and complex, costly and time consuming large scale constructed hillslope research in mine reclamation cover design. The primary focus of this facility is cover systems testing for

cold regions. The facility is funded through Western Economic Diversification Canada, USask, GIWS and industry partners.

Mission of the MOST facility is to help industry improve mining system cover design, improve risk mitigation at their permanent installations, troubleshoot design challenges, reduce cost, and increase accuracy of environmental impact assessment.



MOST Open House for Industries

The MOST facility is the first of its kind to provide pilot scale cover trials with replications of key processes (placement, climate, slope/aspect, vegetation) and the ability to evaluate and characterize the key mechanisms controlling the water dynamics in mine reclamation cover design. [website]

6.2 Green Roof Environmental and Engineering Facility

The mission of Green Roof Environment and EngiNeering (GREEN) facility is to help industry improve green roof design in cold regions, improve risk mitigation, troubleshoot design challenges, reduce costs and improve accuracy of green roof water retention assessments. The

GREEN facility has the capacity to develop, improve and test: drainage systems, membrane effectiveness, water proofing, water quality and retention, reduction of potable water use, snowmelt runoff, reductions in the energy requirements for heating/cooling of interior spaces, and promote the reduction of greenhouse gas emissions by reducing building's energy requirements. Engineering tests utilizing load cells and infrared thermal imaging are performed to evaluate the performance of water drainage and water proofing systems, respectively.



Jeffrey McDonnell Preparing Test Beds at the GREEN Facility

The GREEN Facility is bridging the critical gap between small scale (e.g. soil cores), typically unrepresentative lab experiments, and complex, time consuming and costly large scale constructed roofs. [website]

6.3 Smart Water Systems Laboratory

The SWSL was recently created with support from Western Economic Diversification Canada to develop novel water and snow sensing technologies and bring them to commercialization and commercialization stage. The SWSL will transform the observation of Canadian waters by detecting change in water quantity and quality at high resolutions. SWSL is developing novel sensors that measure snowpacks, ice, open water, flooding, streamflow, soil moisture, wetlands, vegetation and algal growth. Many of these sensors will be



Drone with Smart Water Sensor

deployed on specialized all-weather drones (unmanned aerial systems) for rapid deployment across Canada with first applications in the Prairies and the mountain headwaters of the Saskatchewan River Basin. [website]

6.4 Cold Water Laboratory

In Alberta, the Centre for Hydrology maintains premises at the Coldwater Laboratory in Canmore, AB. The Coldwater Laboratory places over 20 researchers and students in the headwater region of 3 major river basins (Saskatchewan, Columbia and Mackenzie river basins) to study the impacts of climate change and extreme events on water resources in the region. This facility includes offices and a laboratory and provides easy access to over 35 high elevation stations within the southern Canadian Rockies. [website]



USask Coldwater Lab, Canmore, AB

6.5 Centre for Hydrology

The USask Centre for Hydrology addresses Saskatchewan's water sustainability problems and provides national leadership in hydrological research and training. The centre includes unique facilities with equipment for stable isotope analysis, strong expertise in water and wastewater treatment, efficacy of constructed wetlands, mine reclamation and site remediation, water

balance modelling, and hydrogeochemistry. The centre has six labs: Cryospheric Environmental Lab (an experimental cold room for cryospheric simulation); Cool Sample Lab; Hydrological Modelling Lab (computer modelling with PC and Unix); Hydrological Instrumentation Lab; Hydrological Sampling Lab; and Ecohydrology Lab (natural water chemistry). [website]

6.6 Canadian Centre for Water Forecasting and Prediction

The Canadian Centre for Water Forecasting and Prediction (CCWFP) develops transformative data assimilation, management, analysis and delivery system that aims to provide a single national source for water data, analytical products and predictions. CCWFP will address this by creating a common platform for scientists from various disciplines and different universities/institutes to work together on:

- Developing and applying new coupled modeling systems that integrate regional climate, land management, hydrology and water management over climate change sensitive regions.
- Improving models with the capability to explore and assess how changes in population, economic development, and land use will impact water resource management and water quality, in addition to climate change.
- Determining how state-of-the-art model scenarios and predictions can be best framed to inform decision making, policy and adaptive governance for the management of risks from hydrological change to water resources.



Honourable Jonathan Wilkinson, Minister of Fisheries, Oceans and the Canadian Coast Guard (2nd from left) and Francis Scarpaleggia, Member of Parliament (1st from left) visiting GIWS and GWF

The research will further facilitate development and implementation of various plans and activities related to the diagnosing and predicting change in cold regions based on implementation and operation of high-resolution climate and weather models for both forecasting purposes and long-term prediction of climate change. This will support flood, drought, streamflow and water quality forecasting models and inform predictive models for the diagnosis of change in hydrological, water quality, snow, ice and water management systems.

6.7 Environmental DNA Analytical Laboratory

The Environmental DNA (eDNA) laboratory offers the widest possible range of capabilities relevant to water quality, including aquatic chemistry and toxicology. The lab currently has two UHR-MS systems, one interfaced to a liquid chromatography (LC) system and the other to a gas chromatograph (GC). They are also capable of a wide range of analyses for small molecules both man-made and natural. In addition to identification and quantification of both natural and synthetic molecules, the capabilities include proteomics and metabolomics as well as

characterization of large molecules, such as natural dissolved organic matter, including humic and fulvic acids, tannins, peptides and amino acids. Depending on the specific application the instruments are also capable of automated sample extraction and processing for increased accuracy and decreased labor costs. Our aim with the next LOI would be to determine who would be interested in accessing these capabilities and how we might support the various user needs.



Q Exactive GC ultra-high resolution GC/MS



Q Exactive HF and Q Exactive OrbiTrap systems with UHPLC and nano-LC chromatography

6.8 Aquatic Toxicology Research Facility

The ATRF, the only facility of its type in Canada and one of only a few in the world, is a highly sophisticated laboratory for aquatic toxicology research. Located at the Toxicology Centre, the 7,100 sq-ft laboratory was specifically designed to provide areas with different water qualities and temperatures to perform both static and dynamic toxicological experiments with algae, crustaceans, insects, clams, amphibians or fish. In-house research facilities include five walk-in controlled-environment chambers and an analytical laboratory for water quality analysis. [website]



House & Rear Non-traditional Aquatic Organisms

6.9 Toxicology Research Centre: The USask Toxicology Centre is the largest academic research and training centre in the area of aquatic and environmental toxicology in Canada. The centre provides broad-based expertise from the molecular to the ecosystem level, with partners from around the globe. It focuses on investigating the effects of water pollution on ecosystem and human health with an aim towards sustainability and stronger environmental stewardship. [website]

6.10 Aqueous Geochemistry Laboratory

The Aqueous Geochemistry Laboratory (AGL) is an analytical facility for water chemistry, which is providing high-quality and timely quantitative elemental analyses for both academic and non-academic clients. This laboratory supports comprehensive elemental analysis of aqueous

samples ranging from fresh to brackish water. The laboratory houses several major pieces of analytical equipment to support a variety of methods including: i) inductively coupled plasma – mass spectrometry (ICP-MS); ii) inductively coupled plasma – optical emission spectroscopy (ICP-OES); iii) ion chromatograph (IC); iv) high performance liquid chromatography (HPLC); v) gas chromatography (GC); and vi) spectrophotometry. Ancillary equipment to support routine and unique sample processing requirements are also available in the laboratory. [website]

CETAC LSX-200 LAS



PerkinElmer Flexar HPLC System



DIONEX ICS 2100

Analytical Geochemical Laboratory



Agilent GC System

The Analytical Geochemical Laboratory houses a variety of state-ofthe-art analytical instrumentation including: 1. PerkinElmer NexIon 300D ICP-MS, which includes a dual-

- PerkinElmer NexIon 300D ICP-MS, which includes a dualchannel Universal Cell, allowing analysts to use Dynamic Reaction Cell (DRC) technology and/or Kinetic Energy Discrimination (KED) to remove polyatomic interferences on analytes of interest.
- 2. PerkinElmer Elan 5000 ICP-MS.
- PerkinElmer Flexar HPLC System coupled with the NexIon 300D ICP-MS, which allows elemental speciation analyses to be achieved.
- CETAC LSX-200 Laser Ablation System with laser spot size varying from 10 to 300 microns and pulse frequency of 1-20Hz on various samples. Maximum energy ~ 4mJ at 266 nm.
 Dionex Ion Chromatography System 2100 for analysis of major
- anions including F, Cl, NO₂, Br, NO₃, PO₄ and SO₄.
- Agilent Gas Chromatography System for analysis of CO₂, CH₄ and other light hydrocarbons.
- SpectroBLUE Inductively-Coupled Plasma Optical Emission Spectrometer for analysis of major cations including K, Na, Mg, Ca, P and S, and trace metals including Se, As and Cd.



PerkinElmer NexIon 300D ICP-MS



SpectroBLUE ICP-OES

The lab is a multi-user analytical facility for measuring up to 70 chemical elements with concentration ranging from parts per trillion to parts per million in diverse sample types from environmental, biological, geological and industrial sources. Certain anions (Br, Cl, F, NO₃, PO₄ and SO₄) in sub-ppm levels can also be measured.

6.11 Saskatchewan Water Chemistry and Ecology Lab

The lab has expertise in aquatic ecosystem ecology and biogeochemistry, specifically, understanding the effects of changing climate and nutrient loads on aquatic ecology and biogeochemistry. [website]



7. Global Water Futures: Solutions to Water Threats in an Era of Global Change

In September 2016, the University of Saskatchewan (USask) was awarded \$77.8 million from the Canada First Research Excellence Fund (CFREF) to lead the "Global Water Futures: Solutions to Water Threats in an Era of Global Change" (GWF) initiative—the largest university-led water research program ever funded worldwide. With additional partner funding, the total program

budget is \$143.7 million over seven years. GWF aims to transform the way communities, governments, and industries prepare for and manage water-related risks in an era of unprecedented change. GWF makes its administrative home in GIWS: GIWS manages the GWF CFREF for the USask at the request of the USask Office of the Vice President Research. Prof. John Pomeroy is the GWF Program Director.



John Pomeroy, Director Global Water Futures Program –
Speaking at its 2nd Anniversary

GWF is a seven-year pan-Canadian research program focusing on solutions to water threats in the era of global change. Climate warming and human actions are altering precipitation patterns, reducing snow levels, accelerating glacier melting, intensifying floods, and increasing risk of droughts, while pollution from population growth and industrialization is degrading water systems. With such unprecedented change, it is clear that the historical patterns of water availability are no longer a reliable guide for the future. Adaptation to these changes will require *new science* to understand the changing earth system (changing climate, land, water and ecosystems and their interactions); *new modeling tools* that precisely capture these interconnected forces and their societal implications; *new monitoring systems* with greater capacity to warn of critical environmental changes; and *more effective mechanisms to translate new scientific knowledge into societal action.* This translates into the grand challenge for water science in Canada and globally: "How can we best prepare for and manage water futures in the face of dramatically increasing risks?"

GWF's mission is to position Canada as the global leader in water science for cold regions and to address the strategic needs of the Canadian economy in adapting to changing water and managing the risks of uncertain water futures and extreme events. GWF is achieving this mission by delivering risk management solutions—informed by leading-edge water science and supported by innovative decision-making tools—to manage water futures in Canada and other cold regions where global warming is changing landscapes, ecosystems, and the water environment.

The USask-led water research network involves 157 researchers from 15 Canadian Universities and 335 partners/ stakeholders representing a wide range of disciplines who will work with international organizations such as UNESCO, the World Climate Research Programme, and Future Earth in developing the tools and models to mitigate water disasters, protect the environment, and take advantage of economic opportunities.

Currently, GWF has 466 highly qualified personnel (33 projects and 6 core teams personnel), including 43 undergraduate students, 103 master's students, 107 doctoral students, 68 postdoctoral fellows, 1 research engineer, 29 professional research associates, 21 research scientists, 48 technicians, 8 visiting fellows/professors, 4 knowledge mobilization specialists, 34 data and project managers.

7.1 Transformative and Transdisciplinary Science Pillars

7.1.1 Core Modelling and Technical Support

With a strength of 90 highly qualified personnel, GWF core support provides the necessary underpinning for certain core program objectives and deliverables, specifically:

- National capability for the modelling needed to deliver key programme goals; and,
- Capability for observational science, in particular with respect to key observatories.

GWF also provides core support teams for the programme as follows:

- Knowledge Mobilization Support Team
- Computer Science Team Human Computer Interface and Re-engineering Codes
- Observatories, Observations, and Data Management Team
- Modelling Core Team
 - Hydrological and Water Quality Forecasting
 - Climate and Diagnostic Hydrological & Water Quality Modeling
 - Water Resources Modelling

7.1.2 Transformative Science, Big Data and Decision Tools

The GWF program has funded 21 research projects under Pillars 1&2 across Canada totalling nearly \$6.6 million over three years (2018-2021) to tackle some of Canada's most pressing water-related challenges. In total, 94 researchers from 10 Canadian universities are involved in collaboration with 82 partners including international institutions, government agencies, industry partners, non-governmental organizations, and Indigenous communities. The projects are training 100 highly-qualified personnel and are leveraging the GWF investment of \$6.6 million with an additional \$423,000 in cash and \$3.2 million of in-kind contributions from partners.

These new 21 projects will deliver on two key areas: transformative science to help us understand, diagnose and predict change, and developing new decision support systems using new sensors, analytical procedures, and computer models. These projects will complement the previously funded user-question led Pillar 3 projects, and contribute to a better understanding of snow and rain storms, floods and droughts, how to better measure and manage the quality of source waters, how deep groundwater is affected by the surface, how to improve water governance and even how to encourage global water citizenship. Additional information is available at: https://gwf.usask.ca/science/pillar-1-2-projects.php

7.1.3 User Questions-Led Projects

The GWF programme has funded 12 research projects across Canada totaling nearly \$16.9 million over the three years (2017-2020) to tackle some of Canada's most pressing water-related challenges. Four projects are led by the University of Saskatchewan, three by the University of Waterloo, three by McMaster University, one by Wilfrid Laurier University, and one is jointly led by the University of Manitoba and University of Victoria. In total, 117 researchers from 15 Canadian universities are involved in the 12 projects. They are collaborating with 327 partners including international institutions, government agencies, industry partners, non-governmental organizations, and Indigenous communities. The projects are training 278 highly qualified personnel over three years.

These projects were all selected through an international peer-reviewed process. The \$16.9-million investment in the projects has leveraged another \$26.4 million in cash from universities and partners, as well as \$114.8 million in in-kind contributions from partners.

All of these projects span a wide range of critically important topics related to water issues in cold regions of the world during a time of climate change and the research findings will impact all Canadians. These include protecting prairie agricultural lands from drought and floods, mitigating algae blooms in lakes, developing new monitoring systems for Canadian watersheds using drones and satellites, using environmental DNA to assess ecosystem health, understanding the impact that changes to mountain snow packs and glaciers will have on drinking water, and co-create Indigenous water-quality tools with First Nations. Additional information is available at: https://gwf.usask.ca/science/pillar-3-projects.php

7.1.4 Indigenous Community Water Research

Over the last year, the GWF program has reached out to numerous researchers, Indigenous community partners and other partners for advice on what water research GWF and Indigenous communities can conduct together to help address the water issues experienced by Indigenous communities. Consequently, a workshop was organized in Saskatoon, SK on April 17-18, 2018, and involved 62 attendees including 31 Indigenous community representatives to promote

further discussion and action on these research ideas through development of Indigenous community — university partnership projects that both meet Indigenous community needs and are in alignment with the GWF vision/mission. These projects will be supported with up to \$2 million of operating funds and provision of our core data from climate and water models, remote sensing and surface observations. This workshop provided an opportunity for Indigenous community members and GWF academic researchers to co-develop a strategy for Indigenous community water research.

While many GWF researchers had existing relationships and research projects in progress with their Indigenous partners, the workshop provided the first in-person opportunity for everyone to come together from across the country.

The workshop included introductory presentations and working sessions aimed at identifying the funding opportunity from GWF, and co-designing expressions of interest and the proposal evaluation criteria of importance to research with Indigenous communities. The workshop was highly interactive with the discussions and working sessions focused on building on existing relationships, identifying new potential partnerships, identifying common research themes and community needs, co-designing proposal elements and evaluation criteria, and identifying leveraging opportunities with funding partners.

While sharing ideas and potential projects that were emerging, the following research themes were identified as key importance to research with and in Indigenous communities by the group, and which could be focus areas for collaboration and knowledge mobilization across projects (not an exhaustive list):

- Citizen science (capacity building; monitoring; data acquisition)
- Decision support and visualization (web of knowledge; data sharing; computer apps)
- Impacts of floods, droughts, climate change, forestry and water management on water flow
- Environmental flows (quantity; quality; habitat; sediment)
- Western and traditional science (overlap; differences; standing)
- Cultural strengthening as an outcome of research
- Water and health (linking environmental and human health and livelihoods)
- GIS and remote sensing tools (permafrost mapping; drones; autonomous sensors)
- Governance and policy (legislation; knowledge; sharing; decision-making impact)

In essence, the workshop started and concluded on very positive notes with a commitment to co-develop and evolve GWF's Strategy for Indigenous Community Water Research. It was agreed that this was a great beginning to new relationships and a new way of engagement between academic research and Indigenous communities that could be the foundation for the much needed partnerships, knowledge, and capacity to address the water and climate issues affecting

Indigenous communities across Canada. The primary outcome of the workshop was the development of the request for proposals for the expressions of interest, which was issued on April 23, 2018. Subsequently, a total of 11 Expressions of Interest were received requesting funding of \$3.4 million over three years. In consultation with three Academic Indigenous Advisors, the SMC invited 8 EOIs to submit full proposals by September 21, 2018.

7.2 Science Inception Meeting

GWF held its Science Inception Meeting to provide a first opportunity for transformative science and transdisciplinary project principal investigators, and core team leads to meet and gain a perspective of what is being done across the program and to see the broader context. The purpose was to briefly review all of the projects and core elements of the GWF program, identify synergies and linkages among them and key gaps that need to be addressed, and develop strategic plans for integration across the program. A draft GWF strategic analysis/inception report was prepared in advance of the meeting to help identify key issues, synthesize core team work plans, and map linkages across the program. The aim was to solidify plans (at the project and broader programme level), with clear priorities and timelines. At the end, the goal was to identify how well are we addressing the stated objectives and deliverables of GWF? How do our core teams function, how do they interact with and assist the pillar 1, 2, & 3 projects, and how



Inception Meeting hosted by Wilfrid Laurier University at the Balsillie School of International Affairs, Waterloo, ON

do these collective activities fulfill what the programme must accomplish? And how will we operationally manage the program?

The following inception statements were the outcomes of the meeting:

- GWF has identified a Grand Challenge: how can we best prepare for and manage water futures in the face of dramatically increasing risks from a changing climate, developing economy and changing society?
- GWF has thus initiated 33 projects addressing critical water research needs, big data and decision support tool development, sensors and user-questions, and 6 core teams addressing observations, data management, computer model-based prediction, communications and knowledge delivery.
- These projects and teams have exchanged best practices and have begun their research, observations, modelling and knowledge mobilisation activities and are engaging with 335 partners/users whilst training 466 HQP.
- GWF is engaging with all levels of government across Canada, with special interest in engagement with Indigenous communities and international UN-based science organisations.

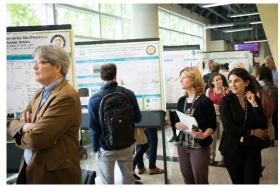
7.3 1st Annual Science Meeting

GWF met as a whole for the first time on June 4-6, 2018 at McMaster Univesity and co-hosted by the Six Nations of the Grand River, Ontario, and has brought together a large and comprehensive transdisciplinary group of water researchers and stakeholders in water research who discussed progress in meeting the GWF Grand Challenge. This meeting was remarkable for being exceptionally comprehensive in the subjects represented, for the early and rapid progress shown, and for being hosted and co-organized by a First Nation, on its own territory.

Over 400 people attended from across Canada, and from UN, WCRP and Future Earth. The meeting included 160 presententations by academics, students, researchers, Indigenous knowledge holders, policy makers, managers and communicators as well as a visit to Six Nations of the Grand River where researchers and community members engaged in land-based knowledge exchange activities.



Meeting at Six Nations of the Grand River, ON



Poster Presentation by Students and Postdocs

The primary purpose of the Annual Science Meeting was to provide a broad perspective of scientific progress from the entire GWF program, to stimulate transdisciplinary discussions and interactions amongst researchers, students and partners, and to showcase and celebrate the scientific and technical advancements emerging from the GWF program. Science presentations involved regional or topical plenaries and transdisciplinary parallel sessions. In addition, the following activities and outcomes were achieved:

- Workshops and events for the GWF community to advance its understanding of Indigenous water issues, knowledge, culture and history.
- A workshop to help develop best practices for knowledge mobilization to research partners.
- Plenary presentations on international water research programs and engagement opportunities for GWF.
- An opportunity for young professionals to come together and hold development activities
 that aid career advancement and social events to enhance camaraderie. This will include
 activities such as workshops, presentations and scientific poster sessions.

For additional information related to GWF Science, please contact Dr. Chris DeBeer, Science Manager at chris.debeer@usask.ca; ph: 306-966-6224 and/or visit: www.globalwaterfutures.ca

8. International Engagement and Training

Water Security is one of the greatest challenges for humankind, with global implications. There is a need a) to develop local and regional studies that are of global significance, and to share that information, b) to address key water challenges around the world, and c) to provide students and researchers with new insights and tools to address these problems. International collaboration and cooperation therefore play a critical role in advancing water science to deliver sustainable solutions.

GIWS strongly believes that internationalization of higher education embraces the mobility of faculty and students, educational aids and international cooperation, and curriculum internationalization. In other words, internationalization of higher education includes faculty and student exchange, joint teaching and research programs, as well as international curriculum development and delivery.

GIWS's philosophy has been to give Canadian students international experience and to give international students Canadian experiences. Our students and postdoctoral fellows represents ethnic and gender diversity representing a mixing of cultures —scientifically and sociologically—which are the key to breakthroughs.

8.1 Leadership of International Programs

GIWS is the host of the World Climate Research Program's (WCRP) only *Regional Hydroclimate Project* in North America – the Changing Cold Regions Network (CCRN) - and also hosts the WCRP's *Global Hydroclimate Project* & UNESCO's International Hydrological Program - International Network for Alpine Research Catchment Hydrology (INARCH). In addition, GIWS is the Canadian node for the Sustainable Water Futures Program with the Future Earth programme. Recently, GIWS-USask has been included as a new member of the USA's University Consortia for Atmospheric Research (UCAR).

8.1.1. World Climate Research program

The Changing Cold Regions Network (CCRN) was one of the ten Regional Hydroclimate Programmes of the World Climate Research Programme's (WCRP) Global Energy and Water Exchanges (GEWEX) project – the only current one in North America.

CCRN was also supported by and linked to Climate and Cryosphere (CliC) projects, to the Canadian High Arctic Research Station (CHARS) programme and integrated within NASA's Soil Moisture Active Passive (SMAP), Airborne Microwave Observatory of Subcanopy and Subsurface (AirMOSS), and Arctic Boreal Vulnerability Experiment (ABOVE) arctic programmes. CCRN has an active research partnership with the US National Centers for Atmospheric Research (NCAR); currently discussions are underway concerning use of the basin as a focus for international model development and inter-comparison studies. In addition, Saskatchewan River Basin (SaskRB) scale water quality modelling is also under development. The SaskRB is a tributary of Lake Winnipeg,

and the SaskRB project is assisting the work of the Canada-US International Joint Commission by developing a nutrient model for the Saskatchewan River, based on the U.S. Geological Survey SPARROW (SPAtially Referenced Regressions ON Watershed attributes) modelling platform, to provide the first basin-wide modelling capability with which nutrient management issues can be explored. In addition, as noted above, large-scale hydrological modelling is being addressed by development and implementation of Environment Canada's MESH modelling system for the Basin.

8.1.2. UNESCO & World Climate Research Program

The International Network for Alpine Research Catchment Hydrology (INARCH) project is led by John Pomeroy, Canada Research Chair in Water Resources and Climate Change. INARCH is a Global Hydroclimate Programme (GHP) cross-cut project of WCRP's GEWEX and a world water security initiative of UNESCO's International recognized contribution to the Hydrological Programme. The overall objective of INARCH is to better understand alpine cold region hydrological processes, improve their prediction and find consistent measurement strategies. To achieve this objective it is necessary to develop transferable and validated model schemes of different complexity that can support research in mountain headwaters where climate change impacts on water resources are anticipated to be very severe. INARCH has 25 intensely instrumented high-mountain research catchments in North and South America, Europe and Asia that form a vast outdoor intercomparison laboratory. By combining the expertise of over 40 principal collaborators from 17 countries, INARCH addresses important issues such as snow, glacier and permafrost hydrology; representation of snow and ice in hydrological land surface models, model downscaling in terrain, and improving the prediction of climate change impacts for themountain headwaters that support water resources half the world's population www.usask.ca/inarch.

