WATER FUTURES FOR THE WORLD WE WANT

OPPORTUNITIES FOR RESEARCH, PRACTICE, AND LEADERSHIP IN ACHIEVING SDG 6

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Both documents are available for download at: gwf.usask.ca/sdgreport

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PREFACE

Canada and the world are faced with unprecedented water-related challenges which impact our ability to meet many of the UN sustainable development goals. 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. Canada has some of the world's highest rates of climate warming along with associated extreme weather; together they impact infrastructure, institutions, ecosystems, and human health. Half of the world's population and all of Canada are dependent upon water from rapidly warming cold regions. More are impacted by the effects of rapid and often poorly regulated development on the sources of their freshwater supply. 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 requires 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 poses a grand challenge for how water science can address sustainable development goals: "How can we best forecast, prepare for and manage water futures in the face of dramatically increasing risks?"

Canada has responded to this challenge with the research programme, Global Water Futures: Solutions to water threats in an era of global change or GWF. The University of Saskatchewan leads GWF in partnership with University of Waterloo, McMaster University, and Wilfrid Laurier University and draws upon the expertise of water scholars at dozens of academic institutions to work with hundreds of sectoral users, governments, Indigenous communities, industries, and others to develop transdisciplinary solutions to water security threats. The overarching 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. GWF aims to position Canada as a global leader in water science for cold regions and addresses the strategic needs of the Canadian economy in adapting to change and managing risks of uncertain water futures and extreme events. End-user needs are critical inputs to drive strategy and shape GWF science. Critical needs for meeting the grand challenge that GWF contributes to include improved disaster warning. Currently, we lack the scientific knowledge, monitoring and modeling technologies, and national forecasting capacity to predict the risk and severity of potentially catastrophic events in Canada. These knowledge gaps and technology barriers have resulted in significant loss of life and property in recent years. Canada and the world need to predict our water futures in order to assess how we can meet many of the Sustainable Development Goals. However, the world lacks water data on a scale to make informed decisions, and we cannot forecast future climate impacts without better models to assess changes in our human/natural land and water systems. These limitations create risks for water supplies, water quality, and sustainability. Meeting the Sustainable Development Goals means that we must adapt to change and manage risk associated with rapidly changing water, development, ecosystems, and climate. Nationally and globally, we lack the governance mechanisms, management strategies, and policy tools needed to reduce the risk of water threats, design adaptive strategies to cope with uncertainty, and take advantage of economic opportunities that arise as change unfolds.

This report was prepared by Professor Corinne Schuster-Wallace of the Dept. of Geography and Planning and the Global Institute for Water Security at the University of Saskatchewan in Saskatoon and Robert W. Sandford, Epcor Chair in Climate and Water Security of the United Nations University Institute for Water, Environment and Health in Hamilton, Ontario at the request of the GWF programme. Both Schuster-Wallace and Sandford are key contributors to GWF and individuals who have made vital contributions to its mission. All 39 GWF projects and six core teams from 15 universities in Canada provided information on how they addressed the Sustainable Development Goals and this was a crucial background for this report. Here, these two renowned and visionary sustainability scholars have brought together this information and much more into a clear and comprehensive report that introduces water in the world, water in Canada, challenges for achieving water-related Sustainable Development Goals, and then maps a path forward by which we can rise to the challenge of sustainability through research, practice and leadership. There are great benefits to following the path they outline and terrible costs if we do not.

I wish to thank them both for providing this report for GWF, for Canada, and for the world.

EXECUTIVE SUMMARY

THE MAJORITY OF CANADIANS PLACE A HIGH VALUE TO WATER, AND SEE FRESH WATER AS OUR MOST IMPORTANT NATURAL RESOURCE. HOWEVER, SUSTAINABLE WATER MANAGEMENT IS NOT A TOP PRIORITY IN THE POLICY SPHERE AND OUR WATER CHALLENGES PERSIST, GROW AND MULTIPLY AS A RESULT – THE MYTH OF WATER ABUNDANCE PERSISTS IN CANADA AND WE DON'T FULLY APPRECIATE HOW IMPORTANT IT IS TO OUR HEALTH, ECONOMY, AGRICULTURE, AND ENVIRONMENT

Where Canada Stands Vol II, 2018, A Sustainable Development Goals Shadow Report

Achievement of Goal 6 is central to the achievement of the Sustainable Development Agenda. The global water cycle literally floods the earth on a seasonal basis. Global warming and subsequent climate change is affecting this seasonal redistribution as well as the form in which water falls from the sky – as rain, snow, or ice. The world is aware that water can increasingly be loved or loathed: it is critical for existence of life and central to our quality of life, while also being responsible for poor health and death from waterborne diseases. Its absence causes droughts, and too much in too short a time causes floods. Water is a cornerstone of economic growth, essential for energy production, and equally as important for ecosystems.

More frequent extreme weather events associated with too much or too little water have become threat-multipliers that are undermining social, economic, and political stability. In many instances, water security and climate stability can be seen as two sides of the same coin. Many of the impacts of climate disruption are, and will continue to be, expressed through effects on water.

Water, and the ways in which it is used, vary significantly between countries. Even in areas where it is abundant, degradation of water quality can ultimately mean that water resources are insufficient. Groundwater resources are particularly important and vulnerable. In many places in the world accelerating hydro-climatic changes are putting greater pressure on already deteriorating water quantity and quality. Climate change is not the only stressor on our water resources. Population growth, urbanization, land use changes including deforestation and degradation, changing diets, and expanding societal wealth also impact the quality and quantity of surface and groundwater resources.

Canada is not a water secure country. This is evidenced through recent catastrophic experiences with floods, drought, fires, and toxic algae blooms. The cost of floods and droughts for families, towns and cities, the insurance sector, businesses, agriculture, and ultimately the Federal Government, are skyrocketing. Moreover, Canadian lakes and rivers support diverse plant and animal habitats, forests, tourism, recreation, agriculture, transportation, and essential ecosystem services such as water purification. However, these are not easily valued and therefore not valued enough.

Canada's water availability is disproportionately spread over a vast country spanning multiple ecozones, of which some, like the Canadian prairies, are semi-arid. Most fresh water drains to the north, while most people live in the south. The Canadian economy remains highly dependent on resource extraction, processing and transportation of oil and gas, ore, and pulp and paper, as well as intensive agriculture for crop and livestock production. All of these sectors are both heavily reliant on water availability, and have costs to the natural environment and our water resources that are not always fully recognized or completely mitigated.

Climate change is exacerbating water insecurity in Canada. Temperature increases in Canada are among the highest in the world. This warming is already having a substantial impact on Canada's cold-dominated hydrological cycle. Hydrologic shifts, especially between snowmelt- and rainfall-driven streams and rivers and subsequent changes in peak water flows have consequences for agricultural productivity, hydropower generation, and floods and droughts. Weather events are becoming more extreme, traditional animal territories are changing, and pathogen ranges are expanding.

Jurisdictional fragmentation, territoriality, and inequities make it difficult to generate and implement a common water management vision in Canada. Portfolios such as agriculture, health, water and wastewater treatment are shared between multiple agencies and levels of government, and water itself flows across municipal, provincial, territorial, and sometimes national boundaries. Inequities also exist with respect to who experiences the impacts of these challenges and who is most vulnerable to them. Indigenous communities, women and girls, and natural ecosystems are being left behind in pursuit of economic progress. In the absence of a coherent vision of itself at its future sustainable best, Canada as a nation remains mired in divisiveness on matters of energy policy, resource development, and action on climate change.

There is considerable opportunity for Canada to coordinate the activities of its water sector. Through the example of good and responsible management of its waters, based on strong science and evidence, Canada can improve its own water management and play a prominent leadership role in meeting water-related targets of the Sustainable Development Agenda. Opportunities exist through leadership, example, and knowledge mobilization. Canada possesses a modern water industry, world-leading water technologies, professionally managed water service provision, and world-class transformative water research. The strengths of our water sector, however, have not been optimally harnessed and fully orchestrated for future national interest. Water cooperation, in particular, is poised to become a major instrument that can be used to prevent conflict while at the same time strengthening international stability and promoting peace.

Major gaps still exist if we are to meet the ambitious yet necessary Goals of the 2030 Agenda. Based on an analysis of reports, syntheses, and activities to date, previous recommendations, the SDG targets, and the challenges associated with meeting and measuring the SDGs nationally and internationally from a variety of sources, we offer recommendations for action in research, practice, and leadership. This report is intended as a blueprint for more coordination between research, policy, and practice between Canadian water researchers, the Canadian government, and other initiatives around the world that will intentionally fill the gaps identified as necessary to achieve a water future for the world we want. There are huge opportunities for Canada on the national and global stage in these areas. Given the right business model and access to support and resources, there is significant capacity within the Canadian water sector to deliver water technology, management, capacity, and predictive tools to emerging markets, particularly in developing countries, to accelerate greatly needed sustainable water resources management.

There is an urgent need to ensure the sustainability of natural bio-diversity-based Earth system function. Presently, there is a huge and growing gap between our understanding of the problems and implementation and practice. These gaps can be bridged by recognition of the link between water, peace, security, and human and planetary health and the SDGs can be a catalyst whereby we organize our intentions and our actions to get there. This report synthesises current undertakings, gaps, and opportunities through research, practice, and leadership to shape sustainability starting with our water future.

There is huge opportunity for university research and leadership to contribute to this water future. Research networks should continue to remind all of the risks and threats posed to future stability by poverty, inequality, injustice, failed governance, climate change, and the massive involuntary human migration that are already beginning to follow in their collective wake. Ideally, however, universities should go beyond just talking about the SDGs and their importance, as they are largely doing now. They are uniquely poised to be showing the country and the world what the SDGs mean and how to implement them. The challenges, as always, lie in generating transformative and sustainable change that is more than the sum of individual programs, projects, and activities, even when they have scientific value in and of themselves. As such, a commitment to leadership is essential to realize these actions and to leverage them to become greater than the sum of their parts.

RECOMMENDATIONS

Major gaps still exist if we are to meet the ambitious yet necessary Goals of the 2030 Agenda. Based on an analysis of reports, syntheses, and activities to date, previous recommendations, the SDG targets, and the challenges associated with meeting and measuring the SDGs nationally and internationally from a variety of sources, we offer recommendations for action in research, practice, and leadership.

