A FEDERAL PERSPECTIVE ON WATER QUANTITY ISSUES

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December, 2007

DRAFT

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A Federal Perspective on Water Quantity Issues

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Introduction

Media coverage of the current drought in the southeastern United States, on what is called Australia's worst drought in 1000 years, and of this summer's floods in the United Kingdom have drawn a significant amount of attention to the importance of water availability. Due to the high profile of these international incidences, uncertainty related to climate change, and the extensive media and public attention to low water levels in the Great Lakes, Canadians are becoming increasingly concerned. We can no longer take our extensive water supplies for granted.

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The challenge of *water quantity* is that there may be too little or too much water, at the wrong place, and at the wrong time.

This paper provides an overview of water quantity issues and outlines implications and considerations for the federal government.

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Federal and Provincial Roles

The management of Canada's freshwater is a shared responsibility between federal and provincial/territorial governments. Primary responsibility for the management and protection of water issues of a local or private nature falls to provincial governments. The federal government, through Indian and Northern Affairs, still manages most major water use decisions in the north via water boards but this is evolving with devolution. Provinces may delegate certain authorities to municipalities, including the treatment and distribution of drinking water and the treatment of wastewater.

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Constitutionally, federal authority relating to freshwater includes water on First Nations and federal lands, navigation and shipping, boundary and transboundary waters, and fisheries and fish habitat. Shared responsibilities relate to agriculture, human health, aquatic ecosystems, pollution management and environmental assessment.

Many watersheds cross provincial and/or national boundaries, making freshwater a shared responsibility. Federal activities include monitoring and assessment of water quality/quantity, research in areas of national interest or regarding regional concerns affecting multiple jurisdictions, and assisting in resolving transboundary water-related disputes.

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A broad suite of federal legislation directly or indirectly pertains to Canada's freshwater. For example, the *Fisheries Act* allows the federal government to ensure that sufficient flows are maintained in bodies of water to protect fish and fish habitat. Under the *Canada Water Act*, the Minister of the Environment can enter into agreements with provinces to protect bodies of water of national interest. The *Canada Water Act* also authorizes the Minister to undertake research and develop management plans for federal, interprovincial, or international waters.

Canada's Water Supply

Canada is considered to have an abundance of freshwater. Canada does possess 20% of the world's freshwater, but in terms of *renewable supply*, Canada actually has only about 7%; much less than Brazil (18%) and Russia, and about the same as the United States.[1] Canada also inhabits 7% of the world's landmass, so our share of the renewable freshwater supply is by no means disproportionate. That said, the majority of our major rivers flow north, away from our major population centres most of which are within 300kms of the Canada-U.S. Border

Renewable supply should form the basis for responsible water management decisions, as it is continuously replenished by natural processes via the hydrologic cycle. Yet rising temperatures, changes in precipitation patterns, or impacts resulting from population growth, urbanization, resource development, or high consumption can affect runoff and evaporation patterns, the amount of water stored in soil moisture, aquifers, seasonal snowpacks, and glaciers.[2]

Of Canada's total water supply, only 1% is renewed annually, with the majority of the remainder contained as groundwater in buried aquifers, and a lesser amount as ice in glaciers, the polar ice caps and lakes.[3] Also, with 60% of the fresh surface water flowing north, and 85% of the population living along the southern border, less than half is actually available and accessible to most Canadians.[4]

Many view the Great Lakes as an infinite supply of freshwater, but most of this water is non-renewable, so-called 'fossil' water. The Lakes were carved out by retreating glaciers and filled by meltwater thousands of years ago. On average, only 1% of the water in the Great Lakes is renewed annually by precipitation and inflow from rivers and groundwater (which is roughly equivalent to the current level of consumption).[5]

As pressure on surface water increases around the world, more people will be relying on their groundwater supply. These resources are much more difficult to understand: in some parts of the world, groundwater volumes are 100 times more extensive than those on the surface. Nevertheless, groundwater resources have a high risk of over-exploitation and a corresponding drop in the water table, as has been seen for several regions in the US.

Information challenges

To adequately manage water resources, Canada requires timely and reliable hydrometric data and information, but there are gaps in understanding the water supply.

For instance, detailed knowledge and monitoring of the factors controlling the renewable surface freshwater in the country's lakes, rivers, and glaciers is limited, as is knowledge with respect to the minimum amount of water required to maintain healthy ecosystems; both in terms of defining how much water an ecosystem requires, and also in establishing a method to determine the amount that is required to meet such needs on a case by case

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basis. Furthermore, there are a variety of uncertainties, including climate change and population growth, that cloud our ability to extrapolate past events to inform the future. The result is that governments often design infrastructure and and water use licenses are based on short-term data that is often not representative of hydrological conditions required in the region.

