Response to the Government of Canada Discussion Paper “Toward the Creation of a Canada Water Agency”

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Introduction

As the development of a Canadian Freshwater Agency (CWA) is undertaken, we must keep in mind that our freshwater is not an endless resource. We have to live with our finite water resources and understand that we are all responsible to keep water healthy and accessible to everyone. Access to clean water is a basic human right, mandated by many countries, including the United Nations. The development of any Canadian wide strategy for water management must first and foremost integrate a human rights-based approach, ensuring the rights of individuals and communities are met, and the obligations of industry and organizations are understood.

Freshwater should not be thought of as a separate (or self-contained) issue from the rest of the hydrosphere and cryospheric systems of our planet. The impact of hemispheric and especially Arctic climate on freshwater in the mid and lower latitudes in Canada is integral to understanding how to manage freshwater resources. Neither the effects of climate change directly on the hydrology and water quality within Continental Canada nor its relationship to the oceans has been mentioned within the CWA document.

Background

Over the past twenty years, the University of Manitoba has emerged as one of the leading research institutions in the world in the field of Arctic system science and technology. The Centre for Earth Observation Science (CEOS) within the Clayton H. Riddell Faculty of the Environment, Earth and Resources serves as the focal point for this activity. CEOS has earned national and international recognition in conducting system-level research, as well as in technological development focusing on the physical, biological, geological and biogeochemical processes operating within rapidly changing Arctic systems. CEOS members include leading researchers in land use and management, soil and water conservation, remote sensing, hydrology, landscape ecology, wetland ecology, watershed processes, statistical and modelling techniques and cross-scale interactions of drivers of water quality parameters. Their experience includes (amongst other regions) research throughout the Nelson River watershed, which spans five ecoregions (Prairies to Subarctic) and four provinces in Canada, and two ecoregions (Great Plains and Northern Forests) and four states in the U.S.

In this response document, we will address key areas we feel are either not adequately considered, or missing from the CWA discussion paper. We have divided this document into key areas of discussion, and have placed the relevant sections from the CWA paper in brackets after the heading.

Network Supported approach (Sections 3.2, 3.7)

Canada's freshwater system cannot be understood in isolation from the rest of the hydrospheric and cryospheric systems. Addressing freshwater issues from the atmosphere through watersheds to the oceans, and on a pan-Canadian or North American scale, requires a multi-disciplinary and in fact transdisciplinary approach. The CWA should support the development of networking platforms (*e.g.* a network of science centres and federal agencies which could work with networks including appropriate provincial departments, Indigenous nations and/or citizen scientists) bringing together a wide range of western science-based multi-disciplinary research expertise, citizen science and Indigenous knowledge. Large scale multi-disciplinary approaches have been proven to work well within Canada and globally. CEOS has been part of ArcticNet, a Network of Centres of Excellence (NCE) of Canada initiative that brought together over 175 researchers from 33 Canadian universities, 8 federal and 11 provincial agencies and departments, and which has incorporated interaction with Indigenous knowledge and community-based research. ArcticNet has allowed Canada to be at the forefront of Arctic research globally, and to partner with research teams in Denmark, Finland, France, Greenland, the USA, the UK and many other countries. CEOS researchers are also heavily engaged with the NCE Marine Environmental Observation, Prediction and Response Network (MEOPAR), and on a more local scale, CEOS also has well developed multi-disciplinary programs that partner industry (Manitoba Hydro) with science teams across Canada to study the role of freshwater-marine coupling and the relative contributions of climate change and regulation on the Hudson Bay system.

Scale (Sections 3.3, 3.7)

A CWA should be aware of and support a range of geographical scales in freshwater engagement. The planning document provides a lot of text for local scale through to regional scale aspects of water and water quality but it does not adequately cover aspects of hemispheric to global atmospheric interaction with water quantity and quality in coupled Earth System processes. We acknowledge that many solutions will require research and action at local scales, for example, finding water storage in wetlands, or reducing nutrient export from fields. However, local processes are affected by and have cumulative impacts on hemispheric and global systems. For example, runoff into northern rivers like the Mackenzie and the Nelson travels to the Arctic and is eventually delivered to the North Atlantic where this freshwater can have dramatic impacts on the Meridional Overturning Circulation (MOC), a strong driver of the global climate.