8.1.3. Future Earth – Sustainable Water Future Program

The Sustainable Water Future Program (Water Future) is a global research programme established under Future Earth² and aims to provide the knowledge and support to accelerate transformations to a 'more sustainable water world'. The GIWS has developed a memorandum of understanding to establish a collaborative Partnership, founded on the principles of collaboration and cooperation, to provide expertise and resources for undertaking coordinated and strategic research activities that will underpin the sustainable management and use of water in this time of significant global environmental change. The broad aim is to enhance the contribution of strategic scientific and technical research and innovation to the sustainable management of the hydrological cycle, including rivers, groundwater and wetlands. Consequently, the GIWS through the GWF program is now considered as the Canadian hub and

² http://www.futureearth.org/

a secretariat to support Canadian engagement with Water Futures in order to build links to the international community and Future Earth and publicise the activities and achievements of the program with a particular emphasis on global cold regions, and enhance the contribution of strategic scientific and technological research and innovation to the sustainable management of the hydrological cycle, including rivers, glaciers, snowpacks, rivers, groundwater, permafrost and wetlands.

8.2. Howard Wheater Symposium

A landmark event to celebrate the achievement of the GWF Founding Program Director and Canada Excellence Research Chair in Water Security, to develop international strategy for GWF, and to develop vision and identify grand challenges in the field of hydrology of societal relevance. The symposium reflected on developments in hydrology, science and practice over the last 40 years, and projections of future directions for the next 40 years. Thirty-five leading international scientists shared their vision and provided valuable feedback to further the GIWS and GWF international agenda. [website]

8.3 Training

GIWS has developed two important new strategic educational initiatives in graduate education and training: 1) The NSERC *Collaborative Research and Training Experience (CREATE) Program in Water Security*, which commenced in September 2015 stimulates research Masters and PhD students to integrate science, engineering, and policy as they address current and future challenges in complex water systems. 2) Beginning in 2016, we are offering an innovative one-year professional Master of Water Security graduate program that provides intensive crosstraining to build disciplinary and interdisciplinary expertise for research and practice.

8.3.1. Notable Short Courses

Dr. Jeffrey McDonnell along with his colleagues Dr. Jan Seibert, University of Zurich and Dr. David Hannah, University of Birmingham delivered a short course on Catchment Science during summer of 2018. It is a 5-day short course that is intended for post-graduate students and post-docs interested in a hands-on catchment science curriculum, focusing on northern catchments, runoff processes and combined hydrometric, isotope/chemical tracer and modeling techniques in catchment hydrology. Enrollment in the class is limited to 30 students. The aim is for a hands-on course experience with a low student-teacher ratio.



Catchment Science Summer School – Course Participants

Dr. John Pomeroy with the assistance of the Canadian Society for Hydrological Sciences offered an intensive course on the physical principles of hydrology with particular relevance to Canadian conditions. Factors governing hydrological processes in Canadian landscapes were discussed including precipitation, interception, energy balance, snow accumulation, snowmelt, glaciers, evaporation, evapotranspiration, infiltration, groundwater movement and streamflow routing and hydraulics. These processes were framed within the context of distinctly Canadian landscape features such as high mountains, glaciers, peatlands, prairies, tundra, boreal forests, frozen rivers and seasonally frozen ground.

The course was focused on classroom instruction, but will take advantage of the proximity to the Marmot Creek Research Basin and the Canadian Rockies Hydrological Observatory to expose students to cold regions hydrological phenomenon, state of the art field instrumentation and measurement techniques. Each day the course started with lectures on the primary subject, and include time to work on assigned exercises.

The course is intended for hydrology and water resources graduate students and early to midlevel career water resource engineers, hydrologists, aquatic ecologists and technologists who are either working directly in hydrology and water resources or are looking to broaden their understanding of hydrological systems and processes. This physical science course is quantitative in nature and so a firm foundation in calculus and physics at the first year university level and some undergraduate hydrology or hydraulics training is strongly recommended.





Physical Principles of Hydrology – Course Participants

Dr. John Giesy completed his three year term as a visiting distinguished professor at the University of Hong Kong (HKU). He was in residence two months in each of three years, 2016, 2017 and 2018. He presented seminars to the School of Biology at HKU and also gave a public lecture and did a talk concert for the graduate students. He also gave seminars at City University of Hong Kong, Hong Kong Baptist University and the University of Macau. Each year he attended the annual meeting of the State Key Laboratory in Marine Pollution (SKLMP) for which he serves on the



Dr. John Giesy with the Leung Lab, with whom he conducted research

International Advisory Committee. He hosted several international scientists in each of the three years. In total he wrote 15 manuscripts and was able to be involved in a wide range of studies on pollutants that are being conducted at HKU as well as other universities in Hong Kong.

8.3.2. Career and Professional Development

GIWS strongly believes in professional development of graduate students and postdoctoral fellows, particularly international scholars. In order to achieve this objective, GIWS offers a short course on "The Future Professoriate," to shed light on and facilitate discussions regarding the workings of academia for graduate students and postdoctoral fellows interested in pursuing academic careers. In addition, we advise our student and postdoctoral fellows in "creating a

research brand" of their own ambitions and for a successful and satisfying research career^{3, 4, 5, 6,7,8,9}.

In addition, GIWS hosts a yearly Distinguished Lecture Series entitled "Breakthroughs in Water Security Research," ¹⁰ which brings 9 world-leading scientists to GIWS for lectures, tutorials and workshops in the areas of soil physics, instrumentation, lab experiments, uncertainty estimation,

hydro-ecological modeling, watershed networks, observatory instream flow modeling, engineering hydrology, aquatic ecosystem science, isotope hydrology and socio-hydrology. This lecture series provides students, postdoctoral fellows, faculty, staff and the broader community with an opportunity to understand breakthroughs in various areas of water security from a global perspective and network with international leaders. Each lecture is streamed live online and archived for subsequent access for the benefit of offinternational campus Canadian and participants which further expands the reach of the lecture series.



2018 Distinguished Lecturers

8.4 Major Conferences Hosted by GIWS Members

8.4.1 International Conference and 69th International Executive Council Meeting of the International Commission on Irrigation and Drainage

The conference was supported by Dr. Warren Helgason, Chemical and Biological Engineering (Organizing Committee Co-Chair), and Dr. Amin Elshorbagy, Civil, Geological and Environmental Engineering (Member of the Scientific Committee) who are both GIWS members.

The theme of the 69th annual ICID conference was "Innovative and Sustainable Agri-water Management: Adapting to a Variable and Changing Climate." The theme was explored in depth

³ McDonnell. 2015. Creating a research brand. Science 349(6249):758, doi: 10.1126/science.349.6249.758

⁴ McDonnell. 2016. Orchestrating a powerful group. Science 352(6283), doi: 10.1126/science.352.6283.378

⁵ McDonnell. 2016. The 1-hour workday. Science 353(6300):718, doi: 10.1126/science.353.6300.718

⁶ McDonnell. 2017. Paper writing gone Hollywood. Science 355(6320):102, doi: 10.1126/science.355.6320.102

⁷ McDonnell, J.J., 2017. The sustainable scientist. Science, 357 (6356): 1202. DOI: 10.1126/science.357.6356.1202.

⁸ Steelman, T., and McDonnell, J.J., 2017. Look for the leaders. Nature, 547, 483. DOI:10.1038/nj7664-483a.

⁹ Stein, S., J.J. McDonnell, and M.M. Miller, 2018. Discussing scientific ethics: what would you do?. Astronomy & Geophysics. 59 (4). DOI: 10.1093/astrogeo/aty187.

¹⁰ http://www.usask.ca/water/lecture-series.php

under three sub-themes during the technical sessions: Competing Water Demands; Resilient Agriculture – Adapting Agriculture to Climate Change; and Irrigation and Drainage in Perspective.



8.4.2 39th Canadian Symposium on Remote Sensing

The symposium was co-chaired by Dr. Karl-Erich Lindenschmidt with GIWS and the School of Environment and Sustainability. The meeting was intended to facilitate an exploration of ideas and forge productive partnerships in the area of remote sensing. Many new missions and new technologies are being developed and have been or will be deployed soon. Hence, the time is right to explore these new opportunities in more depth. These are exciting times for remote sensing research and applications in Canada. The soon to be launching of the RADARSAT Constellation Mission will mean a continued Canadian imaging microwave presence in space. Canada has also been actively participating in aereal surveys in preparation of the Surface Water and Ocean Topography mission. Canadians are also leaders in the development and application of airborne active and passive sensor technologies, multisensor UAV platform development that promises to revolutionize high resolution data acquisition and research. Applications from marine, arctic and northern surveillance, environmental modelling and monitoring, and resource exploration are also coming of age.

9. Performance Indicators

GIWS was created with the vision to attain research excellence at USask and become one of the world- leading research-intensive institutions in the area of water security. Intensive efforts have been invested to recruit members, recruit and retain HQP, develop internationally-recognized research facilities with cutting-edge instrumentation, find a niche in research, take on national and international science leadership roles, attract substantial additional research funding, develop leading training programs, gain recognition of research outcomes through peer reviewed publications, secure national and international awards and honours, and establish collaboration with industry, government and non-government organizations. Since inception, GIWS has made remarkable progress in each of these areas, and is now delivering the exciting science that was foreseen at the programme outset.

- 9.1 Membership: A key aim of GIWS is to develop the new science and new trans-disciplinary science integration that is needed to address the major challenges to water security faced locally, regionally and globally. GIWS now integrates expertise from 254 members (86 Members, 52 Associate Members, 3 Affiliate Members, and 108 Student Members) from 21 academic units across the USask, and has formed strong and mutually supportive working partnerships with Federal and Provincial agencies, in particular Environment and Climate Change Canada (ECCC) and the Saskatchewan Water Security Agency (SWSA) (Appendix A).
- 9.2 Support Staff: GIWS has grown under a policy of developing a lean and efficient administration, and only making new staff appointments when absolutely necessary. However the number of researchers and the level of research funding and facilities to be managed are large, and financial accounting requirements are quite onerous. Therefore, GIWS currently has a Director, Associate Director, GWF Program Director, Assistant Director, Director of Finance, GWF Science Manager, Executive Assistant and Director Facilities and Human Resources, Financial Officer, Communication Specialist, Knowledge Mobilization Specialist, Outreach Coordinator, Clerical Assistant, Data Manager, and Data Support (Appendix B).
- 9.3 Highly Qualified Personnel: During 2017-18, GIWS core faculty and its members have financially supported 114 graduate students (52 PhD and 62 Masters), 37 postdoctoral fellows, 94 research assistants, 17 research associates and scientists, and 17 research technicians and support personnel (Appendix B & C).
- **9.4 Research Funding:** To support our research and training endeavours, financial resources are critical. Healthy financial resources help attract and retain the 'best-of-the-best' from around the world, and help develop cutting edge research facilities. Therefore, another of the institute's main objectives has been the pursuit of research funding to leverage the base CERC funding of \$30 million over seven years. In 2017-18, GIWS faculty members have secured a total of \$13.9

million (64% federal sources, 16% provincial, 15% industry and 5% from international and USask sources) (Appendix D). Since March 2011, GIWS has secured a total funding of \$263.5 million (including the CFREF \$77.8 million) on top of the original \$30 million CERC investment.

9.5 Research Publications: In 2017-18, GIWS members have published 244 journal articles, including papers in Science and Nature, published and presented 184 papers in proceedings and at conferences, delivered 130 plenary, key note and invited lectures, and published 10 book chapters and books. Since 2011, GIWS members have published a total of 1509 journal articles and 77 books/book chapters, participated in 1158 conference proceedings and presentations and delivered more than 672 invited, key-note and plenary lectures to share research outcomes and enlighten our stakeholders and scientific community (Appendix E).

9.6 Awards and Honours: One of the measurable parameters for research and training excellence is the number of awards and honours received by GIWS members and students. Again

in 2017-18, we have achieved significant success in this area and are targeting to promote and support our members and students in pursuing strategic awards and honours in near future. It is a pleasure to recognize that GIWS currently has five Royal Society of Canada (RSC) Fellows, five American Geophysical Union (AGU) Fellows, two Prince Sultan Abdulaziz International Prize for Water (PSBAIPW) winners, Einstein Professor Chinese Academy of Science (CAS), and president of the 7500-member Hydrology Section of the AGU (see page 1 for details).



Royal Society Fellowship Award Ceremony, Halifax 2018; From left: Markus Hecker, Peta Bonham-Smith, John Giesy, Ingrid Pickering, Howard Wheater & George Graham

The current year was very successful year for GIWS members as three of them were recognized for their research by the USask. Dr. Jeffrey McDonnell, School of Environment and Sustainability (SENS) and Dr. Carl Gutwin, Computer Science have been awarded the Distinguished Researcher Award, which is the highest honour for research at USask. While Dr. Tim Jardine, SENS/Toxicology was awarded the News Researcher Award, which is presented annually to an outstanding new



Carl Gutwin - Spring 2018
Distinguished Researcher Award



Tim Jardine - Spring 2018 New Researcher Award



Jeffrey McDonnell - Fall 2018 Distinguished Researcher Award

scholar in recognition of their significant contributions to knowledge or artistic creativity (within 10 years of PhD completion).

Dr. Jeffrey McDonnell was also awarded the Leonardo Lecture, European Geophysical Union, EGU

Leonardo Conference, Saig, Germany, University of the Sunshine Coast, Visiting Professor Fellowship 2017-2019, and Distinguished Visiting Professor, Dept of Civil and Hydraulic Engineering, Tsinghua University.

Dr. Saman Razavi, SENS was awarded the GIWS Research Excellence Award for 2018 in recognition of his outstanding excellence in water security research as acknowledged by his peers based on his international stature, impact of research, training of highly qualified personnel, and research productivity.

Dr. John Giesy, Biomedical Sciences/ Toxicology recieved the *Erasmus Award* from the European Union. This award is to fund

a program between the USask and Masarek University in Brno of the Czech Republic. The funding paid for Dr. Markus Hecker and Dr. Giesy to spend 2 weeks teaching and doing research with colleagues at Masarek University and for Dr. Klara Hilscherova to come to the USask for two weeks to learn ecogenomics techniques and to analyze samples from the Antarctic. One of Dr. Hilscherova's students is in residence at USask for 6



Saman Razavi - GIWS Research Excellence Award Winner



John Giesy (middle), Klara Hilscherova (left), and Yuwei Xie (right) at the Experimental Lakes Area

months and in 2019 Dr. Giesy will spend two weeks teaching and conducting research at Masarek University.

Dr. Ingrid Pickering, Vice-Dean Research, College of Arts and Science has been appointed chair of the board of directors at the Canada Foundation for Innovation (CFI), an independent organization that invests in leading-edge infrastructure that researchers across Canada need to advance research and innovation. (June 2018 for three years). [Article]

Dr. Kerry McPhedran was awarded the Centennial Enhancement Chair in Water Stewardship for Indigenous Communities, Department of Civil, Geological & Environmental Engineering. His research expertise include, municipal wastewater, partitioning to organic matter, stormwater runoff, and recreational water quality.

Two of Dr. John Pomeroy's students were awarded prestigious scholarships from the natural Science and Engineering Research Council (NSERC) of Canada. Caroline Aubry-Wake was awarded NSERC Vanier Scholarship for \$150,000, while Holly Annand received NSERC Postgraduate Scholarship-Doctoral Scholarship for \$42,000.

Dyan Pratt, Research Engineer for the Mine Overlay Site Testing Facility working with Dr. Jeffrey McDonnell received The



Ingrid Pickering



Kerry McPhedran

American Society of Agricultural and Biological Engineers Superior Paper Award for her publication on the "Geochemical evolution and leachate transport beneath two carcass burial sites: a field investigation".



Caroline Aubry-Wake



Holly Annand



Dyan Pratt

At the annual meeting of the Candadian Geophysical Union (CGU) last month, Master's student Nick Dylla received the Top Student Oral Presentation, with PhD Candidate Dan Karran receiving the Top Student Poster Presentation. Both were competing in the Biogeosciences section.



(I-r) Murray Richardson, biogeosciences section president, Nick Dylla; Dan Karran, USask PhD candidate; Richard Petrone, CGU president

Dr. Lorne Doig, Research Scientist, Toxicology, Dr. Steven Mamet, Postdoctoral Fellow, Biology, and Mark Ferguson, Communication Specialist, GIWS won the the fourth annual University of Saskatchewan Images of Research Photo and Imaging Competition for the categories More that Meets the Eye (runner-up), Community and Impact (first place), and Best Description (first place), respectively.



Lorne Doig - Diatom Another Day



Steven Mamet - Citizen Scientists, Global Stewardship



Mark Ferguson - The Great Thaw

Student Corner

The GIWS Students and Young Researchers (GIWS-SYR) had an active year hosting and participating in many academic and social events during 2017-18. These events encouraged the building of teams, mingling of people, passage of knowledge and having just plain fun. Through active participation, members gained new friends, ideas, and an appreciation for teamwork. The following section has been organized in chronological order.

10.1 Movie Night: On January 18th, 2018 the GIWS-SYR organized a movie night at the USask, in coordination with the School of Environment and Sustainability Student Association (SENSSA). In this event, the documentary "Dam Nation" about the nations changing few on large dams in the country. It was clear that the students enjoyed the movie with complimentary pizza and drinks. The event was well attended by GIWS members and School of Environment and Sustainability students. It was a great way to bring the students community together and at the same time see discussion about climate change from other perspectives.

10.2 Christmas Party and Student Fundraiser: On December 7th, 2017 the GIWS hosted a Christmas party for students, members, and employees. GIWS-SYR group was active during the event and a 50/50- Donation-Prize ticket sale was done amongst attendees. A total of \$520.00 CAD was collected during the event and subsequently donated to Water Aid Canada, located at 321 Chapel Street, Ottawa, Ontario, K1N 7Z2, Canada. Moreover, an agreed collaborative event were separately held with the School of Environment & Sustainability Student Association (SENSSA) and Graduate Students Association (GSA). GIWS student members were invited to attend the GSA commons for their student Christmas event.

10.3 World Water Day and Trivia Night: On March 22nd, 2018 the GIWS-SYR was present for World Water Day 2018. The events of the day were very fulfilling and helped promote engagement with members from various water science sectors. There were talks conducted by previous GIWS-SYR committee member and President (2016-2017), Nicholas Dylla, MSc, and Prabin Rokaya, PhD. Following the talks, everyone mingled and viewed posters during the poster







Prabin Rokaya, PhD

presentation period. The World Water Day brought together an interdisciplinary group of researchers and students working in the fields of water resources and enable relevant discussions, exchanging valuable scientific knowledge.

Dr. Nikolas Aksamit received the Best Doctoral Thesis Award in Water Security Research for his thesis titled "Alpine Trubulance and Blowing Snow".

In the poster competition, Abdalla Karoyo, Department of Chemistry received the award for the best poster by a postdoctoral fellow titled "Renewable Carriers with Switchable Adsorption Properties". For the student category, Leila Dehabadi, PhD Department of Chemistry won the first place for her poster titled "Biomaterials for Sustainable Fractionation of Ethanol-Water Mixtures", Allyson Gehart, MSc Toxicology received second place for her poster titled "Toxicity of Aqueous L-Selenomethionine Exposure to Early Life-Stages of Fathead Minnows" and Magali Nehemy, PhD School of Environment and Sustainability received third place for her poster titled



Abdalla Karoyo



Leila Dehabadi



Allyson Gehart



Magali Nehemy

"Larix laricina and Picea mariana radial growth response to water table variability in a Saskatchewan peatland".

Following World Water day, the GIWS-SYR hosted a Trivia Night and Slide Karaoke. The night was entertained by Jay Maillet who played great songs using his carbonless (solar powered) sound system. Joined by many students from the School of Environment and Sustainability and GIWS student members, we conducted a water-themed trivia session and impromptu slide karaoke for the prize of a gift card.

10.4 Potluck: The potluck event occurred on February 23rd, 2018 at the NHRC Seminar Room. Individual GIWS members were asked to bring a home-cooked or store-purchased meal. There was an approximate turnout of 20 persons who brought different dishes of different cultures under one roof. This event had three winners who were appreciated by several prizes.

10.5 Volunteering at the ICID Conference: GIWS-SYR student member and MES with Dr. Saman Razavi, Kasra Keshavarz, participated in the ICID conference and volunteered to facilitate the sessions discussing irrigation and drainage issues. The ICID conference is held every year in different countries and gathers scientific and industrial communities together. The most recent ICID conference took place on August 12th-17th, 2017 in Saskatoon.

10.6 Breakfast: The event was done in an effort to add more socialization and breaks at the office. It was held on August 31st, 2018 in the NHRC Cafeteria (2nd floor). Continental breakfast event mainly was aiming to introduce new students of 'Master of Water Security' to the GIWS.

10.7 Student BBQ: The GIW-SYR held a fun barbecue on August 19th, 2018 on a warm, sunny day at the Saskatoon Forestry Farm. Besides enjoying great barbecue food, students were able to socialize and play some outdoor games. It was a good way to get students out and experiencing a staple of the city of Saskatoon.



GIWS Students at the Saskatoon Forestry Farm

10.8 GIWS-SYR Travel Award: The travel bursary was given to 4 successful graduate candidates. Official winners were awarded this bursary to assist with finances to a scientific conference during the fall or winter 2018. The recipients of the 2018 GIWS Travel Bursary/Award were Mr. Zhe Zang, Ms. Mahtab Nazarbakhsh, Mr. Apurba Das and Ms. Magali Nehemy. GIWS-SYR wanted to encourage students to engage in scientific events and share their work, besides improving communication skills and increasing the visibility of their research.

10.9 GIWS Students and Young Researchers (GIWS-SYR) Elections: On October 22nd, 2018 GIWS-SYR committee election was held. The executives were elected based on the applicants received in each position. Richard Helmle, MES student with Dr. Colin Whitfield was elected as the new president of GIWS student body. Richard previously serviced as a committee member in the GIWS-SYR group and coordinated efforts with the CWRA-SYP. Likewise, the other elected executives are:

 Vice President: Kasra Keshavarz (MES)

Secretary: Lijie Guo (PhD)

 Treasurer: Michelle Wauchope Thompson (PhD)

 Communications and Web Master: Amy Hergott (MES) and,

 Saskatchewan External: Laura McFarlen (MES)

We thank all members of the previous committee for the great year!



GIWS - Student Outreach Committee 2018-19

10.10 GIWS Election Results and Final Trivia Night: We had another great event on October 26th, 2017 at the University Club at USask. The GIWS Student Mixer event was organized to welcome new student members of GIWS and SENS. In this event, students were able to meet each other and interact over some games and appetizers. The event was also marked by the transition between the previous year GIWS-SYR committee and the recent elected members. Attendees participated in water-related trivia and presentation Karaoke slides. The funniest Karaoke presenter, Laila Balkhi, received one of the GIWS-SYR T-shirts.

11. Concluding Remarks

2017-2018 was another remarkable and productive year for GIWS and members. We have experienced exponential growth in terms of activities, members, and outcomes as evidenced by our "Performance Indicators", which we anticipate to continue in foreseen future. GIWS productivity and training programs are testaments of our commitment and excellence to advance the area of Water Security having local, national and global significance.

A significant effort has been invested in enhancing communication of our research outcomes and impact stories to society and stakeholders. GIWS will continue to capitalize upon ts momentum and will establish new and sustain existing collaborations of mutual benefit to local and international partners and communities. GIWS collaboration and outreach activities are listed in Appendix F.

In this brief overview of the recent work of GIWS it has not been possible to do full justice to the work of our members, and we encourage those interested to visit our web-site www.usask.ca/water or to contact our members directly. We welcome students and postdoctoral researchers to either join our team full time or spend time with us as visiting researchers and we also welcome academic colleagues for short or longer visits. Our Assistant Director, Dr. Phani Adapa phani.adapa@usask.ca is always available for contact regarding the work of GIWS and welcomes enquiries from individuals, governments, industry and others concerning research collaboration.

APPENDIX A - Current Membership

Members: Individuals working at a level of responsibility which includes initiating and leading water research activities. This may include, but is not limited to Faculty members at USask; Research Scientists, Staff Scientists, or Science Associates in recognized co-located (e.g. Saskatoon-based) research institutions (i.e. Environment Canada, Saskatchewan Research Council, Canadian Light Source, Agriculture and Agri-food Canada); and USask Research Scientists.