Despite the large amount of freshwater estimated to be contained in aquifers in principle, actual knowledge about groundwater quantity, its quality and renewal rate are sparse and often inadequate for management. This poses significant risks for those who rely on groundwater for their water supply which represents approximately 33% of Canadians. This percentage is much higher in certain regions/provinces- PEI is 100% groundwater dependant and New Brunswick 60%.[6] Knowledge of Canadian groundwater quantity, quality and recharge is also not keeping pace with that of the United States, where the second country-wide water census in the past 12 years is underway. Considering that there are several transboundary aquifers between Canada and the United States, there is an increasing need to establish a complete understanding of these shared resources. Our lack of data places Canada at strategic disadvantage for bilateral negotiations with the US.

Canada's Water Demand

Canadians generally use a lot of water - the second most per capita in the Organization for Economic Co-operation and Development (OECD), and twice the European average. This is partly due to unrepresentative, flat rate pricing, which provides no incentive to limit use (Canadian water prices are the cheapest of all OECD countries).[7] Water use decreases as prices rise, but the low water prices in Canada has in part hampered significant conservation efforts.[8]

Total water use per capita

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  In the Territories, for example, a total of 187 water monitoring stations are operated. The limited information provided by these stations means that Territorial
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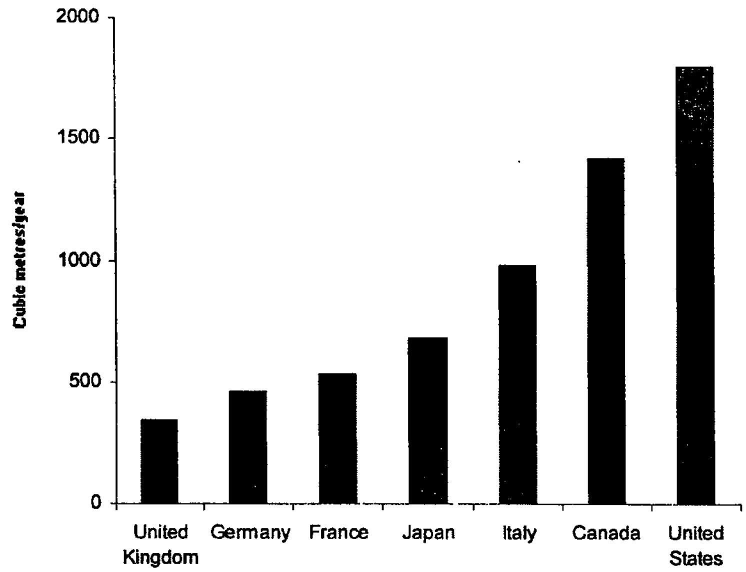

Water plays a critical role in Canada's economy. Recent estimates of the economic activity generated by water range from $7.5 to $23 billion annually (values comparable to agricultural production and other major economic sectors) and others state that approximately 60% of Canada's GDP is directly dependant on water.[10]

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Water is used in many different ways in the economy; as an input (e.g. a critical element in the production and processing of food), or as part of the production process (e.g. in the pulp and paper industry). Also, no other country diverts as much water for hydroelectric power generation as Canada. While providing for flood control, irrigation and recreational benefits, large diversions can have implications for the transfer of invasive species and pollutants, and there is limited knowledge on the impact of diversions on aquatic ecosystems.[11]

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Water *use* refers to water that is extracted or withdrawn and returned to the source, whereas *consumption* refers to water that is not returned to its original source (e.g. through evaporation). Consumption can negatively impact ecosystems and have water availability implications. Water use can also have significant disruptive impacts on maintaining productive, resilient and diverse ecosystems with the capacity to recover and adapt. There are also implications with respect to the quality and temperature of the water when it is returned to its source.

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Agriculture is the largest *consumer* of water, whereas the energy sector is the largest *user*. Unlike other sectors, agriculture consumes most of the water it withdraws, and some in irrigation-dependant watersheds, available water resources are fully allocated. Incentives to conserve water in the agricultural sector are minimal.

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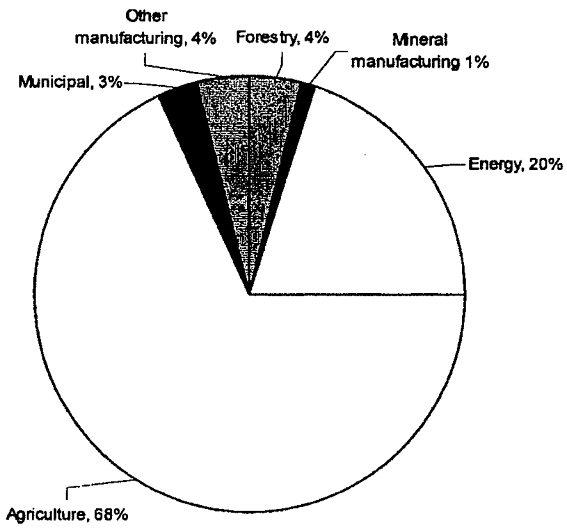
Water consumption by major Canadian sectors



The use of energy and water is closely related. Energy is required to treat, pump and distribute water, and water is used in the energy sector for cooling, extraction and other processes specific to the energy source. Large amounts of water are also needed in the sector for hydropower, oil and gas extraction and production, refining and processing various energy sources, and shipping. The energy sector is the largest user of water in Canada, and is a significant user and consumer of water in Alberta especially.[12] Efforts to increase water efficiency through the recirculation of cooling water have not overcome sector growth; gross water use in the energy sector is increasing. The US has identified water availability as a threat to its national energy production and has invested significant effort in a technology roadmap to minimize impacts.

