Studies in
Risk & Regulation

June 2010

Making Waves: Examining the Case for Sustainable Water Exports from Canada

by Diane Katz

Studies in

Risk and Regulation

June 2010

Making Waves: Examining the Case for Sustainable Water Exports from Canada

by Diane Katz

Contents

Executive Summary

Canadian opposition to bulk water exports[1] runs deep. Bombarded with alarmist claims of widespread water depletion and degradation, citizens understandably feel protective of the natural resource they value most.[2] But as this report documents, Canada is blessed with abundant supplies of unspoiled surface water and groundwater, and bulk exports can be environmentally sustainable. Given the potential benefits of engaging in water trade, a fact-based reconsideration of the issue is warranted.[3]

Millions of people the world over lack access to potable water, making a strong humanitarian case for water exports. There also are compelling domestic reasons that merit consideration. In particular, bulk exports would advance market pricing of water in Canada, thereby rationalizing resource allocation. At present, government mismanagement, including price regulation and subsidies, encourages inefficient water consumption and inhibits conservation.

Opponents claim that permitting exports would induce America to "suck Canada dry." But water exports can be undertaken responsibly. Given the wide variation in annual volumes of renewable water, water rights can be "unitized" i.e., defined as a proportion of water volume based upon specific environmental standards, such as in-stream flows for fish and volumes sufficient for dilution of contaminants. Such calculations would necessarily be customized to the particular water bodies from which water is to be withdrawn. Distinctions can be made between renewable and non-renewable volumes in lakes, rivers, and groundwater.

Water rights also can be apportioned based upon the volume of water conserved. For example, those who hold water rights can be authorized to sell the water they conserve from their allotment. The tort system would provide relief to those whose water rights were abridged by illegal withdrawals.

Water export and attendant resource pricing also would improve monitoring of water levels and water quality. That is, precise hydrologic data are required to allocate and enforce water rights. And water export would promote economic growth.

1 Environment Canada (2009a) defines bulk water exports as "the removal and transfer of water out of its basin of origin by man-made diversions (e.g., canals), tanker ships or trucks, and pipelines."

2 In a poll conducted for *Policy Options* journal, nearly 62% of respondents cited water as Canada's most important resource. See Nanos, 2009.

3 Economist Marcel Boyer prompted debate on the issue in Quebec with the publication of his 2008 study *Freshwater Exports for the Development of Quebec's Blue Gold* (Boyer, 2008).

Natural resource development already is a mainstay of the Canadian economy, generating 12 percent of GDP, or $147.5 billion, in 2008 (Natural Resources Canada, 2010). The profit potential from bulk water sales is slim, at present, given the high costs of transport. But longstanding prohibitions on water exports don't invite R&D investment. There's reason to expect transport innovations will be achieved if governmental barriers to water export are lifted. Thereafter, economic benefits would flow to both the private and public sectors, including royalty and tax payments, and job creation. Given the deterioration of municipal water systems across Canada—with repair cost estimates routinely exceeding $80 billion—an injection of water export revenue certainly could be useful.

There may be reasons Canadians will continue to oppose water export, but the issue should be decided on the facts and not on the basis of protectionism or unfounded claims of environmental destruction. In the interests of improving water valuation and conservation in Canada, as well as assisting water-poor regions, the report offers the following recommendations:

1 **Improve public understanding of water issues.** Ottawa and the provinces should contract for an independent information "audit" of government web sites, curriculum materials and other documents to identify inaccuracies about water resources in Canada. Inaccuracies should be replaced with science-based facts.

2 **Conduct groundwater mapping and freshwater inventories**. An accurate assessment of surface water and groundwater locations and volumes is necessary to determine the sustainable allocation of water for trade and/or export. The availability and reliability of water inventories vary across the provinces, which raises the costs of obtaining the information necessary to calculate accurately sustainable water withdrawals and consumption levels. A centralized private sector data base should be funded by reprioritizing current expenditures (such as eliminating dozens of costly projects premised on hypothetical global warming scenarios) as well as the imposition of user fees.

3 **Determine sustainable water levels.** Establish a process by which water rights are unitized and adjusted periodically for natural variations in water yields. The calculations should account for both in-stream and out-stream uses and historical variations, and be determined by an independent third party awarded a concession through competitive bidding.