> *BECOMING RESILIENT AND PRE-SILIENT UNDER UNCERTAINTY DEMANDS THAT WE FIRST RESTORE MEMORY OF WHO WE ARE AND WHERE WE CAME FROM; RESTORE LOCAL IDENTITY AND HUMANITY'S SENSE OF PLACE; RESTORE TRUTH; RECOGNIZE ENVIRONMENTAL REGULATION AS PROTECTION FOR ALL AND NOT AN OBSTACLE TO MAKING MONEY; RESTORE RESPONSIBILITY TO HUMAN DIGNITY, ECONOMIC MORALITY, AND EQUITY; AND, IN SO DOING, RESTORE COMMON PURPOSE AND A VISION FOR THE FUTURE OF HUMANITY AND THE PLANET.*
>
> *Water Futures for the World We Want, 2019*

Opportunities in Research for Water-related SDGs

- Understand drivers of water quality in Lake Erie and Lake Winnipeg as an improvement blueprint for other large lakes;
- Improve the science for and our understanding of water-land ecosystem interactions for science-based management;
- Enhance groundwater research and monitoring methods especially for quality, quantity, and recharge dynamics to inform water management;
- Improve valuations of ecosystem services, incorporating gendered and Indigenous values;
- Improve understanding of the economic, social, and environmental implications of the intersections between aging infrastructure and climate change in the water, wastewater, and agricultural sectors;
- Understand the unique local water security challenges and opportunities, particularly in rural and remote and northern communities;
- Improve our understanding of climate impacts on infectious disease;
- Assess the impact of natural infrastructure interventions (i.e. nature-based solutions) from social, economic, health, and environment perspectives;
- Collaborate with communities and sectors to undertake risk analyses for natural hazards management;
- Contribute improved methodology for revising and updating flood maps and other enhanced and timely emergency management, public alerting, and post-disaster rehabilitation local decision-making and communication tools;
- Enhance understanding of effects of agriculture, developing new transformative technologies and sustainable management practices for protecting water quality;
- Strengthen the solid base of scientific research on climate change and its impacts especially through modelling and analyses;
- Improve data collection, modelling, and scenario-building to better inform economic, social, and environmental policy decision making under uncertainty that fully analyze impacts, (co)benefits, and trade-offs, especially of different policy options associated with sustainable development and climate change mitigation;
- Model and optimize "carbon sink" practices of water-land related and managed ecosystems such as wetlands and forests;
- Develop robust methods, sensors, and models to support data coverage and monitoring in remote and low resource settings;
- Collaborate with practitioners to develop new and refined indicators and measurement methods, starting with identified gaps in SDG 6;
- Develop and invest in rights-based solutions to water as a fundamental need for humans and nature;
- Invest in research dissemination, information, ethical data access, and capacity building, including for low- and middle-income populations and countries;
- Commit to exploring equity implications and collecting disaggregated data in water-related research (e.g., gender, ethnicity, indigeneity, location);
- Bond Traditional Knowledge (and Traditional Ecological Knowledge) and Western science to enable the best response to and solutions for sustainable societies;
- Advance science-based water resources management, especially through co-developed decision-making tools that incorporate Traditional Knowledge and social, economic, health, and environment considerations;
- Commit to mobilizing evidence into decision-making processes and opportunities by local, regional, national, and international policy-makers; and
- Commit to engaging in public discourse on climate change, its impacts, and solutions in order to combat "post-factual" social and political trends.

Opportunities in Practice for Water-Related SDGs

- Establish nested monitoring programs at local, basin, and regional (ecosystem) scales building on and integrating existing programs for a more comprehensive view of water conditions;
- Provide open access to publicly funded and collected water-related data sets and model outputs, particularly those produced through regulatory requirements;
- Develop "reduced complexity models" for multi-stakeholder management decision support;
- Develop climate-related sector-specific scenarios, especially in areas of human health, agriculture, water, energy (hydroelectric power), and disaster preparedness;
- Generate risk maps and health assessments that can inform climate change adaptation strategies and planning;
- Enhance resilience towards extreme weather events through soil and water management and community-led interventions;
- Develop indicators for assessing quality of participation and partnership, such as effectiveness, value, nature of engagement, and ability to deliver meaningful change;
- Develop user-friendly interfaces for integrated modelling platforms to support access to appropriate and timely information;
- Develop end-user tools and applications, co-designed with practitioners, especially those boundary organizations representing civil society and marginalized groups;
- Evaluate, document, and transfer emerging, innovative solutions;
- Commit to the use of evidence as the foundation for good (water) governance at all management scales;
- Embed the connection to water more explicitly in policies and strategies currently not focused on water, such as the International Feminist Agenda, and embed gender equity and health and well-being into water policies and strategies;
- Target the communication of knowledge through social media, public service announcements, print media, and other public interventions to change attitudes and behaviours towards enhancing water efficiency, water quality, climate change mitigation, and personal climate risk reduction;
- Harness existing capacity in Canadian water research programs, federal government agencies, and NGOs to publish a biennial State of the Water Report for Canada that incorporates health, water quantity and quality, drinking water and wastewater, economic sectors, and the environment.

Opportunities in Leadership for Water-Related SDGs

- Governments at all levels must take seriously and adhere to international commitments, such as the SDGs, the Sendai Framework for disaster risk reduction, and the Paris Climate Agreement;
- Governments and academic institutions must lead by example and commit to tackling the underpinning causes of climate change and water management including adopting a carbon neutral footprint, and equity, diversity, and inclusion in their workforces, policies, programs, and data;
- Following the example of the Canadian Institutes for Health Research, collaboration is required to reform funding mechanisms to facilitate true and meaningful community and stakeholder partnerships, especially in terms of direct research funds and project leadership;
- Academic institutions must value and incorporate community engagement and knowledge mobilization metrics as part of the tenure and promotion process to facilitate professional incentivization of individual researchers in applied and participatory research;
- Likewise, researchers focused on applied problems and solutions must challenge themselves to look at their contributions within the context of the SDGs and climate change adaptation, mitigation, and resilience;
- Politicians and political parties must recognize the urgency behind climate change mitigation and adaptation and the essentialism of sustainable development, commit to evidence-informed decision-making, stand against post-factual information ("fake news"), and articulate these in their platforms; and,
- The Federal Government must modernize the Canada Water Act to enable a more coordinated, practical, and multi-jurisdictional response to the root causes driving Canada's emerging climate and water crisis including federal leadership on the scientific, technical, and administrative capacity to measure, predict, and respond to water problems and opportunities and to engage in water diplomacy domestically and internationally.

1

INTRODUCTION: WATER IN THE WORLD

1. INTRODUCTION: WATER IN THE WORLD

In essence, the United Nations 2030 Agenda for Sustainable Development[1] is both a moral and biological imperative. The Agenda's Sustainable Development Goals (SDGs) form an organic whole; each of its 17 distinguishing elements standing in relation to each other. While it is possible and sometimes necessary to concentrate on just one – as this report does in focusing on water – the goals are modular. They are not separate blocks that can be snapped together. We cannot have good health if we do not have clean water. We cannot have peace and justice if we do not have high quality education, gender equity, good jobs, and economic opportunity. We realize now that all of these goals will continue to be moving targets unless we restore Earth system function—the dynamic, interrelated, and interdependent processes of the planet as a whole system.[2] From this perspective we can better appreciate that prolonged human existence on this planet is a package deal; Earth system function is the life support for the environmental, social, economic, and political stability upon which a prosperous future depends. A fundamental challenge in this thinking is in how to practically connect 17 goals and 169 targets in a way that nation states can effectively re-order their public policy within a timeframe that will make a difference.

> *"THE CAPACITY OF A POPULATION TO SAFEGUARD SUSTAINABLE ACCESS TO ADEQUATE QUANTITIES OF AND ACCEPTABLE QUALITY WATER FOR SUSTAINING LIVELIHOODS, HUMAN WELL-BEING, AND SOCIO-ECONOMIC DEVELOPMENT, FOR ENSURING PROTECTION AGAINST WATER-BORNE POLLUTION AND WATER-RELATED DISASTERS, AND FOR PRESERVING ECOSYSTEMS IN A CLIMATE OF PEACE AND POLITICAL STABILITY."*
>
> *UN-Water definition of 'Water Security', 2013*

In essence, this can be considered a matter of planetary health. A planetary health lens facilitates the relatability of the 17 SDGs and their 169 Targets to our own national and regional circumstances, and how they relate to one another in terms of achieving a meaningful level of true global sustainability. So how does water fit into this vision of planetary health? Goal 6 – the water management goal – bridges environmental integrity, human health, and social development as well as linking directly to many other Goals, such as Goal 2 (Food Security), Goal 3 (Health and Well-Being), Goal 5 (Gender Equity), and Goal 13 (Climate Action). Indeed, all 17 SDGs benefit from realizing the link with water security[3] within the context of planetary health. As an illustration, water security has been identified as a key element of safe and healthy communities. Managing water in a manner that will help end hunger and poverty, however, cannot be achieved without industry innovation and infrastructure; but innovation and infrastructure development cannot come into existence without quality education which demands gender equity which in itself leads to reduced inequality. Quality education, gender equity, and reduced inequality lead to economic growth. It is only through economic stability that we will be able to make a smooth transition to affordable and clean energy for all, which is critical for climate action. Climate action will help restore planetary health thereby contributing to better physical and mental health and well-being for all.

Through these pathways, achievement of Goal 6 is central to the achievement of the Sustainable Development Agenda. The global water cycle literally floods the earth on a seasonal basis. Approximately 52 million km^3 of water is moving through the global hydrological cycle at any given moment and 10 trillion tonnes of water is shifted between hemispheres in the form of winter snow cover during each annual seasonal cycle.[4] Global warming and subsequent climate change is affecting this seasonal redistribution through higher ratios of rain- to snow-fall and the timing, duration, and properties of precipitation, and therefore snow cover, are changing.[5] The effect is being further amplified by the increasingly rapid loss of glaciers that is adding more water to an energized global cycle.[6]

The world is aware that water can increasingly be loved or loathed: it is critical for existence of life and central to our quality of life, while also being responsible for poor health and death from waterborne diseases. Its absence causes droughts, and too much in too short a time causes floods. Water is a cornerstone of economic growth, essential for energy production, and equally as important for ecosystems. Water, and the ways in which it is used, vary significantly between countries. Renewable internal freshwater resources range from less than five cubic metres per capita (e.g., Sudan) to over 10,000,000 (e.g., Greenland),[7] reflecting not only the available resources but also population levels. Globally, water-use efficiency, measured by the value added ($) per unit volume of water used (m^3), averages 15 USD/m^3.[8] However, in agriculture-dominant nations, this can fall as low as two USD/m^3 compared to service industry-dominated nations where it is as high as 1,000 USD/m^3.[9]

In many places in the world accelerating hydro-climatic changes are putting greater pressure on already deteriorating water quantity and quality. It is estimated that two billion

people currently live in water-stressed areas.[10] Given changes to the hydrological system as a result of climate change, this is predicted to grow to five billion by 2050.[11] Climate change is not the only stressor on our water resources. Population growth, urbanization, land use changes including deforestation and degradation, changing diets, and expanding societal wealth also impact the quality and quantity of surface and groundwater resources. As a case in point, a recent study on private sector water use indicated that more companies are using more water since 2015, especially in agriculture and manufacturing sectors and in Asia and Latin America.[12]

Furthermore, over half of companies reporting to the Carbon Disclosure Project (CDP) indicated that broader climate risks (of which many manifest as water-related) posed substantive strategic or financial risks in addition to potential opportunities.[13]

Groundwater resources are particularly important and vulnerable, representing more than 90% of liquid fresh water resources and supplying drinking water to up to 40% of the global population.[14] More importantly, these resources are out of sight and less well understood than surface water resources given universal difficulties assessing and monitoring them.