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In particular, oil production is highly dependant on water. Roughly 50% of oil production in Alberta is dependant on water for extraction. On average, 2 to 4.5 barrels of water are needed to produce 1 barrel of oil from the oil sands.[13] Alberta's government is investing in research to reduce water consumption in recognition that water availability may constrain development unless greater efficiencies are developed and implemented.[14] Natural Resource Canada's Canmet Energy Technology Centre - Devon are investing in research to reduce water consumption and find ways to deal with the contaminated produced water.

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A prime example of freshwater's importance to Canada's economy is the Great Lakes-St. Lawrence river region. This region supports 45% of Canada's industrial capacity, 25% of its agricultural capacity, and contributes $180 billion to Canada-US trade annually. The Lakes sustain a $100 million commercial fishing industry and a $350 million recreational fishing industry.[15] The shipping industry contributes $3 billion to the economy each year and provides jobs for 60,000 Canadians and Americans.[16] Tourism revenue continues to increase annually from hunters ($2.6 billion), recreational boaters

($2 billion), anglers ($2.5 billion), and the more than 70 million people who visit the Great Lakes region.[17]

Although municipal water only represents 3% of Canada's total consumption, there are significant implications for water infrastructure.[18] Excessive municipal water use increases the capital and operating cost of treatment and distribution infrastructure and also puts pressure on ecosystems.[19] An expected 15-20% population growth over the next 25 years, largely concentrated in the Great Lakes basin, will place additional stress on aging infrastructure. It is estimated that water infrastructure needs in Canada will cost $70-90 billion over the next 20 years.[20]

Information challenges

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Canada lacks sound information at a national scale on the major uses and user of water. Municipal and industrial water use surveys have been conducted over the years but more attention analysis of current and future uses should be undertaken. Gaps exist on uses (e.g., oil and gas) and national forecasting of water availability has never been done because traditionally our use of the resource was thought be unlimited. This is no longer the case in many watersheds across the country at many times of the year.

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Pressures on Canada's Water Quantity

Climate change

Current and forecasted changes to the hydrologic cycle because of temperature and precipitation variations and the frequency and severity of extreme weather events introduce a great deal of uncertainty into estimates of freshwater availability.[21]

Canadian water resources are already experiencing the effects of climate change. For instance, glacier cover has decreased rapidly in recent years and now approaches the smallest extent in the past 10,000 years.[22] Historic records indicate a potential 30% decline in summer flows to the Athabasca River since 1970 and glaciers feeding the Bow River further south have undergone extensive retreat.[23]

The Intergovernmental Panel on Climate Change predicts that increased temperatures will cause premature melting of snow and ice, which will remove moisture from the soil, reduce surface water levels, and slow groundwater replenishment. This may result in reduced water availability in the summer during periods of high water usage.[24]

In general, decreased water levels are expected in some regions of Canada, especially during the summer months. In the winter, less ice cover, less snowfall, more rain-on-snow precipitation events, and more frequent winter thaws could increase the risk of winter flooding throughout the country.[25] More frequent forest fires due to moisture deficit are also possible, potentially causing extensive social and economic impacts.[26]

However, specific impacts of climate change are expected to vary. Regional projections include declining water levels for the Great Lakes, decreasing soil moisture in southern Canada and a reduction of wetlands in the Prairies.[27] In Atlantic Canada, although water

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Climate change is expected to bring advantages for some agricultural crops by lengthening the growing season, but disadvantages through reduced water availability and pest problems.[28] Lower water levels in the Great Lakes will have significant economic impacts for the hydroelectric and shipping sectors and for the health of ecosystems. Since water availability issues will continue to be elevated in the western provinces, freshwater allocation for oil sands development may conflict with other water needs and uses (see Annex 1 for a detailed summary of potential impacts of climate change on water).

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It should be noted that floods, droughts and forest fires are all natural occurrences to some degree. For instance, droughts have occurred throughout history and are part of the planet's cyclical fluctuations. Similarly, fires are very important for the natural life cycle of a forest.[29] The issue is that these natural occurrences could be exacerbated by climate change.