Abdelrasoul, Amira, Assistant Professor, Chemical and Biological Engineering Membrane Science and Technology for Energy and Water Sustainability; Process Modeling, Simulation and Optimization of Complex Systems; Nanomaterials for Advanced Technologies and Clean Energy

Achenbach, Sven, Professor, Electrical and Computer Engineering & Canadian Light Source Micro and Nanotechnology; Sensor Fabrication; Polymer Based MEMS; Micro and Nano Fluidics; IR-Transparent Fluid Cells; Nano Pore Based Sensing

Barbour, Lee, Professor, Civil and Geological Engineering Geotechnical/Geo-environmental: Saturated/Unsaturated Groundwater Flow and Contaminant Transport, Mine Waste Reclamation

Baulch, Helen, Assistant Professor, School of Environment and Sustainability Water quality; Aquatic ecology; Global change; Biogeochemical cycles; Greenhouse gas emissions; Eutrophication

Bedard-Haughn, Angela, Associate Professor, Soil Science

Study fundamental understanding of pedologic properties of Canadian ecosystems and how land use and climate changes affect, and are affected by, these properties

Belcher, Ken, Professor, Bioresource Policy, Business and Economics Ecological economics; Resource and environmental economics; Environmental policy; Climate change; Wetland and wildlife conservation policy

Bharadwaj, Lalita, Associate Professor, School of Public Health

Barriers and Key Issues to the Access of Safe and Sustainable Drinking Water Sources in First Nations Communities; Community Based Participatory Research with Indigenous Communities; Human and Environmental Health Risk Assessment; Community-Based Education

Bradford, Lori, Research Associate, Water Governance and Global Health Social psychological and social determinates of health including policy analysis which supports the Institute's goals of improving understanding of societal controls of water management

Brinkmann, Markus, Assistant Professor, School of Environment and Sustainability Exposure and Risk Assessment Modelling; Toxicokinetic Modelling; Aquatic Ecotoxicology

Cessna, Allan, Research Scientist, Agriculture and Agri-Food Canada Agricultural pesticides and veterinary pharmaceuticals

Chambers, Patricia, Research Scientist and Section Head, Environment Canada Human Impacts on Aquatic Ecosystems Processes

Chang, Won Jae, Assistant Professor, Civil and Geological Engineering Contaminated site assessment and remediation; Bioremediation of oil sands pollutants, mine wastes, frozen contaminated sites; Characterization of microbial communities/populations; Molecular biology techniques for contaminated environmental matrices

Chapra, Steve, Professor, Civil and Environmental Engineering, Tufts University
Water Quality Modeling, Numerical Methods, Advanced Computer Applications in
Environmental Engineering

Clark, Bob, Research Scientist and Adjunct Professor, Environment Canada Avian Ecology, Reproction and breeding habitate selection, Landscape ecology

Clark, Doug, Centennial Chair and Assistant Professor, School of Environment and Sustainability Polar bear-human conflicts; Decision-making under conditions of rapid social-ecological change; Wildlife and protected area management; Environmental governance and policy processes

Dalai, Ajay, Canada Research Chair in Bioenergy and Environmental Friendly Chemical Processes, Chemical and Biological Engineering
Renewable Energy; Heavy Oil and Gas Processing; Catalytic Reaction Engineering

Davison, Bruce, Research Scientist, Environment Canada

Hydrometeorological modelling, including incorporating physical or statistical processes into models; Operationalization of modelling tools; Incorporating software engineering tools into model development; Models for decision making

de Boer, Dirk, Research Scientist, Environment Canada Drainage basin; Suspended sediment; Fluvial geomorphology; Soil Erosion

Doig, Lorne, Research Scientist, Toxicology Centre

Bioavailability and toxicity of metals, including nanomaterials, in surface waters and sediments; Deriving environmental quality criteria (water, sediment, and tissue-based); Aquatic ecotoxicology; Aquatic paleoecotoxicology

Elliott, Jane, Research Scientist, Environment Canada

Soil processes; Soil-water interactions and agrochemical leaching; Impacts of management practices on water transport of nutrients and contaminants

Elshorbagy, Amin, Professor, Civil, geological and Environmental Engineering

Water Resources Engineering: Hydrinformatics - mechanistic & data-driven watershed modeling, soft-computing techniques; Multicriterion decision analysis, system dynamics

Evans, Marlene, Research Scientist and Adjunct Professor, Environment and Climate Change Canada and Department of Biology

Mercury; Lake acidification; Organic contaminants; Fish; Nitrogen

Famiglietti, James (Jay), Director GIWS, Professor and Canada 150 Research Chair in Hydrology and Remote Sensing

Hydrology; freshwater; groundwater; water availability; water security; water management; water policy; food security; transboundary water; remote sensing; satellites; computer models

Ferguson, Grant, Associate Professor, Civil, geological and Environmental Engineering Hydrogeology; Geothermal Energy; Climate Change

Fonstad, Terry, Associate Professor, Civil, geological and Environmental Engineering Ion exhange, groundwater, livestock, waste, nutrients, mass mortalities

Fulton, Murray, Professor and Graduate Chair, Johnson-Shoyama School of Public Policy Economics of biotechnology; Policy analysis of corruption; Performance of co-operatives

Giesy, John, Professor and Canada Research Chair in Environmental Toxicology Ecology; Ecotoxicology; Aquatic toxicology; Environmental analytical chemistry of organic compounds; Environmental chemistry (Fates of trace substances in aquatic ecosystems)

Gober, Patricia, Professor Emeritus, Johnson-Shoyama School of Public Policy Water policy; Sustainability science; Decision making under uncertainty; Urban systems; Human migration and population geography; Science-policy interface and stakeholder engagement; Applied climatology

Gray, Richard, Professor, Bioresource Policy, Business and Economics Agricultural trade; Agricultural marketing; Environmental economics

Hania, Patricia, Assistant Professor, College of Law Legal water governance models in Canada

Hecker, Markus, Associate Professor and Canada Research Chair in Predictive Aquatic Ecotoxicology

Investigation of biological effects of environmental stressors; Environmental risk assessment; Development and application of bioanalytical techniques to assess environmental pollution; Aquatic ecology/fish biology

Hassanzadeh, Elmira, Asistant Professor, Civil, Geological and Mining Engineering, Polytechnique Montreal

Integrated Water Resource Modeling and Management; Climate change Impact Assessment; Decision Making Under Uncertainty; Environmental Analysis; Sustainable Development; Cold Region Hydrology; System Dynamics; Evolutionary Algorithms

Helgason, Warren, Associate Professor, Civil, geological and Environmental Engineering Atmospheric boundary layer processes; Energy and mass transport in the soil-plant-atmosphere continuum; Irrigation

Hendry, Jim, Professor and NSERC-Cameco Industrial Research Chair

Aqueous and environmental geochemistry of contaminants in uranium tailings; Characterization of biogeochemical reaction rates in vadose zones; Fate and transport of solutes in aquitards; Sorption controls on the transport of bacteria in saturated porous media; Reactive barrier technologies

Hill, Harvey, Research Scientist, Agriculture and Agri-Food Canada Economics; Climate decision support and adaptation

Hobson, Keith, Research Scientist, Environment Canada

Conservation and management of boreal forest birds and other wildlife; Conservation and management of waterbirds with particular emphasis on the interactions between fish-eating birds and commercial and sport fisheries; Use of stable isotopes to track the source and fate of environmental contaminants in terrestrial and marine systems

Hogan, Natacha, Assistant Professor, Animal and Poultry Science

Aquatic toxicology; Sources and fate of aquatic contaminants; Aquatic animal health; Agricultural intensity and water quality

Howard, Allan, Manager, Agriculture and Agri-Food Canada

Adaptation techniques for drought and conditions of extreme wetness; Best practices for monitoring soil moisture; Models for assessing drought and for forecasting regional scale crop yield; Develop systems for accessing local and regional scale information on climate impacts

Hudson, Jeff, Professor, Biology

Biogeochemical cycles in aquatic ecosystems; Effects of food web structure, ultraviolet radiation, climate change and biodiversity on elemental cycling and energy flow

Ireson, Andrew, Associate Professor, School of Environment and Sustainability

Climate change and water security; Land-water management and environmental change; Sustainable development of natural resources

Janz, David, Professor, Veterinary Biomedical Sciences

Climate change and water security; Land-water management and environmental change

Jardine, Tim, Assistant Professor, School of Environment and Sustainability

Freshwater food webs; Applications of stable isotope analysis in ecology; Tropical floodplain hydrology and ecology; Contaminant biomagnification in aquatic ecosystems; Sources and fate of trace metals; Fish migration; Land-water and river-ocean connectivity

Johnstone, Jill, Associate Professor, Biology Climate change and water security

Jones, Paul, Associate Professor, School of Environment and Sustainability Land-water management and environmental change; Naphthenic Acid

Kells, Jim, Professor, Civil, geological and Environmental Engineering
Hydraulic Structures; Use of Rock in Hydraulic Engineering; Scour Processes in Cohesionless
Materials; Water Quality of Stormwater Runoff; Ecologically Engineered Systems

Kinar, Nicholas, Assistant Director, Smart Water Systems Laboratory Electronic Circuits; Mathematical Modelling; Intelligent Sensors; Near-surface Remote Sensing; Signal Processing; Embedded Systems

Laroque, Colin, Professor, College of Agriculture and Biorsource Climate change; Boreal ecosystems; Dendrochronology; Dendrochemistry; Dendrohydrology

Li, Yanping, Assistant Professor, School of Environment and Sustainability Regional climate modelling; Mesoscale dynamics; Boundary layer meteorology; Air-sea interaction

Liber, Karsten, Professor and Director, Toxicology Centre

Bioavailability and toxicity of metals, including nanomaterials, in surface waters and sediments; Deriving environmental quality criteria (water, sediment, and tissue-based); Aquatic ecotoxicology; Aquatic paleoecotoxicology

Lindenschmidt, Karl-Eric, Associate Professor, School of Environment and Sustainability Surface water quality modelling; River ice processes; Climate change and river morphology; Flood and flood risk management

Lindsay, Matt, Associate Professor, Geological Sciences and NSERC/Syncrude Industrial Research Chair in Mine Closure Geochemistry

Groundwater; Biogeochemistry; Mining management and reclamation

Lloyd-Smith, Patrick, Assistant Professor, Department of Agricultural and Resource Economics Water resource economics; Non-market valuation; Recreational demand modelling; Consumer decision-making; Ecosystem services; Hydro-economic modelling

Loring, Philip, Associate Professor, Geography, Environment and Geomatics, University of Guelph Rural water systems, Climate change, Food-water-energy nexus, Environmental health, Cumulative effects, adaptive capacity

Loukili, Youssef, Research Scientist, Global Water Futures

Water Models; Data Assimilation; Parameter Identification; Hydrometeorology; Forecasting; Weather Forcing Data; Land Surface Schemes; Surface Water; Watershed Hydrology; Hydraulics; Groundwater; Pollutant Transport; Protection Perimeters

Marsh, Phil, Canada Research Chair in Cold Regions Water, Wilfrid Laurier University Hydrologic processes and modelling of snowmelt and rainfall runoff in cold environments; Impact of climate change on water resources of the Canadian Arctic

Martz, Lawrence, Professor and Vice-Dean Faculty Relations, Arts & Science Soil erosion and sediment transport; Impacts of climate change on water use in the South Saskatchewan River Basin

McDonnell, Jeffrey, Professor and Associate Director, Global Institute for Water Security Watershed hydrology; Runoff processes; Modelling, Isotope hydrology

McKenzie, Marcia, Associate Professor and Director, Sustainability Education Research Institute Place, environment and sustainability

McPhedran, Kerry, Assistant Professor, Environmental Engineering Municipal wastewater, Partitioning to organic matter, Stormwater runoff, Recreational water quality

Meda, Venkatesh, Associate Professor, Chemical and Biological Engineering Water treatment system design and development

Morrissey, Christy, Assistant Professor, Biology

Ecotoxicology; Water pollution; River and wetland ecology; Freshwater biology; avian and aquatic ecotoxicology

Nazemi, Ali, Assistant Professor, Civil and Environmental Engineering, Concordia University Hydrology; Water Security and Climate Change; Coupled Human-Water Systems; Mathematical Modelling and Algorithm Development

Noble, Bram, Professor, Geography and Planning

Environmental impact assessment; Cumulative effects assessment; Strategic environmental assessment; Environmental planning and management; Environmental decision making

Patrick, Robert, Professor and Chair of Regional & Urban Planning Program, Geography & Planning

Water Policy and Governance; Watershed Planning and Management; Source Water Protection; Integrated Water Resource Management; First Nations access to safe Drinking Water; Regional Planning; Urban Water Issues

Pennock, Dan, Professor Emeritus, Soil Science Landscape-scale soil processes and the spatial pattern of soil properties **Pickering, Ingrid**, Professor and Canada Research Chair in Molecular Environmental Science Development of new synchrotron radiation techniques; Metals and metalloids transformation in the environment; Identification of toxicologically significant compounds in vivo

Pomeroy, John, Professor and Canada Research Chair in Water Resources and Climate Change Hydrological processes and modelling in mountain, prairie and arctic environments; Climate change, hydrology and water resources; Snow chemistry and ecology; Droughts in the Canadian Prairies; Cold regions hydrometeorological modelling and surface-atmosphere feedbacks

Razavi, Saman, Assistant Professor, School of Environment and Sustainability Environmental and Water Resources Systems Planning and Management; Hydrologic and Groundwater Models Development and Calibration; Single- and Multi-objective Optimization and Uncertainty Analysis; Climate Change and Impacts on Hydrology and Water Resources; Reconstruction of Paleo-hydrology – Implications for Climate Change Analysis; Short-term and Long-term Rainfall and runoff forecasting; Surrogate Modeling, Artificial Intelligence, and Machine Learning

Reed, Maureen, Professor, School of Environment and Sustainability

Environmental Governance; Sustainability of Rural Communities; Feminist and Gender-based Analysis; Social Resilience; Political Ecology; Forestry; Model Forests; Biosphere Reserves; National Parks

Sagin, Jay, Assistant Professor, Department of Engineering, School of Engineering, Nazarbayev University, Kazakhstan

Applications of Earth Observation Satellites (EOS); Geographic Information System (GIS), integrated surface and groundwater modeling

Shook, Kevin, Research Scientist and SGI Canada Research Fellow, Geography and Planning Snowmelt modelling; Fractal analysis of hydrological phenomena; Flood modelling and extreme events analysis

Si, Bing, Professor, Soil Science

Understand the mechanisms of soil water dynamics and thermal regimes in non-level landscapes—at the pedon, hillslope (catchment) and landscape scale

Soltan, Jafar, Professor, Chemical and Biological Engineering Emerging pollutants in water; ozone in water treatment; catalytic ozonation in water treatment; advanced oxidation; industrial wastewater treatment; environmental catalysis

Spence, Christopher, Research Scientist, Environment Canada

Hydrology and hydrometeorology of Canada's cold regions, especially the subarctic Canadian Shield; Hydrological processes in the Prairie Pothole region of Saskatchewan

Spiteri, Raymond, Professor, Computer Science

Numerical Analysis; Scientific Computing; High-performance Computing; Scientific Software; Optimization; Efficient time-stepping methods for differential equations; Problem-solving software Environments; Global optimization; Simulation of physical systems

St-Maurice, Jean-Pierre, Canada Research Chair in Environmental Sciences, Arts and Science Atmospheric electricity; Space weather; Geophysical fluid dynamics; Atmospheric evolution; Climate change

Strickert, Graham, Assistant Professor, School of Environment and Sustainability He is a social-systems scientist specializing in hazards, with an interest in how human behaviours influence the environment around us, especially in light of extreme environmental events.

van der Kamp, Garth, Research Scientist, Global Institute for Water Security Impacts of climate changes and land-use changes on prairie wetlands and lakes; Evaluation of groundwater availability and sustainability; Impacts of groundwater withdrawals on aquatic ecosystems; Groundwater flow and solute transport in low -permeability formations; Study of the hydrology of peatlands

van Rees, Ken, Professor, Soil Science Agroforestry and biomass energy systems and their impacts on soils

Westbrook, Cherie, Associate Professor, Geography and Planning Wetland Ecohydrology; Effect of beavers and humans on pathways between surface and ground waters; Transport of water and nutrients from wetlands and riparian areas

Wheater, Howard, Professor, Canada Excellence Research Chair in Water Security, and Director, Global Institute for Water Security

Hydrological processes and modelling, with applications to the management of flood risk, water resources, water quality, wastes and climate change adaptation

Wheaton, Elaine, Senior Research Scientist, Saskatchewan Research Council Climatology; Climate impacts and adaptation; Climate change; Hazards climatology

Whitfield, Colin, Assistant Professor, School of Environment and Sustainability Atmospheric pollution, Hydrochemistry, Catchment modelling, Hydrology, Biogeochemistry

Wilson, Lee, Associate Professor, Chemistry

Water, Solution Chemistry, Hydration Phenomena, Polymers, Biomaterials, Membranes, Porous Materials, Colloids & Surfactants, Materials & Environmental Science, and Chemical Separations

Wittrock, Virginia, Research Scientist, Saskatchewan Research Council Climatology; Climate impacts and adaptation; Climate change; Hazards climatology

Yang, Daqing, Research Scientist, Environment Canada

Global water resources and availability; Climate change; Extreme hydrological events; Human impact on water systems; Arid and cold region hydrology

Associate Members: Individuals who are making a significant contribution to water research or who are providing support for water research activities in areas relevant to GIWS. This may include, but is not limited to USask research staff (e.g. Research Associates, Research Assistants, Research officers or Postdoctoral fellows); Research staff from recognized national or international research institutions who are affiliated with a member of the Institute; and Professional affiliates — professional individuals who may not hold a PhD, but who can serve on graduate student advisory committees and/or teach graduate courses.

Ali, Melkamu, Postdoctoral Fellow, Global Institute for Water Security Hydrology, Subsurface, Solute transport, Groundwater, Physically based model, Snowmelt, Surface flow

Alimezelli, Hubert Tote, Postdoctoral Fellow, Integrated Training Program in Infectious Diseases, Food Safety and Public Policy Water quality, water safety, water security, and health implications in First Nation communities

Ameli, Ali, Postdoctoral Fellow, Global Institute for Water Security
Hydrology & Hydrogeology, Groundwater Ecohydrology, Contaminant Hydrogeology & Applied
Hydro-geochemistry, Water-Energy Nexus, Contaminant Fate and Transport, Multi-Phase Flow
Through Porous Media, Environmental Isotopes, Water Resources Planning, security and
Restoration, Water Resources and Environmental Engineering

Anis, Muhammad Rehan, Postdoctoral Fellow, Global Institute for Water Security Climate change impact, Distributed hydrological modelling, Statistical downscaling, Disaggregation of climate variables, Sensitivity and uncertainty analysis

in Saskatchewan and the Yukon

Apples, Willemijn, Postdoctoral Fellow, Global Institute for Water Security Vadose zone; groundwater; infiltration; recharge; solute transport

Asong, Zilefac Elvis, Postdoctoral Fellow, Global Institute for Water Security Physical and regional climatology; the impact of climate change on hydrological regimes and water resources under non-stationarity; development of statistical downscaling models for downscaling of AOGCM output; regional flood frequency and risk analysis; seasonal hydrological forecast; analysis of drought characteristics; weather generation for water and agricultural applications

Bahremand, Abdolreza, Associate Professor, Watershed Management Department, Gorgan University of Agricultural Sciences and Natural Resources
Physics/Process based distributed hydrological modelling; Flood simulation

Carr, Meghan, Postdoctoral Fellows

River ecology; Fluvial Geomorphology; Sediment & contaminant transport; In-stream flow needs; Fish habitat

Chu, Yin, Visiting Scholar, Civil and Geological Engineering
Watershed Modeling; Water Quality; Hydrology; Forest Watershed; Water Pollution Control

Chun, Kwok Pan, Assistant Professor, Department of Geography, Hong Kong Baptist University Hydrology; Statistics; Climate change

Da Costa, Diogo Andre Pinho, Postdoctoral Fellow, Department of Geography and Planning Agricultural land management in the Canadian Prairies

Do, Nhu Cuong, Postdoctoral Fellow

Water Resources Management; Water Distribution Systems; Uncertainty; Sensitivity Analysis; Optimization; Stochastic Models

Diodato, Nazzareno, Fellow Geoscientist, HyMex, Hydrological Mediterranean Experiment, Met European Research Observatory

Climate; Hydrology; Water resources; GIS; Geostatistics; Modelling

Elshamy, Mohamed, Research Associate, Global Institute for Water Security Climate change, Satellite hydrology, Water resources modelling, Flood forecasting, Downscaling, Land surface schemes

Ghanbarpour, Reza, Water Allocation Modeller, Alberta Energy and utilities Board Flood-risk modelling, Watershed hydrology, Decision analysis, Optimization

Gharari, Shervan, Postdoctoral Fellow, School of Environment and Sustainability How information is translated into the model via assumptions on model structure, model parameterization and model parameters.

Gooding, Raea, Research Assistant, College of Agriculture and Bioresources Agriculture; Wildlife; Community engagement; Stewardship; Conservation; Outreach

Karoyo, Abdalla, Postdoctoral Fellow, Department of Chemistry, College of Arts and Science, University of Saskatchewan

Environmental Remediation; Water-Treatment; Materials Science; Structure and function of Biopolymers

Haghnegahdar, Amin, Postdoctoral Fellow, Global Institute for Water Security, and Program Manager for IMPC-GWF-CFREF

Land surface-Hydrological Modeling, Model Sensitivity and Uncertainty Assessment, Model Calibration/Validation

Harder, Phillip, Postdoctoral Fellow

Cold-region hydrology; Agriculture; Snow; Land-atmosphere interactions; Unmanned aerial vehicles

He, Zhihua, Postdoctoral Fellow

Hydrological modelling; Snow and ice melt runoff; Remote sensing; Uncertainty analysis

Hosseini, Nasim, Research Associate, Global Institute for Water Security Water quality modelling of surface water, model calibration, model validation, and sensitivity analysis

Janzen, Kim, Research Associate, Global Institute for Water Security Analysis and post processing of stable isotope data

Kehoe, Michael, Postdoctoral Fellow, School of Environment and Sustainability Water quality; Ecological modeling; Toxic cyanobacteria blooms; Monitoring; Data mining

Keim, Dawn, Postdoctoral Fellow, Global Institute for Water Security Recharge processes; hydrogeology; unsaturated flow processes; contaminant transport

Leroux, Nicolas, Postdoctoral Fellow, Centre for Hydrology Improving the understanding and modelling of heat and mass flow through snow at different scales

Li, Lintao, Postdoctoral Fellow

Convection-permitting WRF Simulations; Hydrological Extremes; Water Cycle; Moisture Source Tracing; Climate Prediction

Li, Zhi, Professor, Northwest A&F University, China Impact assessment of climate change on streamflow, Weather generator, Groundwater recharge, Isotope hydrology

Mahaninia, Mohammad, Research Assistant, Department of Chemical and Biological Engineering, College of Engineering, University of Saskatchewan Water purification; Adsorption process; Phosphate/arsenate removal; Polymer modification; Biomass treatment

Mahmood, Taufique, Assistant Professor, University of North Dakota Hydrology; water quality; remote sensing

Mamet, Steven, Postdoctoral Fellow, Department of Biology Effect of climate and environmental change on tree line dynamic

Manandhar, Sujata, Postdoctoral Fellow, School of Environment and Sustainability, University of Saskatchewan

Community-based and Integrated Water Management; Water Poverty; Indigenous Knowledge Integration in Water Management; Water Education; Climate Change Adaptation

Mantyka-Pringle, Chrystal, Postdoctoral Fellow, School of Environment and Sustainability Conservation planning; biodiversity; Land-use change; Climate change; Environmental decision-making; Prioritization; Water management

Morales Marin, Luis Alejandro, Postdoctoral Fellow

River water-quality; Hydrological modelling; Lake Hydrodynamics; Transport of solutes in river catchments

Mekonnen, Balew, Postdoctoral Fellow, Centre for Hydrology, University of Saskatchewan Prairie Hydrology; Watershed Modelling; Wetland Dynamics; Climate Change; Land Use Change

Mohamed, Mohamed, Research Associate, Department of Chemistry
Oil sands process water remediation, Sequestration of agrochemicals from environmental waters, Removal of organic pollutants from aqueous media

Musselman, Keith, Postdoctoral Fellow, Centre for Hydrology, University of Saskatchewan Hydrology; Water Resources; Snow; Hydrometeorology

Nachshon, Uri, Research Scientist, The Jacob Blaustein Institute for Desert Research, Ben-Gurion University of the Negev, Isreal

Hydrology, Vadose zone, Salinization, Land-atmosphere interaction, Salt dynamics, Evaporation

Nazemi, Ali, Assistant Professor, Concordia University, Montreal Water resources modelling and management under climate change conditions

North, Rebecca, Assistant Professor, University of Missouri Utrophication issues; Phytoplankton physiology and ecology; Land use practices and nutrient bioavailability; Nutrient limitation of algae; Aquatic biogeochemistry

Pan, Xicai, Postdoctoral Fellow, Global Institute for Water Security Hydrology; Cryosphere; Climate; Soil physics; Hydrogeophysics

Pedinotti, Venessa, Postdoctoral Fellows, Global Institute for Water Security
Using modelling to better understand the large scale interactions between the multiple components of the water cycle

Pernica, Patricia, Postdoctoral Fellow, Global Institute for Water Security Lake-atmosphere interaction; physical limnology; modelling; mixing dynamics

Richard, Dominique, Postdoctoral Fellow, Centre for Hydrology, University of Saskatchewan Streamflow; Lake; River; Forecast; Flood

Rokaya, Prabin, Postdoctoral Fellow

Hydrology; Water Resources; River Ice Processes; Watershed Modelling; Flood Risk Management; GIS and Remote Sensing

Ryan, Christopher, Visiting Scientist & Director, Operations, Environment Canada and Tundra Energy Marketing Limited

Environmental forensics; Athabasca oils sands; Synchrotron radiation; Absorption spectroscopy; Naphthenic acids; Petroleum Coke; Mine drainage; Industrial effluent

Tesemma, Zelalem, Postdoctoral Fellow, Centre for Hydrology, University of Saskatchewan Data assimilation; Watershed hydrology; Watershed and river modelling; Climate and land use change

Wayand, Nicholas, Postdoctoral Fellow, Centre for Hydrology, Department of Geography and Planning

Vetting and diagnosing current issues in model representation of critical snowpack processes that impact the hydrology of Canada

Wong, Jeff, Postdoctoral Fellow, Global Institute for Water Security Development of large-scale hydrological models

Xu, Li, Postdoctoral Fellow, Global Institute for Water Security

Complex systems analysis with specific focuses on socio-hydrology and social-ecological systems of rivers and lakes; Sustainability and resilience sciences and their integration; Risk assessment and management in response to natural disasters; and Science-policy interface in environmental contexts

Yeteman, Omer, Lecturer, Environmental Engineering, The University of Newcastle, Australia Ecohydrology; Geomorphology; Vegetation dynamics; Landscape evolution

Affiliates: Distinguished individuals who have a demonstrable commitment to the goals and objectives of GIWS's SaskRB program. Affiliates are generally positioned outside traditional research environments.