Even in areas where it is abundant, degradation of water quality can ultimately mean that water resources are insufficient. An overall global water quality risk analysis[15] for the three major water quality indicators of SDG 6.3.2—nitrogen; electrical conductivity; and biological oxygen demand (BOD)—indicates that water quality issues are larger and more complex than perceived, even for high-income status countries where keeping up the monitoring and management of a growing range of water pollutants such as nutrients, plastics, and pharmaceuticals is difficult—and nearly impossible in developing countries.

On top of these pre-conditions, ever more frequent extreme weather events associated with too much or too little water have become threat-multipliers that are undermining social, economic, and political stability, often even further exacerbating many already troubled nations and near-failed states. Sustainable development in these countries has not just slowed and stalled because of water and water-related climate disasters; past progress has been reversed in some cases, leaving countries vulnerable to new kinds of conflict in which water resources and installations are being used as weapons.

A picture is now emerging, from both science and experience, demonstrating how intricately water and climate are linked. In many instances, water security and climate stability can be seen as two sides of the same coin. It is now widely held that to understand climate change it is important to follow the water. The logic behind this is very simple - liquid water, snow, and ice respond directly, visibly, and measurably to temperature. As such, by monitoring what is happening to our water, we can gauge what is happening to our climate; and, to our world. Many of the impacts of climate disruption are,

and will continue to be, expressed through effects on water. Evidence of this appears almost daily in the news. There has been a near doubling of weather-related disasters globally. The 6,457 floods, storms, droughts and other weather-related events over the past two decades up to 2017 caused 90% of disasters worldwide. These disasters have claimed more than 600,000 lives and caused more than $1.9 trillion in direct damage and incalculable human suffering.[16] As such, an overwhelming proportion of climate change effects are transmitted through acceleration of the global water cycle.

Science has already provided a breakthrough in understanding how we can use nature itself to address the climate threat. Research has revealed new and very interesting findings that suggest that extraordinary efforts to restore natural system function are not only warranted, but may be our only practical and affordable way forward in the future.[17] What we are discovering is that by degrading landscapes and river systems over time, nations and entire regions lose the effective buffering provided by intact natural processes, leaving them exposed to the full force of increasing hydro-climatic variability. But, it also suggests that the reverse is true—we can reduce and moderate the threat of climate disruption by restoring and rehabilitating natural system function.

Since 2015, the SDGs have slowly become embedded in policies and programs at international, national, and local levels. They weave through international development assistance programs, National Development Plans, institutional research priorities, and community projects. While overall, people are living better lives than they were a decade ago, globally we are not yet on track to meet all 17 goals.[18] Some individual nation states have made more progress than others, and inequities remain at subnational levels in many countries. Additionally, some indicators still cannot be adequately measured (i.e. Tier III indicators).[19]

Improved human health and well-being allows an ever more crowded world to be more proactive and more resilient to the multiplier effect of climate change on public health threats like epidemics and natural disasters driving large-scale forced human migration[20]. This resilience against such 'threat multipliers' contribute to peace, justice, and strong institutions. Strong institutional structures are necessary to guide humanity toward responsible production and consumption. It is only through strong institutions, responsible production and consumption, clean water, sanitation, and climate action that we can have sustainable cities and communities. Making and acting upon the link between water security, climate stability, and human and planetary health, and subsequently achieving all 17 of these global goals simultaneously, will demand the creation of the new kinds of partnerships. The building of such partnerships will in turn build trust, which will contribute globally to state and military security.

There is an urgent need to ensure that everyone is rowing in the same direction to ensure the sustainability of natural bio-diversity-based Earth system function. Presently, however, there is a huge and growing gap between our understanding of the problems and implementation and practice; between awareness of global challenges and the actual level of global leadership and cooperation. These gaps can be bridged by recognition of the link between water, peace, security, and human and planetary health and the SDGs can be a catalyst whereby we organize our intentions and our actions to get there. This report synthesises current undertakings, gaps, and opportunities through research, practice, and leadership to shape sustainability starting with our water future.

> *WATER IS THE NEEDLE ON THE GAUGE WE USE TO MEASURE CLIMATE*

WATER IN CANADA

2. WATER IN CANADA

Canada is known around the world as a water-rich country, with five of the ten largest freshwater lakes in the world by surface area[21] and more than 100,000 m^3 per capita[22] annual renewable water resources. It is widely cited that Canada also holds 20% of the world's fresh water resources;[23] the total volume of the renewable resource is in fact much lower, at 7%,[24] but this is still the third largest percentage in the world.[25] This water availability, however, is disproportionally spread over a vast country spanning multiple ecozones, of which some, like the Canadian prairies, are semi-arid. Furthermore, 85% of the Canadian population is located in the south, while approximately 60% of Canada's fresh water drains to the north.[26]

Canada is not the most water-efficient nation in the world, but total water use fell from 3,875 million m^3 in 2005 to 3,239 million m^3 in 2013. Per capita use has fallen from 330 litres per capita per day to 250 according to the most recent data.[27] The Canadian economy remains highly dependent on resource extraction, processing and transportation of oil and gas, ore, and pulp and paper as well as intensive agriculture for crop and livestock production. All of these sectors are both heavily reliant on water availability, and have costs to the natural environment and our water resources that are not always fully recognized or completely mitigated. Water stress is compounded by large-scale urbanization and population growth in several key regions. Conversely, Canadian lakes

and rivers support diverse plant and animal habitats, forests, tourism and recreation, agriculture, and the transportation sector as well as providing essential ecosystem services such as water purification,[28] many of which are not easily quantifiable.

Through our recent catastrophic experiences with floods, drought, fires, and toxic algae blooms, there is a growing recognition that, despite all that we have held to be true of ourselves since confederation, Canada is not a water secure country. These "creeping threats"[29] to water availability and quality not only affect the ecosystems of our rivers, lakes, streams, and parks and protected areas, but also our quality of life stemming from their use, the Canadian economy, and public health and safety. The cost of floods and droughts for families, towns and cities, the insurance sector, businesses, agriculture, and ultimately the Federal Government, are skyrocketing. The Parliamentary Budget Office, which oversees the Federal Disaster Financial Assistance Arrangements (DFAA) program that reimburses provinces and territories for some damages resulting from natural disasters, reports that the average total annual payments in indexed dollars rose from $54 million a year from 1970 to 1994, to $291 million a year between 1995 and 2004, to $410 million a year between 2005 and 2014[30]—an increase of 660% in 2010 dollars. This is even a small fraction of the total costs to the economy due to these events, which have been estimated to have exceeded $28 billion from 2000 to 2017.[31]

And climate change has a lot to do with these trends; temperature increases in Canada are among the highest in the world, with increases for the country as a whole being about twice the global average, and more than three times in the north.[32]

This warming is already having a substantial impact on Canada's cold-dominated hydrological cycle, including glacier and ice field melt, permafrost warming and thaw from the boreal forest to the tundra, increasing rainfall intensities, decreasing snowfall versus rainfall amounts, and changing the timing of water availability such as higher winter and spring stream flows, lower flows and risks of water shortages in the summer months, later winter freeze-up, and earlier spring breakup.[33, 34] These hydrologic shifts, especially between snowmelt- and rainfall-driven streams and rivers and how this alters the timing of peak water flows have consequences for agricultural productivity, hydropower generation, and floods and droughts. Weather events are becoming more extreme, traditional animal territories are changing, and pathogen ranges are expanding (e.g., Lyme disease).[35] These climate trends (and subsequent impacts) are projected to continue in these directions into the future.[36]

While the outlook can seem grim, there is also opportunity here through leadership, example, and knowledge mobilization. Canada possesses a modern water industry, world-leading water technologies, and professionally managed water service provision. As such, Canada has an opportunity to play a more prominent and focused role with respect to meeting, and helping other countries meet water-related targets of the Sustainable Development Agenda. Water cooperation, in particular, is poised to become a major instrument that can be used to prevent conflict while at the same time strengthening international stability and promoting peace.

> *"SCIENCE AND DATA UNDERPIN OUR SUSTAINABLE DEVELOPMENT AGENDA, FROM CLIMATE CHANGE POLICY TO WATER STEWARDSHIP TO BIODIVERSITY PROTECTION. CANADA'S SCIENTISTS GENERATE KNOWLEDGE THAT SUPPORTS PROGRESS IN THESE AND OTHER AREAS. THEY ALSO CONTRIBUTE TO INTERNATIONAL INITIATIVES—FOR EXAMPLE, TO ASSESSMENT REPORTS OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE"*
>
> *Government of Canada, Achieving a Sustainable Future, 2019-22*

Water Research in Canada

The Canadian Federal Government has committed to transparent evidence-based decision-making, especially when it comes to the national sustainable development agenda.[37] The major federal funder of water research in Canada is the Natural Sciences and Engineering Research Council of Canada (NSERC), with additional, yet disproportionately and increasingly less,[38] funding through the Social Sciences and Humanities Research Council (SSHRC) and the Canadian Institutes for Health Research (CIHR). The Government of Canada also funds research centres through its Centres of Excellence program, four of which have a focus on the environment but not water explicitly.[39] The Canada Research Chair and Canada 150 Research Chair programs also contribute to research excellence in water at Canadian post-secondary educational institutions. Further, the Government of Canada invests tens of millions of dollars into various programs and initiatives that contribute to the restoration and protection of the Great Lakes. Northern and Western Canada have been the focus of numerous large-scale collaborative research initiatives aimed at improving the understanding and prediction of changes in climate, water, and the cryosphere.

However, challenges exist in bridging research, policy, and practice. If science is viewed by political leaders as just another form of bitcoin without substance or relevance then progress towards meaningful resolution of global challenges will stall. It must also be recognized that good research can take time and rarely aligns with operational and political timelines. The peer review process can be long as well as rigorous. A case in point, the data upon which the Intergovernmental Panel on Climate Change (IPCC) has made its conclusions was, in some instances, up to 10 years old. Additionally, these public consumption reports have been criticized by some very high-profile researchers as downplaying impacts in efforts to come to scientific consensus and avoid being too alarmist. [40,41]

Historically, funding cycles for research have meant that research projects stop and start or never reach an end point that is useful for policy and practice at a time of need, although this is changing through larger, transdisciplinary grant opportunities. Indeed, a recent survey of climate scientists in Canada called for an increase in “long-term, mid-sized grants,” and stressed the importance of continuity, and confirmed the broad need for collaboration between governments and academia as well as cross-disciplinary collaboration.[42] These strategies could go a long way towards addressing the seemingly disproportionately large number of research studies and projects that appear to stop short of meaningful conclusions pointing to tangible action for practitioners. A recent Canadian blue-ribbon panel report that looked at the state of science funding in Canada also points out the gender, diversity, and discipline funding biases that exist within Canadian research[43] that may also be lessening outcomes with benefits to women and minorities (particularly Indigenous people) – those often also disproportionately affected by lack of water security – and social significance and governance knowledge needed to understand and influence better water decision making. Further, academia can often hold itself back in terms of meaningful contributions to policy and practice if the majority focus is on publications and career advancement rather than research impact and societal benefits.