Successful management of freshwater is only possible by acknowledging that water flows across First Nations, municipal, provincial or even international borders and therefore should not be studied as if it stops at a political boundary. In particular, Indigenous and other communities who depend on water for recreational and commercial purposes, as well as a source of drinking, can be affected by flow originating hundreds of kilometres upstream of their location, not to mention climate developed half a world away.

Climate Change Effects (Sections 3.3, 3.7, 3.9)

Understanding and managing freshwater issues related to climate change in Canada requires understanding the effects of global teleconnection effects as well as downstream, local climate issues. In particular, the Hudson Bay, Pacific and Atlantic Watersheds are affected by meteorological or environmental influences that occur thousands of kilometres away. Freshwater is extremely buoyant compared to seawater and supports long-range transport of nutrients (*e.g.* carbon, phosphorus) and contaminants (*e.g.* mercury) to the marine system and through it (in Hudson Bay, for instance, carrying contaminants sourced in the continental interior as far as the North Atlantic Ocean). A better understanding of the downstream effects on the marine system from long-range transport of these compounds is necessary.

Extreme weather, an important aspect of climate change, can affect freshwater hydrology and water quality at local, regional and hemispherical (*e.g.* the Arctic) scales. These weather events need to be considered in relation to how they are modulated by climate gradients across the continent-water-ocean systems; as well as how they affect lakes directly through mechanisms such as momentum exchange, evaporation, warming and increased nutrient and contaminant mobilization by runoff and flooding due to high-intensity precipitation events (the latter two impacts contributing to eutrophication of downstream lakes (*e.g.* as has been demonstrated in Lake Winnipeg).

In particular, the current CWA document does not address teleconnection effects such as the role of the Polar Vortex in modulating precipitation (and temperature) at southern latitudes; and the changing persistence of the polar jet and how this manifests in floods and droughts throughout Canada.

Freshwater prediction (Sections 3.3, 3.7)

While monitoring and powerful models (of climate, hydrology, transport and biogeochemistry) undeniably underly freshwater prediction, the process must be iterative, *i.e.* model development, prediction, continued monitoring, targeted research to improve process replication, then repeat. This is how Global Climate Models (GCMs) have continued to improve predictions of 21^{st}- century climate, and how weather and especially hurricane forecasting have gradually become more accurate. The iterative process is often honoured in water quantity modelling because the costs of inaccuracy are so great, but less so in water quality and freshwater ecosystem modelling—whether because of inadequate follow-up monitoring or inadequate resources devoted to research. A local example of this failing is the lack of funding for follow-up monitoring in nutrient-reduction projects funded by the Lake Winnipeg Basin Initiative. The iterative process described here is fundamental to successful adaptive management—whether we are adapting to real-world change (*e.g*. climate change, land-use changes—changing forcing requiring a change in our responses) or simply failed prediction due to model error. The CWA should incorporate this iterative process into its basic philosophy and use its influence and funds to encourage it in freshwater management nationally.

Water quality and quantity (Sections 3.3, 3.4, 3.7, 3.9)

Freshwater quality and quantity are intrinsically linked. The impact of flooding on the mobilization of nutrients and contaminants from both rural and urban watersheds is well known, if not well quantified. Less often considered is the link between droughts and nutrient supply, for instance, to support healthy fisheries in downstream water bodies.

There are thousands of freshwater bodies throughout Canada, confounding our ability to establish a well-distributed national database for water quality measurements. A CWA could contribute toward these knowledge gaps by facilitating the integration of long-term monitoring data with community-based monitoring work to provide the most detailed coverage available at the local and regional levels. One important aspect of integrating a variety of datasets would be in supporting the capability of emerging community-based organizations, including First Nations, to meet national data quality standards. More data without better quality data will not be enough. We will need both to monitor and predict the impacts of climate change on everything from health issues related to drinking water in Indigenous and local communities to the potential for economic development through small scale hydroelectric installations. More and better information is necessary not only in the southern and central regions, but also, perhaps especially, in the mid-latitudes and up into the Arctic.