Halliday, Bob, Senior Vice President, Chief Financial Officer, Applied Materials, Inc.

Lamb, Susan, Chief Executive Officer, Meewasin Valley Authority and Chair of VIDO/Intervac liaison Committee

Sandford, Bob, EPCOR Chair of the Canadian Partnership Initiative in support of United Nations "Water for Life" Decade, Director of the Western Watersheds Research Collaborative

Student Members: Students registered at a postsecondary institution who are engaged in water-related research activities, and who are under the supervision or co-supervision of a GIWS member, or any graduate or undergraduate student registered at the University of Saskatchewan.

Glossary: MSc – Master of Science; PhD – Doctor of Philosophy; MSEM – Master in Sustainable Environmental Management; MPP – Master of Public Policy; MES – Master of Environment and Sustainability; MPH – Master of Public health; MPA – Master of Public Administration; SENS – School of Environment and Sustainability; JSGS – Johnson Shoyama Graduate School of Public Policy; SPH – School of Public Health

Name	College/ School	Supervisor	Degree
Abdelhamed, Mohamed	Civil Engineering		PhD
Abirhire, Oghenemise	Biology	J. Hudson	Masters
Abu, Razak	SENS	M. Reed	PhD
Adesokan, Adedoyonsola	SENS		MSEM
Aghbolaghy, Mostafa	Chemical & Biological Engineering	J. Soltan	PhD
Ahmed, Hafiz	Chemical & Biological Engineering	W. Helgason	MSc
Akomeah, Eric	SENS	K. Lindenschmidt	PhD
Aksamit, Nikolas	Centre for Hydrology	J. Pomeroy	PhD
Alam, Md. Shahbul	Civil & Geological Engineering	A. Elshorbagy	MSc
Amin, Mahmud Rashedul	Civil & Geological Engineering	K. Mazurek	MSc
Amos, Mike	Civil & Geological Engineering	L. Barbour	
Anderson, Emily	Geography	J. Pomeroy	MSc
Annand, Holly	Geography & Planning	J. Pomeroy	PhD
Armstrong, James	Biology	N. Chilton	MSc
Armstrong, Maria	Geography & Planning	H. Baulch	MSc
Aubry-Wake, Caroline	Geography & Planning	J. Pomeroy	PhD
Awume, Bennet	SENS		MSEM
Baer, Thomas	Civil & Geological Engineering	L. Barbour	MSc
Bagatim, Tabata	SENS	M. Hecker	MSc
Baijius, Warrick	Geography & Planning	R. Patrick	MA
Bam, Edward	SENS	A. Ireson	PhD
Beitel, Shawn	Toxicology	P. Jones	MSc
Bell, Kaitlyn	SENS		MWS
Berry, Pamela	SENS	K. Lindenschmidt	MES
Bertoncini, Andre	Geography & Planning		PhD

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Bihum, Samantha	Arts & Science		Undergraduate
Boyer, Lisa	SENS	H. Baulch	MSc
Brockman, Keenan	SENS		MWS
Brown, Robin	Soil Sc.	A. Bedard-	MSc
		Haughn	
Brown, Robyn	Arts & Science		Undergraduate
Bruce, Kristin	JSGS	P. Gober	MPP
Buchanan, Astri	SENS	M. Reed	MES
Budhathoki, Sujata	SENS	A. Ireson	MES
Burke, Amanda	SENS	H. Wheater	MES
Burlock, David	Arts & Science		Undergraduate
Cavaliere, Emily	SENS	H. Baulch	PhD
Chowdhury, Rocky	Civil & Geological Engineering	K. Mazurek	MSc
Coccola, Carley	SENS		MWS
D'Silva, Lawrence	Toxicology	K. Liber	MSc
Das, Apurba	SENS	K-E.	MES
		Lindenschmidt	
David, Cody	Soil Science	W. Helgason	MSc
Dehabadi, Leila	Chemistry	L. Wilson	PhD
DeMars, Shelby	Civil & Geological Engineering	A. Ireson	MSc
Demuth, Brandon	Biology	D. Chivers	PhD
De Toledo, Mauro	SENS		PhD
Bevilacqua			
Dobrovolskaya,	SENS	B. Si	MES
Yekaterina			
Dylla, Nicholas	SENS	H. Baulch	PhD
Dudiak, Scott	Arts & Science		Undergraduate
Eamen, Leila	SENS	S. Razavi	PhD
Elliott, Carlie	SENS		MES
Ferdous, Jannatul	Chemical & Biological	W. Helgason	PhD
	Engineering		
Flemke, Jason	SENS		MSc
Ford, Lorelei	SENS	L. Bharadwaj	MES
Franco, Jorge Garcia	GIWS	A. Ireson	Visiting UG
Garvey, Phillip	Soil Science	S. Siciliano	PhD
Ghoreishi, Seyed	SENS		PhD
Mohammed			
Gibb, Josh	SENS	K. Mazurek	PhD
Gibson, Randie	SPH		MPH
Gilmour, Kim	Arts & Sc.		Undergraduate
Gillio Meina, Esteban	Toxicology Centre	K. Liber	PhD
Gonda, Jordan	Civil & Geological Engineering	A. Elshorbagy	MSc
Green, Derek	Toxicology Centre	D. Janz	MSc
Guo, Lijie	Civil Engineering		PhD
			

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	Guselle, John	SENS		MWS
	Hatzel, Kayla	Arts & Science		Undergraduate
	Head, Kerry	Biology	J. Hudson	MSc
	Helmle, Richard	SENS		BSc
	Hoemsen, Greg	SENS		MWS
	Huang, Ya	SENS		PhD
	Imtiazy, Md Noim	Biology	J. Hudson	MSc
	Iuliano, Devin	SENS		MWS
	Javid, Hammad	SENS	K. Lindenschmidt	PhD
	Kamal, Mostofa	SENS		PhD
	Keshavarz, Kasra	SENS		MES
	Kurkute, Sopan	SENS	Y. Li	PhD
	Lakhanpal, Anchit	Civil & Geological Engineering	Elshorbagy/Razavi	PhD
	Lang, Zachary	SENS		MES
	Leach, Nigel	Environmental Engineering		
	Li, Yiwen	SENS	Y. Li	MSc
	Maangold-Doring, Annika	SENS		MSc
	Marsh, Chris	Geography	Pomero/	
	McFarlan, Laura	SENS		MES
	Mkandla, Herbert	SENS		MWS
	Nazarbakhsh, Mahtab	SENS	A. Ireson	PhD
	Nehmey, Magali	SENS	J. McDonnell	PhD
	Newman, Kevin	Geography & Planning		MSc
	Phelan, Nicholas	SENS		MWS
	Pradhananga, Dhiraj	Centre for Hydrology	J. Pomeroy	PhD
	Qin, Kaixuan	Geological Sciences	M. Lindsay	MSc
	Rabiul Hasan,	Electrical & Comp Eng	·	MSc
	Mohammed	· -		
	Rahman, Rashadur	Ag & Bioresource Economics	P. Lloyd-Smith	MSc
	Raine, Taya	SENS		MWS
	Robinchaud, Hailey	Geography & Planning		MSc
	Safaei, Sahar	SENS	S. Razavi	MSc
	Sanyal, Palash	SENS		MWS
	Scaff, Lucia	SENS	Y. Li	PhD
	Sen, Pritam	Mechanical Engineering		BE
	Sheikholeslami, Razi	GIWS	S. Razavi	PhD
	Staines, Cob	Geography & Planning		MSc
	Terry, Juli	SENS	H. Baulch/ K.	PhD
			Lindenschmidt	
	Thapa, Anuja	SENS		MES
	Tipman, James	Civil & Geological Engineering	L. Barbour	MSc
	Van Hoy, Diane	Civil Engineering		PhD
	Wan, Lixuan	Electrical & Comp Eng		BE
-				

Wauchope-Thompson,	SENS	H. Baulch	PhD
Michelle			
Weber, Darian	Arts & Science		Undergraduate
Zaghloul, Mohanad	Civil Engineering		PhD
Zhang, Fan	SENS	K. Lindenschmidt	PhD
Zhang, Zhe	SENS		MES

APPENDIX B – GIWS Core Faculty, Staff and Highly Qualified Personnel 2017-2018

The following table provides information on GIWS employees and students funded during the period of 2017-18. A total of 188 personnel were funded during this period, including 15 GIWS faculty members, 12 administrative staff, 10 research technicians, 43 research assistants/ staff, 1 research scientist, 5 research associates, 28 postdoctoral fellows, 42 doctoral students, and 32 masters' students.

Baulch, Helen Associate Professor SENS Brinkmann, Markus Assistant Professor SENS/ Toxicology Famiglietti, James Professor and Director GIWS SENS/ Arts & Science Ireson, Andrew Associate Professor SENS/ Engineering Li, Yanping Assistant Professor SENS/ Engineering Li, Yanping Assistant Professor SENS/ Arts & Science Lindenschmidt, Karl-Erich Associate Professor SENS Llyod-Smith, Patrick Assistant Professor Agriculture & Bioresources Papalexiou, Simon Assistant Professor Engineering Pomeroy, John Professor and Director GWF Arts & Science Razavi, Saman Assistant Professor SENS/ Engineering Schuster-Wallace, Corinne Associate Professor Arts & Science McDonnell, Jeffrey Professor and Associate Director GIWS Wheater, Howard Professor and CERC Laureate SENS/ Engineering Whitfield, Colin Assistant Professor SENS/ Engineering Whitfield, Colin Assistant Director SENS/ Engineering Braatan, Morgan Outreach Coordinator J. Famiglietti/ J. Pomeroy DeBeer, Chris GWF Science Manager J. Pomeroy Dumanski, Stacey Outreach Coordinator (on mat. leave) Dumanski, Stacey Outreach Coordinator (on mat. leave) McDonnell, Veva Business Development Officer - 0.6 FTE J. Famiglietti/ J. Pomeroy McDonnell, Veva Business Development Officer - 0.6 FTE J. Famiglietti/ J. Pomeroy Onclin, Joni Executive Assistant J. Famiglietti/ J. Pomeroy Onclin, Joni Executive Assistant J. Famiglietti/ J. Pomeroy Onclin, Joni Executive Assistant J. Famiglietti/ J. Pomeroy Dreterson, Amber Data Manager J. Famiglietti/ J. Pomeroy Data Manager J. Famiglietti/ J. Pomeroy Data Manager J. Famiglietti/ J. Pomeroy Dreterson, Amber Data Manager J. Famiglietti/ J. Pomeroy	Name	Title/Area	Supervisor/Unit
Brinkmann, Markus Assistant Professor SENS/ Toxicology Famiglietti, James Professor and Director GIWS SENS/ Arts & Science Ireson, Andrew Associate Professor SENS/ Engineering Li, Yanping Assistant Professor SENS/ Arts & Science Lindenschmidt, Karl-Erich Associate Professor SENS Llyod-Smith, Patrick Assistant Professor Agriculture & Bioresources Papalexiou, Simon Assistant Professor Engineering Pomeroy, John Professor and Director GWF Arts & Science Razavi, Saman Assistant Professor SENS/ Engineering Schuster-Wallace, Corinne Associate Professor Arts & Science Martz, Lawrence Professor Arts & Science McDonnell, Jeffrey Professor and Associate Director GIWS Wheater, Howard Professor and CERC Laureate SENS/ Engineering Whitfield, Colin Assistant Professor SENS Administrative Staff Adapa, Phani Assistant Director J. Famiglietti/ J. Pomeroy DeBeer, Chris GWF Science Manager J. Pomeroy Dumanski, Stacey Outreach Coordinator (on mat. leave) J. Pomeroy Dumanski, Stacey Outreach Coordinator (on mat. leave) J. Famiglietti/ J. Pomeroy Martel-Andre, Michelle Executive Assistant J. Famiglietti/ J. Pomeroy McDonnell, Veva Business Development Officer - 0.6 FTE McSchae, Kelly Director of Finance J. Famiglietti/ J. Pomeroy Olauson, Sherry Clerical Assistant J. Famiglietti/ J. Pomeroy Onclin, Joni Executive Assistant J. Famiglietti/ J. Pomeroy Peterson, Amber Data Manager J. Famiglietti/ J. Pomeroy Truong, Viet Financial Officer J. Famiglietti/ J. Pomeroy	Core Faculty		
Famiglietti, James Professor and Director GIWS SENS/ Arts & Science Ireson, Andrew Associate Professor SENS/ Engineering Li, Yanping Assistant Professor SENS/ Arts & Science Lindenschmidt, Karl-Erich Associate Professor SENS Agriculture & Bioresources Papalexiou, Simon Assistant Professor Engineering Pomeroy, John Professor and Director GWF Arts & Science SENS/ Engineering Pomeroy, John Professor and Director GWF Arts & Science SENS/ Engineering Pomeroy, John Assistant Professor SENS/ Engineering Schuster-Wallace, Corinne Associate Professor Arts & Science Martz, Lawrence Professor Arts & Science McDonnell, Jeffrey Professor and Associate Director GIWS SENS Wheater, Howard Professor and CERC Laureate SENS/ Engineering Sthuster-Wallace, Colin Assistant Professor SENS Administrative Staff Administrative Staff Adapa, Phani Assistant Director J. Famiglietti/ J. Pomeroy DeBeer, Chris GWF Science Manager J. Pomeroy Dumanski, Stacey Outreach Coordinator (on mat. leave) J. Pomeroy Dumanski, Stacey Outreach Coordinator (on mat. leave) J. Famiglietti/ J. Pomeroy Martel-Andre, Michelle Executive Assistant J. Famiglietti/ J. Pomeroy McDonnell, Veva Business Development Officer - 0.6 FTE McShane, Kelly Director of Finance J. Famiglietti/ J. Pomeroy Olauson, Sherry Clerical Assistant J. Famiglietti/ J. Pomeroy Onclin, Joni Executive Assistant J. Famiglietti/ J. Pomeroy Onclin, Joni Executive Assistant J. Famiglietti/ J. Pomeroy Deteron, Amber Data Manager J. Famiglietti/ J. Pomeroy Truong, Viet	Baulch, Helen	Associate Professor	SENS
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Papalexiou, Simon Assistant Professor Engineering Pomeroy, John Professor and Director GWF Arts & Science Razavi, Saman Assistant Professor SENS/ Engineering Schuster-Wallace, Corinne Associate Professor Arts & Science Martz, Lawrence Professor Arts & Science McDonnell, Jeffrey Professor and Associate Director GIWS SENS Wheater, Howard Professor and CERC Laureate SENS/ Engineering Whitfield, Colin Assistant Professor SENS Administrative Staff Adapa, Phani Assistant Director J. Famiglietti/ J. Pomeroy Braatan, Morgan Outreach Coordinator J. Pomeroy DeBeer, Chris GWF Science Manager J. Pomeroy Dumanski, Stacey Outreach Coordinator (on mat. leave) J. Pomeroy Ferguson, Mark Communications Specialist J. Famiglietti/ J. Pomeroy Martel-Andre, Michelle Executive Assistant J. Famiglietti J. Pomeroy McDonnell, Veva Business Development Officer - 0.6 FTE J. Famiglietti McShane, Kelly Director of Finance J. Famiglietti J. Pomeroy Olauson, Sherry Clerical Assistant J. Famiglietti J. Pomeroy Olauson, Sherry Clerical Assistant J. Famiglietti J. Pomeroy Onclin, Joni Executive Assistant J. Pomeroy Peterson, Amber Data Manager J. Famiglietti J. Pomeroy Truong, Viet Financial Officer J. Famiglietti J. Pomeroy	Lindenschmidt, Karl-Erich	Associate Professor	SENS
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Razavi, Saman Assistant Professor SENS/ Engineering Schuster-Wallace, Corinne Associate Professor Arts & Science Martz, Lawrence Professor Arts & Science McDonnell, Jeffrey Professor and Associate Director GIWS SENS Wheater, Howard Professor and CERC Laureate SENS/ Engineering Whitfield, Colin Assistant Professor SENS Administrative Staff Adapa, Phani Assistant Director J. Famiglietti/ J. Pomeroy Braatan, Morgan Outreach Coordinator J. Pomeroy DeBeer, Chris GWF Science Manager J. Pomeroy Dumanski, Stacey Outreach Coordinator (on mat. leave) J. Famiglietti/ J. Pomeroy Ferguson, Mark Communications Specialist J. Famiglietti/ J. Pomeroy Martel-Andre, Michelle Executive Assistant J. Famiglietti/ J. Pomeroy McDonnell, Veva Business Development Officer - 0.6 FTE J. Famiglietti McShane, Kelly Director of Finance J. Famiglietti/ J. Pomeroy Moradi, Laleh Data Support J. Famiglietti/ J. Pomeroy Olauson, Sherry Clerical Assistant J. Famiglietti/ J. Pomeroy Onclin, Joni Executive Assistant J. Pomeroy Peterson, Amber Data Manager J. Famiglietti/ J. Pomeroy Truong, Viet Financial Officer J. Famiglietti/ J. Pomeroy	Papalexiou, Simon	Assistant Professor	Engineering
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Whitfield, Colin Assistant Professor SENS Administrative Staff Adapa, Phani Assistant Director J. Famiglietti/ J. Pomeroy Braatan, Morgan Outreach Coordinator J. Pomeroy DeBeer, Chris GWF Science Manager J. Pomeroy Dumanski, Stacey Outreach Coordinator (on mat. leave) J. Pomeroy Ferguson, Mark Communications Specialist J. Famiglietti/ J. Pomeroy Martel-Andre, Michelle Executive Assistant J. Famiglietti/ J. Pomeroy McDonnell, Veva Business Development Officer - 0.6 FTE J. Famiglietti McShane, Kelly Director of Finance J. Famiglietti/ J. Pomeroy Moradi, Laleh Data Support J. Famiglietti/ J. Pomeroy Olauson, Sherry Clerical Assistant J. Famiglietti/ J. Pomeroy Onclin, Joni Executive Assistant J. Pomeroy Peterson, Amber Data Manager J. Famiglietti/ J. Pomeroy Truong, Viet Financial Officer J. Famiglietti/ J. Pomeroy	McDonnell, Jeffrey	Professor and Associate Director GIWS	SENS
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McShane, Kelly Director of Finance J. Famiglietti/ J. Pomeroy Moradi, Laleh Data Support J. Famiglietti/ J. Pomeroy Olauson, Sherry Clerical Assistant J. Famiglietti/ J. Pomeroy Onclin, Joni Executive Assistant J. Pomeroy Peterson, Amber Data Manager J. Famiglietti/ J. Pomeroy Truong, Viet Financial Officer J. Famiglietti/ J. Pomeroy	Martel-Andre, Michelle	Executive Assistant	J. Famiglietti/ J. Pomeroy
Moradi, Laleh Data Support J. Famiglietti/ J. Pomeroy Olauson, Sherry Clerical Assistant J. Famiglietti/ J. Pomeroy Onclin, Joni Executive Assistant J. Pomeroy J. Pomeroy Truong, Viet J. Famiglietti/ J. Pomeroy J. Famiglietti/ J. Pomeroy J. Famiglietti/ J. Pomeroy	McDonnell, Veva	Business Development Officer - 0.6 FTE	J. Famiglietti
Olauson, Sherry Clerical Assistant J. Famiglietti/ J. Pomeroy Onclin, Joni Executive Assistant J. Pomeroy Peterson, Amber Data Manager J. Famiglietti/ J. Pomeroy Truong, Viet Financial Officer J. Famiglietti/ J. Pomeroy	McShane, Kelly	Director of Finance	J. Famiglietti/ J. Pomeroy
Onclin, Joni Executive Assistant J. Pomeroy Peterson, Amber Data Manager J. Famiglietti/ J. Pomeroy Truong, Viet Financial Officer J. Famiglietti/ J. Pomeroy	Moradi, Laleh	Data Support	J. Famiglietti/ J. Pomeroy
Peterson, Amber Data Manager J. Famiglietti/ J. Pomeroy Truong, Viet Financial Officer J. Famiglietti/ J. Pomeroy	Olauson, Sherry	Clerical Assistant	J. Famiglietti/ J. Pomeroy
Truong, Viet Financial Officer J. Famiglietti/ J. Pomeroy	Onclin, Joni	Executive Assistant	J. Pomeroy
3,,,,,,,, -	Peterson, Amber	Data Manager	J. Famiglietti/ J. Pomeroy
Zdravkovic, Branko Data Manager J. Pomeroy/ H. Wheater	Truong, Viet	Financial Officer	J. Famiglietti/ J. Pomeroy
	Zdravkovic, Branko	Data Manager	J. Pomeroy/ H. Wheater

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			P U . L

Research Administrative Staff Anderson, Emily J. Pomeroy Research Administrative Staff Aubry-Wake, Caroline J. Pomeroy Research Administrative Staff Fang, Xing J. Pomeroy Research Administrative Staff Mokievsky, Zubok J. Pomeroy Research Administrative Staff Reid, Kirsten J. Pomeroy Roste, Jennifer Research Administrative Staff H. Baulch Shea, Joseph Research Technician J. Pomeroy Shook, Kevin Research Scientist J. Pomeroy Courtin, Eric Research Technician J. Pomeroy Galloway, Greg Research Technician J. Pomeroy

Nugent, Katy
Research Technician
Nugent, Katy
Research Technician
H. Baulch
Research Administrative Staff
G. Poelzer
Research Administrative Staff
K. Lindenschmidt

Lindenschmidt. Marie Research Administrative Staff H. Wheater Bahremand, Abdolreza Research Professional Staff S. Razavi Research Professional Staff H. Wheater Brannen, Rosa Chen, Jing Research Professional Staff H. Wheater Li, Zhenhua Research Professional Staff H. Wheater Loukili, Youssef Research Professional Staff J. Pomeroy Luo, Sigiong Research Professional Staff J. Pomeroy Merrill, Stephanie Research Professional Staff J. Pomeroy Ponomarenko, Olena Research Professional Staff H. Wheater

Princz, Daniel Research Professional Staff H. Wheater Research Professional Staff H. Wheater Slaughter, Andrew Research Professional Staff van der Kamp, Garth H. Wheater Research Professional Staff Vionnet, Vincent J. Pomeroy Wolfe, Jared Research Professional Staff C. Whitfield Zhao, Dong Research Professional Staff J. Pomerov Sanyal, Palash **Research Support Staff** H. Wheater Siemens, Evan **Research Support Staff** H. Wheater White, Kevin Research Support Staff K. Liber Barr, Alan Research Technician H. Wheater

Bauer, JayResearch TechnicianBaulch/Bedard-HaughnBerry, PamelaResearch AssistantK. LindenschmidtBrenna, BritniResearch AssistantH. Baulch

Buchynski, Matthew Research Assistant A. Ireson
Das, Apurba Research Associate K. Lindenschmidt

Doig, LorneResearch TechnicianK. LiberElshamy, MohamedResearch AssociateH. WheaterEsfahbod, BaharehData Visualization SpecialistS. Razavi

Gilmour, Kimberly Research Assistant H. Baulch
Hosseini, Nasim Research Associate H. Wheater
Hunter, Kristine Lab Technician J. Hudson
Janzen, Kim Research Associate J. McDonnell