Shortages and Allocation

Freshwater resources are subject to conflicting demands, and shortages occur due to a wide range of factors including high use, population growth, urbanization, and changes in climate. In 1999, 26% of Canadian municipalities with water distribution systems reported water availability problems in the previous 5 years.[30]

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Governments (primarily provincial) allocate water in ways that influence where, when and how much may be used. The needs of municipalities, agriculture, and industry, for example, must be balanced against the necessity of maintaining adequate streamflows in rivers and lakes to support important aquatic ecosystems and fish populations.[31]

All provinces require permits or licenses for a user to withdraw surface water. The process for allocating permits varies by province. In Ontario, for example, the *Ontario Water Resources Act* regulates allocation. In British Columbia, the *Water Act* and *Water Protection Act* establish the basic regulatory framework for water management.[32] The Newfoundland and Labrador *Multi-barrier Strategic Action Plan* contains extensive permitting systems and fee schedules for a wide range of activities affecting water resources.

In southern Ontario, economic development and population growth are placing pressure on surface and groundwater resources, leading to some building restrictions. For example, development in the Oak Ridges Moraine region near Toronto was halted because the area was a key recharge zone for an important aquifer. In 2006, the Alberta government closed the Bow, Oldman, and South Saskatchewan rivers to new water allocations. This may also constrain economic development and has implications for conflict between the different water users.

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Extreme events (droughts and floods)

Extreme events affect the health, safety, economy and environment of Canadians. For example, the federal government has contributed $1 billion in disaster financial assistance since 1997 for flood damage. The 1997 Red River flood in Manitoba resulted in $815 million in damages, while the 1999 Saguenay flood resulted in 10 deaths and over $1.5 billion in damages.

The 2001-02 drought covered a large geographic area and had significant economic implications. Dry conditions encompassed most of southern Canada - extending from British Columbia, through the Prairies, into the Great Lakes-St. Lawrence region and even the Atlantic Provinces.[33] The total Canadian loss in value for the agricultural sector was estimated to be $3.6 billion, which resulted in an estimated $5.8 billion drop in Canada's GDP and 41,000 jobs lost.[34] Impacts were also felt in areas as wide-ranging as municipal water supplies, recreation, tourism, health, hydro-electric production, transportation and forestry.

Regional Challenges

Threats such as the 2001-2002 drought can be broadly applicable throughout the nation, but many challenges are regional or watershed-based. A watershed is the geographic boundary of where water flows. It contains an interdependent ecosystem of plants and animals that function as a system.[35] A watershed can vary in size from a few square kilometres to a basin that drains much of Northern Canada as in the Mackenzie Basin.

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Beyond the regions presented below, Atlantic Canada has challenges associated with drought, groundwater depletion and the encroachment of saltwater into aquifers used for drinking water, while the North is experiencing modifications in its water supply as a result of climate change (e.g. glacier retreat, melting freshwater ice).

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Prairies

The Prairies are historically, and continue to be the most drought-prone region in the country. Population growth, development, high use, and climate change are placing increasing pressure on water resources.

Crop production on the Prairies is largely dependant on irrigation and accounts for 75% of consumptive use in the region. Southern Alberta in particular has one of the lowest renewable supplies of freshwater in Canada, but also has a high demand for water from agriculture and population growth. As a result, water use per capita is significantly higher than the national average.[36]

Water supply in the northern regions of the Prairie Provinces is also expected to experience stress. For example, although only 3.9% of the average natural supply of the Athabasca River in northern Alberta is presently allocated for oil sand surface mining development through water licenses, the concern is the continued rapid growth of the industry. If all proposed projects are approved, water use for oil sands development is expected to more than double and may exceed the threshold for instream flow needs as defined by the Department of Fisheries and Oceans and Alberta Environment's recently released report on the Athabasca River Water Management Framework. Presently, very

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little water that is removed from the Athabasca River for oil sands development is returned, and its flow is decreasing (along with the flow of other rivers that feed the Mackenzie River).

However, linkages between decreased flows in these rivers and current water use in the oil sands are not proven.

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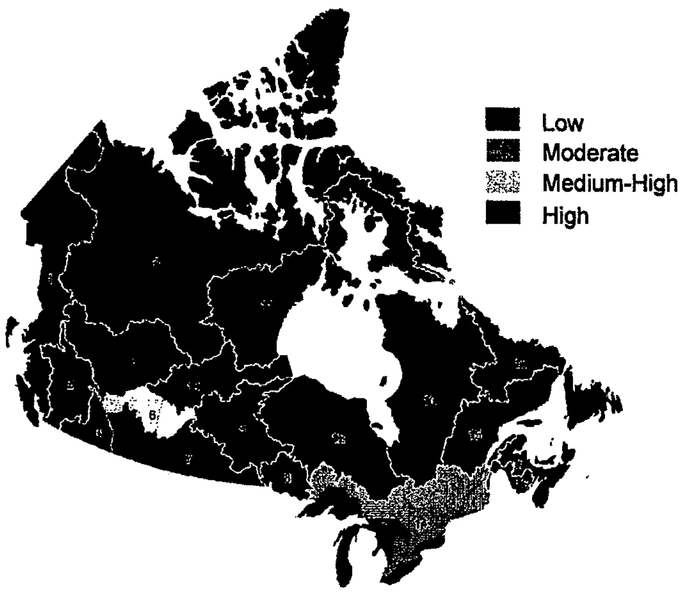
Water Demand to Supply Ratio[37]



British Columbia

British Columbia faces pressures from high population growth, development, overuse, increasing irrigation demand, and climate change. Groundwater levels are dropping in some locations. Since groundwater provides the drinking water supply for approximately 25% of British Columbians, the sustainability of levels in the face of increasing use and population growth is a serious concern, especially in the Okanagan Valley.[38] Water availability in the Okanagan is a growth limiting factor. British Columbia is also often subject to extremes such as drought and the 2006 emergency rationing of water in Tofino.