Biogeochemical Cycles

While it is increasingly recognized that inland waters play a significant role in the global carbon cycle, the greenhouse gas (GHG) source/sink status of Canadian waterways remains, with few regional exceptions, poorly quantified. An important knowledge gap relates to the role of reservoirs and associated flow regulation in support of hydroelectric production. Studies suggest water impoundment could be a major contributor to greenhouse gas emissions, yet, again, little is known on the net impact of the reservoirs on regional carbon budgets, outside of perhaps, Quebec. The demonstration that Canadian hydroelectric production is green using scientifically defensible data would not only benefit our export market but also improve Canada's chances of meeting international commitments to curb GHG emissions.

Ecosystem services, fish habitat

Other than one mention of fisheries, the CWA planning document is silent on the impact of water planning on freshwater as an ecosystem. We have already identified the need for a systems-level approach to understanding water issues, in particular, atmospheric and surface water interactions. Freshwater is also a part of ecosystems. Water quality affects and is affected by the biological community that resides in it. At the level of economics, water quantity affects fisheries directly by recruitment losses due when streams fail to meet minimum discharge requirements, and water quality affects fisheries when nutrient loading is either too high (eutrophication) or too low (limiting primary productivity). The CWA must incorporate concepts of ecosystem services and habitat requirements in its basic approach to both water quantity and water quality issues. One of the largest freshwater fisheries is located in the Manitoba Great lakes and the ecosystem services that derive from this fishery are a significant part of the economy of Indigenous, the Metis Nation and the general public in Canada. Fisheries tourism is also a key part of the economic impact of climate change on freshwater quality and quantity in many sectors of Canada.

Cyanobacteria

The CWA discussion paper briefly references the issue of toxic and nuisance algae as an impact of climate change. These are two different challenges related to both climate change and cultural eutrophication and should be addressed as such. Algal blooms may or may not be composed of toxin-producing algae, conversely, toxin-producing algae may be present in high numbers in a water body but never present as an actual "bloom". Regardless of toxicity, algal blooms may have an adverse impact on commercial fisheries (*e.g.* through net fouling), recreation and aesthetics. Moreover, with regard to the fishery, the impact is complicated—fishers may be concerned by net fouling, but also recognize the need for sufficient nutrient loading to support productivity. On the other hand, toxins present a direct human and animal health concern. New toxins like BMAA have been shown to be involved in Alzheimer and Parkinson disease development. This area of research should be clearly denoted in the CWA planning.

Groundwater

The CWA discussion paper mentions the need for models and tools to predict extreme climate events reliably, including prediction of surface and groundwater levels. Atmospheric, glacial, surface and groundwater freshwater must therefore be an *integral* part of a CWA—

and the agency must support an *integrated* understanding of their processes and functions. To manage Canada's total renewable water resources, better data is needed to calculate more accurate long term average ground- and surface water availability including from sources such as precipitation (and losses by evaporation), groundwater recharge and surface inflows, not only from within Canada but also from transboundary sources (*e.g.* the upper Red River, the U.S. states in the Laurentian Great Lakes and Lake of the Woods watersheds). This can only be accomplished through better integration between existing networks such as ECCC's national atmospheric and hydrometric monitoring networks, provincial hydrometric monitoring agencies and groundwater monitoring agencies, and harmonization with sister agencies in the United States. It may mean enlarging existing groundwater monitoring networks.

Research and Education (Sections 3.2, 3.5)

Universities and other academic institutions should be engaged more directly in the consultation and development of a CWA. Understanding where specific research questions are most appropriate, and which institutions are best placed to address these questions would help guide the development of capacity and collaboration between agencies and institutions.

Canadians need a better understanding of the science behind decisions about freshwater. The CWA could facilitate this by supporting research and educational institutions in the collection and sharing of scientific information, and by providing tools to enable the clear and concise translation and sharing of science to the public. For example, the agriculture sector hears many conflicting messages when it comes to the proper method of keeping nutrients from water bodies – is it "keep water on the land", for how long? Is it return water to crops via local storage and irrigation? How should the soil be treated, does it depend on the type of soil? How do the types of crops or animals affect water management decisions?

Engaging Canadians (Section 3.11)

The CWA is looking for feedback on engaging Canadians in managing and protecting freshwater. This can only be accomplished through education, open access to data and demystifying scientific data for the public. Only when we teach people to understand the value of water will we be successful in protecting our freshwater resources. (We still flush drinking water via the toilet in most countries). If the public does not value water, they will not protect it.