Johnson, Bruce	Research Technician	Helgason/ Wheater
Kaur, Navjot	Research Assistant	H. Baulch
Kelly, Tess	Research Assistant	H. Baulch
Kiss, Jeremy	Research Assistant	Baulch/Bedard-Haughn
Millar, Cody	Research Assistant	J. McDonnell
Moradi, Laleh	Research Assistant	B. Zdravkovic
Murray, Carolyn	Research Assistant	C. Whitfield
Pratt, Dyan	Research Technician	J. McDonnell
Princz, Dan	Research Assistant	H. Wheater
Snarr, Kyle	Research Assistant	Helen Baulch
Steeves, Joel	Research Assistant	A. Ireson
Yassin, Fuad	Research Assistant	K. Lindenschmidt
Postdoctoral Fellows		
Mekonnen, Balew	Postdoctoral Fellow	C. Whitfield/ J. Pomeroy
Asare, Eric	Postdoctoral Fellow	C. Whitfield
Do, Nhu	Postdoctoral Fellow	S. Razavi
Gaj, Marcel	Postdoctoral Fellow	J. McDonnell
Liu, Jian	Postdoctoral Fellow	H. Baulch
Malaj, Egina	Postdoctoral Fellow Postdoctoral Fellow	C. Whitfield J. Pomeroy
Tesemma, Zelalem Woldegiorgis, Befekadu	Postdoctoral Fellow	H. Baulch
Ali, Melkamu	Postdoctoral Fellow	Ireson/Ferguson
Anis, Muhammad Rehan	Postdoctoral Fellow	H. Wheater
Asong, Elvis	Postdoctoral Fellow	H. Wheater/ S. Razavi
Bradford, Lori	Postdoctoral Fellow	L. Bharadwaj
Carr, Meghan	Postdoctoral Fellow	K. Lindenschmidt
Chen, Wenrui	Postdoctoral Fellow	K. Lindenschmidt
Haghnegahdar, Amin	Postdoctoral Fellow	S. Razavi
Huang, Mingbin	Postdoctoral Fellow	A. Ireson
Gharari, Shervan	Postdoctoral Fellow	S. Razavi
Kehoe, Michael	Postdoctoral Fellow	H. Baulch
Kinar, Nicholas	Postdoctoral Fellow	J. Pomeroy
Li, Zhaoqin	Postdoctoral Fellow	K. Lindenschmidt
		Jardine/Bedard-
Mantyka-Pringle, Chrystal	Postdoctoral Fellow	Haughn/Baulch
Morales Marin, Luis	Postdoctoral Fellow	Lindenschmidt/Wheater
Pinho da Costa, Diogo	Postdoctoral Fellow	Pomeroy/Wheater
Wayand, Nicholas	Postdoctoral Fellow	Pomeroy/Wheater
Wong, Jeff	Postdoctoral Fellow	H. Wheater/ S. Razavi
Xu, Li	Postdoctoral Fellow	H. Wheater
Richard, Dominique	Postdoctoral Fellow	J. Pomeroy
Graduate Students		
Annand, Holly	Doctoral Student	J. Pomeroy
Harder, Phillip	Doctoral Student	J. Pomeroy

Marsh, Chris	Doctoral Student	J. Pomeroy
Rasouli, Kabir	Doctoral Student	J. Pomeroy
Aksamit, Nik	Doctoral Student	J. Pomeroy
Krogh Navarro, Sebastien	Doctoral Student	J. Pomeroy
Kurkute, Sopan	Doctoral Student	Y. Li
Leroux, Nicolas	Doctoral Student	J. Pomeroy
Lv, Zhibang	Doctoral Student	J. Pomeroy
Pradhananga, Dhiraj	Doctoral Student	J. Pomeroy
Agyeman, Richard	Doctoral Student	
Bertoncini, Andre	Doctoral Student	J. Pomeroy
Guo, Lijie	Doctoral Student	W. Helgason
Akomeah, Eric	Doctoral Student	K. Lindenschmidt
Bam, Edward	Doctoral Student	A. Ireson
Carr, Meghan	Doctoral Student	K. Lindenschmidt
Cavaliere, Emily	Doctoral Student	H. Baulch
Coles, Anna	Doctoral Student	J. McDonnell
Das, Apurba	Doctoral Student	K. Lindenschmidt
de Toledo, Mauro	Doctoral Student	H. Baulch
Evaristo, Jaivime	Doctoral Student	J. McDonnell
Ahmed, Hafiz	Doctoral Student	W. Helgason
Nehemy, Magali	Doctoral Student	J. McDonnell
Gabrielli, Chris	Doctoral Student	J. McDonnell
Hossain, Kamrul	Doctoral Student	Wheater/Elshorbagy
Kurkute, Sopan	Doctoral Student	Y. Li
Liu, Ning	Doctoral Student	K. Lindenschmidt
Morandi, Garrett	Doctoral Student	J. Giesy
Nazarbakhsh, Mahtab	Doctoral Student	A. Ireson
Rokaya, Prabin	Doctoral Student	K. Lindenschmidt
Sadeghian, Amir	Doctoral Student	K. Lindenschmidt
Scaff, Lucia	Doctoral Student	Y. Li
Sheikholeslami, Razi	Doctoral Student	S. Razavi
Terry, Julie	Doctoral Student	Lindenschmidt/Baulch
Wauchope-Thompson, Michelle	Doctoral Student	H. Baulch
Yassin, Fuad	Doctoral Student	H. Wheater
Zhang, Fan	Doctoral Student	K. Lindenschmidt
Karran, Daniel	Doctoral Student	H. Wheater
Abu, Razak	Doctoral Student	H. Wheater
Dogniez, Christopher	Doctoral Student	J. McDonnell
Abdelhamed, Mohamed	Doctoral Student	H. Wheater
Zaghloul, Mohanad	Doctoral Student	S. Razavi
Newman, Kevin	Masters Student	D. de Boer
Robichaud, Hailey	Masters Student	J. Pomeroy
Brockman, Keenan	Masters Student	J. Pomeroy

Ab	irhire, Oghenemise	Masters Student	J. Hudson
Ali	Shah, Mustakim	Masters Student	S. Razavi
Arı	mstrong, Maria	Masters Student	C. Westbrook
Be	rry, Pamela	Masters Student	K. Lindenschmidt
Во	yer, Lisa	Masters Student	H. Baulch
Bu	dhathoki, Sujata	Masters Student	A. Ireson
Ca	rr, Meghan	Masters Student	K. Lindenschmidt
Da	s, Apurba	Masters Student	K. Lindenschmidt
De	Mars, Shelby	Masters Student	A. Ireson
He	witt, Kelsey	Masters Student	G. Ferguson
Mi	llar, Cody	Masters Student	J. McDonnell
Saf	āei, Sahar	Masters Student	S. Razavi
Wa	atts, Christena	Masters Student	P. Jones
Zha	ang, Fan	Masters Student	M. Hecker
Zha	ang, Zhe	Masters Student	Y. Li
Elli	ott, Carlie	Masters Student	C. Whitfield
Fle	mke, Jason	Masters Student	I. Creed
He	lmle, Richard	Masters Student	C. Whitfield
Sra	iyko, Stephen	Masters Student	H. Wheater
Αw	rume, Obadiah	Masters Student	H. Wheater
Ко	egel, Michael	Masters Student	H. Wheater
Ba	ijius, Warrick	Masters Student	H. Wheater
Но	ggarth, Cameron	Masters Student	K. Lindenschmidt
Wi	tham, Stephanie	Masters Student	H. Baulch
Du	ffy, Ashleigh	Masters Student	C. Whitfield
Mo	Aleer, Esther	Masters Student	C. Whitfield
Ke	shavarz, Kasra	Masters Student	H. Wheater
Dy	lla, Nick	Masters Student	H. Baulch

APPENDIX C – Students and Highly Qualified Personnel

The following table provide information on students and highly qualified personnel funded by GIWS members. It was determined that a total of 40 graduate students (PhD 10 and Masters 30) were funded by our members during the period 2017-18. In addition, our members supported and trained 87 highly qualified personnel, including 9 postdoctoral fellows and research associates, 7 research technicians, 5 research scientists, 15 Visiting Scholars (including 8 Distinguished Lecturers) and 64 Research Assistants, Research Engineers and Summer Students.

Glossary: MSc – Master of Science; PhD – Doctor of Philosophy; MSEM – Master in Sustainable Environmental Management; MPP – Master of Public Policy; MES – Master of Environment and Sustainability; MPH – Master of Public health; MPA – Master of Public Administration; SENS – School of Environment and Sustainability; JSGS – Johnson Shoyama Graduate School of Public Policy; SPH – School of Public Health

Students

Student	Supervisor/ Co- Supervisor	Degree	Department	Subject Area
Al Rafi, S.	MacPhedran	MSc	Engineering	Stormwater
Al-Harbi, H.	Giesy	PhD	Toxicology	Enviro. Tox.
April, D.	Janz	MSc	Toxicology	Petroleum in fish
Bianchini, K.	Morrissey	PhD	Toxicology	Avian
				Ecotoxicology
Bryan, T.	Morrissey	MSc	Biology	Avian Ecology/
				Ecotoxicology
Cavallaro, M.	Liber/ Morrissey	PhD	Toxicology	Aquatic
				Toxicology
Chad, S.	Barbour/	MSc	Civil & Geo Eng	Geoenviro Eng
	McDonnell			
DeBofsky, A.	Giesy	PhD	Toxicology	Environmental
				Toxicology
Elgin, A.	Morrissey	MSc	Biology	Avian Ecology
Gerhart, A.	Janz	MSc	Toxicology	Selenium in Fishes
Graves, S.	Janz	MSc	Toxicology	Selenium in Boreal
				Lakes
Guo, W.	Spiteri	MSc	Computer Sc	Runge-Kutta-
				Chebyshev
Haghoo, M.R.	Spiteri	MSc	Computer Sc	Numerical
				modeling
Howell, J.	Morrissey	MSc	Biology	Avian Ecology
James, A.	Pickering	PhD	Toxicology	Mercury in
				Zebrafish
Kapronczai, L.	Janz	MSc	Toxicology	Proteomic
				Markers
Kader, M.A.	Abdelrasoul	MSc	Chem Eng	Water Treatment

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Layeghpour, S.	Abdelrasoul	MSc	Chem Eng	Water Treatment
Lunny, E.	Morrissey	MSc	SENS	Avian
				Ecotoxicology
Maghami, M.	Abdelrasoul	MSc	Chem Eng	Water Treatment
Maloney, E.	Liber/Morrissey	PhD	Toxicology	Aquatic
				Ecotoxicology
Mendoza, E.	Pickering	PhD	Geological Sc.	Selenoprotein
				Inhibition
Mihalicz, J.	Jardine/ Baulch	MES	SENS	Aquatic
				Toxicology
Moate, A.	Hecker/ Jardine	MSc	Toxicology	Emerging
				Contaminants
Mont'Alverne, R.	Jardine	MES	SENS	Science/Policy
				Interface
Morandi, G.	Giesy	PhD	Toxicology	Enviro. Tox.
Nehzati, S.	Pickering	PhD	Geological Sc.	Mercury Custom
				Chelators
Oldach, M.	Janz	MSc	Toxicology	Selenium
Pettem, C.	Janz	MSc	Toxicology	Zebrafish
Prestie, K.	Jardine	MSc	Toxicology	Fish
				Biomonitoring
Read, S.	MacPhedran	MSc	Engineering	Stormwater
Ruso, G.	Jardine	MSc	Toxicology	Amphibian Health
Schmidt, M.	Spiteri	MSc	Computer Sc	Global
				Optimization
Schultz, D.	Janz	MSc	Toxicology	Aquatic Pollutants
Shulja, I.	Dalai	MSc	Chem Eng	Catalysis
Srayko, S.	Jardine/ Chivers	MSc	Biology	Toxicology
Summers, K.	Pickering	PhD	Chemistry	Copper in Health
				& Disease
Theoret, S.	MacPhedran	MSc	Engineering	Stormwater
Waats, T.	Giesy	MSc	Toxicology	Env Tox
Wade, A.	Morrissey	MSc	Toxicology	Aquatic
				Ecotoxicology

Highly Qualified Personnel

Glossary: Postdoctoral Fellow – PDF; Visiting Scholar – VS; Research Engineer – RE; Research Assistant – RA; Research Associate – RAsso; Research Technician – RT; Summer Student – SS; Research Scientist – RS

Research Personnel	Supervisor	Position	Department	Subject Area
Agarwal, T.	Dalai	SS	Chem Eng	Catalysis
Argumeedi, Srija	Abdelrasoul, A	SS	Chem & Bio Eng	Water Treatment

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Berzins, L.	Morrissey	PDF	Biology	Avian Ecology
Bettman, N.	MacPhedran	RE	Engineering	Stormwater
Blondin, R.	Dalai	RT 🏴 💮	Chem Eng	Catalysis
Cantin, J.	Giesy	VS	Toxicology	Environmental
				Toxicology
Chaurasia, S.P.	Dalai	VS	Chem Eng	Catalysis
Choudhury, S.	Pickering	RA	Geological Sc	Confocal X-ray
				Fluorescence
Cotelesage, J.	Pickering	RA	Geological Sc	Biomolecule
				Structure
				Analysis
Crawford, A.	Pickering	PDF	Geological Sc	Advanced
				Imaging Methods
Devi, P.	Dalai	PDF	Chem Eng	Catalysis
Dolgova, N.	Pickering	RA	Geological Sc	Selenium in
_	_		_	Zebrafish
Dumachali, A.	MacPhedran	RE	Engineering	Stormwater
Eng, M.	Morrissey	PDF	Toxicology	Avian
O,	,		o,	Ecotoxicology
Eunike, H.	Dalai	RT	Chem Eng	Catalysis
Fehr, J.	Morrissey	RA	Biology/SENS	Biology
Green, K.	Spiteri	PDF	Computer Sc	0,
Guo, W.	Spiteri	RT	Computer Sc	
Hong, S.	Morrissey	VS	Biology	Avian Ecology
Houston, J.	Jardine ,	RA	Toxicology	Field Assistance
Kothari, P.	Dalai	SS – Mitacs	National	VIC Modelling
,			Agricultural	Ü
			Institute of	
			Tunisia	
Langs, L.	Pomeroy	RT	Geography	Hydrology
Lemire, D.	Jardine ,	RA	Toxicology	Enviro. Tox.
Lin, S.	Giesy	SS	Toxicology	Env Tox
Jain, N.	Giesy	SS	Toxicology	Env Tox
Kwong, M.	Abdelrasoul, A	SS	Chem & Bio Eng	Water Treatment
Malaj, E.	Morrissey	PDF	Toxicology	Pesticide
, ,	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,			Ecotoxicology
McConkey, I.	Spiteri	SS	Computer Sc	
Mondal, P.	Dalai	VS	Chem Eng	Catalysis
Nelson, S.	Morrissey	RA	Biology/SENS	Biology
Ohiozebau, E.	Jardine	RA	Toxicology	Enviro. Tox.
Olowoyo, J.	Giesy	VS	Toxicology	Env Tox
Panchuk, J.	Pickering	RA	Chemistry	Metal Chelators
Pomonarenko,	Pickering	RA	Geological Sc	Metals in Biology
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Popick, H.	MacPhedran	SS	Engineering	Stormwater
Prokopishyn, R.	Dalai	RT	Chem Eng	Catalysis
Read, J.	Giesy	VS 🖖	Toxicology	Enviro. Tox.
Sharma, A.	Dalai	SS	Chem Eng	Catalysis
Shu, S.	Giesy	PDF	Toxicology	Env Tox
St. Yves, A.	Geisy	RT	Toxicology	Enviro. Tox.
Sura, S.	Giesy	PDF	Toxicology	Enviro. Tox.
Thapa, A.	Jardine	RA	SENS	Enviro. Tox.
Urban, R.	Jardine	SS	Toxicology	Enviro. Tox.
Xie, Y.	Giesy	PDF	Toxicology	Env Tox
Yang, Z.	Giesy	SS	Toxicology	Env Tox
Zee, J.	Jardine	RT	Toxicology	E-DNA
40 Students	Giesy	VS	Toxicology	Environmental
				Toxicology

Geisy supervised 40 students at the City University of Hong Kong, The University of Hong Kong, Hong Kong Baptist University, Hong Kong University of Science and Technology Nanjing University, Xiamen University, and the Chinese Academy of Environmental Research (CRAES)

APPENDIX D - GRANTS 2016-2017

Following table shows ongoing and new grants received by members of GIWS during the period of 2017-18. The GIWS membership received a total funding of \$13,932,978 of which core GIWS faculty secured \$10,184,349, which is in addition to the base operating funding of \$249.6 million secured by GIWS from 2011-17. To avoid double counting of total grant value, we have listed amounts in *Italics* that were either previously reported or are co-led by investigators.

Abdelrasoul, Amira		
\$1500	Zeolites Mixed Matrix Membranes (Zeolites-MMM) for Nanofiltration Applications, Publications Fund, Office of the Vice-President Research, USask	
\$7200	Electrospun Membranes with Induced Artificial Crystalline-Aqueous Channels, President's NSERC Fund, Office of the Vice-President Research, USask	
\$60,000	Faculty Recruitment and Retention Program, Faculty Recruitment and Retention Program, College of Engineering	
Baulch, Helen		
\$880,000	Undertaking lake metabolism and algal blooms: New tools for the management of potable water sources, Natural Sciences and Engineering Research Council (NSERC) Strategic Project Grant (Co-I: J.P. Giesy, R. Leavitt, P. Jones, K. Liber, K-E. Lindenschmidt)	
\$130,000	Biogeochemistry of lakes in winter and the implications of declining ice cover, NSERC Discovery Grant	
\$309,478	A water quality modelling system of the Qu'Appelle River catchment for long- term water management policy development, Environment Canada Environmental Damages Fund (PI: Lindenschmidt, Co-Is: Noble, Strickert)	
\$400,000	Centennial Enhancement Chair, University of Saskatchewan	
\$1,700,000	PrairieWaterSAVE, Global Water Futures Grant (PI: McDonnell)	
\$1,498,700	Agricultural Water Futures, Global Water Futures Grant (PI: Macrae)	
\$860,000	FormBloom, Global Water Futures Grant	
\$186,000	Better BMPs – Budgeting and minimizing greenhouse gas emissions from agricultural water bodies, Agriculture and Agri-Food Canada (PI: Whitfield)	
\$5,500,000	LakePulse Network, NSERC Strategic Network Grant (PI: Yannick Huot)	
Bedard-Haughn,	Angela	
\$200,934	Enhanced Saskatchewan Soil Data for Sustainable Land Management, Co-Funded by Saskatchewan Ministry of Agriculture – Agriculture Development Fund, Saskatchewan Canola Development Commission, and Saskatchewan	

PrairieWaterSAVE, Global Water Futures Grant (PI: McDonnell)

Hydric Soils of the Prairie Pothole Region, \$160,000. Natural Sciences and Engineering Research Council of Canada Discovery Grant; April 2017 – March

2022

Pulse Growers (Co-I: Van Rees)

\$1,700,000

\$160,000

\$852,036	Understanding Resilience in Agroecosystems, \$852,036. Natural Sciences and
	Engineering Research Council of Canada Strategic Partnerships Grants for
	Projects; September 2016 – August 2019 (Co-I: Arcand, Knight, Laroque, Peak,
	Stewart, Walley, Belcher)

Dalai, Ajay	
\$20,000	Removal of heavy metals from groundwater and industrial effluents by activated carbon prepared from waste agricultural biomass, Shastri Institutional Collaborative Research Grant

	Institutional Collaborative Research Grant
Famiglietti, Jam	nes (Jay)
\$7,000,000	Canada 150 Research Chair in Hydrology and Remote Sensing
Giesy, John	
\$2,000,000	Saskatchewan River Basin: a large-scale observatory for new interdisciplinary water science, Canada Foundation for Innovation (PI: H. Wheater, Co-I: J. Pomeroy)
\$491 180	Emission Diffusion and Environmental Effects of Emerging Pollutants from

\$2,000,000	water science, Canada Foundation for Innovation (PI: H. Wheater, Co-I: J. Pomeroy)
\$491,180	Emission, Diffusion and Environmental Effects of Emerging Pollutants from Rapid Urbanization, National Science Foundation of China (Co-I: X. Zhang)
\$1,400,000	Canada Research Chair Program
\$530,000	Institutional Support from University of Saskatchewan for Canada Research Chair
\$77,840,000	Global Water Futures: Solutions to Water Threats in an Era of Global Change, Canada First Research Excellence Fund, Tri-Agency 2016-2023 (PI: Wheater plus 8 Co-PIs)
\$224,250	Evaluating Effects of the Huskey Oil Spill on Fishes in the North Saskatchewan River, National Contaminants Advisory Group, Fisheries and Oceans Canada (PI: Jardine, Co-I: Jones)
\$286,800	Potential Impacts of Modern Perfluorinated Chemicals on Fish, National Contaminants Advisory Group, Fisheries and Oceans Canada (PI: Jones)
\$195,000	Novel Natural and Synthetic Brominated and Iodinated Compounds in the Environment, Discovery grant, National Science and Engineering Research Council of Canada 2017-2022
\$502,000	Assessment of Occurrence of Synthetic Hormone [melengestrol Acetate (MGA), Trenbolone Acetate (TBA)] and Beta-agonist (ractopamine) in Cattle Operations and Associated Environments, Beef Cattle Research council of Canada; 2018-2021 (PI: Larney, Co-I: Jones)
\$75,545	Toxico-genomic Assessment of Emerging Environmental Pollutants Using Novel Functional Genomic and High Throughput Technologies, European Commission, Directorate for Innovation and Research, Directorate of Environment, total funding \$453,270 (Co-PI: X. Zhang)

Ireson, Andrew	
\$132,000	Groundwater-surface water interactions in the prairies, NSERC Discovery Grant
\$1,846,000	The Mine Overlay Site Testing (MOST) Facility, Western Economic Diversification (Co-I: Barbour, Hendry and Ireson)
\$122,305	An evaluation of the controls on salt release from oil sands reclamation covers, Syncrude – NSERC Collaborative Research and Development Grant (Co-Is: J. McDonnell, L. Barbour)
\$25,000	Improving and benchmarking models for snowmelt infiltration in seasonally frozen soils, NSERC Engage Grant with Geo-slope International Ltd
\$208,000	Quantifying salt release from oil sands reclamation covers, NSERC Collaborative Research and Development Grant with Syncrude Canada Ltd as an industry partner
\$150,000	Quantifying the Effects of Freeze-Thaw Cycles on Mine Cover System Design and Performance, NSERC Collaborative Research and Development Grant with O'Kane Consultants Inc as an industry partner
Janz, David	
\$616,622	Grizzly-PAW: Grizzly Population Assessment in yelloWhead: Integrated Approaches Toward Conserving Grizzly Bears on a Human-Dominated Landscape of Western Alberta. NSERC, Collaborative Research and Development Grants Program. Total funding is \$1.8 million
\$725,070	Advancing environmental risk assessment of selenium (ERASe). NSERC Strategic Project Grant (Co-PIs M. Hecker and K. Liber)
\$124,000	Development of a fish biomonitoring program for northern Saskatchewan. Environmental Damages Fund (Co-I: Jardine)
\$149,233	Critical need for a new chiller for the Aquatic Toxicology Research Facility, Toxicology Centre, Research Tools and Instruments, Natural Sciences and Engineering Research Council of Canada (PI: Hecker; Co-I: Liber, Hogan, Niyogi, Weber, Giesy, Raine)
\$117,114	Moving from lab to field to assess cardiorespiratory and metabolic contaminant effects in fish, Research Tools and Instruments, Natural Sciences and Engineering Research Council of Canada (PI: Weber)
\$115,404	Motivated for movement? Exercise and the gestation environment on sow performance and welfare, Agriculture Development Fund, Government of Saskatchewan
\$224,480	Bioaccumulation and effects of environmental contaminants in St. Lawrence Estuary belugas and minke whales, National Contaminants Advisory Group, Fisheries and Oceans Canada (PI: Verreault; Co-I: Houde, Lesage, Helbing, Brinkman)
\$255,000	Mechanisms of Developmental Toxicity and Metabolic Disruption in Fishes Exposed to Selenium, NSERC Discovery Grant. 2016-2021
\$837,750	NSERC Industrial Research Chair in Swine Welfare, Industrial Research Chair, Natural Sciences and Engineering Research Council of Canada. (Seddon, Yolande (PI) & Heather Wilson, Andrew Van Kessel, Jennifer Brown)

\$837,750	Industrial Research Chair Funding Agreement, Ontario Pork (Seddon, Yolande (PI) &
	Heather Wilson, Andrew Van Kessel, Jennifer Brown)
\$5,000	Global Ambassador Outgoing Program, \$5000 (CAD). Global Ambassador Program, Office of the Vice-President Research, University of Saskatchewan
\$3,000	

Jardine, Tim	
\$140,000	Ecological benefits and toxicological consequences of flooding in river ecosystems, NSERC Discovery Grant
\$20,000	Enhancing institutional connectivity to study biological connectivity in the world's great rivers. USask International Research Partnership Fund (Co-I: Villamarin, F., and Magnusson, W.)
\$12,000	Monitoring Saskatchewan's waters for invasive species and fish health. CleanTech Internship funding.
\$30,008	How do fish that are commercially valuable for riverine people influence foodweb structure and create linkages between freshwater environments in the Amazon basin? National Geographic Society (Co-I: Villamarin, F., Jardine, T., Peres, C., Magnusson, W., and Campos-Silva, J.)
\$35,000	Application of an advanced and user-friendly rapid environmental DNA protocol to detect aquatic invasive species. Saskatchewan Fish and Wildlife Development Fund. (PI: Hecker M.)
\$1,650,000	Integrated Modelling for Prediction and Management of Change in Canada's Major River Basins, Global Water Futures - Canada First Research Excellence Fund, 2017-2020 (Co-Is: Pietroniro, Lindenschmidt, Elshorbagy, Li, Jardine, Wheater, Pomeroy, Strickert, Gober, Gutwin, Stadnyk, Brouwer, Tolson, Coulibaly)