Great Lakes / St. Lawrence region

The Great Lakes region is home to the largest system of surface freshwater in the world. Approximately 41 million inhabitants in Canada and the United States live within the watershed. The Great Lakes are both the receiving water for discharges from sewage treatment plants, while at the same time being the source of drinking water for one quarter of Canada's population.

There are concerns about the impacts of population growth, urban expansion, agricultural and industrial development and climate change. Groundwater depletion is occurring at an unknown rate, and lowered water levels will result in serious costs to the shipping and hydroelectric industries. For instance, a 0.08-1.18 metre drop in Great Lake water levels equates to a $240-350 million annual loss for the hydroelectric industry alone.[39]

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The low levels in the Great Lakes have become an issue of concern to the public and industry, and have been the subject of considerable media attention in recent months. The International Joint Commission (IJC), an independent binational organization with the purpose of helping prevent and resolve disputes relating to the use and quality of boundary waters and to advise Canada and the United States on related questions, recently initiated a five-year, $17.5 million International Upper Great Lakes Study to look at the management of water levels and flows in the Great Lakes.

There is speculation that longer ice-free periods on Lake Superior are allowing for increased overall evaporation and is contributing to the low water levels. However, there is still much uncertainty due to limited data and incomplete understanding of the hydrometeorological processes in the region.

Implications and Opportunities for the Government of Canada

Implications and considerations

Escalating concern for water issues

The recent public focus on environmental issues and water quantity issues such as floods, droughts, lower lake water levels, and impacts from climate change will likely escalate. External stakeholders like the Gordon Group, Pollution Probe among others are calling for a "renewed" federal leadership role on water policy and management, and there are currently several Senate and Private Member's Bills related to water before Parliament.

Future jurisdictional issues

Jurisdiction for water in Canada is shared between federal and provincial governments. If there is a significant reduction in water availability and shortages become more prevalent, there may be a heightened risk for jurisdictional conflict for water allocation between provinces and also between Canada and the United States. Current challenges in the United States with respect to water availability may illustrate comparable future pressures throughout North America.

For example, Georgia, Florida, and Alabama are presently experiencing serious water allocation problems due to the southeastern US's worst drought in decades. Lake and river levels are lowering, translating into hundreds of millions of dollars in losses. Competing for the same water resources are Georgia's growing Atlanta population, Florida's $200 million commercial fishing industry, and Alabama's nuclear energy industry that generates electricity for 800,000 households. Georgia has filed a lawsuit to try and force the US federal government to reduce the amount of water it sends downstream each day. Florida and Alabama have strongly opposed the suit.

There is also perennial public concern that Canada will face pressure to export freshwater given that the United States' population is expected to grow by one-third in the next 35 years.[40] The US government predicts that at least 36 states will face challenges from inadequate water supplies in the next 5 years.[41]

The US's current and projected water shortages have received significant media and non-governmental organization attention. Speculative reports about the possibility of bulk water exports are expected to persist in the media and the issue of bulk water exports is expected to remain or intensify.

The federal government has sent a clear message to Canadians that the country's water is not for sale. Canada also has restrictions in place through the *International Boundary Waters Treaty Act* and its regulations prohibiting the bulk removal of water from the Canadian portion of boundary waters like the Great Lakes. All provincial governments except New Brunswick have legislation banning bulk water exports. Notwithstanding these mechanisms, stakeholders are still calling on the federal government to develop a more comprehensive strategy to deal with the issue.

Also, some studies have shown that conservation, improving efficiency, and reallocating water among users is generally more economically viable than exporting water.[42,43,44] Bulk water removal projects would also have direct or cumulative effects on watersheds, including the disruption and alteration of natural ecosystems, and changes in water flows and levels.[45]

In the near term, most stakeholders agree that it is unlikely Canada will experience pressure to export freshwater. However, in the longer term, a region such as the American southwest may exhaust the local alternatives and seek other water sources for relief. The uncertainty of climate change impacts could also hasten the possibility.