4 **Reform public subsidies of water use.** While the elimination of all such subsidies would rationalize water pricing and thus encourage the highest and best uses of water, that's not likely a realistic option at present. However, artificially low residential and industrial water rates should be phased out in favor of full-cost recovery, at the very

least. As for agriculture, irrigation subsidies should require adoption of water conservation measures such as water-sensor technology.

5 **Repeal prohibitions against water exports.** Myriad federal and provincial statutes and regulations effectively bar water export. These should be eliminated and replaced with institutional mechanisms for assigning private water rights. As an interim measure, such mechanisms could duplicate procedures for leasing crown land and royalty payments for development of minerals, timber and other natural resources. (Rights exercised to maintain in-stream flows should be permitted.)

Introduction

Canadians regard water as the natural resource of greatest importance to the country's future (Nanos, 2009). In a poll [4] conducted for *Policy Options* journal, nearly 62% of respondents cited water as the country's most important resource compared to 22% for oil and gas, 11% for forestry and 4% for fisheries. Treasured as water is, however, misconceptions about its supply, quality, and governance abound. To a large extent, the public generally regards Canada's water resources as despoiled and diminished (Nanos, 2009).

These public perceptions, inaccurate though they may be, drive government policy. It is hardly surprising, then, that a majority of Canadians and their elected representatives oppose any consideration of bulk water exports.[5] When asked what should be government's top policy priority for water, "forbidding bulk water export" ranked second among five options, surpassed only by "adopting a national water strategy" [6] (Nanos, 2009).

In the context of global water issues, Canadians' general refusal to consider bulk water export defies logic. Worldwide demand for potable water is significant; an estimated one billion people lack access to safe drinking water (Environment Canada, 2006). The number of people in water "stressed"[7] countries is expected to increase by more than a billion by 2025[8] (Ayoubi and McNiven, 2006).

Where clean water is scarce, the human toll of contamination is tragic. Pathogens in water induce cholera, typhoid, hepatitis, dysentery, trachoma, hookworm, and a slew of other dreadful maladies. Of the 3 million to 4 million people who die of waterborne diseases annually (Environment Canada, 2009, Nov. 19), most are children in developing countries (World Health Organization, 2010), where more than 90% of

---

4 The poll of 1,001 Canadians was conducted by telephone between May 26, 2009, and June 1, 2009, and has a margin of error of 3.1 percent, 19 times out of 20.

5 Environment Canada (2009a) defines bulk water exports as "the removal and transfer of water out of its basin of origin by man-made diversions (e.g., canals), tanker ships, or trucks, and pipelines."

6 The last comprehensive national water strategy was proposed in 1999 by the Liberal government of Jean Chrétien.

7 "Water stress" is defined as less than 1,700 m^3 per capita annually (Environment Canada, 2009, Nov. 19).

8 Some of the more alarmist predictions of water scarcity are based upon exaggerated claims related to the hypothetical effects of global warming.

sewage and 70% of industrial wastes are simply dumped into surface waters[9] (Environment Canada, 2009, Nov. 19).

Water systems throughout Eastern Europe and Central Asia also are inadequate—deteriorated infrastructure being a legacy of communist regimes (OECD, 2006a). As noted by Roy Herndon, director of the Institute for International Cooperative Environmental Research: "When the Iron Curtain finally collapsed… the world saw for the first time the great environmental cost of decades of communist rule" (Herndon, 1999).

Even wealthy countries are not immune from water shortages, albeit less severe than in poorer nations. The primary culprit is government mismanagement of water allocations. As in Canada, for example, agricultural subsidies have encouraged the cultivation of marginal soils and increased water demand in areas otherwise unsuitable for water-intensive crops[10] (Edwards, 2007). Artificially low water rates also foster inefficient water use. Indeed, water rates in only a third of OECD countries actually cover the costs of operating and maintaining water facilities (OECD, 2006a). As economists Terry Anderson and Clay Landry explain, "Low prices provide little incentive for consumers to conserve, and low revenues provide little incentive for producers to increase supply. It is not surprising that classic shortages arise" (Anderson and Landry, 2001).