A Research Investment Example: Global Water Futures

Many of the large-scale Canadian water-related research activities and directions established in earlier large research

programs, such as those funded under the Canadian Foundation for Climate and Atmospheric Sciences, are now being continued within the Global Water Futures Program (GWF)[44]. The overall mission of GWF is to improve disaster warning, predict water futures, and inform adaptation to change and risk management. A seven-year partnership between the Universities of Saskatchewan, Waterloo, Wilfrid Laurier, and McMaster, with more than 800 faculty investigators, highly qualified personnel, and students working on 39 water and climate science projects across the country,[45] GWF is one of the largest university-led water research programs of its kind in the world. As a Canada First Research Excellence Fund (CFREF) initiative, GWF is, by mandate, expected to address the strategic needs of the Canadian economy. As such, GWF is driven to meet the needs of diverse water managers (Table 1), representing varying degrees of co-created research with an emphasis on knowledge mobilization for both transformative science and transformative water management outcomes. Effectively research priorities for Canadian water resources, these needs represent regional and sectoral challenges from knowledge gaps in cold regions hydrology to the identification of climate change impacts and risks and how to adapt to them. While not intentionally aligned with the SDGs, these gaps reflect the knowledge and tools required to achieve a more sustainable society.

Other Notable Research Contributions to Water, Climate Change, and the SDGs

The universities engaged in the Global Water Futures Program are by no means alone in their endeavours to support water and climate change research or international frameworks such as the SDGs. Indeed, there is a great deal of activity in the broader Canadian academic community outside of GWF. Though not an exhaustive list these include the Canadian branch of the Sustainable Development Solutions Network (SDSN), hosted at the University of Waterloo, which is part of a global movement to build a network of universities, research centres, civil society organizations, and knowledge institutions.[47] The University of Manitoba hosts the global academic impact hub for SDG 6.[48] The Prairie Climate Centre[49] at the University of Winnipeg ties its climate work directly to building resilience of Canadians as well as supporting climate adaptation and mitigation, as does the Adaptation to Climate Team at Simon Fraser University.[50] The newly formed Canadian Centre for Climate Services,[51] funded by Environment and Climate Change Canada (ECCC) and hosted by the Pacific Climate Impacts Consortium (PCIC) in British Columbia and Ouranos in Québec, also provide services and resources for Canadians in the face of climate change and represent a Canadian contribution to national sustainable development.

As part of Canada's international assistance efforts, the International Development Research Centre (IDRC)[52] has invested more than $100 million over three decades to support research on climate change, water, and water-related issues such as poverty reduction, improving health and sanitation, and increasing local governments' ability to provide sustainable services to citizens. In the civil society sector, the Centre for Affordable Water and Sanitation Technology (CAWST)[53] helps people all over the world access safe drinking water and adequate sanitation in their own homes by providing capacity development services to complement technology infrastructure advances.

Table 1

Cross-cutting science and research needs of the user communities consulted for the formation of the Global Water Futures Program [46]

Needs	Mentioned by User Communities		Mentioned by Region
Forecasting and Predictive Modelling	Agriculture Electric Utilities Water Utilities Research NGOs	Federal Government Provincial Governments Emergency Response Organizations	Mountain Prairie Northern Central Atlantic West
Climate Change Impacts, Risk Identification	Agricultural Municipal Electric Utilities Mining	Forestry Water Utilities Federal Government Provincial Governments	Mountain Prairie Northern Central Atlantic West
Best Managemment Practices (BMPs)	Agricultural Municipal Extractive Industry Water Utilities	Civil Society Organizations Research NGOs Federal Government	Mountain Prairie Northern Central Atlantic
Adaptations	Agricultural Municipal Indigenous	Federal Government Provincial Governments	Mountain Prairie Northern Atlantic West
Past/Future Scenarios	Municipal Insurance/Engineering Fisheries Forestry Extractive Industry	Electric Utilities Water Utilities Agriculture Provincial Governments	Mountain Atlantic West
Land/Water Interactions	Agriculture Forestry	Water Utilities Federal Government	Prairie Central Atlantic
Surface/Ground Water Interactions	Municipal		Mountain Prairie Atlantic
Human Health	Indigenous Civil Society Organizations	Federal Government	Prairie Northern Central
Decision Support Tools (often with reference to multi-stakeholder needs)	Agriculture Forestry	Water Utilities Federal Government	Prairie Central Atlantic
Indigenous Knowledge	Indigenous	Federal Government	Northern Central
Sensors	Industry Electric Utilities	Federal Government Provincial Governments	West Prairies

CHALLENGES FOR ACHIEVING WATER-RELATED SDGs

3. CHALLENGES FOR ACHIEVING WATER-RELATED SDGs

In responding to the urgency and the opportunity of finally achieving sustainable development, the United Nations created the SDGs as a new framework for global action. An overarching implementation challenge is to ensure that, in the process of meeting individual Goals, other Goals are not compromised, and further, to ensure that no one is left behind.

> *EVEN THOUGH CANADA IS A DEVELOPED COUNTRY, IT STILL HAS SIGNIFICANT CHALLENGES IN MANY AREAS COVERED BY THE SUSTAINABLE DEVELOPMENT GOALS.*
>
> *Commissioner of the Environment, 2018*

Drinking water and sanitation were targets under the Environment Goal of the Millennium Development Goals (2000-2015), the precursor to the SDGs. The SDG Water Goal now has an expanded emphasis to include wastewater and water resources management as well as water co-operation. As such, new metrics were required to be able to measure baselines and track progress. Currently, of the 11 indicators under SDG 6, less than 10% of countries are able to report on more than eight, and the majority could not report on more than four.[54] More strategically, challenges exist in terms of the scale at which data are collected (i.e. ecosystem, basin, sub-basin) or aggregated (e.g. national water-use efficiency), trading off efficiency and perspective with the need to inform local policies and practice, as well as the capacity to implement monitoring systems (technical, financial, and human) (Box 1[55,56]).

Mine Tailings, Ontario

Box 1: IDENTIFIED CHALLENGES FOR SDG 6

Challenges for specific Indicators include:

6.3.2:	Difficulty in determining temporal trends in ambient water quality given existing data availability
6.4.1:	Difficulty in determining temporal trends in water use efficiency, particularly without using global data sets that are too coarse to be meaningful for intervention
6.4.2:	Difficulty in determining temporal trends in water stress in basins and sub-basins
6.6.1:	Difficulty in determining temporal trends in the extent of water-related ecosystems, although data on open water extent is more available

Other recommendations that deal with improving or broadening the scope of existing Indicators:

6.3:	Need to incorporate earth observation, citizen science, and private sector data to fill spatial and temporal gaps and augment knowledge
6.3.1:	Need to incorporate effluent water quality parameters that impact upon human health and not just the environment, including wastewater reuse
6.3.2:	Need to incorporate E. coli as an ambient water quality monitoring parameter. Need to improve turbidity and chlorophyll-a data. Need for broader focus on water quality beyond indicators of sanitation-related contaminants, including nutrients, plastics, and pharmaceuticals
6.4:	Need to improve methods to estimate environmental flow requirements
6.6:	Need to augment existing in-situ data to understand the processes and benefits of water-related ecosystems using additional geospatial, qualitative, and quantitative data as well as earth observation data. Need to improve methods to measure spatial extent of different water bodies (i.e., lakes, reservoirs, estuaries, wetlands)
6b1:	Need to incorporate quality of social participation (i.e., nature, extent, value)

Or, sharing knowledge, practices, and tools:

6.3.2:	Opportunity to share successful ambient water quality monitoring programs and enhance capacity to collect and analyze for parameters required

Water-related Challenges in Canada

Many water-related challenges resonate around the world, including habitat loss, pollution, depletion of fish stocks, and droughts and floods.[57] Canada faces three main water challenges. The first is degraded water quality, with only 112 of 175 Canadian monitoring locations indicating good or excellent water quality between 2015 and 2017[58]. This trend has been relatively stable since 2002, but where changes have been observed they have declined more than improved, most often in regions with agriculture, mining, or high population density.[59] Scaling up to river basins, only 67 of 167 sub-watersheds even have water quality indicator data available, of which, almost two thirds are rated as fair or poor in terms of water quality.[60]

> *CLIMATE CHANGE IS A CRITICAL GLOBAL PROBLEM THAT POSES SIGNIFICANT RISKS TO HUMAN HEALTH, ECOSYSTEMS, SECURITY, ECONOMIC GROWTH, AND THE ABILITY OF FUTURE GENERATIONS TO MEET THEIR BASIC NEEDS*
>
> *ECCC, Achieving a Sustainable Future, 2018 Progress Report*

The second challenge, climate change, is likely to exacerbate water quality degradation by increasing temperatures and providing new conditions for water-borne toxins and disease and creating new or increased frequency along existing contamination pathways such as flood events.[61] At this time, while a priority for Environment and Climate Change Canada in partnership with the Global Water Futures program, Canada does not yet possess sufficient modelling, prediction, and forecasting capabilities for floods and droughts on a national or trans-provincial scale which is increasingly impacting public health and our national economy.