Previous federal commitments relating to water quantity

The 1987 Federal Water Policy (FWP) contained several statements with respect to water quantity. For example, under the water pricing strategy, the federal government committed to develop new water-efficient technologies and industrial processes that minimize costs and encourage water conservation. With respect to science leadership, the federal government committed to develop and maintain, with the provinces and territories, water data and information systems directed to improving the knowledge available for managing Canada's water resources. Other commitments included:

- producing legislative provisions to address interjurisidictional water issues relating to levels, flows, and quality;
- encouraging existing mechanisms like the Prairie Provinces Water Board and develop others to address potential provincial-territorial and interprovincial water conflicts;
- encouraging public participation and initiate, develop and deliver a national water conservation awareness program;

- undertaking, support, and promote research into establishing appropriate prices for water, identifying areas of potential user conflicts, and encouraging the development and transfer of water conservation technologies and practices; and
- negotiating with the provinces on the development of a mechanism which would allow for the ultimate resolution of interjurisdictional disputes in cases where all other means of reaching an agreement have failed.

Many of the initiatives outlined in the FWP were not aggressively pursued by the federal government during the past 20 years. For example, since the 1987 policy was introduced, no major initiatives involving pricing, economic instruments or education has taken place to reduce consumption. Concerns with respect to water quantity are more relevant and pressing today than they were when the FWP was released in 1987. Also, certain issues such as climate change, as well as the interface between water and energy have evolved in both their degree of complexity and level of understanding.

Comment [r10]: Paul's note: What about CCME's Water Efficiency work in the mid 1990s?

Experiences in other jurisdictions may lend itself to an increased federal role. In both the United States and Australia, sub-national governments are traditionally known as the primary managers of water. However, the water availability emergency situation in Australia has prompted the federal government to introduce a National Water Initiative to improve water management. In the United States, the federal government has recently decided to intervene in the conflict between the southeastern States and has announced plans to hold more water in Georgia lakes rather than sending it downstream to Florida and Alabama.

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Opportunities for the federal government

To address the various challenges with respect to water quantity, the federal government could take action in a number of areas – e.g., supporting the development of water efficient technologies, raising public awareness, encouraging the use of economic instruments, strengthening collaboration, providing leadership in water science, and mitigating the impacts of extreme events.

Technology and best-practice development

Demand management strategies that involve water efficiency technologies have the potential to reduce the amount of water Canadian industries and households use. Current technologies, if implemented, could yield a 25% water savings (Peter Gleik). Further gains require benchmarking current trends so that key areas for improvement can be identified and technologies that target these can be strategically developed.

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The need to find more efficient ways of using water is currently relevant in regions such as the Okanagan and southern Alberta. The primary concern in these areas is not necessarily extracting more water - since surface water rights are already fully allocated, although groundwater use is still in question - but putting the available water to its most efficient use.

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Federal departments have made research investments to reduce industrial water consumption and investments have been made to advance efficiencies for irrigation and in generating power from small hydro. The agricultural sector and some industries have also reduced their water use rates by increasing efficiencies in irrigation and recirculation, respectively.

However, there is a considerable scope for further progress towards efficiencies, water recycling, and re-use.[46] For example, the City of Edmonton has partnered with Petro-Canada to re-use municipal wastewater at an oil refinery. Such arrangements that use alternate "types" of water can greatly reduce stress on traditional water sources.

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Education and information

Water consumption patterns may also be influenced by using effective communication strategies, awareness campaigns or product rating programs, particularly at the household level. On a small scale, Environment Canada has recently released public education material encouraging water use efficiency.

The federal government is in a position to lead a national education campaign to raise public awareness on how much water Canada actually has, and educate households and industry about the importance of water conservation. Practices such as the use of greywater could be taught and encouraged (greywater is wastewater unfit for drinking, but of sufficient quality for many industrial processes and household uses).

Economic instruments

Placing an appropriate monetary value on water with benchmark rates of consumption could affect the way industries and households use the resource. Instruments such as metering or full-cost pricing are options for managing demand. With respect to economic instruments, the federal government would continue to play the role of enabler (supplier of information, funding, equipment), while the provinces would continue to operate as program implementers.

Fiscal policies that link investments to demand management requirements are also a consideration. For example, proposals for new municipal water infrastructure could be contingent on a demand management plan that includes education and metering to promote conservation. The federal government has provided $1.8 billion in leveraged funding for water and wastewater infrastructure projects since 2000. Criteria that encourage demand management tools have been developed.

Comment [d12]: Does this mean the funding was contingent on the demand management tools being used? Sounds a bit evasive as written.

Strengthened collaboration

Jurisdictional collaboration has been recognized as being an important aspect of water policy and management. Although several provincial and territorial governments are seeking greater collaboration on water issues, there is no clear consensus on how to achieve it in all cases. Apart from CCME which is exclusively Environment Ministers, there is no forum for discussion of water issues of national significance.

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An example of effective collaboration with respect to water quantity issues is the decision by Alberta, Saskatchewan, Manitoba and Canada to establish the Prairie Provinces Water Board (PPWB) in 1948 to manage water between the provinces. The PPWB

Comment [r13]: What about enabling process for nested watershed management, where each player understands and contributes at their relative competency. Feds: provide the forum for sharing of info and enable discussion; minimize 13 solutions to same problem; harness energy/efforts into same direction

- ensures that interprovincial waters are protected and equitably apportioned;
- provides a forum for exchange of information in order to prevent or resolve conflicts; and
- promotes cooperation in interprovincial water management.