Notwithstanding relatively minor shortages, Canada is blessed with abundant supplies of both surface water and groundwater, and the country enjoys an overall water surplus (Ayoubi and McNiven, 2006). The 30-year average annual water yield[11] for Canada is an enviable 3,435 km^3 (Bemrose, et al., 2009). Meanwhile, the economy withdraws a mere 1.4% of the fresh water renewed annually in the country—the vast majority of which is discharged back, generally in the same watershed (Soulard and Henry, 2009).

9 This fact raises questions about whether the problem actually is water scarcity or the degradation of existing supplies.

10 In recent years, the massive subsidization of ethanol is putting enormous pressure on both water supplies and arable land.

11 Water yield represents the amount of renewable water from groundwater recharge (i.e., the precipitation that seeps into the ground) and runoff from precipitation.

The Case for Exporting Canada's Water

Water export can be environmentally sustainable. The level of allowable exports can be based on a proportion of renewable flow (as opposed to absolute volume), or a proportion of water conserved, to adjust for variations in water levels and to ensure the sustainability of aquatic ecosystems, fisheries, and recreational uses. Allocations also can be based on seasonal variations in water levels and domestic demands on supplies.

Natural resource development already is a mainstay of the Canadian economy, generating 12 percent of GDP, or $147.5 billion, in 2008 (Natural Resources Canada, 2010). Both of these broad facts have led proponents of water export, such as Jack Lindsay, chief executive officer of the water marketing firm Sun Belt Water, Inc., to question why water should be off limits. "Canada chops down its trees so we can build houses in California," Lindsay has pointed out. "Canada drills holes to deliver oil to the United States. These resources take decades or millions of years to renew themselves. Water is renewable every year."

The profit potential from bulk water sales is slim at present, given the high costs of transport. But longstanding prohibitions on water exports don't invite R&D investment. There's reason to expect transport innovations will be developed if governmental barriers to water export are lifted. Thereafter, economic benefits would flow to both the private and public sectors, including royalty and tax payments, and job creation. Given the deterioration of municipal water systems across Canada—with repair cost estimates routinely exceeding $80 billion—an injection of water export revenue certainly could be useful.[12]

For Canada, in particular, the initiation of bulk water exports also would help to drive much-needed reforms in water pricing, infrastructure maintenance, and conservation. Thus, there are both humanitarian and economic grounds for Canada to consider water exports. Indeed, natural resource trade and cooperation between countries has been the historical norm (Yoffee and Wolf, 1999), and a mainstay of peaceful relations between countries.

12 This is not to suggest that government manage water exports, but water auction revenue or royalties could finance infrastructure improvements.

In some respects, Canada already exports water.[13] Water moves outside the country in "embedded" or "virtual" form, i.e., as an input in the manufacture of food and beverages, pulp and paper, durable goods, and petroleum.[14] Canadian exports of bottled water, primarily to the US, Taiwan, and Japan, more than doubled in value from 1996 to 2002, increasing from $130.5 million to $284.3 million, and the industry expects double digit growth for the next five years (Agriculture and Agri-Food Canada, 2009). As researcher Cynthia Baumann has noted, "it is somewhat misleading to say that Canada wants to ban water export when it already exports large quantities of its water worldwide in bottles rather than in tankers, trucks, and pipelines" (Baumann, 2001).

A number of proposals for water export have been floated over the years, but none has actually transpired. In some instances, government officials rejected permit requests outright, while in others the initial approval was rescinded in the face of public opposition.

The opposition to water exports

Opponents of water export contend that Canada is not actually a water-rich country despite ranking third worldwide in the most "renewable" fresh water, behind Brazil and Russia (Environment Canada, 2009, Nov. 19). The problem, they claim, is that 60% of Canada's fresh water drains to the north, but three-quarters of the population is concentrated within 160 km of Canada's southern border with the United States (Environment Canada, 2009, Nov. 19). Therefore, water shortages loom in Canadian population centers.

Bulk export of water would only be problematic if there was insufficient water in total to meet domestic needs. However, water can be rechanneled between drainage basins, which already occurs in considerable quantities for hydro-electric power (Environment Canada, 2004). Although costly, the economic feasibility would improve as demand increases. The country's topography is particularly well-suited for such diversions, although care must be taken in the execution to minimize environmental impacts. According to Environment Canada (2004), "Nature has provided an environment amenable to surface water manipulation in Canada. More impressive

13 Canada exports municipal water from British Columbia to Point Roberts, Washington, and from Coutts, Alberta, to Sweetgrass, Montana, but that is viewed as a neighborly arrangement for the efficient delivery of municipal services rather than water export.