Li, Yanping	
\$5,000,000	Chaging Cold Regions network, Climate Change and Atmospheric Research, NSERC (36 Canadian Scientists and 15 International Collaborators),
\$345,000	Climate change study using high resolution NWP nested in RCMs. Global Water Futures, Modeling Core support
\$1,498,700	Canadian Agricultural Water Use: Current State and Prospects, Global Water Futures (PI: Macrae)
\$1,650,000	Integrated Modeling Network for Prediction and Management of Change in Canada's Major River Basins, Global Water Futures (PI: Razavi)
\$1,100,000	Climate-Related Precipitation Extremes, Global Water Futures (Co-PIs: Stewart/Ziwers)
\$471,656	The Global Water Futures: Solutions to Water Threats in an Era of Global Change. Compute Canada's Research Platforms and Portals 2017 competition
\$110,000	Warm season diurnal precipitation over the plains east of the Rockies, NSERC Discovery Grant, 2017-2022
\$5,000	Hybrid Modeling to generate annual and daily source contributions and ambient concentrations for NO2, PM2.5, and O3 at a high spatial resolution (≤1 km) across Canada, Health Canada (PI: Hakami)

Lindenschmidt, K	Karl-Eric
\$1,650,000	Integrated Modelling for Prediction and Management of Change in Canada's
	Major River Basins, Global Water Futures - Canada First Research Excellence
	Fund, 2017-2020 (Co-Is: Pietroniro, Lindenschmidt, Elshorbagy, Li, Jardine,
	Wheater, Pomeroy, Strickert, Gober, Gutwin, Stadnyk, Brouwer, Tolson,
	Coulibaly)
\$71,250	Near real-time Ice-Related Flood Hazard Assessment (RIFHA), Canadian Space
	Agency's & C-Core (PI), St. John's, NFLD 2016-2018
\$10,000	Climate change impacts on secondary production for fish, SK Fish and Wildlife
	Development Fund
\$25,000	Reinforcing river and lake ice covers to maintain their load-bearing capacity in

Lloyd-Smith, Patrick

\$24,150 Hypothetical bias, strategic stated preferences and the demand for gene-

a warming climate, NSERC Engage grant with NOR-EX ICE Engineering, Ottawa

edited canola, Agriculture and Agri-Food Canada (Co-PI)

Mamet, Steven	
\$2,000	International Travel Award, University of Saskatchewan
\$51,886	Shell Earthwatch Stakeholder Engagement Fund
\$2,500	Aurora Research Institute – Research Assistantship

Mantyka-Pringle, Chrystal

\$140,000 Mitacs Elevate Fellowship to Chrystal Mantyka-Pringle

McDonnell, Jeffi	rey
\$630,000	GREEN facility - for green roof entrepreneurship, Western Economic
	Diversification
\$150,000	Impacts of biofuel production in forested watersheds, US Dept. of Energy
\$425,000	How do watersheds store and release water? NSERC Discover Grant
\$120,000	How do watersheds store and release water? NSERC Accelerator Award
\$108,300	Hydrological impacts of biofuel production. US Dept of Energy
\$208,512	Eucalyptus plantation impacts on catchment water balance, US Dept. of Energy
\$143,855	Sustainable Water Use and Bioenergy: Application of Isotopic Tracers
	techniques to Improve Methods for Estimating Water Use in Intensively
	Managed Woody Crop Systems, Su-contract, University of Georgia, USA
\$1,846,000	The Mine Overlay Site Testing (MOST) Facility, Western Economic
	Diversification (Co-I: Barbour, Hendry and Ireson)
\$77,840,000	Global Water Futures: Solutions to Water Threats in an Era of Global Change,
	Canada First Research Excellence Fund, Tri-Agency 2016-2023 (PI: Wheater
	plus 8 Co-PIs)
\$150,000	Quantifying the Effects of Freeze-Thaw Cycles on Mine Cover System Design
	and Performance, NSERC Collaborative Research and Development Grant with
	O'Kane Consultants Inc as an industry partner

McPhedran, Kerr	У
\$300,000 \$24,941 \$24,556 \$2,250 \$60,500 \$5,040 \$16,000 \$180,000	Centennial Enhancement Chair in Water Security for Indigenous Communities Natural Sciences and Engineering Research Council Engage Plus Grant Natural Sciences and Engineering Research Council Engage Plus Grant Undergraduate Student Research Award Mitacs Accelerate Grant Canadian Light Source Beamline Grant New Faculty Graduate Student Support Program Investigation of the role of organic matter in partitioning of chemicals in the municipal wastewater treatment process, NSERC Discovery Grant; 2016-2021
Morrissey, Christ	ev.
\$691,000	Tools and strategies for mitigating pesticide impacts on wetlands to improve sustainable crop production, SK Agricultural Development Fund (Co-Is K. Liber, C. Willenborg, P. Badiou, J. Devries, J. Headley, C. Sheedy, T. Plews)
\$20,453 \$45,000	Facilitation of a coordinated multi-provincial research strategy towards resilient Prairie agricultural landscapes. NSERC Connect Grant Canadian Prairie Agroecosystem Resilience Network, NSERC Strategic Network
\$45,000	Grant development fund
\$45,000	Mitacs Accelerate Grant (Co-Is Berzins, L, Clark, RG)
\$185,000	Contaminant induced impacts on avian migration: evaluating cue perception, fuelling and orientation. NSERC Discovery Grant
\$120,000	Contaminant induced impacts on avian migration: evaluating cue perception, fuelling and orientation. NSERC Discovery Accelerator Supplement
\$46,000	Pesticide impacts on bird migration. Molson Foundation
\$32,500	Chaplin Lake shorebird research. Sask Environment
\$240,000	Operating funds for Facility for Applied Avian Research
\$80,000	Assessing potential risks to wildlife related to direct and indirect effects of climate change. Environment Canada G&C
\$134,500	Prairie Water. Global Water Futures (Co-PI Spence, C. & Withfield, C.)
Patrick, Robert	
\$25,000	Challenges and Opportunities for Source Water Protection Plan Implementation in First Nation Communities: A Pan-Canada Assessment, Global Water Futures, Capacity Building Competition – Seed Funding
\$7,000	Integrating community-based participatory research into source water protection planning: A case study at Onion Lake Cree Nation, SK, SSHRC Explore
\$3,000	Saskatchewan River Delta Water Stewardship Plan, SSHRC Exchange
Pickering, Ingrid	
\$425,000	Canada Research Chair Operational Support, University of Saskatchewan (OVPR, College, Department)
\$250,000	Support for Canada Research Chair, Province of Saskatchewan

\$305,000	Synchrotron studies of selenium environmental chemistry, Natural Sciences
	and Engineering Research Council (NSERC) Discovery Grant
\$296,000	Analyzing Crude Oils for Sulfur Species and Oxygen Speciation, Chevron Energy
	Technology Company, Richmond California, USA (PI: G.N. George)

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Pomeroy, John	
\$120,469	MESH Modelling for Simonette River Basin and Upper Portion of the Red Deer River Basin, 120469 (CAD). Alberta Environment and Parks. (Ireson, Andrew (PI) & John Pomeroy, Saman Razavi, Grant Ferguson, Kevin Shook, Phani Adapa, Mohamed Elshamy, Fuad Yassin, Zelalem Tesemma, Dominique Richard)
\$100,000	Hydrology study to assess impacts of Kaskawulsh Glacier / Slims River changes to Kluane Lake levels, 100000 (CAD). Government of Yukon
\$68,750	Preventing and Managing Water Pollution, 68750 (CAD). Environment and Climate Change Canada (Co-I Helen Baulch, Diogo Pinho da Costa)
\$150,000	Vanier Canada Graduate Scholarships Program, Natural Sciences and Engineering Research Council of Canada, Scholarship to Caroline Aubry-Wake
\$74,980	Diagnosis of Historical and Future Flow Regimes of the Bow River at Calgary - Using a Dynamically Downscaled Climate Model and a Physically Based Land Surface Hydrological Model, 74980 (CAD). Climate Change Adaptation Program, Natural Resources Canada (Co-I: Howard Wheater, Saman Razavi, Yanping Li)
\$1,400,000	Canada Research Chair in Water Resources and Climate Change
\$224,000	Canada Research Chair Research Grant, Internal CRC Support – Research, College of Arts and Science.
\$350,000	Highly Qualified Personnel, Internal CRC Support – Research, College of Arts and Science.
\$42,000	Postgraduate Scholarship-Doctoral, Natural Sciences and Engineering Research Council of Canada, NSERC PGSD2 Scholarship for Holly Annand
\$360,000	Snow Hydrology, Discovery Grant, NSERC
\$2,000,000	Saskatchewan River Basin: a large-scale observatory for new interdisciplinary water science, CFI (Co-I: J. Giesy, H. Wheater)
\$374,000	Changing Cold Regions Network, NSERC FCAR
\$350,000	NSERC CREATE in Water Security
\$100,527	Canada Foundation for Innovation – Infrastructure Operating Fund
\$77,840,000	Programme Director, Global Water Futures: Solutions to Water Threats in an Era of Global Change, Canada First Research Excellence Fund, Tri-Agency 2016-2023
\$27,500,000	Programme Director, Global Water Futures: Solutions to Water Threats in an Era of Global Change, University of Saskatchewan Contribution 2016-2023
\$1,374,576	Autonomous and Airborne Cold Regions Innovation Facility, Western Economic Diversification Grant 2017-2020

Razavi, Saman	
\$1,650,000	Integrated Modelling for Prediction and Management of Change in Canada's Major River Basins, Global Water Futures - Canada First Research Excellence Fund, 2017-2020 (Co-Is: Pietroniro, Lindenschmidt, Elshorbagy, Li, Jardine, Wheater, Pomeroy, Strickert, Gober, Gutwin, Stadnyk, Brouwer, Tolson, Coulibaly)
\$125,000	Development of a New Framework for Watershed Systems Analysis and Modelling under Climate and Environmental Changes, NSERC Discovery Grant Chaging Cold Regions network, Climate Change and Atmospheric Research, NSERC (36 Canadian Scientists and 15 International Collaborators); \$5,000,000; 2013-2018

Spiteri, Raymond	
\$150,000	Game-changing time integration of complex systems for the exaflop era, NSERC Discovery Grant
\$170,000	Saskatoon Police Service and Saskatchewan Ministry of Justice, Missing Persons Project, Defence Research and Development Canada
\$55,000	Saskatchewan Ministry of Justice, Remand Risk Assessment Tool
\$30,000	A real-time framework for Mercedes-Benz Fuel Cell big data system, Mitacs Accelerate Grant (PI: Al-Anbagi)
\$25,000	Using big data methods to improve fuel cell manufacturing, NSERC Engage Grant

Wheater, Howard	
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\$30,000,000	Canada Excellence Research Chair in Water Security: Sustainable freshwater
	resources and environmental change, Government of Canada, Government of
	Saskatchewan and University of Saskatchewan
\$5,000,000	Chaging Cold Regions network, Climate Change and Atmospheric Research,
	NSERC (36 Canadian Scientists and 15 International Collaborators),
\$2,000,000	Saskatchewan River Basin: a large-scale observatory for new interdisciplinary
	water science, CFI (Co-I: J. Giesy, J. Pomeroy)
\$240,000	Saskatchewan River Basin: a large-scale observatory for new interdisciplinary
	water science, CFI Infrastructure Operating Fund (Co-I: J. Giesy, J. Pomeroy)
\$475,000	Environment and Climate Change Canada grant 2016-2021
\$77,840,000	Global Water Futures: Solutions to Water Threats in an Era of Global Change,
	Canada First Research Excellence Fund, Tri-Agency 2016-2023
\$1,374,576	Autonomous and Airborne Cold Regions Innovation Facility, Western Economic
	Diversification Grant 2017-2020
\$240,000	GWF PhD Scholarship Supplement, College of Graduate and Postdoctoral
	Studies, University of Saskatchewan 2017-2023
\$471,656	The Global Water Futures: Solutions to Water Threats in an Era of Global
	Change. Compute Canada's Research Platforms and Portals 2017 competition
\$415,000	Water Cycle Prediction in Global Water Futures, Environment and Climate
	Change Canada 2017-2020

Whitfield, Colin	
\$3,800	Plain language summary of boreal and taiga soils of SK for Boreal Watershed
	Initiative Report, Saskatchewan Ministry of Environment
\$186,000	Better BMPs – Budgeting and minimizing greenhouse gas emissions from
	agricultural water bodies, Agriculture and Agri-Food Canada (Co-I: Baulch)
\$3,000	LUGNuts Project Co-ordinator, Winnipeg

APPENDIX E – Publications, Conference Proceedings and Presentations

Journal Publications - 2018

- Abdelrasoul, A., Doan, H., Lohi, A., Cheng, C.-H., (2018). Aquaporin-Based Biomimetic Refereed Journalsand Bioinspired Membranes for New Frontiers in Sustainable Water Treatment Technology: Approaches and Challenges, Polymer Science, Series A, Vol. 60, No. 4, pp. 429–450.
- Abdelrasoul, A., Doan, H., Lohi, A., Cheng, C.-H., (2018). Gas and Liquid Backwash for Flux Refereed Journals Restoration in Latex Paint Effluent Ultrafiltration,, Separation and Purification Technology, 204243 254.
- Adame, M.F., Jardine, T., Fry, B., Valdez, D., Lindner, G., Nadji, J., and Bunn, S.E. 2018. Estuarine crocodiles in a tropical coastal floodplain obtain nutrition from terrestrial prey. PLoS One 13: e0197159.
- Aksamit NO, Pomeroy JW, (2018). Scale Interactions in Turbulence for Mountain Blowing Snow, Journal of Hydrometeorology, 19(-): 305 320.
- Allen, G. H., C. H. David, K. M. Andreadis, F. Houssain and J. S. Famiglietti, Global Estimates of River Flow Wave Travel Times with Implications for Low-Latency Satellite Data, Geophys. Res. Lett., 45, https://doi.org/10.1029/2018GL077914
- Andrews, E.J., Reed, M.G., Jardine, T.D., and Steelman, T.A. 2018. Damming knowledge flows: Power as a constraint on knowledge pluralism in river flow decision-making in the Saskatchewan River Delta. Society and Natural Resources 31: 892-907.
- Bam, E., A. Ireson, G. and J.J. McDonnell, 2018. Quantifying wetland water balances. Journal of Hydrology, in press.
- Bartlett, M.S., A.J. Parolari, J.J. McDonnell, and A. Porporato, 2018. Response to Ogden et al Comment on "Beyond the SCS-CN method: A theoretical framework for spatially lumped rainfall-runoff response". Water Resources Research, 53 (7): 6351–6354, DOI: 10.1002/2017WR020456
- Behrangi, Ali; Alex Gardner; John T. Reager; George J. Huffman; Robert F. Adler; Joshua Fisher; Daqing Yang, 2018: Using GRACE to estimate snowfall accumulation and assess gauge undercatch corrections in high latitudes. Journal of Climate (in press).
- Bianchini, K. and Morrissey, CA. (2018). Polycyclic aromatic hydrocarbon exposure impairs premigratory fuelling in captively-dosed Sanderling (Calidris alba). Ecotox Environ Safety 161:383-391.
- Bonina, S.M.C., G. Codling, M.B. Corcoran, J.-H. Guo, J.P. Giesy, A. Li, N.C. Sturchio, K.J. Rockne. 2018. Temporal and Spatial Differences in Deposition of Organic Matter and Black Carbon in Lake Michigan Sediments over the Period 1850-2010. J. Great Lakes. Res. DOI.org/10.1016/j.jglr.2018.03.001
- Bradford, L., Vogel, T., Lindenschmidt, K.-E., McPhedran, K., Strickert, G., Fonstad, T. and Bharadwaj, L. (2018) Co-Design of water services and infrastructure for Indigenous Canada: a scoping review. FACETS 3: 487-511. http://dx.doi.org/10.1139/facets-2017-0124
- Bradford, L., Vogel, T., Lindenschmidt, K.-E., McPhedran, K., Strickert, G., Fonstad, T. and Bharadwaj, L. (2018) Co-Design of water infrastructure for Indigenous Canada. FACETS —

- MEDIUM. Retrieved from https://medium.com/facets/co-design-of-water-infrastructure-for-indigenous-canada-d2f170786bca
- Brinkmann, M., M. Hecker, J.P. Giesy, P.D. Jones, H.T. Ratte, H. Hollert and T.G. Preuss. 2018. Generalized Concentration Addition Accurately Predicts Estrogenic Potencies of Mixtures and Environmental Samples Containing Partial Agonists. Tox Invitro. 46:294-303. DOI.org/10.1016/j.tiv.2017.10.022
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- Cavallaro, M., Liber, KL, Headley, JV, Peru, KM, Morrissey, CA. (in press). Community-level and phenological responses of emerging aquatic insects exposed to three neonicotinoid insecticides: an in situ wetland limnocorral approach. Environ Tox Chem
- Cattet M, Stenhouse GB, Boulanger J, Janz DM, Kapronczai L, Swenson JE, Zedrosser A, (2018). Can concentrations of steroid hormones in brown bear hair reveal age class? Conservation Physiology 6: 10.1093/conphys/coy001.
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- Chen, L., J.P. Giesy and P. Xie. 2018. The Dose Makes the Poison. Sci. Tot. Environ. 621:649–653. DOI:org/10.1016/j.scitotenv.2017.11.218
- Codling, G., S. Hosseini, M.B. Corcoran, S. Bonina, T. Lin, A. Li, N.C. Sturchio, K.J. Rockne, K. Ji, H. Peng, and J.P. Giesy. 2018. Current and Historical Concentrations of Poly and Perfluorinated Compounds in Sediments of the Northern Great Lakes Superior, Huron, and Michigan. Envir. Pollut. 236:373-381. DOI:org/10.1016/j.envpol.2018.01.065.
- Codling, G., N.C. Sturchio, K.J. Rockne, A. Li, H. Peng, T.J. Tse, P.D. Jones and J.P. Giesy. 2018. Spatial and Temporal Trends in Poly- and Per-fluorinated Compounds in the Laurentian Great Lakes Erie, Ontario and St. Clair. Environ. Pollut. 237:396-405. DOI.org/10.1016/j.envpol.2018.02.013
- Coles, A.E. and J.J. McDonnell, 2018. Fill and spill drives runoff connectivity over frozen ground. Journal of Hydrology, in press.
- Conway JP, Pomeroy JW, Helgason WD, Kinar NJ*, (2018). Challenges in modelling turbulent heat fluxes to snowpacks in forest clearings, Journal of Hydrometeorology, 19(-): 1599 1616.
- Costa D, Pomeroy JW, Wheater HS, (2018). A numerical model for the simulation of snowpack solute dynamics to capture runoff ionic pulses during snowmelt: the PULSE model, Advances in Water Resources, 122(-): 37 48.
- Darmiana, M.D. S.A. Monfared, G. Azizyan, S.A. Snyder and J.P. Giesy. 2018. Assessment of Water Quality Protection Tools. Uncontrollable Discharges of Pollutants. Ecotox. Environ. Safety 161:190–197. DOI.org/10.1016/j.ecoenv.2018.05.087

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- Abu, R. and Reed, M.G., 2018. Employing bricolage as a lens to understand diverse experiences of social and ecological change in the Saskatchewan River Delta. Annual General Meeting of the Canadian Association of Geographers and the Regional Meeting of the International Geographical Union. Aug 6-10, 2018; August 9.

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- Bianchini, K., Newstead, D., and Morrissey, C.A. Impacts of polycyclic aromatic hydrocarbon exposure on Sanderling pre-migratory fuelling and migration. SETAC Europe, Rome, Italy. May 2018 (oral presentation, given by C.A. Morrissey)
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- Haghgoo, M.R., D.J. Bergstrom, and R.J. Spiteri, Proper orthogonal decomposition analysis of dominant particle- ow structures in a bubbling uidized bed, 9th International Symposium on Turbulence, Heat and Mass Transfer, July 10{13, 2018, Col egio Brasileiro de Altos Estudos (UFRJ), Rio de Janeiro, Brazil (4 pages; also oral presentation).
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- Gerhart A, Lane T, Hecker M, Janz DM, (2018). Toxicity of aqueous L-selenomethionine to early life-stages of Pimephales promelas. Prairie Northern SETAC Regional Meeting, Edmonton, AB.
- Giesy, J.P., P.D. Jones. "New Mass Spectrometry Techniques for the Measurement of Persistent Organic Pollutants". To: 27th Annual meeting, 13-17, 2018, Rome, Italy.
- Janz DM, Pettem CM, Thomas JK, Weber LP, (2018). Zebrafish as a model to investigate mechanisms of adverse metabolic and cardiovascular outcomes associated with elevated dietary selenium exposure. Society of Environmental Toxicology and Chemistry Europe, Rome, IT.
- Kinar NJ, Pomeroy JW, (2018). Internet of Things (IoT) Systems and Measurement of Snowpacks. Joint Meeting of the Canadian Geophysical Union (CGU), Canadian Soil Science Society, Computational Infrastructure in Geodynamics, Eastern Section of Seismological Society of America and Canadian Society for Agricultural and Forest Meteorology, Niagara Falls, Canada, June 10, 2018

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- Maghami A. and Abdelrasoul A. (2018). Molecular Dynamic Simulation Study of Water transport across Hydrophilic and Hydrophobic Membranes, 27th North American Membrane Society Annual Meeting, June 9 13, 2018, Lexington, KY USA
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- Andrews, E., Baines, S., Reed, M.G., Jardine, T., and Steelman, T. 2017. Reflections on Power and Politics for Research, Policy, and Practice with Culturally-Sensitive Management in the Governance of River Systems. Resilience Conference, Stockholm, Sweden. August 23, 2017.
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- Brinkmann, M., H. Alharbi, S. Wiseman, S. Sura, G. Morandi, H. Peng, J.P. Giesy, P. Jones, M. Hecker. "In vitro Assessment of PH-dependent Uptake and Toxicity of Ionizable Organic Chemicals in Fish." To: 44th Canadian Ecotoxicity Workshop, Guelph, ON, October 1-4, 2017.
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- Costa D, Pomeroy J, Wheater H, (2017). PULSE: A numerical model for the simulation of snowpack solute dynamics to capture runoff ionic pulses during snowmelt. American Geophysical Union (AGU) Fall Meeting, New Orleans, USA, December 11, 2017
- Devi, P., Das U., Dalai, A.K. "Recalcitrance and feasibility study of using biochar in in-situ chemical oxidation process for degradation of naphthenic acids" 4th Water Research Conference, Waterloo, 10 13 September 2017.
- Dhungana, B., H. Peng, B. Subedi, P.D. Jones, J.P. Giesy and G.P. Cobb. "Untargeted Screening and Apportionment of Brominated Compounds in House Dust". To: Fall ACS national meeting, August 20-24, 2017, Washington, D.C.
- Doering, J., M. Brinkmann, A. Alcaraz, S. Wiseman, M. Hecker, J.P. Giesy. "A Quantitative Adverse Outcome Pathway for Activation of the Aryl Hydrocarbon Receptor Leading to Early Life Stage Mortality" To: 38th Annual Meeting, November 11-16, 2017, Minneapolis, MN.
- Drouillard, K.G., LaFontaine, J., Grgicak-Mannion, A., McPhedran, K., Szalinska, E., Haffner, G.D., (2017). Sediment contamination in the Huron-Erie Corridor and linkages to AOC beneficial use impairments. International Association for Great Lakes Research; From Cities to Farms: Shaping Great Lakes Ecosystems, Detroit, MI
- Eng, M.L., Stutchbury, B.J., and Morrissey, C.A. Tracking the effects of a neonicotinoid insecticide on migratory birds. Society for Environmental Toxicology and Chemistry (SETAC) NA 38th Annual Meeting, Minneapolis, MN. November 2017 (oral presentation)
- Eng, M.L., Stutchbury, B.J., and Morrissey, C.A. Tracking the effects of a neonicotinoid insecticide on migratory birds. Joint Meeting of the American Ornithology Society and the Society of Canadian Ornithologists, East Lansing, MI. August 2017 (poster).
- Fortin V, Vionnet V, Dimitrijevic M, Abrahamowicz M, Gauthier N, Garnaud C, Belair S, Milbrandt J, Pomeroy J, Forecasting of rain-on-snow events in alpine region using a fully coupled atmosphere/snowpack/hydrology model. American Geophysical Union (AGU) Fall Meeting, New Orleans, USA, December 11, 2017
- Gerhart A, Lane T, Hecker M, Janz DM, (2017). Toxicity of aqueous exposure to L-selenomethionine to early life-stages of fathead minnows. Society of Environmental Toxicology and Chemistry, Minneapolis, MN.
- Giering Y, McPhee J, Pomeroy J, Landscape-based discretization for modeling of hydrological processes in the semi-arid Andes Cordillera: a case study in Morales Basin. American Geophysical Union (AGU) Fall Meeting, New Orleans, USA, December 11, 2017
- Goodwin, L.V., J.P. St-Maurice, H. Akbari, and R.J. Spiteri, Monte-Carlo simulations of ion velocity distributions and resulting incoherent radar spectra under strong ion frictional heating conditions, General Assembly and Scienti c Symposium of the International Union of Radio Science (URSI GASS), 2017 XXXII nd, August 19{26, 2017, Montreal, CA (abstract).