Finally, in addition to the physical water challenges themselves, governance issues of jurisdictional fragmentation and territoriality exist[62] that make it more difficult to generate and implement a common water management vision. Portfolios such as agriculture, health, water and wastewater treatment are shared between multiple agencies and levels of government, and water itself flows across municipal, provincial, territorial, and sometimes national boundaries. Inequities also exist with respect to who experiences the impacts of these challenges and who is most vulnerable to them. Women and girls (an international priority area for the Canadian Federal Government) and Indigenous communities[63] represent two of these groups. It is argued that these groups, and natural ecosystems themselves, are being left behind in pursuit of economic progress.[64,65]

The Targets for access to drinking water and sanitation are a stark indication of this. At the country level, just over 98% of Canadians have access to safely managed drinking water.[66] However, this means that 1.4% of the population, or 540,000 people, do not. Unfortunately, many of these live on First Nation reserves, where there are currently 69 on-going, long-term boil water advisories (i.e. ongoing for more than one year).[67] For many Indigenous people water also holds cultural and emotional values that degrade with degrading waterscapes, decoupling people and place.[68] In addition, the changing climate is increasing isolation and cost of living in communities that rely on ice roads, displacing and destroying communities through fires and floods, and undermining critical infrastructure through permafrost thaw. These impacts are disproportionately higher for those living in northern Canada.[69]

Women and Water Lecture Series, 2019

> *WE DISCOVERED CANADA DOESN'T COLLECT AND SHARE ENOUGH DATA TO ASSIGN A BASELINE HEALTH SCORE TO THE MAJORITY OF THE 167 SUB-WATERSHEDS THAT MAKE UP CANADA'S 25 WATERSHEDS. WE ALSO DISCOVERED THAT SUFFICIENT DATA FOR ALL 11 KEY HEALTH AND THREAT INDICATORS IS BEING COLLECTED IN ONLY 14 OF OUR 167 SUB-WATERSHEDS; AT THE WATERSHED LEVEL, 15 OF 25 WATERSHEDS ARE DATA DEFICIENT.*
>
> *WWF-Canada, Watershed Reports, 2017*

RISING TO THE CHALLENGE

4

4. RISING TO THE CHALLENGE

Canada's Sustainable Development Commitment

The Government of Canada has initiated a two-pronged approach to the SDGs that focuses on international and domestic portfolios.[70]

> *CANADA RECOGNIZES THE IMPACT OF CLIMATE CHANGE ON THE POOREST AND MOST VULNERABLE, WHO ARE THE LEAST ABLE TO COPE.*
>
> *Commissioner of the Environment and Sustainable Development, Spring Reports, 2018*

Canada's international development investments are shaped by its Feminist International Assistance Policy and six action foci: gender equality and empowerment of women and girls; human dignity; inclusive growth; environment and climate action; inclusive governance; and, peace and security.[71] International climate investments focus on risk management, adaptation, and resilience-building as well as on clean tech and natural resources management.[72]

On the domestic front, broad strategies include renewing relationships with Indigenous peoples, gender equality and empowerment, environmental sustainability, and climate action.[73] Domestic priorities are determined through the Government's Federal Sustainable Development Strategy (FSDS) that is developed and implemented under the Federal Sustainable Development Act (2008).[74] It demonstrates that Canada is aware of the SDGs and Targets at a federal level and is working towards achieving them, at least at an aspirational level. The FSDS sets out national sustainable development priorities and associated goals and targets for climate action; low carbon government; clean growth; clean energy; clean drinking water; resilient infrastructure; sustainable food; sustainable management of lands and forests; healthy coasts and oceans; healthy wildlife populations; pristine lakes and rivers; safe and healthy communities; and connecting Canadians with nature.[75] Of the 13 goals of the strategy, six relate directly and four indirectly to water. The implementation of FSDS priorities as they relate to water, however, have yet to be embraced as standard practice in the Canadian water community. This is emphasized in the 2018 National Voluntary Review submitted to the UN General Assembly.[76] In alignment with terminology used in Federal policies and programs, emphasis has otherwise been placed on Gender Equity (SDG 5), Poverty Eradication (SDG 10), Climate Action (SDG 13), Green Growth (SDG 12), and Advancing Indigenous Self-determination (SDG 10).[77]

Several self- and third-party assessments of Canada's progress and contribution towards the SDGs have been published in the last few years. Statistics Canada has established an SDG data portal that indicates an ability to report on Targets 6.4.1, 6.4.2, 6.5.2, and 6.A.1, and is currently exploring data sources to be able to report out on Targets 6.1.1, 6.3.1, 6.3.2, 6.5.1, 6.6.1, and 6.B.1, and has determined that Target 6.2.1 (Sanitation) is not applicable.[78] The Government has further made an explicit commitment to a long-term drinking water strategy in First Nation communities that includes eradicating all drinking water advisories by 2021; progress towards self-determination of drinking water management; as well as improving water, wastewater, and stormwater infrastructure.[79] The Government has also established GC InfoBase, an integrated platform for government information and performance metrics.[80] Additional indicators used to measure sustainability in different sectors include: the Index of AgriEnvironmental Sustainability that incorporates water, soil, and air quality as well as biodiversity;[81] the federal agency mandate letter tracker and annual department reports;[82] and the Canadian Environmental Sustainability Indicators (CESI) program.[83] However, according to the Commissioner of the Environment, Canada is not on track due to a lack of a formal implementation approach, monitoring and reporting infrastructure, and associated governance structure for achieving the SDGs in Canada, and an unbalanced focus on environmental, rather than social and economic sustainability within the FSDS.[84] The government plans to reverse this through the establishment of an SDG Unit whose mandate will be to coordinate, monitor, and report on FSDS activities and progress.[85]

More generally, the federal government has made a commitment to these goals thorough information-sharing and capacity building (e.g., the newly established Canadian Centre for Climate Services) and policy coherence (e.g., Conservation 2020 response to UN Convention on Biological Diversity); risk reduction (e.g., Drought Watch Initiative); Traditional Knowledge (e.g. Indigenous Guardians Program), and evidence-based decision-making (e.g., recent reviews and modernization of Fisheries Act, Navigable Waters Act, Canadian Environmental Assessment Act, and Pan Canadian Framework on Clean Growth and Climate Change), and improved management of water, land, and resources (e.g., 4R Nutrient Stewardship Framework, Arctic Policy Framework, increased parks and protected lands and waters/oceans, enhanced data and monitoring).[86]

Though efforts are being made to advance the FSDS, at the

moment implementation of these goals remains voluntary and unconnected to the desperate and increasingly urgent global need to restore Earth system function. For example, key water-related ecosystems, such as wetlands, cannot be inventoried at the national level, preventing assessments of loss and compensation.[87]

Canada has diverse water governance experience, technologies, and cutting-edge models that have value to be shared with or applied in other parts of the world. Projects undertaken jointly by the Federal, Provincial, and Territorial governments involve the regulation, apportionment, surveying and monitoring, and planning of water resources, especially within transboundary basins with shared waters between jurisdictions. The critical importance of such cooperation must be recognized and continually strengthened, especially with Indigenous Nations, and the Federal Government can and must take an enhanced leadership role.

We should not undervalue Health Canada, which, along with provincial and territorial health departments and public health organizations, collect and synthesize data on waterborne diseases, and are increasingly weighing in on climate change impacts on physical and mental health.[88] All jurisdictions in Canada are actively addressing challenges related to aging or inadequate drinking water and wastewater treatment infrastructure.[89] Federal-provincial-territorial ministerial councils play important roles in environmental protection with impacts on water as part of their focus on sustainable development.

> *"INDIGENOUS PEOPLES' TRADITIONAL KNOWLEDGE HAS BEEN DEVELOPED OVER GENERATIONS THROUGH DAILY LIFE PRACTICES AND A CLOSE UNDERSTANDING OF LOCAL ENVIRONMENTS. IT CAN OFFER VALUABLE RESPONSES TO CLIMATE CHANGE, FOOD INSECURITY, REDUCING INEQUALITIES AND OTHER CHALLENGES THAT WE ARE TRYING TO RESOLVE THROUGH THE SUSTAINABLE DEVELOPMENT GOALS. TRADITIONAL KNOWLEDGE OFFERS TREMENDOUS OPPORTUNITIES IN SUCH AREAS AS LAND MANAGEMENT, CONSERVATION, AND SCIENTIFIC, TECHNOLOGICAL AND MEDICAL RESEARCH."*
>
> *ECCC, Achieving a Sustainable Future, 2018 Progress Report*

Although the provision of appropriate water and wastewater facilities to First Nations remains a major problem in Canada, there are now investments in place aimed at addressing these water, health, and environmental needs. Some jurisdictions in Canada are already engaged – very successfully – in consent-based governance tables with First Nations which supports the implementation of Indigenous water jurisdictions, the most exciting of which are in the area of legislative and policy development and agreement-making regarding water. For example, the Alberta-Northwest Territories Bilateral Water Management Agreement signed in 2015[90] is one of the most comprehensive of its kind.

The collaborative consent approach, which forms the basis of respectful, nation-to-nation governance founded on common agreement on the importance of careful management of water, may well be something that Canada can share. If by 2040, the country resolves this internal challenge — as it should –- it will demonstrate leadership in this domain. This may then give an impetus to complete resolution of similar problems for Indigenous Nations worldwide.

From this, we see that there is considerable opportunity for Canada to coordinate the activities of its water sector. Through the example of good and responsible management of its waters, Canada can improve its own water management while simultaneously helping others abroad to do the same.[91] The strengths of our water sector, however, have not been optimally harnessed and fully orchestrated for future national interest.

Other nations including Canada's nearest neighbour—the USA—are seeing the need to address global water issues as their national interests. A recently released U.S. Global Water Strategy[92] builds on a 2012 assessment of global water security and provides a concrete roadmap through which U.S. government departments and agencies will work to improve global water security in regions and countries around the world. There is no reason why Canada cannot develop a similar strategy.

Global Water Futures and the SDGs

GWF was never positioned with the explicit purpose of supporting achievement of SDG Goals and Targets. However, the funding agency CFREF, and therefore GWF, strive to embody many principles that resonate with the 2030 Agenda and Canada's national policies, including cross-sectoral engagement, emphasis on vulnerable populations, and gender equity, inclusion, and diversity.

The research activities being undertaken within GWF have the potential to inform water practice and policy, primarily in regions around the world dominated by snow and ice hydrological regimes. As examples, GWF has co-drafted a guidance document[93] and hosted a strategic briefing and discussion in Ottawa for federal government officials on achieving water security in Canada and developed Memoranda of Understanding to deliver key science contributions to major federal agencies including Natural Resources Canada and Environment and Climate Change Canada.

GWF research is using, developing, and refining sensors and methods (Supplementary Table: Appendix II) as well as simulation models (Supplementary Tables: Appendix III) to measure, map, and predict aspects of a changing hydrological cycle and translate them into tools that diverse water managers in all levels of government, industry, civil society organizations, and Indigenous governments, communities and organizations can use to mitigate risk and implement adaptation strategies to improve well-being (Figure 1). The research is also generating large data sets across the major river basins in Canada from field measurements and Earth Observation (Supplementary Table: Appendix IV) as well as model runs, and making them accessible and usable through an innovative data portal[94]. While this is expected to change over the seven-year course of the program, at the moment, pursuit of fulfilment of the SDG Goals and Targets remains peripheral to most of the research being conducted under the GWF umbrella. However, specific activities have the potential to be linked more specifically to supporting individual Goals and Targets (Supplementary Table: Appendix V) for Canada, and in some cases internationally.