The federal government provides 50% of the funding for the PPWB, while the remainder is shared by each of the participating provinces. A similar example of effective collaboration is the Mackenzie River Basin Board.

Notwithstanding the PPWB example, water governance in Canada is generally considered to need improvement. There is concern that the PPWB mechanism may not be strong enough to deal with potential water availability challenges in the future. For instance, it would not be unrealistic for western Canada to experience a water availability conflict situation similar to the southeastern United States. Nevertheless, through the PPWB, the federal government would be in a position to strengthen the Board and develop a response strategy or establish agreements between the jurisdictions with respect to acquiring water during emergency water availability situations.

Information leadership

The federal government can address information gaps that can address uncertainty around present and future water supply and demand. Current federal action in this area includes regional aquifer characterization, surfacewater quantity monitoring, water use surveys, and studies of market instruments for demand management. Information gaps exist in the following areas, among others:

Ecosystems
- The minimum amount and timing of water required for healthy ecosystems
- Impacts of changing water levels on ecosystem health and beneficial uses of the ecosystem by humans, and the costs of adaptation
- Monitoring and reporting on wetland water quantity
- Contribution of groundwater to baseflow (surface water)

Water demand and use trends
- Understanding demand pressures and water use trends (much of Canada's demand information is estimated or outdated)
  - Benchmark rates and seasonality of withdrawal and consumption of different sectors
  - Cumulative effects of water withdrawal and consumption by multiple uses
  - Anticipating and adapting to changes in supply and predicting demand (population growth, energy demands, agricultural demands)

Information about current quantity
- Groundwater resources and the relationship to surface water (recharge zones and discharge into wetlands)
- Northern water resources, including the majority of northward flowing rivers and those strongly affected by cryospheric components such as snow, glaciers, permafrost, and freshwater
- Water quantity monitoring in the Great Lakes region

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Information about future quantity

- Impacts of projected population growth, urbanization, increased energy use, and economic development on water resources
- Impacts/opportunities of potential shifts in water availability patterns on economic growth and population movement
- Current and past changes in water quantity from natural processes; this would assist in predicting impacts of future changes

Climate change

- Impacts of projected climate change on all major water resources, water availability, infrastructure, and extreme events
    - Given that much of Canada's hydrology is dominated by cold-region processes, a special focus should be placed on the highly sensitive nature of Northern water resources to be affected by climate change
- The causal factors of droughts and floods, and how they will change in the future climate (intensity, severity, and duration)

Extreme events

Extreme events are perceived by the public as being natural hazards that should be addressed by governments in terms of prediction, warning, and response. Although most provinces have comprehensive strategies for such events, the federal government is also implicated.

Current federal action in this area includes environmental predictions and forecasting, monitoring floods and droughts, analyzing flood risk and drought history, and emergency response. Some provinces are also working on drought preparedness and response plans. For example, Alberta's *Drought Risk Management Plan* is an approach to reduce the effects of drought on Alberta's farmers and ranchers. Saskatchewan's *Water Management Framework* provides planning with regards to flooding, drought and other climate change impacts. Ontario's *Low Water Response Program* is an approach to minimize drought impacts and includes grants to encourage drip irrigation methods.

Additional federal opportunities could involve support for improved prediction, early warning, monitoring and response to extreme events. With acceptable measurements over many years, the economic costs of hazards can be substantially reduced through proper infrastructure design. There is also scope for improved monitoring of water levels, flows, and the related weather conditions.

More effective flood and drought mitigation and adaptation strategies may be required as the frequency and severity of hazards potentially escalate. Better coordinated emergency response on a national scale between federal agencies and provincial/territorial agencies may also be an area to consider.

ANNEX

Potential impacts of climate change on water resources

Region	Potential changes	Associated concerns
Yukon and coastal British Columbia	• Increased spring flood risks (BC), impacts on river flows caused by glacier retreat and disappearance	• Reduced hydroelectric potential, ecological impacts (including fisheries), damage to infrastructure, water apportionment
Rocky Mountains	• Rise in winter snowline in winter-spring, possible increase in snowfall, more frequent rain-on-snow events	• Increased risk of flooding and avalanches
	• Decrease in summer streamflow and other changes in seasonal streamflow	• Ecological impacts, impacts on tourism and recreation
Prairies	• Changes in annual streamflow, possible large declines in summer streamflow	• Implications for agriculture, hydroelectric generation, ecosystems, and water apportionment
	• Increased likelihood of severe drought, increasing aridity in semiarid zones	• Losses in agricultural production, changes in land use
	• Increases or decreases in irrigation demand and water availability	• Uncertain impacts on farm sector incomes, groundwater, streamflow, and water quality
Great Lakes basin	• Possible precipitation increases, coupled with increased evaporation leading to reduced runoff and declines in lake levels	• Impacts on hydroelectric generation, shoreline infrastructure, shipping, and recreation
	• Decreased lake-ice extent, including some years without ice cover	• Ecological impacts, increased water loss through evaporation and impacts on navigation
Atlantic	• Decreased amount and duration of snow cover	• Smaller spring floods, lower summer flows
	• Changes in the magnitude and timing of ice freeze-up and break-up	• Implications for spring flooding and coastal erosion
	• Possible large reductions in streamflow	• Ecological impacts, water apportionment issues, hydroelectric potential
	• Saline intrusion into coastal aquifers	• Loss of potable water and increased water conflicts
Arctic and Subarctic	• Thinner ice cover, 1- to 3-month increase in ice-free season, increased extent of open water	• Ecological impacts, impacts on traditional ways of life, improved navigation, changes in viable road networks
	• Increased variability in lake levels, complete drying of some delta lakes	• Impacts on ecosystems and communities