- Graves S, Liber K, Palace V, Hecker M, Janz DM, (2017). Characterization of selenium uptake and trophic transfer through Canadian boreal lake food webs. Society of Environmental Toxicology and Chemistry, Minneapolis, MN.
- Green D, Janz DM, Liber K, Hogan N, Alcaraz A, Lane T, Bluhm K, Brinkmann M, Hecker M, (2017). Adverse outcome pathways for selenomethionine exposure in four commercially and culturally relevant Canadian fish species. Society of Environmental Toxicology and Chemistry, Minneapolis, MN.
- Green D, Janz DM, Liber K, Hogan N, Alcaraz A, Lane T, Bluhm K, Brinkmann M, Hecker M, (2017). Adverse outcome pathways for selenomethionine exposure in four commercially and culturally relevant Canadian fish species. Canadian Ecotoxicity Workshop, Guelph, ON.
- Howell, J. McKellar, A., Espie, R., Morrissey, C.A. American Ornithologists Union. East Lansing, Michigan, U.S.A. August 2017 (oral presentation)
- Krogh S, Pomeroy J, (2017). Determining hydrological changes in a small Arctic treeline basin using cold regions hydrological modelling and pseudo-global warming approach. American Geophysical Union (AGU) Fall Meeting, New Orleans, USA, December 11, 2017
- Krogh S, Pomeroy J, Past, Present and Future Arctic hydrology under changing climate and vegetation. 8th Global Energy and Water Exchanges (GEWEX) Open Science Conference: Extremes and Water on the Edge, Canmore, Canada, May 6, 2018
- Harder P, Pomeroy J, Helgason W, Diagnosing stubble management and climate variability impacts on runoff and infiltration in cold semi-arid agricultural regions. American Geophysical Union (AGU) Fall Meeting, New Orleans, USA, December 11, 2017
- Lane T, Janz DM, Liber K, Green D, Bluhm K, Raes K, Doig LE, Hecker M, (2017). Developmental effects of maternally transferred selenium to early life stage fathead minnow (Pimephales promelas). Society of Environmental Toxicology and Chemistry, Minneapolis, MN.
- Maloney, E. Morrissey, C.A, Headley, J., Peru, K., Liber, K. Investigating the Cumulative Toxicity of Imidacloprid, Clothianidin, and Thiamethoxam to Aquatic Insects under Laboratory and Field Conditions. Society for Environmental Toxicology and Chemistry (SETAC) NA 38th Annual Meeting, Minneapolis, MN. November 2017 (oral presentation)
- Maloney, E. Morrissey, C.A, Headley, J., Peru, K., Liber, K. Characterizing the Cumulative Action of Neonicotinoid Insecticide Mixtures on a Sensitive Aquatic Insect Species. Setac PNC June 2017 (oral presentation).
- Markwart B, Doig L, Raes K, Hecker M, Janz DM, Liber K, (2017). The influence of community composition on selenium bioaccumulation in field-collected freshwater periphyton. Canadian Ecotoxicity Workshop, Guelph, ON.
- Marsh C, Wayand N, Pomeroy J, Wheater H, Spiteri R, (2017). A finite volume, scalar-transport blowing snow model for use with variable resolution meshes. American Geophysical Union (AGU) Fall Meeting, New Orleans, USA, December 11, 2017
- Marsh CB, Spiteri RJ, Pomeroy JW, Wheater HS, PBSM3D: A complex terrain blowing snow model for use with variable resolution meshes. 3rd Annual International Network for Alpine Research Catchment Hydrology (INARCH) Conference, Zugspitze, Germany, February 8, 2018
- Morrissey, C.A. et al. Canadian Ecotoxicity Workshop, Guelph, Ontario, August 2017.
- Morandi, G., S. Wiseman, M. Guan, X. Zhang, J. Martin ker, J.P. Giesy. "Elucidating Mechanisms of Toxic Action of Dissolved Organic Chemicals in Oil Sands Process Affected Water (OSPW)" To: 8th Annual Meeting, June 15-16, 2017, Saskatoon SK.

- Morrissey, C.A., Why are farmland birds declining? SETAC Minneapolis, MN, Nov 2017 (Oral)
- Pettem CM, Janz DM, Weber LP, (2017). Metabolic and cardiovascular effects of dietary selenomethionine exposure in adult rainbow trout (Oncorhynchus mykiss). Society of Environmental Toxicology and Chemistry, Minneapolis, MN.
- Raes K, Doig L, Liber K, Janz DM, Markwart B, Hecker M, (2017). Assessing the trophic transfer of selenomethionine to an amphipod (Hyalella azteca) through a diet of field-collected microorganism communities. Society of Environmental Toxicology and Chemistry, Minneapolis, MN.
- Raes K, Doig L, Liber K, Janz DM, Markwart B, Hecker M, (2017). Assessing the trophic transfer of selenomethionine to an amphipod (Hyalella azteca) through a diet of field-collected microorganism communities. Canadian Ecotoxicity Workshop, Guelph, ON.
- Rasouli K, Pomeroy J, (2017). Permafrost Response to Transient Vegetation and Climate Changes in a Northern Mountain Basin, Canada. The 2nd Asian Conference on Permafrost, Sapporo, Japan, July 2, 2017
- Rasouli K, Pomeroy J, Hayashi M, Fang X, Gutmann E, Li Y, Assessment of the Suitability of High Resolution Numerical Weather Model Outputs for Hydrological Modelling in Mountainous Cold Regions. American Geophysical Union (AGU) Fall Meeting, New Orleans, USA, December 11, 2017
- Rasouli K, Pomeroy J, Interaction between climate and vegetation changes in affecting hydrological processes in mountainous regions. 8th Global Energy and Water Exchanges (GEWEX) Open Science Conference: Extremes and Water on the Edge, Canmore, Canada, May 6, 2018
- Rasouli K, Pomeroy JW, Fang X, Whitfield PH, Marks D, Janowicz JR, How interactions between climate and vegetation impact hydrological processes in mountain headwater basins. 8th Global Energy and Water Exchanges (GEWEX) Open Science Conference: Extremes and Water on the Edge, Canmore, Canada, May 6, 2018
- Redman, A.D., T. Parkerton, J. Butler, D. Letinski, R. Frank, M. Hewitt, A.J. Bartlett, P. Gillis, J. Parrott, J. Marentette, S.A. Hughes, R. Guest, A. Bekele, G. Morandi, S. Wiseman, J.P. Giesy. "Application of the Target Lipid Model and Possive Samplers to Characteriza the Toxicity of the Organics in Oil Sands Process-Affected Water" To: 38th Annual Meeting, November 11-16, 2017, Minneapolis, MN.
- Reed, M.G., (session organizer and chair) 2017. Crossing bridges together to understand long-term social-ecological change: A novel, transdisciplinary journey associated with Canada's inland deltas. Resilience Conference, Stockholm, Sweden. August 21, 2017.
- Robichaud H, Pomeroy J, Helgason W, Climate change and sensitivity in a high alpine catchment. Joint Meeting of the Canadian Geophysical Union (CGU), Canadian Soil Science Society, Computational Infrastructure in Geodynamics, Eastern Section of Seismological Society of America and Canadian Society for Agricultural and Forest Meteorology, Niagara Falls, Canada, June 10, 2018
- Schultz D, Tang S, Miller C, Janz DM, Hecker M, (2017). Determination of acute and sub-chronic toxicity of emerging contaminants in early life stages of three Canadian fish species. Canadian Ecotoxicity Workshop, Guelph, ON.

- Sergiel A, Cattet M, Kapronczai L, Janz DM, Selva N, Zedrosser A, (2017). How much does a follicle matter? Testing the effects of follicles on hair cortisol levels in brown bears. International Conference on Bear Research and Management, Quito, EC.
- Shea J, Harder P, Pomeroy J, Kraaijenbrink P, Improved quantification of mountain snowpack properties using observations from Unmanned Air Vehicles (UVAs). American Geophysical Union (AGU) Fall Meeting, New Orleans, USA, December 11, 2017
- Shook K, Pomeroy J, Classification of Prairie basins by their hysteretic connected functions. American Geophysical Union (AGU) Fall Meeting, New Orleans, USA, December 11, 2017
- Van Huizen BS, Petrone RM, Pomeroy JW, Modelling Seasonal Ground Ice and Evapotranspiration in a Western Boreal Plains Peatland using the Cold Regions Hydrological Model (CRHM). Joint Meeting of the Canadian Geophysical Union (CGU), Canadian Soil Science Society, Computational Infrastructure in Geodynamics, Eastern Section of Seismological Society of America and Canadian Society for Agricultural and Forest Meteorology, Niagara Falls, Canada, June 10, 2018
- Watts, C., H. Peng, J.P. Giesy, P.D. Jones. "Unregulated Disinfection By-Products: Integration of Temporal Trends in Occurrence, In Vitro Toxicity, and Natural Organic Matter Precursors" To: 38th Annual Meeting, November 11-16, 2017, Minneapolis, MN.
- Watts, T., H. Peng, J.P. Giesy, P.D. Jones. "Occurrence and In Vitro Toxicity of Disinfection By-Products in Saskatchewan Water Treatment Plants" To: 8th Annual Meeting, June 15-16, 2017, Saskatoon SK.
- Wayand N, Marsh C, Shea J, Pomeroy J, (2017). Remotely Sensed Snow Redistribution Indices.

 American Geophysical Union (AGU) Fall Meeting, New Orleans, USA, December 11, 2017
- Wheater H, Xu L, Gober P, Pomeroy J, Wong J, Resilience of Socio-Hydrological Systems in Canadian Prairies to Agricultural Drainage: Policy Analysis and Modelling Approach. American Geophysical Union (AGU) Fall Meeting, New Orleans, USA, December 11, 2017

Books and Book Chapters - 2018

- Abdelrasoul, A. 2018. Biomimetic and Bioinspired Membranes for New Frontiers in Sustainable Water Treatment Technology. United Kingdom: InTech Publisher ISBN 978-953-51-3662-0
- Chen, J., C. R. Wilson, J. S. Famiglietti and B. R. Scanlon, Groundwater Storage Monitoring From Space. In S. Liang (Ed.), Comprehensive Remote Sensing, Vol. 4, pp. 295–314. Oxford: Elsevier.
- Maghami M. and Abdelrasoul, A. 2018. Zeolites Mixed Matrix Membranes (Zeolites-MMM) for Sustainable Engineering. Zeolites and its Applications (pp.115-134). United Kingdom: InTech Publisher
- McDonnell, J.J., 2018. Book Foreword. Hydrology of Artificial and Controlled Experiments. InTechOpen Publishers, Croatia, in press.
- Westphalen H. and Abdelrasoul, A. 2018. Challenges and Treatment of Microplastics in Water. In Matjaz Glavan (Ed.), Water Challenges of an Urbanizing World (pp. 71-84). United Kingdom: InTech Publisher

Books and Book Chapters - 2017

Cervi J., and R.J. Spiteri, High-Order Operator-Splitting Methods for the Bidomain and Monodomain Models, Mathematical and Numerical Modelling of the Cardiovascular System and Applications, accepted December 10, 2017 (18 pages).

Plenary, Key Note and Invited Lectures - 2018

- Famiglietti, J. Urban Water Institute, Annual Water Conference, San Diego, CA, Keynote Address, August 22, 2018
- Famiglietti, J. Northwestern University, Students for Ecological and Environmental Development, Evanston, IL, Public Lecture, May 14, 2018
- Famiglietti, J. Resources for Future Generations, RFG 2018, Vancouver, BC, Keynote Address, June 20, 2018
- Famiglietti, J. University of Virginia, Charlottesville, VA
- Famiglietti, J. McMaster University, Hamilton, Ontario;
- Famiglietti, J. World Bank, Washington, DC
- Famiglietti, J. S. P.-W. Liu, A. McEvoy, D. N. Wiese, J. T. Reager, A. J. Purdy, M. Rodell and C. H. David, Food Grows where Groundwater Flows: California Grapples with Chronic Water Scarcity, AGU Fall Meeting, Washington, DC
- Famiglietti, J. S., M. Rodell, J. T. Reager, C. H. David, D. Stampoulis, M. H. Lo, Y. Wada, H. Beaudoing, D. N. Wiese and F. W. Landerer, How Can GRACE and GRACE-FO Global Hydrology Inform Land Surface Model Development and Evaluation? AGU Fall Meeting, Washington, DC
- Giesy, J.P. "P. B. T. What is it and How is it Determined". Department of Environmental Science, Baylor University, Waco, Texas, April 11, 2018.
- Giesy, J.P. "Probabilistic Risk Assessment". To: ENV 5342 Environmental Risk Assessment, Department of Environmental Science, Baylor University, Waco, Texas, April 12, 2018.
- Giesy, J.P. "Siloxanes in the Environment and Development of the Science Court in Canada". To Fundamentals of Toxicology. Baylor University, Waco, Texas, April 19, 2018.
- Giesy, J.P. "Stable Isotopes for Determining Trophic Status and Sources of Diets, Relative to Accumulation of Contaminants in the Environment. To: Ecology class Baylor University, Waco, Texas, April 19, 2018.
- Giesy, J.P. "A Toolbox for Aquatic Impact Assessment of Municipal Wastewater Effluents (AIME)" With M. Brinkmann, M. Hecker T. Bagatim, G. Codling, S. Hanson, N. Hogan, A. Hontela, P. Jones H. Peng H, B. Sarauer, K. Steeves, S. Wiseman and J.P. Giesy. To: 13th International Congress on the Biology of Fish of the Physiology Section of the American Fisheries Society. Calgary, Alberta, Canada, July 15-19, 2018.
- Giesy, J.P. Environmental Forensics: What is it and What can it Do?"1st Annual Science Meeting of the Global Water Futures Network, Hamilton, Ontario, Canada, June 6, 2018.
- Janz DM, (2018). Development and application of noninvasive biomarkers of physiological stress in charismatic megafauna. Invited seminar, Institute for Environmental Sciences, University of Koblenz-Landau, Landau, DE.

- Janz DM, (2018). Aquatic ecotoxicology of selenium: When a good nutrient goes bad. Invited seminar, Institute for Environmental Sciences, University of Koblenz-Landau, Landau, DE.
- Janz DM, (2018). Development and application of noninvasive stress markers in charismatic megafauna. Invited seminar, Institute for Environmental Research, RWTH Aachen University, Aachen, DE.
- Janz DM, (2018). Aquatic ecotoxicology of selenium: When a good nutrient goes bad. Invited seminar, Institute for Environmental Research, RWTH Aachen University, Aachen, DE.
- Janz DM, (2018). Development and application of noninvasive biomarkers of physiological stress in charismatic megafauna. Invited seminar, Duke University Ecology Seminar Series, Duke University, Durham, NC.
- Janz DM, (2018). Endocrine disrupting chemicals: Is there a scientific basis for concern? Invited lecture, Sustainable Management of Coastal Areas program, National Autonomous University of Mexico, Sisal Campus, Sisal, MX.
- Janz DM, (2018). Development and application of noninvasive biomarkers of physiological stress in charismatic megafauna. Invited seminar, Ecology Group, National Autonomous University of Mexico, Sisal Campus, Sisal, MX.
- Janz DM, (2018). Aquatic ecotoxicology of selenium: When a good nutrient goes bad. Invited seminar, Unit of Chemistry, National Autonomous University of Mexico, Sisal Campus, Sisal, MX.
- McDonnell, J.J. (2018) Workshop on 'Water Ages', Freiburg, Germany Key Note
- McDonnell, J.J. (2018) Workshop on 'Isotope-based studies of water partitioning and plant-soil interactions in forested and agricultural environments', Tuscany, Italy Key Note
- McDonnell, J.J. (2018) Distinguished Lecture, Tsinghua University, Dept of Civil and Environmental Engineering, Beijing China
- McDonnell, J.J. (2018) Northwest Agriculture and Forestry University, Yangling China

McDonnell, J.J. (2018) Beijing Normal University, Beijing China

McDonnell, J.J. (2018) Faculty of Soil and Water Conservation, Beijing Forestry University

McDonnell, J.J. (2018) Distinguished Lecture, SUSTEC, Shenzen China

McDonnell, J.J. (2018) Birmingham University, Campus World Water Day celebration, Birmingham UK.

McDonnell, J.J. (2018) Melbourne University, School of Engineering, Melbourne, Australia

McDonnell, J.J. (2018) Monash University, Dept. of Civil Engineering, Melbourne, Australia

McDonnell, J.J. (2018) University of the Sunshine Coast, Sustainability Institute, Sippy Downs, Australia

McDonnell, J.J. (2018) Concordia University, Faculty of Engineering and Computer Sciences Distinguished Speaker Series, Montreal

McGill University, Dept. of Earth and Planetary Sciences, Montreal

Morrissey, C.A. Holistic Management Conference, Moosimin, SK. Feb 2018

Morrissey, C.A. Distinguished Alumni Speaker, Simon Fraser University, Burnaby, BC, Feb 2018

Morrissey, C.A. Holos Workshop, Leduc, Alberta, March 2018

Morrissey, C.A. Agriculture Seminar Series, Dalhousie University, Truro, Nova Scotia, March 2018

Morrissey, C.A. Alberta Federation of Agriculture, Camrose, AB, June 26 2018.

- Patrick, R. 2018. Toward water security and climate change adaptation through source water protection planning: Stories from the Canadian Prairie. Alberta Watershed Planning Advisory Committee (WPAC) 2018 Summit held in Peace River, AB. June 19-22, 2018.
- Patrick, R. 2018. Source Water Protection Planning. Global Water Futures Inaugural Annual Science meeting held in Hamilton, ON. June 3-6, 2018.
- Patrick, R. 2018. Yorkton Tribal Council (April 24, 2018). Housing Workshop for Touchwood Agency, Qu'Appelle and Yorkton Tribal Councils. Presentation title: Source water protection planning in your community.
- Patrick, R. 2018. American Association of Geographers (AAG) New Orleans April 9-14, 2018. Lessons learned from community-based participatory research: Cumberland House Water Stewardship Plan.
- Patrick, R. 2018. File Hills Qu'Appelle (March 22, 2018) Water Operators Workshop. Advancing source water protection in your community.
- Pomeroy J, (2018). Impact of meteorological forcing data on snowpack and streamflow simulations simulations in the Canadian Rockies. Fourth Annual International Network for Alpine Research Catchment Hydrology (INARCH) Workshop, Santiago and Portillo, Chile, October 24, 2018
- Pomeroy J, (2018). How interactions between climate and vegetation impact hydrological processes in mountain headwater basins. Fourth Annual International Network for Alpine Research Catchment Hydrology (INARCH) Workshop, Santiago and Portillo, Chile, October 24, 2018
- Pomeroy J, (2018). International Network for Alpine Research Catchment Hydrology (INARCH). Fourth Annual International Network for Alpine Research Catchment Hydrology (INARCH) Workshop, Santiago and Portillo, Chile, October 24, 2018
- Pomeroy J, (2018). Global Water Futures for Alberta. Agri-Environmental Partnership of Alberta (AEPA) Advisory Committee Meeting, Edmonton, Canada, October 17, 2018
- Pomeroy J, (2018). International Conference Plenary session: Agricultural Water Futures in an era of Changing Agriculture and Climate. International Conference and 69th International Executive Council Meeting of the International Commission on Irrigation and Drainage, Saskatoon, Canada, August 12, 2018
- Pomeroy J, (2018). Improving hydrologic process representations. Integrated Modelling Program for Canada (IMPC) First Annual Meeting, Saskatoon, Canada, July 18, 2018
- Pomeroy J, (2018). Global Water Futures: Year One Progress. Integrated Modelling Program for Canada (IMPC) First Annual Meeting, Saskatoon, Canada, July 18, 2018
- Pomeroy J, (2018). The Global Water Futures Programme and its National Water Forecasting and Prediction System for Canada. 3rd Kazakhstan-Canada Business Council Meeting, Ottawa, Canada, June 11, 2018
- Pomeroy J, (2018). Rocky Mountain Water Supply Resilience and Vulnerability Evaluation. Alberta Innovates Water Innovation Program Forum, Edmonton, Canada, May 23, 2018
- Pomeroy J, (2018). Extreme Hydrology, Climate Change and Water Futures in Canada. Insurance Brokers Association of Alberta (IBAA), Banff, Canada, May 6, 2018
- Pomeroy J, (2018). Opening Plenary: Global Water Futures Program and its Science Contributions to GEWEX. 8th Global Energy and Water Exchanges (GEWEX) Open Science Conference: Extremes and Water on the Edge, Canmore, Canada, May 6, 2018

- Pomeroy J, (2018). The role of integrating observation and prediction systems in generating data and learning from models a hydrological and weather extremes prespective. Joint Young Earth System Scientists (YESS) and Young Hydrologic Society (YHS) Early Career Researcher (ECR) Workshop at the 8th Global Energy and Water Exchanges (GEWEX) Conference, Canmore, Canada, May 3, 2018
- Pomeroy J, (2018). Upcoming projects and work by Global Water Futures. Government of Alberta Workshop on Floodplain Mapping and Climate Change, Edmonton, Canada, March 20, 2018
- Pomeroy J, Helgason, (2018). Theme B overview and synthesis: CCRN Special Observation and Analysis Period (SOAP). Changing Cold Regions Network Annual General Meeting "The CCRN Finale", Saskatoon, Canada, March 5, 2018
- DeBeer C, Wheater H, Pomeroy J, (2018). CCRN status and future directions as a GEWEX RHP. Changing Cold Regions Network Annual General Meeting "The CCRN Finale", Saskatoon, Canada, March 5, 2018
- Pomeroy J, (2018). Cold regions process and modelling studies. Changing Cold Regions Network Annual General Meeting "The CCRN Finale", Saskatoon, Canada, March 5, 2018
- Pomeroy J, (2018). Introduction, GWF overview, and aims & objectives for the meeting. Global Water Futures Inception Meeting, Waterloo, Canada, January 22, 2018
- Spiteri, R. Departmental Seminar, Department of Mathematics, University of Utrecht, Utrecht, Netherlands, April 2018 Title: High-order operator-splitting methods for the bidomain and monodomain models
- Spiteri, R. Mathematical and Numerical Modeling of the cardiovascular system, Rome, Italy, April 2018 Title: High-order operator-splitting methods for the bidomain and monodomain models
- Spiteri, R. Departmental seminar, Department of Mathematics, Michigan Technological University, Houghton, MI, March 14, 2018 Title: High-order operator-splitting methods for the bidomain and monodomain models
- Spiteri, R. CAIMS Annual Meeting, Toronto, ON, June 04-07, 2018 Title: eBACOLI: a time- and space-adaptive multi-scale PDE solver
- Spiteri, R. CAIMS Annual Meeting, Toronto, ON, June 04-07, 2018 Title: CFD Modelling and Simulation of the Lux Vertical Axis Wind Turbine
- Spiteri, R. CAIMS Annual Meeting, Toronto, ON, June 04-07, 2018 Title: High-order operator-splitting methods for the bidomain and monodomain models
- Spiteri, R. Workshop on Adaptive Numerical Methods for Partial Di erential Equations with Applications, Banff International Research Station, Banff, AB, May 27-June 01, 2018 Title: eBACOLI: a time- and space-adaptive multi-scale PDE solver
- Spiteri, R. Saskatchewan Safety Research Symposium, Saskatchewan Polytechnic, Saskatoon Campus, Saskatoon, SK, May 03, 2018 Title: Rapid learning: research, software, experience

Plenary, Key Note and Invited Lectures - 2017

- Famiglietti, J. Frontiers of Geosciences Lecture, Los Alamos National Laboratory, Los Alamos, NM, June 12, 2017
- Famiglietti, J. Case Western University, Think Forum, Cleveland, OH, April 2, 2017