14 According to research commissioned by the Netherlands National Institute of Public Health and the Environment, Canada ranked second (behind the United States) among the top five countries in net virtual water exports for crops in the period 1995-1999 (Hoekstra and Hung, 2002).

even than the general abundance of fresh surface water is the density of interconnected and almost-connected lakes and rivers that make up our drainage network."

Many of the temporary shortages that do occur in Canada are largely a result of water system mismanagement (Anderson and Hill, 1997). For example, up to 30% of the total water entering supply lines is lost to leaks from poorly maintained infrastructure (Environment Canada, 2009b); older systems may lose as much as 50% (Hunaidi, 2000). Water subsidies and inadequate pricing promote careless water use by households, industry and agriculture. Indeed, Canada ranks as second worldwide in per capita water consumption (Environment Canada, 2009, Nov. 19).

Finally, the prospect of water export evidently stokes fears that the United States will suck Canada dry if given the opportunity. Such views reflect, in part, protectionist forces within Canada that long have opposed free trade with the United States. Global warming alarmism also is to blame. For example, the release of the United Nations Fourth Assessment report on global warming prompted one Canadian academic to announce: "We need to start having policy discussions about how we're going to get fresh water to the US. How do we do that before they say to us 'we want it and we're coming to get it?'" (Weaver, 2007).

Managing water exports

If exports were initiated, Canada supposedly would be powerless to restrict water sales to the US under existing trade agreements. But that is largely a misrepresentation of the North American Free Trade Agreement. NAFTA does not prohibit signatories from regulating resource use as long as the restrictions are applied equally to domestic and foreign firms. The treaty also permits trade limitations for environmental protection.

It also is questionable that the US would risk spoiling relations with its most significant trading partner when enormous volumes of renewable water supply are available from Alaska (United States Geological Service).

History is replete with examples of the superiority of trade to optimize resource allocation. Indeed, market pricing is the most powerful means of equalizing demand and supply (Anderson and Landry, 2001), as well as generating funds for infrastructure development, renewal, and maintenance (OECD, 2006a).

Canadian exports of water will not solve all the world's water problems, of course. Ensuring sustainable supplies of safe water requires functional local water systems where none currently exist, and upgrades to those in disrepair. Improvements in desalination technology and wastewater treatment systems also are necessary to reduce the costs of processing water into potable form.[15] All of these improvements will take time, leadership[16] and a great deal of money. For example, to realize the United Nations' goal of reducing by half the proportion of people without access to safe drinking water and sanitation will cost an estimated $21 billion annually for a decade, over and above current aid (Devarajan et al., 2002).

However, water exports can alleviate spot shortages, augment supplies in regions with limited availability, and meet demand where sanitation facilities are undergoing repair.

Overview of this report

These and other water export issues are examined in this report, and common misconceptions are corrected. It begins with an overview of global water supplies, followed by an examination of Canada's hydrology, current patterns of water use, and the laws and regulations that govern the resource. Water diversions and transfers, both past and present, are summarized, as are the benefits and challenges to water export. The paper concludes with recommendations for policy reforms.

Critics argue that water, as the basis of life, is too precious a resource to commoditize. The Council of Canadians, for example, contends that because water is essential to life, "no one should be able to control it or expropriate it for profit" (Council of Canadians, 2009). A number of activist groups are lobbying the government to declare water a "human right" for purposes of guaranteeing water access to all; ensuring that water systems are "democratically owned and controlled"; and, to prohibit any interference by government or industry to individual water access (Blue Planet Project).

If water commoditization violates human rights, what possible justification can there be for depriving those in need of a portion of Canada's surplus?

15 Researchers at Dalhousie University estimated the cost of exporting water from Nova Scotia to Brownsville, Texas, via ocean tanker to be nearly $90 million. However, the use of floating polyurethane bags would reduce the cost of transport to one-eighth that of the tanker, or comparable to the cost of a constructing a desalination plant (El Ayoubi and McNiven, 2006).

16 Often in short supply among the despots of the most water plagued regions, such as Africa.

Hydrology

The volume of water on Earth remains constant over time, although the form in which it exists continuously changes. Without beginning or end, water moves through the Hydrological Cycle, evaporating from oceans and transpiring from plants, condensing into clouds, and precipitating as rain and snow. This transformation between liquid, solid, and vapor states is powered by solar radiation and gravity.