Governance (Section 3.2)

Water governance cannot be separated from human health and well being. This should be priority one when developing a CWA.

The CWA can learn from and engage international organizations like the United Nations to ensure alignment with global priorities. For example, the UN has developed seventeen sustainable development goals, many of which relate to water, with Goal 6 – Clean Water and Sanitation and Goal 14 – Life below water specifically referencing water quality related to humans and animals. The CWA could focus on strengthening and expanding links to these goals through support of existing works instead of trying to design something new. The CWA could also facilitate bi-annual water conferences to discuss developments in the water sector globally.

Freshwater data (Sections 3.7, 3.8, 3.10)

Open access to data and data management is a theme that was heard repeatedly in national and regional consultations for the CWA. The workshops made clear that there is still a large barrier to accessibility and comprehension around freshwater data. The challenges around data can be broken down into three main themes:

Where: Data collection in Canada is disparate and often hidden behind multiple layers of extraneous information. A single location to see where data has been/will be collected, the theme (*e.g.* groundwater, nutrients) and by whom, is not available. Understanding where there are gaps in our knowledge is impossible if we cannot understand the amount and type of historical and current data available.

Accessibility: When data has been collected, often the data itself is still in formats that are not easily machine-readable (*e.g.* data only available as a table in the literature). Data is often collected in formats that are not interoperable or robust (*e.g.* data collected in proprietary formats such as Microsoft Word, Excel, Corel Word Perfect). These formats can be difficult to read and share and make long term standardization challenging. Water quality data is not universally available via open data portals (*e.g.* in Manitoba, provincial data is supplied only on written request).

Quality: Data is often stored with insufficient metadata to be useful long-term. Data shared without key information such as sample collection or analytical methods, instrumentation details or contributor details do not allow adequate data provenance, which makes it difficult to compare data collected by different organizations. A CWA must support freshwater agencies in improved data sharing and in developing mutually agreed-upon sampling and analytical standards. Only then will freshwater data be fully utilized for research and management at a national and global scale.

The Government of Canada has put a vast amount of resources into its open data repository and mapping platforms. These initiatives are needed, but cannot be the “one-stop-shop” for freshwater science. The multi-disciplinary nature of information required to truly understand and inform freshwater research and policy in Canada is such that there will always be domain specialists required to appropriately interpret the information collected. Standardizing and sharing of research data initially requires domain-specific expertise, and for one agency or organization to attempt to gather and curate all types of freshwater research into a single repository would be time and cost-prohibitive. There already exist examples of domain-specific repositories where an institution or group of organizations have worked together to curate data according to national or global standards. Once data is truly interoperable it can be shared easily, and with confidence in the quality of the data, allowing for sharing of reproducible and robust information. Data can then be digested into key facts for policy and decision-makers and public consumption. A CWA could coordinate a base set of metadata and data standards for freshwater in Canada, using guidelines from initiatives globally as well as nationally that have already accomplished this. For example, in Canada, the CCADI initiative has been working through this same set of challenges for Arctic data. The CWA could also act as a federated search site (think Google for freshwater data) to provide access to freshwater data from multiple data nodes across Canada.

Summary

In summary, we reiterate several key messages:

1. Atmospheric circulation, ice, groundwater, surface freshwater and oceans function as one integrated system. In the face of a changing climate, CWA support for research and management of water quantity and quality must incorporate this understanding of the larger system into every regional situation.
2. Water flows across borders: municipal, Indigenous, inter-provincial and international. While the CWA will certainly be involved in regional freshwater concerns, it must use its influence and support to ensure that freshwater science and management is organized by watershed boundaries, not political boundaries.
3. From an academic perspective, the above two concerns indicate the need to combine centres of excellence with inter-university, inter-agency networks to predict system-wide (and deep) impacts of climate change on Canada`s water resources, and conversely the impact of water systems on GHG cycling and budgets.
4. We fully support the CWA's emphasis on data collection and information sharing. The response to this concern should range from support for standard methods, and where appropriate, inter-agency testing of comparability among field and laboratory methods among provinces, First Nations and citizen scientists, to support of standardization and federated access to both data and derived information.
5. The CWA must incorporate the strategies of adaptive management in dealing with water quantity and water quality concerns.