- Famiglietti, J. Salmonid Restoration Federation, Salmonid Conference Keynote Address, March 31, 2017
- Famiglietti, J. Mississippi State University, Energy Institute, The Future of Water Conference, Keynote Address, March 28, 2017
- Famiglietti, J. California Irrigation Institute, 55th Annual Conference, Sacramento, CA, January 30, 2017
- Famiglietti, J. University of Rhode Island, Kingston, RI
- Famiglietti, J. AquaHack, Cleveland, OH
- Famiglietti, J. S., M. Rodell, A. Richey and J. T. Reager, The Global Groundwater Crisis, AOGS, Singapore
- Famiglietti, J. S., M. Rodell, A. Richey and J. T. Reager, The Global Groundwater Crisis, AGU-JpGU Conference, Tokyo
- Famiglietti, J. S., GEWEX/GLASS, Tokyo
- Giesy, J.P. "Halogenated "Pollutants" Everywhere: An Overview of Findings from the Great Lakes Sediment Surveillance Program". With: K.J. Rockne, H. Peng. J.-H. Guo, S. Hosseini, A. Li and N. Sturchio. To: 9th Internatiral Conference on Remediation and Management of Contaminated Sediments, January 9-12, 2017, New Orleans, LA, USA.
- Giesy, J.P. "Untargeted Screening of Brominated and Iodinated Disinfection By-Products". With: T. Watts, H. Peng and P. Jones. To: Buffalo Pound Water Treatment Workshop, March 1, 2017, Moosejaw, Saskatchewan.
- Giesy, J.P. "Toxin Monitoring: Temporal-spatial distribution". With: H. Peng and P.D. Jones. To: Buffalo Pound Water Treatment Workshop, March 1, 2017, Moosejaw, Saskatchewan.
- Giesy, J.P. "New Mass Spectrometry Techniques for the Measurement of Persistent Organic Pollutants." With: P.D. Jones. To: Dioxin 2017, the 37th International Symposium on Halogenated Persistent Organic Pollutants, Vancouver, British Columbia, Canada, August 20-25, 2017.
- Giesy, J.P. "Characterizing toxicity of oil sands process-affected waters (OSPW)". With: G. Morandi, S. Wiseman and J. Martin. To: Oil Sands Process Water (OSPW) Science Workshop COSIA, Calgary, Alberta, Canada, September 6, 2017.
- Giesy, J.P. "Toxicological Evaluation of Perfluorooctane Sulfonate (PFOS) in the Environment: Anatomy of an Environmental Issue". To: School of Biological Sciences of the University of Hong Kong, Hong Kong, SAR, Peoples Republic of China, February 2, 2018.
- Morrissey, C.A. NSERC Connect Workshop, Winnipeg, Manitoba, Sept. 2017
- Morrissey, C.A. Saskatchewan Agrologists, Saskatoon, SK, Nov 2017
- Patrick, R. 2017. Partners for the Saskatchewan River Basin. Leduc, AB. Annual Conference October 17-19, 2017. Presentation Topic: Frog Lake Source Water Protection Plan (with Len Quinney).
- Patrick, R. 2017. FSIN Health and Social development Climate change Adaptation Workshop. Sept 21-22, 2017. Presentation: Adapting to Climate Change: University Research in your Community.
- Patrick, R. 2017. Prairie CAG Morris Manitoba Sept 30-Oct 1, 2017. Paper: Cumberland House Water Stewardship Plan

- Pickering, I.J. T. K. Sham and G. N. George, AXS: A New Advanced X-ray Spectroscopy Facility at the Canadian Light Source. Presentation to the Science Advisory Committee of the Canadian Light Source, Saskatoon, SK, Canada, May 4, 2017.
- Pickering, I.J. Life at the (absorption) edge: synchrotron research in industry, a national laboratory and academia. Chemistry Graduate Student Symposium, University of Saskatchewan, Saskatoon, SK, Canada, May 3, 2017.
- Pickering, I. J., G. N. George, E. Arnér and Q. Cheng, Direct observation of methylmercury and auranofin binding to selenocysteine in thioredoxin reductase. Se2017: 200 Years of Selenium Research. The 11th International Symposium on Selenium in Biology and Medicine and The 5th International Conference on Selenium in the Environment and Human Health. Karolinska Institutet Stockholm, Sweden, August 13-17, 2017.
- Pomeroy J, Rasouli K*, Fang X*, Whitfield P*, Marks D, Janowicz R, (2017). Water Futures for Cold Mountain Ecohydrology under Climate Change Results from the North American Cordilleran Transect. American Geophysical Union (AGU) Fall Meeting, New Orleans, USA, December 11, 2017
- Pomeroy J, Pradhananga D*, Brown T*, Anderson E*, Demuth M, (2017). Modelling Changing Glacier Hydrological Processes using an Object Oriented Cold Regions Hydrological Model and Long-term In-situ and Remote Sensing Information. American Geophysical Union (AGU) Fall Meeting, New Orleans, USA, December 11, 2017
- Marsh C*, Pomeroy J, Wheater H, (2017). Simulating Complex, Cold-region Process Interactions Using a Multi-scale, Variable-complexity Hydrological Model. American Geophysical Union (AGU) Fall Meeting, New Orleans, USA, December 11, 2017
- Pomeroy J, (2017). Rocky Mountain Water Supply Resilience and Vulnerability Evaluation. Title City Dates Alberta Irrigation Projects Association (AIPA) Water Conference, Lethbridge, Canada, November 20, 2017
- Pomeroy J, Shook K*, Fang X*, Annand H*, Krogh S*, (2017). Overview of CRHM development and application at the observatories, including long term diagnostic CRHM runs using WRF PGW, station downscaled RCM and statiscally dowscaled RCM, including transient change impacts. Discussion on insights from fine-scale results for large-scale modelling and next steps. Changing Cold Regions Network (CCRN) Modelling and Theme D Workshop, Canmore, Canada, November 2, 2017
- Pomeroy J, (2017). The big thaw, Canada and the Global Water Futures Programme. Imperial College London, Grantham Institute, London, England, October 27, 2017
- Pomeroy J, (2017). Climate Change and Mountain Hydrology: Results from the Global Energy and Water Exchange Project's International Network for Alpine Research Catchment Hydrology. United Nations Educational, Scientific and Cultural Organization (UNESCO) Knowledge Forum on Water Security and Climate Change: Innovative Solutions for Sustainable Water Resources Management. UNESCO Headquarters, Paris, France, October 18, 2017
- Pomeroy J, (2017). The Global Water Futures Programme and its Science Contributions to the UN's Sustainable Development Goals and the Paris Climate Agreement. United Nations Educational, Scientific and Cultural Organization (UNESCO) Knowledge Forum on Water Security and Climate Change: Innovative Solutions for Sustainable Water Resources Management. UNESCO Headquarters, Paris, France, October 18, 2017

- DeBeer C, Pomeroy J, (2017). International Network for Alpine Research Catchment Hydrology (INARCH). Global Energy and Water Exchanges (GEWEX) Hydroclimatology Panel (GHP) Third Pole Environment (TPE) Meeting, Kathmandu, Nepal, October 17, 2017
- Pomeroy J, (2017). Global Water Futures Programme and the National Water Prediction and Forecasting System. Canadian Dam Association (CDA) Conference, Kelowna, Canada, October 16, 2017
- Pomeroy J, (2017). Canadian Prairie Hydrology and Runoff Generation. Prairie WATERSAVE Meeting, Saskatoon, Canada, October 3, 2017
- Pomeroy J, (2017). Wolf Creek as an Outdoor Hydrology and Climate Laboratory 25 years of Contributions to Understanding Global Energy and Water Cycling. Wolf Creek Summit, Whitehorse, Canada, September 28, 2017
- Costa D, Pomeroy J, (2017). Non-point source modelling (HYPE and future of MESH/CHM). GWF Integrated Modelling Program for Canada (IMPC) kick-off Workshop, Saskatoon, Canada, September 14, 2017
- Pomeroy J, (2017). Cold regions hydrology in mountain and northern river basins: measurements, processes and modelling. Swiss Polar Institute High Altitudes meet High Latitudes: Globalizing Polar Issues Conference, Crans-Montana, Switzerland, September 11, 2017
- Rasouli K, Krogh S, Pavlovskii I, Hayashi M, Pomeroy J, (2017). The role of soil freezing and thawing in hydrological processes: Canadian case studies. The 2nd Asian Conference on Permafrost, Sapporo, Japan, July 2, 2017
- Spiteri, R. Mathematical methods in cardiac electrophysiology workshop, University of Ottawa, Ottawa, ON, November, 2017 Title: High-order operator splitting for heart simulation
- Spiteri, R. CAIMS Annual Meeting, Halifax, NS, July 17-21, 2017 Title: Extending BACOLI to simulate multi-scale models
- Spiteri, R. CAIMS Annual Meeting, Halifax, NS, July 17-21, 2017 Title: Toward real-time heart simulation

Patents

Abdelrasoul, A., Water Purification Device with Novel Filter, United States Provisional Patent Application No. 62/580,898

Editorial Boards

Famiglietti, James

 Editorial Board Member, Earth and Environmental Sciences, Scientific Reports, Nature Publishing Group. 2017-2019

Giesy, John

- Editor in Chief, J. Environmental Science Research. Chinese Research Academy of Science, Beijing, China. 2015-Present
- Associate Editor Environmental Development The Transdisciplinary Journal of Scientific Committee for Pollution in the Environment (SCOPE) of United Nations, 2011-Present
- Editorial Board. Ecosystem Health and Sustainability. Published by Ecological Society of America and Ecological Society of China. 2013-Present

- Editorial Board Geochemistry and Environmental Health. 2006-Present
- Editorial Board Environmental Bioindicators. 2007-Present
- Editorial Board. Reviews in Environmental Contamination and Toxicology. 2007-Present
- Editorial Advisory Board: Toxicological and Environmental Chemistry. Gordon and Breach/Scientific Publishers. London. 1989-Present.
- Editorial Board: Environmental Toxicology and Pharmacology. 2006-Present
- Guest Editor: Proceedings of the National Academy of Science, USA. 2007-Present
- Editorial Board: Environmental Research: 2014-Present
- Editorial Board: Environmental Reviews. 2014-Present
- Advisory Board: The Handbook of Environmental Chemistry series. Springer Verlag. 2004-Present.
- Editorial Board Handbook of Ecotoxicology, Lewis Publishers /CRC Press. 1992-Present.

Janz, David

- Senior Editor for journal Bulletin of Environmental Contamination and Toxicology, 2016present
- Editorial Board Member for journal Aquatic Toxicology, 1998-present

Li, Yanping

• Serve as the Special issue editor of "Hydrology and Earth System Sciences" (HESS), European Geosciences Union journal, 2017-

McDonnell, Jeffrey

- Editorial Board, Rhyzosphere, Elsevier
- Editorial Board, Sustainable Water Developments (Book Series), CRC Press
- Editorial Board, Ecohydrology, John Wiley and Sons
- Editorial Advisory Board, Forest Science and Technology, Taylor and Francis Ltd
- Editorial Board, Wires Water, John Wiley and Sons
- Associate Editor, Hydrological Processes, John Wiley and Sons.
- Editorial Board, Hydro-Science and Engineering, Nanjing Hydraulic Res. Institute, China
- Editorial Board, Advances in Water Science (China), UNESCO
- Editorial Board, MASKANA (the multidisciplinary journal of the University of Cuenca).
- Editorial Board, Forest Research—Open Access, OMICS Publishing Group (final year)
- Associate Editor, Journal of Hydrology and Hydromechanics, Open access journal
- Editorial Board, Asian Journal of Geosciences, Hindawi Publishers
- Editorial Board, Journal of Hydrogeology and Hydrologic Engineering, Sci-Technol.
- Editorial Board, Riparian Ecology and Conservation, Versita and Springer
- Editorial Board, Water, MDPI Publishers, Switzerland
- Editorial Board, International Journal of Hydrology Science and Technology, Inderscience Enterprises Ltd (UK).

Spiteri, Raymond

Associate Editor, Applied Numerical Mathematics

Founding co-Editor-in-Chief, Mathematics in Science and Industry

APPENDIX F - Collaborations and Outreach

Famiglietti, James

- Famiglietti, J., Earth's dismal water future, mapped, Los Angeles Times, June 10, 2018
- Famiglietti, J. and M. Miro, Los Angeles Times, California will always be thirsty, March 7, 2017
- Water: The Molecule That Made Us, Passion Pictures, 3-part PBS Water Documentary Mini-Series, Featured Expert, Filmed May, 2018
- Day Zero, KEO Films, water documentary, filmed May, 2018
- Parched: The Water Wars, Jigsaw Productions, Series Advisor and Interview Subject, March, 2017
- Water and Power: A California Heist, Jigsaw Productions, Advisor and Interview Subject, January, 2017
- National Geographic Water Currents, Contributor, http://newswatch.nationalgeographic.com/author/jfamigli/
- Huffington Post, Contributor, http://www.huffingtonpost.com/jay-famiglietti/

Giesy, John

- Research Centre for Toxic Compounds in the Environment Centre (RECETOX), Faculty of Science, Masaryk University. Chair, Scientific Board/international Advisory Committee for Large Infrastructure Program, Ministry of Education, Youth and Sports. 2016-Present
- Canada Institute for Health Research (CIHR) Member College of Reviewers, 2018
- Health Canada Member Chemical Management Plan Science Committee, 2017-2020
- Alberta Minister of Environment and Parks Science Advisory Panel, 2016-2018
- Chair Advisory Council for Research Centre for Toxic Compounds in the Environment Centre (RECETOX), Faculty of Science, Masaryk University. 2016-Present.

Janz, David

- Member, Evolution and Ecology Scholarships and Fellowships Selection Committee (169),
 Natural Sciences and Engineering Research Council of Canada, 2016-present
- Member, North American Metals Council, Selenium Working Group 2008-present

Jardine, Tim

- Jardine, T.D., and Carriere, S. 2018. Understanding, managing and preserving the Saskatchewan River Delta. Northumberland Learning Connection Speaker Series, April 19, Cobourg, ON.
- Jardine, T.D., and Carriere, S. 2018. Do rivers need floods? Northumberland Learning Connection Speaker Series, April 20, Port Hope, ON.

Li, Yanping

Serve as one of the two Member Representatives of University of Saskatchewan at UCAR.
 University of Saskatchewan's UCAR membership was approved on October 2017

- Serve in the Canadian Space Agency (CSA)'s Earth System Science Advisory Committee (ESSAC), 2017-2022
- Grant proposal reviewer for National Science Foundation (NSF) of United States, Natural Sciences and Engineering Research Council of Canada (NSERC) Discovery Grant.

Lindenschmidt, Karl-Erich

- Karl-Erich Lindenschmidt and his team developed the first operational ice-jam flood forecasting system that was tested for the Athabasca River at Fort McMurray in April 2018. This was a collaboration with forecasters from the Government of Alberta.
- Lindenschmidt carried out on independent review of the 17 May 2017 ice-jam flood event along the Churchill River in Labrador for the Government of Newfoundland and Labrador, submitted September 2017 and posted at https://www.mae.gov.nl.ca/waterres/flooding/mud_lake_flooding.html. Two CBC media clips featuring this work include:
- N.L. hires Saskatchewan professor to conduct review of Mud Lake flooding (https://www.cbc.ca/news/canada/newfoundland-labrador/mud-lake-report-karl-erich-lindenschmidt-1.4159769)
- Natural causes to blame for Mud Lake flooding, concludes independent report (https://www.cbc.ca/news/canada/newfoundland-labrador/report-mud-lake-flooding-natural-causes-1.4317112)

Mamet, Steven

- Earthwatch International, Citizen Science Each year, I lead three groups of citizen scientists in the collection and curation of long-term environmental monitoring data from two subarctic settings: the western Mackenzie Mountains in the NWT and the Hudson Bay Lowlands, Manitoba.
- Canadian Mountain Network In December 2017, I shared my research via live stream as part of International Mountain Day.
- Under National Geographic's Changing Planet blog, my Earthwatch colleague Alix Morris authored a post on my research in Churchill, Manitoba, in December 2017.
- I recently contributed to a review article on the changing boreal forest entitled "The Great Global Species Shakeup" in the Toronto Star in December 2017
- MAMET, S.D., MA, B., ULRICH, A., SCHRYER, A., & SICILIANO, S.D (2018) Who is the rock miner and who is the hunter? The use P18O4 to differentiate between C and P fluxes in a benzene-degrading consortium. Sustainable In-Situ Remediation Co-operative Alliance (SIRCA) Technical Meeting. Apr. 20th, 2018. Saskatoon, SK. Oral Presentation

Morrissey, Christy

- Society of Environmental Toxicology and Chemistry (SETAC), Wildlife toxicology IG Steering Committee co-chair. 2016- 2017
- Organizer NSERC Connect Workshop for 50 participants on redesigning Prairie agricultural systems for improved sustainability and resiliency, Sept.22-23, Winnipeg, MB
- Principle Investigator, CPARN, NSERC Strategic Network Committee Site Visit, March 2018

SETAC session chair, Minneapolis, MN, Nov 2017

McDonnell, Jeffrey

- President, AGU Hydrology Section (7000 members of section)
- Member, AGU Council (the administrative body of the 60,000 member Union)
- Board Member, Helmholtz Inst., Germany, TERENO Terrestrial Observatory Network (one annual Board meeting)
- Member, CGU Isotopes Committee

Pickering, Ingrid

- Chairperson of the Board, Canada Foundation for Innovation (CFI), June 2018-June 2021. The CFI, an independent, non-governmental organization, is the major entity in Canada responsible for funding world-class research infrastructure. This is a Governor in Council Appointment, signed by the Governor General of Canada.
- July 2013-June 2018 I served as one of seven Member-appointed Directors representing the Canadian research community (six others appointed by the Government in Canada) and one of only three professors. Board meets three times per year.
- Governance and Nominating Committee, CFI Board, January 2014-present. Meets three times per year by teleconference.
- Vice Chair, Science Advisory Committee, National Synchrotron Light Source-II (NSLS-II), September 2017-present. Member May 2013-present. Advises on scientific utilization and developments of NSLS-II at Brookhaven National Laboratory, NY, USA.
- Board of Directors, Canada Foundation for Innovation (CFI), July 2013-June 2018.
 The CFI, an independent, non-governmental organization, is the major entity in Canada responsible for funding world-class research infrastructure. I am one of seven Memberappointed Directors representing the Canadian research community (six others are appointed by the Government in Canada) and one of only three professors. Board meets three times per year.
- Governance and Nominating Committee, CFI Board, January 2014-present. Meets three times per year by teleconference.
- Chair, Proposal Review Panel (PRP), Molecular Environmental and Interface Science (MEIS) subpanel, Stanford Synchrotron Radiation Lightsource (SSRL), Menlo Park, California, USA. Member since June 2015; chair January 2016-present. Meets 3 times per year to consolidate ratings for MEIS proposals to access beamtime at the SSRL synchrotron.
- Organizing Committee Member, International Conference on X-Ray Microscopy (XRM2018), to be held summer 2018 in Saskatoon, SK. Committee activity from October 18, 2014.
- BioXAS Beam Team co-Leader, Canadian Light Source (2007-). Scientific co-lead with Graham George. Three endstations for biological X-ray absorption spectroscopy and X-ray fluorescence imaging

Pomeroy, John

- Co-convener, The Mountain Water Cycle Session, 8th Global Energy and Water Exchanges (GEWEX) Open Science Conference: Extremes and Water on the Edge, Canmore, Canada, May 2018
- Scientific Committee Member, Wold Meteorological Organization (WMO) High Mountain Summit, April 2018 to February 2019
- Chair, 3rd Annual International Network for Alpine Research Catchment Hydrology (INARCH) Conference, Zugspitze, Germany, February 2018
- Canadian International Policy on Water, Peace and Security, InterAction Council, High-Level Expert Group (HLEG), Ottawa, Canada, November 2017
- Scientific Committee Member, 1st International Conference on Water Security, Toronto, Canada, October 2017 to June 2018
- Blue Ribbon Panel Review of Environment and Climate Change Canada's National Hydrological Service Workshop, Ottawa, Canada, National Hydrological Service, October 2017 to November 2017
- External Review Panel Member for the Integrated Network Design Project conducted by the Meteorological Service of Canada (MSC), Meteorological Research Division, November 2017 to January 2018
- Other Activity Calgary flood 5 years later Nature's power and the long-lasting impacts on southern Alberta rivers, Broadcast Interview. Global News, June 2018
- Other Activity Of forests and floods: Devastatingly high water raises clear-cut questions,
 Text Interview. CBC News, June 2018
- Other Activity Epic 2013 flood harbinger of a changing climate's impact, Text Interview. Calgary Herald, June 2018
- Other Activity Global Water Futures conference: Water problems seeking solutions, Broadcast Interview. Radio Canada International, June 2018
- Other Activity National flood forecasting strategy, Broadcast Interview. News Talk 770 CHQR, May 2018
- Other Activity Record floods show world has changed and N.B. must adapt, scientists say, Text Interview. The Canadian Press / La Presse, May 2018
- Other Activity Forecasters on alert as river basins across Alberta have high snowpacks, Text Interview. Toronto Star Newspapers Ltd, April 2018
- Other Activity Could Calgary see 2013 flooding again?, Text Interview. Canadian Underwriter, April 2018
- Other Activity High snowpack across Alberta has river forecasters on alert this spring, Broadcast Interview. CBC Edmonton, April 2018
- Other Activity Deliverance from Flood: Pitting city against country, Text Interview. Alberta Views, April 2018
- Other Activity Canada isn't as water-rich as you might think, Broadcast Interview. CTV News, March 2018
- Other Activity Coast to Coast questioning from local CBC radio shows, Broadcast Interview. CBC/Radio-Canada, March 2018

- Other Activity Vulnerability in Canada to drought and water extremes, Broadcast Interview. CBC News, March 2018
- Other Activity Here are the places in Canada yes, Canada vulnerable to drought, Broadcast Interview. CBC/Radio-Canada, March 2018
- Other Activity Snowpack levels high but flooding concerns depend on rain forecast, Text Interview. Calgary Herald, March 2018
- Other Activity Even with its massive water resources, Canada is not immune to dramatic droughts, Broadcast Interview. Radio Canada International, March 2018
- Other Activity 'It's not impossible': Western Canada's risk of water shortages rising, Broadcast Interview. CBC Calgary, March 2018
- Other Activity Is Canada's West Coast immune from a water crisis?, Broadcast Interview.
 CBC News The National, March 2018
- Other Activity Un nouveau modèle climatique permettra de mieux prédire les inondations dans l'Ouest canadien, Broadcast Interview. CBC/Radio-Canada, March 2018
- Other Activity Day Zero for Cape Town water, what about Canada, and elsewhere?, Broadcast Interview. CBC/Radio-Canada, March 2018
- Other Activity USask researchers say they can better predict storms caused by rising temps, Broadcast Interview. Global Saskatoon, March 2018
- Other Activity Sask. Researchers say they can now better predict storms caused by rising temperatures, Broadcast Interview. CBC Saskatchewan, March 2018
- Other Activity New science is forecasting the future in the changing climate of Western Canada, Text Interview. University of Saskatchewan, March 2018
- Other Activity Expect more rain, floods as part of climate change: experts, Text Interview. Winnipeg Free Press, March 2018
- Other Activity Canadian researchers find way to better predict severe storms, Text Interview. Canadian Underwriter, March 2018
- Other Activity River flooding is not a risk at the moment, according to experts, Text Interview. Metro Calgary, March 2018
- Researchers say they can better predict storms caused by rising temperatures, Broadcast Interview. CTV News, March 2018
- Study shows shocking reality of climate change in Saskatchewan and around the world, Broadcast Interview. 620 CKRM The Source, March 2018
- Researchers say they can better predict storms caused by rising temperatures, Text Interview. Saskatoon StarPhoenix, March 2018
- Global Water Futures, Broadcast Interview. CBC Saskatchewan, December 2017
- Global Institute for Water Security Receives \$1.3m to Develop Sensors, Text Interview. Water Canada, November 2017
- Boosting Canada's Global Expertise in Water Security and Precision Agriculture Research, Text Interview. Canadian Insider, November 2017
- Yukon's Wolf Creek 'research basin' helps track and plan for climate change, Broadcast Interview. CBC North, October 2017
- In Saskatchewan, high water washes farm profits away, Text Interview. The Globe and Mail, September 2017

- Pomeroy J, (2018). Global Water Futures: Researching water in a changing climate. Freshwater Alliance Webinar, Toronto, Canada, June 28, 2018
- Pomeroy JW, (2018). Saskatchewan Water Futures. University of Saskatchewan Provincial Tour, Swift Current, SK, June 13, 2018
- Global Water Futures, Climate Change and Water Science for the Canadian Rockies and Beyond. Let's Talk Climate and Water Science, Canmore, Canada, May 5, 2018
- The Global Water Futures Programme Science, Prediction and Policy for the Canadian Prairies. PHJV Policy Committee Webinar Series, February 14, 2018
- Saskatchewan Water Futures. Canadian Federation of University Women, Saskatoon, Canada, February 5, 2018
- Wolf Creek Research Basin Yukon's Own Water and Climate Science Catalyst. Yukon Science Institute, Whitehorse, Canada, September 26, 2017
- Wolf Creek Research Basin Yukon's Own Water and Climate Science Catalyst, Global Water Futures. Yukon Water Forum, Whitehorse, Canada, September 26, 2017

Spiteri, Raymond

- Incoming Chair (Applied Mathematics stream), NSERC Evaluation Group 1508 (Mathematics and Statistics)
- Past-President, Canadian Applied and Industrial Mathematics Society