Adapted from Climate change impacts and adaptation: Natural Resources Canada

GLOSSARY OF TERMS

Boundary water
A river or lake that is part of the boundary between two or more countries or provinces that have rights to the water

Cryosphere
A component of the Earth's system that is frozen water; the forms include: snow, permafrost, floating ice, and glaciers

Diversion
The transfer of water from a stream, lake, aquifer, or other source of water by a canal, pipe, well, or other conduit to another watercourse or to the land as in the case of an irrigation system

Drought
A prolonged period of abnormally dry weather that depletes water resources for human and environmental needs

Ecosystem
A system formed by the interaction of a group of organisms and their environment

Evaporation
The process by which a liquid changes to a vapour

Flood
The temporary inundation of normally dry land areas resulting from the overflowing of the natural or artificial confines of a river or other body of water

Freshwater
There are two main types of aquatic ecosystems: saltwater and freshwater. Canada has an abundance of freshwater ecosystems - from lakes, rivers, and streams to ponds and wetlands - and is surrounded on three sides by coastal ecosystems.

Greywater
Wastewater unfit for drinking, but of sufficient quality for many industrial processes and household uses

Groundwater
The supply of freshwater found beneath the earth's surface (usually in aquifers) that supplies wells and springs

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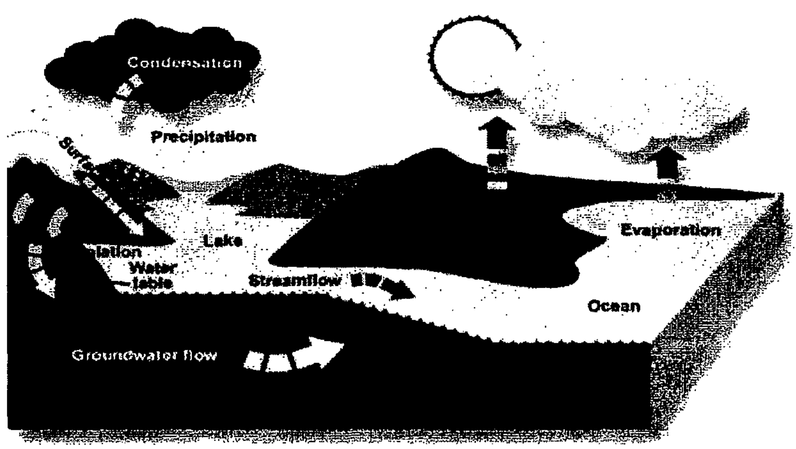
Hydrologic cycle
The endless circulation of water - from oceans and the land surface into the atmosphere through evaporation, dropped on the land as precipitation, and transferred back to the sea by rivers and groundwater



Inflow
The entry of extraneous rainwater into a sewer system from sources other than infiltration, such as basement drains, sewer holes, storm drains, and street washing

Invasive species
Non-native species of plants or animals that out-compete and are detrimental to native species in a specific habitat

Irrigation
The controlled application of water to cropland, hayland, and/or pasture to supplement water supplied through nature

Non-renewable water
Water trapped in glaciers, the polar ice caps, or underground where a small amount is annually replenished. A non-renewable resource can be used up completely or else used up to such a degree that it is economically impractical to obtain any more of it

Renewable water
Water continuously replenished by natural processes via the hydrologic cycle.

Runoff
The amount of precipitation appearing in surface streams, rivers, and lakes: defined as the depth to which a drainage area would be covered if all of the runoff for a given period of time were uniformly distributed over it

Vapour
The gaseous phase of substances that is liquid or solid at atmospheric temperature and pressure

Wastewater
Water that carries wastes from homes, businesses, and industries; a mixture of water and dissolved or suspended solids

Watershed
A watershed is the geographic boundary of where water flows. It contains an interdependent ecosystem of plants and animals that function as a system.

Water consumption
Water consumption refers to water that is not returned to its original source (e.g. through evaporation)

Water flow
The rate of water discharged from a source; expressed in volume with respect to time

Water use
Water that is extracted or withdrawn and returned to the source

Wetland
Lands where water saturation is the dominant factor determining the nature of soil development and the types of plant and animal communities living in the surrounding environment

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