GWF and other research groups have strengthened trans-sectoral and multi-disciplinary collaborations to undertake co-developed research. These experiences provide opportunities to more effectively mobilize knowledge not only regarding decision-support tools and water management outcomes that emerge from research, but also about the challenges, opportunities, and strengths afforded through these processes and the benefits to post-secondary institutions. Co-produced research also provides opportunities to build capacity in data collection, research techniques, multi-stakeholder collaboration, community engagement, knowledge mobilization, and communication. GWF contributions are enhanced by the development of core academic programs within GWF partner institutions, including undergraduate and graduate programs in Hydrology and in

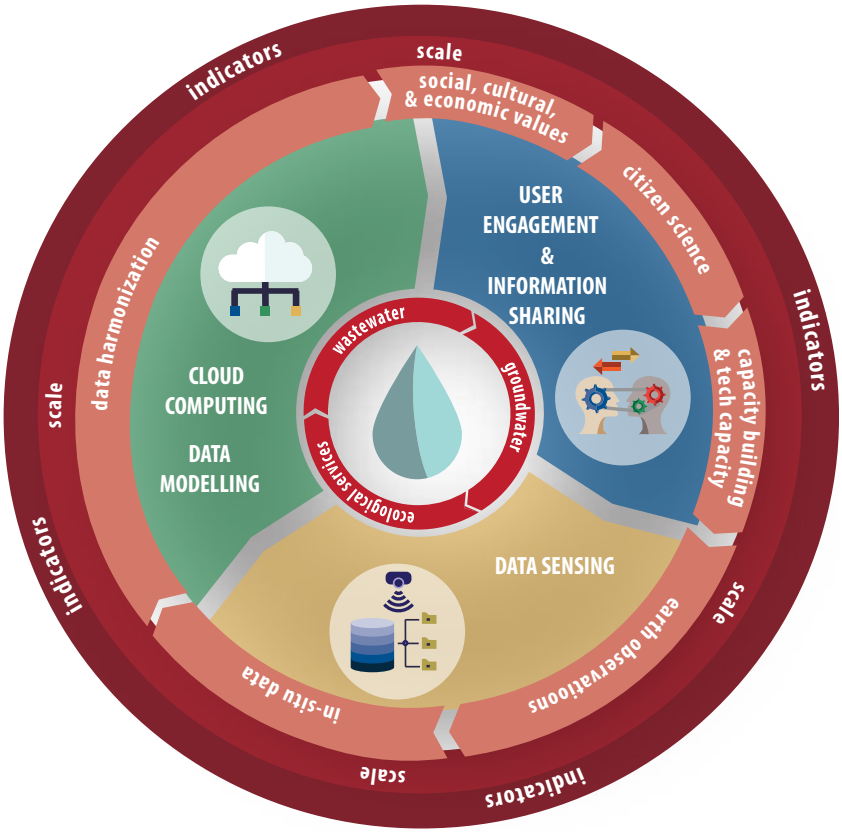

Figure 1: GWF research advances (blue, green, yellow) with opportunity to support achievement of SDGs (reds)

Changing Environments and Health that will increase water-related capacity beyond the life of the research program.

There are approximately 300 graduate students, post-doctoral fellows, and laboratory and field technicians currently working on and supporting GWF research projects[95]. While the majority are from Canada, others are from the United States, Germany, the Netherlands, and the United Kingdom and approximately 20% represent visible minorities attracted to the program from a diversity of countries including Bangladesh, Ghana, India, Iran, China, Columbia, Nepal, and Jamaica. In addition to supporting these international trainees, visiting scholars come to the partner institutions to train on hydrological models so that these models can be used by their governments and research institutes. For example, the CHRM model (Supplementary Table III) has been applied to basins in Western China[96], Patagonia[97], the German Alps[98], and the Western North American Cordillera[99], as well as 10 reference sites across France, United States, Japan, Finland, Switzerland, and Canada as part of the Earth System Models Snow Model Inter-comparison Project[100]. Collaborative research stations are being explored in countries such as China and India. GWF and its institutional partners are contributing international leadership in water science for cold regions, supporting and collaborating with five major global programs.[101] These collaborations serve to expand scientific activity beyond Canada through shared knowledge and tools to address the issues of climate and Earth system change and water security.

A significant contribution emerging out of GWF through the guidance and support of Indigenous scholars, leaders, and Elders, is the co-creation of knowledge and the bonding of Western science with Traditional Knowledge for the advancement of sustainable water-related health and wellbeing, adaptation, and management (Box 2).[102] While these considerations have been incorporated into health and social science research, their inclusion in water science is essential and forward-thinking. The development of mechanisms that allow for authentic engagement of Indigenous Peoples within the UN system represents an ongoing challenge that the UN is working to overcome, and which was not resolved in time for the 2030 Agenda. However, there is strong, emerging recognition of the value of Traditional Knowledge[103] and respect for Indigenous leadership in environmental stewardship.[104]

Box 2: ADVANCING INDIGENOUS ENGAGEMENT AND CO-CREATION OF RESEARCH

Indigenization of water management in Canada is an ambitious yet essential goal. GWF researchers and

Indigenous partners across Canada have co-developed a research strategy to address the unique water challenges facing Indigenous communities and supporting nation to nation water governance. In 2018, 60 researchers and Indigenous community partners came together in an interactive workshop at Wanuskewin Heritage Park in Saskatoon, Saskatchewan.

The outputs of that meeting were intentionally co-created request for proposals and evaluation criteria that are explicitly reflective of Indigenous values and processes including co-applicant status; appropriate timelines and financial distributions; culturally sensitive data management and sharing; joint proposal development; and, direct community research benefit. From the workshop, six co-created research projects were funded.

GWF has further committed to shared learnings during annual science meetings. Indigenous leaders, Elders, and community representatives participate in the meetings which also include time spent on First Nations reserves and Traditional lands learning and sharing about Indigenous cultures, food, knowledge, and ways of being.

FOUNDATIONS FOR A PATH FORWARD

5. FOUNDATIONS FOR A PATH FORWARD

In 2015, a synthesis report was developed that laid out a series of recommendations for achieving water sustainability within a sustainable development era.[105] Many of these recommendations (Box 3, 4) are relevant in the context of this report, reflecting opportunities for both the Federal Government and the Canadian research community, as exemplified by GWF.

In any research program, there is a delay between the onset of research and the delivery of outputs. Almost half-way through the 7-year funding term, GWF researchers and collaborators have undertaken much of the co-planning, co-visioning, and foundational research required to realize the full potential of the program. As such, there is significant potential to use GWF outputs alongside those of other research institutions to direct and guide Canada's efforts to achieve the SDGs, particularly, but not exclusively linked to water outcomes. This extends to international opportunities through technological and knowledge transfer.[106,107]

> *"THUS FAR, SHORTCOMINGS IN OUR WATER MANAGEMENT STRATEGY HAVE NOT CAUSED WIDE-SPREAD PROBLEMS DUE TO OUR ABUNDANCE OF AVAILABLE CLEAN WATER AND SPRAWLING POPULATION. MOVING FORWARD, HOWEVER, WITH INCREASING PRESSURES FROM INDUSTRY, POPULATION GROWTH, CLIMATE CHANGE, AGING INFRASTRUCTURE, AND LACK OF ROBUST WATER LAWS AND STANDARDS – THESE SHORTCOMINGS MAY PREVAIL, LEAVING MORE COMMUNITIES BEHIND IN CANADA."*
>
> *BCCIC, Where Canada Stands, 2018*

To achieve this potential, honest reflection is required to assess where research engagement capacity and willingness actually resides; how efforts are actually performing in terms of measurable progress toward meaningful engagement with the Goals; and, how needs for science users are being met. This presents an opportunity to reflect on existing stakeholder requirements for better decision-making and operations (Table 1), including gaps and needs identified by the Federal Government and others in meeting Canada's commitments to the SDGs. The SDGs provide an area of objective study for academics, but if this is as far as the relationship goes, meaningful research contributions to realizing sustainable societies will not emerge. Like most in our society, the SDGs are remote to most researchers, if only because they are bound by purpose to other primary goals - the "publish or

Box 3: GOVERNANCE, MANAGEMENT & CAPACITY RECOMMENDATIONS

- Joint sector, multi-level national water commission
- Harmonized national water policy
- National water act based on international water convention with legally binding standards
- A data revolution that underlines and supports evidence-informed decision-making
- Common parameters and platforms for data collection, management, and sharing
- Global commitment to augmenting existing data collection with new technology and expanded international cooperation on satellite based remote sensing and ground-truthing, data harmonization, data sharing, privacy screening, and ethical use
- (Virtual) centralization of data sets regionally, nationally and globally, including private sector non-proprietary water-related information
- Trans-boundary knowledge, information, and data management and sharing
- National arm's length water agency to i) store disaggregated social and physical data; ii) synthesize, analyze, disseminate information; iii) provide oversight and validation; and, bridge research, policy, private sector
- Capacity enhancements: concept and data literacy (leaders and general public); resilient, innovative infrastructure design, construction, and operation and maintenance; design and programming of data management systems, knowledge portals, and virtual learning platforms; collecting, managing, interpreting, utilizing, and disseminating data; development and application of model simulations (prediction and forecasting); and, supporting legal expertise

Box 4: WATER QUALITY & QUANTITY RECOMMENDATIONS

- Equitable, full-service access to sustainable water, sanitation, and wastewater treatment and management for everyone
- Safe (re)use of resources from human and animal waste and wastewater
- Agricultural efficiencies in land, drainage, and drought management i.e., “crop per drop”, crop choice, and harmful runoff
- Irrigation, pesticide, and herbicide solutions based on traditional knowledge and working in tandem with natural systems in order to reduce impact on both water quantity and quality
- Account for ecological and ecosystem services
- Strategically protect and rehabilitate wetlands, forests and other hydrologically important eco-zones for enhanced delivery of ecosystem services
- Flood resilience strategies that simultaneously address eutrophication challenges and are part of defined broader basin-wide, multi-use sustainable water management objectives.
- Move beyond traditional IWRM, building upon progress to date and transitioning into IWRM that emphasises sustainable management for people, economies, and ecosystems
- Make a serious commitment to green infrastructure solutions based on utilising and mimicking natural ecosystem processes
- Shift to integrated impact assessments (environmental, economic, health, cultural)
- Measure, monitor, and manage withdrawals against supply
- Enhanced forecasting and prediction models (e.g. Long-range precipitation and drought prediction models; integration of prediction of extreme weather events; early warning systems; agent based modeling of social systems)
- Development of standardised assessment methods to provide more accurate data on direct and indirect economic impacts of water-related disasters in order to be able to justify investments in disaster risk reduction and understand the broad impact that different types of disasters can have on various sectors for better disaster planning and risk reduction

perish" imperative and commitment to graduating students. There is little or no need and little reward or incentive for academics to actually aspire to the achievement of the Goals themselves, beyond personal conviction.

However, with all of this academic and related research activity and potential, it would not be unreasonable to ask why Canada is not moving more quickly toward realization of the SDGs as a means of achieving a level of sustainability that would protect its environment, help stabilize the global climate, and in so doing ensure future prosperity as much as possible. The answer to this question is that implementation challenges remain nationally and globally.