The total amount of water on Earth is estimated to be 1.4 billion km^3, of which 97.5% is salt water and 2.5% is fresh water (Environment Canada, 2009, Nov. 19). As table 1 indicates, most fresh water—about 69%—exists as glaciers and polar ice caps; if melted, sea levels would rise some 70 metres (USGS, 2009). Groundwater comprises the second largest volume of fresh water, followed by surface water in lakes and rivers.

Both groundwater and surface water are constantly replenished through precipitation. About 505,000 km^3 of water evaporates from ocean surfaces annually, and 72,000 km^3 evaporates from land surfaces (Environment Canada, 2009, Nov. 19). In return, some 458,000 km^3 of water (in precipitation) falls back to the oceans, and 119,000 km^3 falls to land (Environment Canada, 2009, Nov. 19). The difference between the amount of evaporation from land and precipitation over land—47,000 km^3 annually—constitutes "groundwater recharge" (i.e., the precipitation that seeps into the ground) and "runoff" (i.e., the precipitation that does not permeate the land surface, but which flows into streams, rivers, and lakes, and ultimately the ocean) (Environment Canada, 2009, Nov. 19).[17]

Taken together, this flow of surface water and groundwater recharge constitutes the "renewable" supply of water. Estimated volumes of renewable freshwater

Table 1: Freshwater Sources Worldwide by Volume (in km^3)

Glacial Ice/Permafrost/Permanent Snow	24.4 million
Groundwater/Soil Moisture	10.7 million
Lakes/Marshlands	0.1 million
Rivers	0.002 million

Source: Environment Canada, 2009, Nov. 19.

17 Rates of recharge and runoff vary by soil type, topography, and geology, among other factors.

Table 2: Annual Renewable Water Resources (in km^3/yr)

Brazil	8,233.00
Russia	4,498.00
Canada	3,300.00
United States of America	3,069.00
China	2,829.60
Cape Verde	0.3
United Arab Emirates	0.2
Qatar	0.1
Malta	0.07
St. Kitts and Nevis	0.02

Source: Gleick, 2008.

vary dramatically among countries, with Canada ranking third worldwide, as indicated in table 2.

Water alarmists, such as Maude Barlow of the Council of Canadians, repeatedly assert that "the world is running out of fresh water" (Barlow and Clarke, 2002). That is erroneous. To be sure, water is not evenly distributed, nor is it uniformly pristine, and the draw-down of groundwater in some areas is unsustainable. However, vast improvements in water efficiency and water quality have been made. As the Global Environmental Management Initiative has summarized:

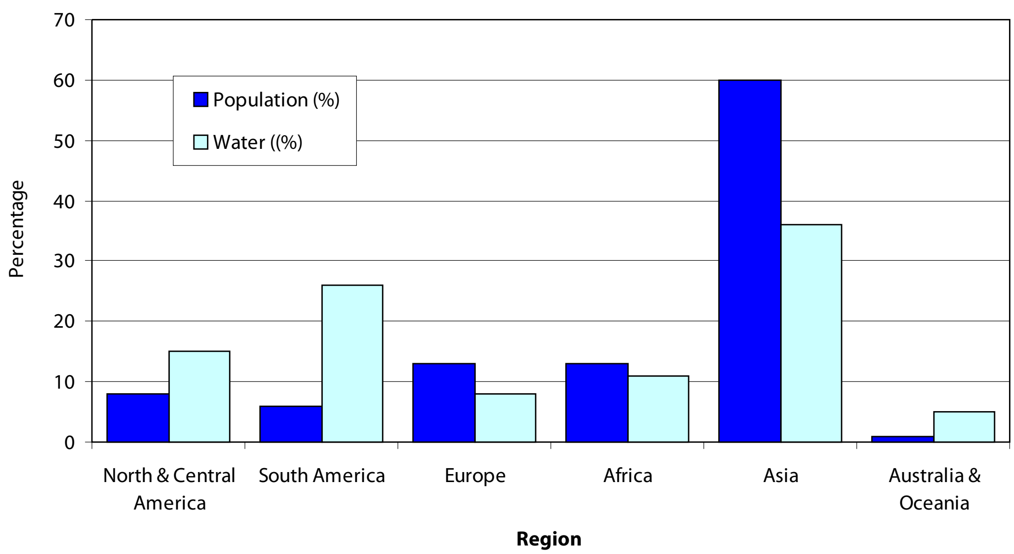
> Significant progress has been made in developing technologies and best practices for conserving, purifying, recycling, and desalinating water, all actions that effectively increase fresh water availability. In the developed world, basic efficiency measures are now widely practiced in the industrial and commercial sectors and include the use of low-volume plumbing fixtures, reduction of irrigation schedules, and efficiency improvements for water-cooling technologies and equipment. Industrial dischargers generally employ best available pollution control technologies. Basic drinking water and sewage treatment are in place throughout the developed world and some developing nations. More efficient and effective technologies are gradually emerging (Global Environmental Management Initiative).

