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Global Water Futures Shows Important Scientific Progress and Outcomes at Its 4th Annual Open Science Meeting

Virtual Meeting
17–19 May 2021

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Canada and the world are facing immense water-related threats from climate warming, environmental change, and human actions. Cold regions supply much of the world's freshwater and are undergoing rapid change with an increasing occurrence of extreme events. Finding solutions for how to best forecast, prepare for, and manage water futures in the face of dramatically increasing risk is a global imperative. *Global Water Futures (GWF): Solutions to Water Threats in an Era of Global Change* (www.globalwaterfutures.ca) is a Canadian-led initiative over seven years (2016–2023) that involves over 380 scientists from 18 Canadian universities and 39 federal and provincial government agencies, as well as many collaborators and stakeholder partners from across Canada and internationally. GWF's overarching goal 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, with a focus on 1) improving disaster warning and developing forecasting capacity to predict the risk and severity of extreme events, 2) predicting water futures through the use of big data and improved numerical models to assess change in human and natural land and water systems, and 3) informing adaptation to change and risk management through governance mechanisms, management strategies, and policy tools and guidance. In Canada, GWF focuses on large (and often transboundary) river basins spanning the country, and key ecological, climatological, and physiographic regions that are representative of the scientific and societal issues faced globally, especially within cold regions.

GWF builds upon several decades of Canadian contributions to the GEWEX project. This began in the 1990s with the Mackenzie GEWEX Study, focusing on the Mackenzie River Basin between 1994 and 2005. In 2012, the Saskatchewan River Basin (SaskRB) Regional Hydroclimate Project (RHP) was approved and was expanded in 2014 to include the Mackenzie Basin. This broader RHP for western Canada mirrored the Changing Cold Regions Network, running from 2013 to 2018. This effort was further expanded in scientific and geographic scope with the GWF program, which since 2018 has contributed to GEWEX as a fully operational RHP—the only current RHP for North America (see https://gwf.usask.ca/documents/gewex-global-water-futures-proposal_submit_2018.pdf).

Last year, GWF reached a milestone with its mid-term point of its 7-year program. GWF continues to make scientific and institutional progress despite the challenges of the pandemic; has

launched its full suite of transdisciplinary and transformative projects and teams; implemented a co-developed Indigenous community water research strategy; developed an innovative virtual approach to linking science and art; and is implementing an ambitious equality, diversity, and inclusion (EDI) strategy. GWF is working with its community of users to make important advances that enhance water security for Canadians and address some of the world's most important and pressing water problems. A comprehensive report on the scientific strategy and progress was released and provides more detail (*https://gwf.usask.ca/outputs-data/midterm-report-2020.php*).

Over 1,000 GWF members and partners met online in the second year of the global pandemic for GWF's 4th Annual Open Science Meeting (GWF2021), held May 17–19, 2021. This brought together the GWF community to share our advances in knowledge, connect with users and partners, provide updates on co-developed water solutions, and discuss the actions needed to secure a sustainable water future. GWF2021 offered a variety of virtual programming to enable shared learning and insightful discussions through key events, including keynote talks, panels, and an interactive poster session. These were complemented by parallel sessions, networking, social activities, and workshops for GWF's Young Professionals. The meeting's programming was designed to engage both researchers and stakeholders in two-way learning and exchanges.

View the posters and recordings of the plenaries and parallel sessions on the GWF2021 website: *https://www.gwf2021.com/*. The meeting was organized around five major themes and five cross-cutting challenges, as follows:

Theme 1	Theme 2	Theme 3	Theme 4	Theme 5
Climate-driven changes of water environments in cold regions	From anthropogenic pressures to ecosystem services	Turning research into policy and management solutions	Innovation in water science and technology	Knowledge co-creation with Indigenous communities

Cross-cutting challenges and opportunities
Transferable knowledge and tools
Predictive modeling and forecasting
(Big) data science and management
Social, economic and health determinants and impacts
Stakeholder engagement and knowledge mobilization

Within this framework, the meeting included four plenary sessions (three keynote speakers and 10 panelists), 14 parallel sessions (75 presentations and talks, 92 GWF speakers, and 15 external speakers), and 131 poster presentations. It was a unique experience to have parallel sessions in a virtual science meeting, but this worked very well as sessions were recorded and available for viewing the same day. Poster presenters were assigned "live chat" times when they were available on a Zoom chat to interact with viewers and respond to questions and comments.

The topics covered were varied and diverse, including: permafrost landscapes; vegetation in arctic ecosystems; SARS-CoV-2 (COVID-19) wastewater surveillance and variant detection; river discharge and water quality prediction, flood forecasting and modeling for water reservoir management; remote sensing of water resources; sensors for water monitoring; best practices in Indigenous community water research; climate modeling and future climate projections; advances in water resources modeling; water valuation; economic value of water quality and behaviors; big data and artificial intelligence; next-generation data science; Indigenous water governance and justice; groundwater in cold regions; aquifer recharge and baseflow trends; sustainable urban water management; agriculture, crops, and hydrology; wetlands and ecosystem services; water quality modeling and nutrient legacy; and advancing access to clean water in Indigenous communities.

Parallel Sessions

Day 1 – Monday, May 17	Day 2 – Tuesday, May 18	Day 3 – Wednesday, May 19	
The Vulnerability and Resilience of Northern Ecosystems to Change	Mechanistic Modeling under Future Climates	Groundwater as a Cause and Cure of Water Insecurity	Theme 1
From Fish Toxicology to Covid Monitoring		Managing Urban Water Challenges in a Changing Climate	Theme 2
From Modeling to Management, Policy & Practice–Case Studies from Global Water Futures	Valuing Canada's Water Resources and Aquatic Ecosystem Services	Water and Agriculture	Theme 3
Sensors and Observations	Innovations in Data Science	Improved Tools for Prediction of Water Futures	Theme 4
Best Practices in Indigenous Community Water Research	Indigenous Water Governance and Justice	Co-creating Research to Advance Access to Clean Water in Indigenous Communities	Theme 5

List of parallel sessions of the GWF2021 meeting

The GWF2021 meeting represented an important event to bring the program together and synthesize results, and clearly showed the progress being made. GWF has improved the scientific underpinning to support disaster warning from floods, droughts, and water quality degradation episodes, and, through new code and computer technologies, is delivering state-of-the-art prediction systems. These prediction systems now require integration and implementation. GWF has made scientific progress in diagnosing the varied dimensions of changing water futures under climate and ecosystem change and in response to water resource development and has built the models that can predict this change. Now it is time to synthesize our assessment of water futures and to deploy those models to predict change and impacts on people, the environment, and the economy.

GWF has worked with over 450 users to develop transdisciplinary solutions to managing water-related risk in a wide variety of sectors, communities, and regions. Now we need to:

- Share, evaluate, compare, and contrast those solutions;
- Work with our users on the implementation and institutionalization of a solutions-based, equitable, inclusive, and evidence-informed approach to achieving water sustainability for Canada; and,
- Contribute to global water solutions through our international partnerships.

The final two years of the GWF program are now underway and we look forward to completing the project objectives and synthesizing the science behind recent extreme events in Canada such as the 2021 heat wave and subsequent drought, wildfires, glacier melt, and flooding and to linking hydrological models to water resource, health, and water use modeling with policy-informing model scenarios developed in consultation with users across Canada. The expansion of international and continental activities of GWF holds great promise for the future.