> *THE APPROACH TO PROTECTING AND IMPROVING HUMAN HEALTH AND WELL-BEING WILL INCLUDE (1) TAKING ACTION TO ADDRESS CLIMATE CHANGE RELATED HEALTH RISKS AND (2) SUPPORTING HEALTHY INDIGENOUS COMMUNITIES. ADAPTATION ACTIONS WITH AN INCLUSIVE VIEW OF WELLBEING (E.G. SOCIAL AND CULTURAL DETERMINANTS OF HEALTH AND MENTAL HEALTH) WILL KEEP CANADIANS HEALTHY AND REDUCE PRESSURES ON THE HEALTH SYSTEM.*

Pan Canadian Framework on Clean Growth and Climate Change, 2016

> *COOPERATION AND COLLABORATION AMONG DIVERSE ACTORS AND STAKEHOLDERS CAN YIELD POSITIVE RESULTS FOR SUSTAINABLE DEVELOPMENT.*

Where Canada Stands, 2018

One thing is certain: there is huge potential in these combined initiatives to synergize Canada's direction towards sustainability for itself and, by example and support, for developing nations to do the same with aid and support. However, the harnessing of the substantial capacity of the broader water sector in Canada will require government coordination and support to fully realize its potential. Such coordination and support are within our existing national capabilities; what is missing is a sense of urgency and leadership.

CHARTING A PATH FORWARD

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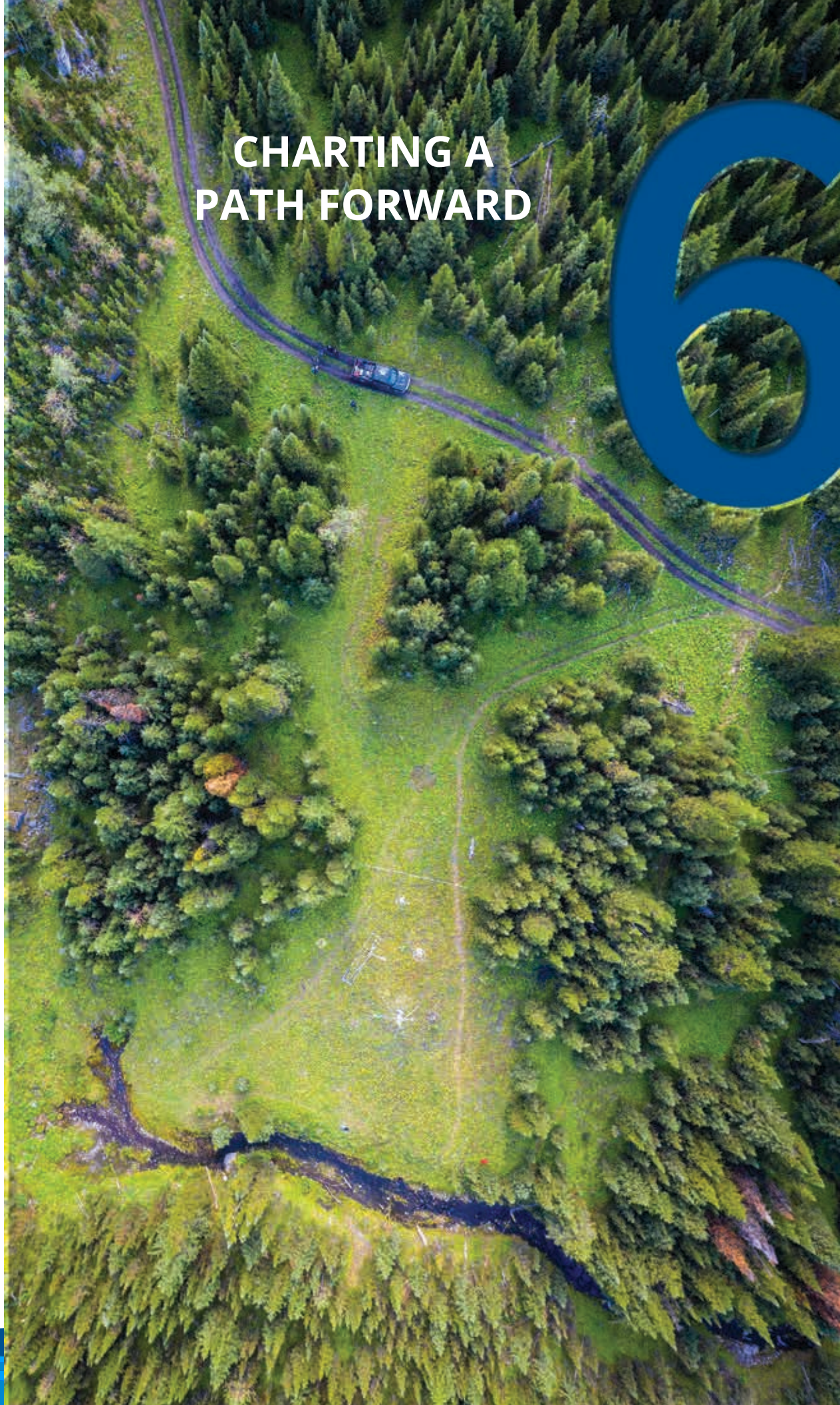


6. CHARTING A PATH FORWARD

Over the course of the last decade there appears to be nothing less than a revolution in what we know. The growing accuracy of data, expanded understanding of Earth system function, greater knowledge, and emerging common urgency are driving rapid changes in the Earth sciences. Multi-spectral space-based remote sensing is making the invisible visible. Combined with careful terrestrial ground-truthing, what was once thought impossible may soon be possible because of the cutting-edge advancements of Canadian research initiatives such as the GWF program's integrated flood and drought prediction and forecasting capabilities. This report underscores the importance of science and the critical need to convey the outcomes of research to leaders, but also the importance of bridging disciplines and bridging research, policy, and practice—providing a guide to developing a water-related SDG strategy for Canada.

However, major gaps still exist if we are to meet the ambitious yet necessary Goals of the 2030 Agenda. Based on an analysis of reports, syntheses and activities to date, previous recommendations, the SDG targets, and the challenges associated with meeting and measuring the SDGs nationally and internationally from a variety of sources, we offer recommendations for action in research, practice, and leadership.

> *AS SCIENTISTS WE NEED TO FIND A WAY TO MAKE OURSELVES HEARD, NOT AS ADVOCATES FOR SOME POLITICAL CAUSE OR ANOTHER, BUT AS ADVOCATES FOR A FUNDAMENTALLY RATIONAL PUBLIC DISCOURSE, ONE THAT STARTS FROM THE FACTS – NOT FROM WHAT WE MIGHT CHOOSE TO BELIEVE – AND THEN CONFRONTS THE MESSY QUESTIONS OF WHAT SOCIETY SHOULD DO. SO IF YOU WERE EVER INCLINED TO STAND UP, SPEAK OUT, AND MAKE YOURSELF HEARD, NOW WOULD BE AN EXCELLENT TIME TO DO IT.*
>
> *Professor James Kirchner*
> *2016 Langbein Lecture, American Geophysical Union*

Opportunities in Research for Water-related SDGs

As uncertainties around spatial and temporal patterns of water quantity and quality increase, water management becomes more complex, and we can no longer use the past to predict the future, it becomes easier to identify where we lack sufficient knowledge to act sustainably. The following emerge as opportunities to enhance knowledge for Canada that can be adapted and adopted by other nation states:

- Understand drivers of water quality in Lake Erie and Lake Winnipeg[108] as an improvement blueprint for other large lakes
- Improve the science for and our understanding of water-land ecosystem interactions for science-based management[109]
- Enhance groundwater research and monitoring methods especially for quality, quantity, and recharge dynamics to inform water management[110]
- Improve valuations of ecosystem services,[111] incorporating gendered and Indigenous values
- Improve understanding of the economic, social, and environmental implications of the intersections between aging infrastructure and climate change in the water, wastewater, and agricultural sectors
- Understand the unique local water security challenges and opportunities, particularly in rural and remote and northern communities
- Improve our understanding of climate impacts on infectious disease[112]
- Assess the impact of natural infrastructure interventions (i.e. nature-based solutions)[113] from social, economic, health, and environment perspectives
- Collaborate with communities and sectors to undertake risk analyses for natural hazards management[114]
- Contribute improved methodology for revising and updating flood maps[115] and other enhanced and timely emergency management, public alerting, and post-disaster rehabilitation local decision-making and communication tools

- Enhance understanding of effects of agriculture, developing new transformative technologies[116] and sustainable management practices for protecting water quality[117]

- Strengthen the solid base of scientific research on climate change and its impacts especially through modelling and analyses[118]

- Improve data collection, modelling, and scenario-building to better inform economic, social, and environmental policy decision making under uncertainty that fully analyze impacts, (co)benefits, and trade-offs[119], especially of different policy options[120] associated with sustainable development and climate change mitigation

- Model and optimize "carbon sink" practices of water-land related and managed ecosystems such as wetlands and forests[121]

- Develop robust methods, sensors, and models to support data coverage and monitoring in remote and low resource settings

- Collaborate with practitioners to develop new and refined indicators and measurement methods, starting with identified gaps in SDG 6 (Box 1)[122]

- Develop and invest in rights-based solutions to water as a fundamental need for humans and nature[123]

- Invest in research dissemination,[124] information, ethical data access, and capacity building, including for low- and middle-income populations and countries[125]

- Commit to exploring equity implications and collecting disaggregated data in water-related research[126] (e.g., gender, ethnicity, indigeneity, location)

- Bond Traditional Knowledge (and Traditional Environmental Knowledge) and Western science[127] to enable the best response to and solutions for sustainable societies

- Advance science-based water resources management,[128] especially through co-developed decision-making tools that incorporate Traditional Knowledge and social, economic, health, and environment considerations

- Commit to mobilizing evidence into decision-making processes and opportunities by local, regional, national, and international policy-makers

- Commit to engaging in public discourse on climate change, its impacts, and solutions in order to combat "post-factual"[129] social and political trends

Opportunities in Practice for Water-Related SDGs

Science and knowledge alone rarely lead to enhanced decision-making; they need to be adopted into practice. As such, connecting research to operations is critical to driving change towards a sustainable water future while building on existing platforms (Box 5). The following represent opportunities at the research-practice interface to ensure that data and knowledge are shared in an accessible and timely fashion; that research outputs align with and support day-to-day operations; and, that progress can be monitored and evaluated as part of an adaptive decision-making framework:

- Establish nested monitoring programs at local, basin, and regional (ecosystem) scales[130] building on and integrating existing programs for a more comprehensive view of water conditions

- Provide open access to publicly funded and collected water-related data sets and model outputs, particularly those produced through regulatory requirements

- Develop "reduced complexity models" for multi-stakeholder management decision support[131]

- Develop climate-related sector-specific scenarios, especially in areas of human health, agriculture, water, energy (hydroelectric power), and disaster preparedness

- Generate risk maps and health assessments that can inform climate change adaptation strategies and planning

- Enhance resilience towards extreme weather events through soil and water management[132] and community-led interventions