Canada's Water Supply

Canada is rich in water wealth, with nearly 1.2 million square kilometres of water area,[18] or 37,151 square metres per capita (Statistics Canada, 2009). The 30-year average annual water yield[19] for Canada is 3,435 km^3 (Bemrose, et al., 2009), or the equivalent of about 100,000 cubic metres per capita (Soulard and Henry, 2009). Even greater volumes of groundwater lie beneath the land surface (Environment Canada, 2006), although it has not been systematically mapped or measured. Compared with other nations, Canada enjoys a large water inventory relative to population, as indicated in figure 1.

Water resources vary across Canada's vast expanse. As noted earlier, about 60% of Canada's fresh water drains north (Environment Canada, 2006) while three-quarters of the population is concentrated within 160 km of the Canada-US border (Envi-

Figure 1: Population and Water Supplies

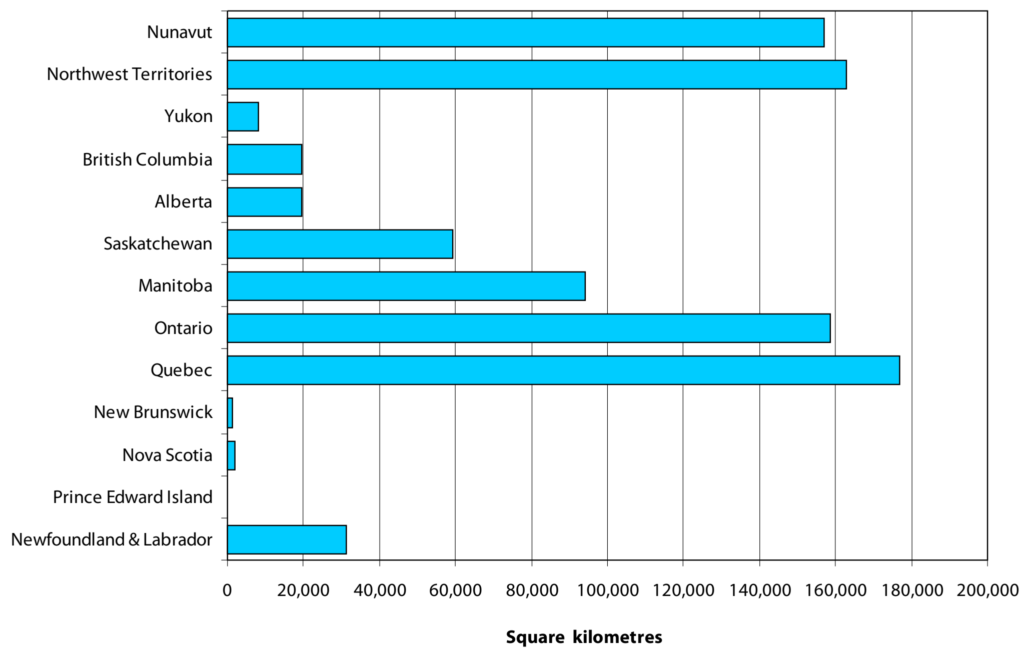


Source: Environment Canada, 2009, Nov. 19

18 Water area represents the geographic measure of lakes, rivers, streams, and various other inland waterways.

19 Water yield represents the flows in streams, rivers, and lakes, including water that originates from groundwater as well as rain and melted snow.