- Develop indicators for assessing quality of participation and partnership, such as effectiveness, value, nature of engagement, and ability to deliver meaningful change[133]

- Develop user-friendly interfaces for integrated modelling platforms to support access to appropriate and timely information

- Develop end-user tools and applications, co-designed with practitioners, especially those boundary organizations representing civil society and marginalized groups

- Evaluate, document, and transfer emerging, innovative solutions

- Commit to the use of evidence as the foundation for good (water) governance at all management scales
- Embed the connection to water more explicitly in policies and strategies currently not focused on water, such as the International Feminist Agenda, and embed gender equity and health and well-being into water policies and strategies
- Target the communication of knowledge through social media, public service announcements, print media, and other public interventions to change attitudes and behaviours towards enhancing water efficiency, water quality, climate change mitigation, and personal climate risk reduction
- Harness existing capacity in Canadian water research programs, federal government agencies, and NGOs to publish a biennial State of the Water Report for Canada that incorporates health, water quantity and quality, drinking water and wastewater, economic sectors, and the environment[134]

Box 5: MANY COORDINATION AND ADVOCACY PLATFORMS EXIST THAT CAN BE LEVERAGED AND USED TO SHARE KNOWLEDGE AND SOLUTIONS:

- INTERNATIONAL DECADE FOR ACTION ON WATER FOR SUSTAINABLE DEVELOPMENT, 2018-2028
- WORLD WATER DAY (MARCH 22)
- EARTH DAY (APRIL 22)
- CLIMATE CHANGE WEEK (OCTOBER)
- THE SDG ACCORD (UNIVERSITY AND COLLEGE SECTOR RESPONSE TO THE SDGS)
- ASSOCIATION FOR THE ADVANCEMENT OF SUSTAINABILITY IN HIGHER EDUCATION
- HIGHER EDUCATION SUSTAINABILITY INITIATIVE (HESI)
- GLOBAL ALLIANCE
- EAUC - THE ALLIANCE FOR SUSTAINABILITY LEADERSHIP IN EDUCATION
- SECOND NATURE

Opportunities in Leadership for Water-Related SDGs

The challenges, as always, lie in generating transformative and sustainable change that is more than the sum of individual programs, projects, and activities, even when they have scientific value in and of themselves. As such, a commitment to leadership is essential to realize these actions and to leverage them to become greater than the sum of their parts. Ultimately there must be stronger leadership from leaders—elected officials, governments, universities, and others—to provide example and authenticity and to create the space and reduce the barriers for the needed research and practice:

- Governments at all levels must adhere to international commitments, such as the SDGs, the Sendai Framework for disaster risk reduction, and the Paris Climate Agreement
- Governments and academic institutions must lead by example and commit to tackling the underpinning causes of climate change and water management including adopting a carbon neutral footprint, and equity, diversity, and inclusion in their workforces, policies, programs, and data
- Following the example of the Canadian Institutes for Health Research, collaboration is required to reform funding mechanisms to facilitate true and meaningful community and stakeholder partnerships, especially in terms of direct research funds and project leadership
- Academic institutions must value and incorporate community engagement and knowledge mobilization metrics as part of the tenure and promotion process to facilitate professional incentivization of individual researchers in applied and participatory research
- Likewise, researchers focused on applied problems and solutions must challenge themselves to look at their contributions within the context of the SDGs and climate change adaptation, mitigation, and resilience
- Politicians and political parties must recognize the urgency behind climate change mitigation and adaptation and the essentialism of sustainable development, commit to evidence-informed decision-making, stand against post-factual information (“fake news”), and articulate these in their platforms
- The Federal Government must modernize the Canada Water Act, to enable a more coordinated, practical, and multi-jurisdictional response to the root causes driving Canada’s emerging climate and water crisis including federal leadership on the scientific, technical, and administrative capacity to measure, predict, and respond to water problems and opportunities and to engage in water diplomacy domestically and internationally[135]

CONCLUSIONS

7

7. CONCLUSIONS

This report is intended as a blueprint for more coordination between research, policy, and practice, between Canadian water researchers, the Canadian government, and other initiatives around the world that will intentionally fill the gaps identified as necessary to achieve a water future for the world we want. There are huge opportunities for Canada on the national and global stage in these areas. Given the right business model and access to support and resources, there is significant capacity within the Canadian water sector to deliver water technology, management, capacity, and predictive tools to emerging markets, particularly in developing countries, to accelerate greatly needed sustainable water resources management.

Canada and Canada's water sector also possess a great deal of capacity with respect to water research and governance that could be of huge value in meeting, and helping others to meet, the SDG Goals and Targets as they pertain to water. What is missing is a sense of urgency and coordination of existing capacity. Alongside the diverse community of like-minded academic and civil society organizations working on furthering these aspirations, the harnessing of this substantial capacity will need continued government coordination and support to fully realize.

> *"I AM FIRMLY OF THE VIEW THAT THE NEXT 18 MONTHS WILL DECIDE OUR ABILITY TO KEEP CLIMATE CHANGE TO SURVIVABLE LEVELS AND TO RESTORE NATURE TO THE EQUILIBRIUM WE NEED FOR OUR SURVIVAL"*

HRH Charles, The Prince of Wales,
2019 Reception for Commonwealth Foreign Ministers (BBC, McGrath)

Current geopolitical uncertainties, the urgency of responding to climate change-induced acceleration of the global water cycle, Canada's commitment to its own Federal Sustainable Development Strategy, large federal investments in water research, and a new Decade of Action on the global water crisis, all provide great impetus for governments, Indigenous Peoples, research institutions, and civil society organizations at all levels, to work harder to coordinate and orchestrate the significant capacity in Canada's water sector for the benefit of the country and the world.

The Eden Project, Biomes, Cornwall, UK

In the meantime, in the absence of a coherent vision of itself at its future sustainable best, Canada as a nation remains mired in divisiveness on matters of energy policy, resource development, and action on climate change. With tensions between provincial and federal governments as well as regions of the country, the Pan Canadian strategy for clean growth and climate action – a lynch pin in achieving the SDGs – is in shambles. The research and actions by academics to

date have had little effect on changing our country's course. For all of the positive activity that this report showcases, the country as a whole continues in the wrong direction with respect to sustainability.

> *MAINTAINING A HEALTHY ENVIRONMENT DEPENDS ON THE ACTIVE ENGAGEMENT OF ALL CANADIANS IN ITS STEWARDSHIP.*

Government of Canada
Federal Sustainable Development Strategy, 2016-19

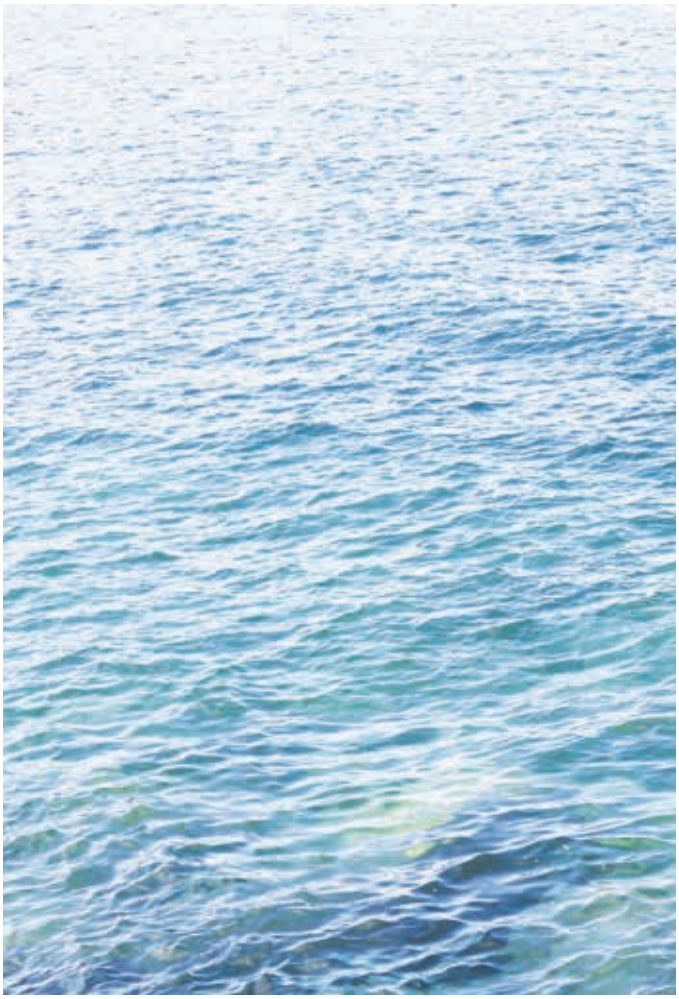
What has been invested in the status quo has cemented society into a direction that it cannot seem to change. The enduring solution is to reverse the damage we have created and to end this era by constructing a business model that respects the real value of Earth's ecosystem services rather than simply creating markets for repairing the uncalculated and often incalculable damage we do to them as a matter of authorized course. Becoming resilient and pre-silient under uncertainty demands that we first restore memory of who we are and where we came from; restore local identity and humanity's sense of place; restore truth; recognize environmental regulation as protection for all and not an obstacle to making money; restore responsibility to human dignity, economic morality, and equity; and, in so doing, restore common purpose and a vision for the future of humanity and the planet. As the writer William Kittredge once said about the American Midwest, "what we need most urgently is a fresh dream of who we are – one that tells us how to act; new stories about taking care of what we have that drive us to take appropriate action".[136]

The SDGs need to be seen for what they are: a constellation of actions and targets aimed as much as possible at societal self-preservation. In order to undertake this social transformation in ways that will prevent eventual collapse, the SDGs have to meaningfully define social, economic, and environmental action in research, policy and practice. They must be at the forefront of leadership directions at the international, national, and all sub-national levels.

It is clear, however, that we are not keeping pace with the ambitions of the 2030 Agenda and we urgently need to close the gap between research promise and implementation practice if we want to achieve our vision of water futures for the world we want. There is huge opportunity for university research and leadership to contribute to this future. Research networks can keep the possibility of that happening in the future by continuing to remind all of the risks and threats posed to future stability by poverty, inequality, injustice, failed governance, climate change, and the massive involuntary human migration that are already beginning to follow in their collective wake. Ideally, however, universities should go beyond just talking about the SDGs and their importance, as they are largely doing now. They are uniquely poised to be showing the country and the world what the SDGs mean and how to implement them.

The long-term benefits are significant: there is economic opportunity and quality of life reward in restoring damaged landscapes, upgrading and refining infrastructure, developing and adopting new technologies, and sharing what we know profitably with others. The opportunity before us is to create a cleaner, healthier, better world, now and in the future. The 2030 Agenda is the perfect vehicle for advancing all of these aims together.

In so doing, we make where we live a better place and move our country in the direction of a new national water ethic. Through this process, we not only get our own house in order, we help to create a better, more just, equitable, and sustainable world for all.



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