Figure 2: Fresh Water Area by Province or Territory



Source: Statistics Canada, 2005b.

ronment Canada, 2009, Nov. 19). By extension, then, great quantities of Canada's renewable fresh water go unused by humans.

There is significant variation in water resources among the provinces and within provinces, as indicated in figure 2 (Statistics Canada, 2005b). Water flow variation is greatest in the Prairie provinces and parts of central and southeastern British Columbia (Soulard and Henry, 2009). In the Northwest Territories and Nunavut, surface waters are covered in ice for six to 10 months of the year. The ice cover lasts five to eight months in the Yukon.

Canada is composed of five major "drainage basins" that direct the flow of water to the ocean: the Atlantic basin encompasses the Great Lakes and St. Lawrence River region; the Pacific basin extends west from the Rocky Mountains, containing the Yukon and Columbia rivers; the Hudson Bay basin drains eastwards from the continental divide; the Arctic basin is dominated by the Mackenzie River region; and the Gulf of Mexico basin drains a portion of southern Alberta and Saskatchewan (Environment Canada, 2006). The area and volume of flow within each drainage basin varies considerably, as table 3 indicates.

Table 3: North American Basin Drainage Areas (million km²)

Arctic Ocean	3.9
Hudson Bay	3.5
Atlantic Ocean	1.4
Pacific Ocean	1
Gulf of Mexico	0.03

Source: Environment Canada, 2006.

Enormous quantities of water run through Canadian rivers, which discharge a remarkable 105,000 cubic metres of water per second. One cubic metre per second (m^3/s) would fill 1,000 rail tank cars in a single day (Environment Canada, 2006).

Canada also features more lake area than any other country on Earth (Environment Canada, 2009, Nov. 19)—some two million lakes in total, and 563 that span more than 100 square kilometres (Environment Canada, 2006). Chief among them, of course, are the Great Lakes, which hold an astonishing one-fifth of the world's total fresh surface water, as quantified in table 4 (Environment Canada, 2006).

Lake levels have fluctuated dramatically for millennia, and may rise or fall in mere hours depending on factors such as wind velocity and direction. Variations in precipitation and temperature, not water use, are the primary factors influencing lake levels. Ambient temperatures affect rates of evaporation which, in turn, cause water levels to rise or fall. The same holds true for precipitation volumes, as indicated in table 5.

Human impacts on lake levels are relatively minor compared to the effects of natural factors. In fact, more water is now diverted into the Great Lakes basin for hydropower, navigation and other uses than is siphoned away for use in areas outside

Table 4: Quantity of Water in Canada's Great Lakes

	Maximum Depth (m)	Total Area (km²)	Volume (Low Water Datum; km³)
Superior	406	82,100	12,100
Michigan	282	57,800	4,920
Huron	229	59,600	3,540
Erie	64	25,700	484
Ontario	244	18,960	1,640

Source: Environment Canada, 2006.

Table 5: Precipitation Volume in Various North American Drainage Regions (in km^3)

Pacific Coastal	451
Fraser—Lower Mainland	156
Okanagan—Similkameen	7
Columbia	68
Yukon	115
Peace—Athabasca	241
Lower Mackenzie	486
Arctic Coast—Islands	333
Missouri	11
North Saskatchewan	67
South Saskatchewan	74
Assiniboine—Red	86
Winnipeg	74
Lower Saskatchewan—Nelson	183
Churchill	151
Keewatin—Southern Baffin Island	310
Northern Ontario	466
Northern Quebec	656
Great Lakes—Ottawa—St. Lawrence	556
North Shore—Gaspe	367
St. John—St. Croix	48
Maritime Coastal	153
Newfoundland & Labrador	392
Canada Total	5,451

Source: Statistics Canada, 2009.

the basin (Michigan Dept. of Environmental Quality, 2000). Withdrawals and consumption of Great Lakes water actually have decreased by 48 percent in recent decades (International Joint Commission, 2000). The decrease is largely a result of technological innovations, many of which also improve the quality of water discharged back to the basin. All manner of water-efficient appliances—toilets, washing machines, and dishwashers, for example—have come to market, along with a variety of leak-detection and pressure-control equipment.

Even withdrawals for bottled water are quantitatively insignificant. The Great Lakes basin actually imports more bottled water than it exports—37 million gallons imported compared to just 2.6 million gallons exported (International Joint Commission, 2000). In its latest report on the Great Lakes, the International Joint Commission (IJC) concluded:

> [B]ottled water appears to have no effect on water levels in the Great Lakes Basin. (International Joint Commission, 2000)

New technologies and efficiency improvements also have dramatically reduced the amount of pollution discharged into the lakes. In the past two decades, for example, discharges into the St. Lawrence River by 50 of the most polluting industrial plants had been reduced by 96% (Environment Canada, 2009, Nov. 19). A total of 11 "persistent bioaccumulative toxic substances" have been eliminated entirely (Environment Canada, 2009, Nov. 19).

The single largest "point source" of nitrogen and phosphorus releases to the lakes is municipal wastewater, which also ranks among the largest sources of pollution (by volume) in Canadian waters (Environment 2009, Nov. 19). Nonetheless, eutrophication[20] in the Great Lakes is largely under control (Environment Canada, 2006).

The most vexing problem of the Great Lakes is unrelated to either water withdrawals or contaminated discharges. Since the 1800s, more than 140 "exotic" plants, fish, algae, and mollusks have been introduced into the Great Lakes (GLIN, 2009). These non-native species can radically change ecosystem dynamics through increased predation and competition, disease, habitat destruction, and genetic stock alterations (US EPA, 2010). Approximately 68% of the losses of fish species in North America over the last century were due to exotic species (EPA, 2010). The economic impacts are also substantial; the rapid reproduction of the zebra mussel, for example, has created blockages in industrial and municipal water pipes that are costly to remedy, while other species displace or eliminate fish prized for commercial and sport fishing.

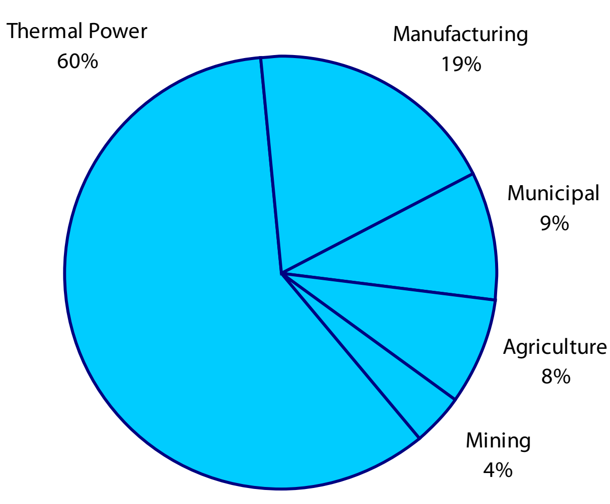
20 Eutrophication results when runoff of nutrients, such as nitrogen fertilizers and sewage effluents, stimulate excessive growth of algae in lakes. Decomposition of the algae reduces dissolved oxygen in the water, causing other organisms in the water to die.

Water Uses

Canadians use water in two ways: it is withdrawn for irrigation, manufacturing, and household uses, and it also is managed "in stream" for hydroelectric power, fisheries, and transportation. Either way, only a minute proportion of the water withdrawn is not discharged back into the basin from which it was taken (Soulard and Henry, 2009).

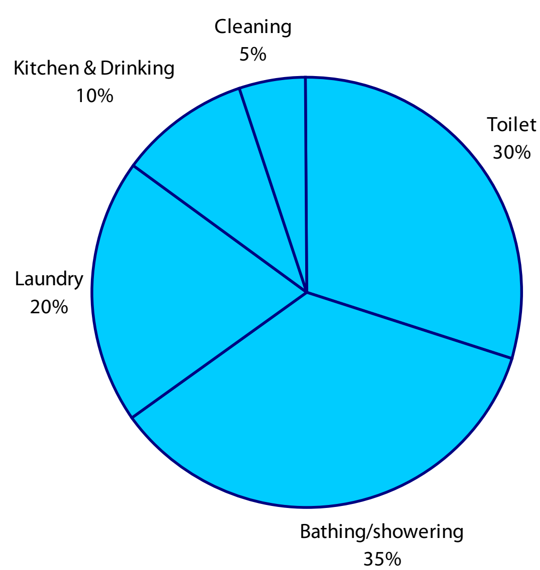
The difference between the amount of water withdrawn and the amount discharged is referred to as "consumption." The Canadian economy withdraws only 1.4% of the country's renewable fresh water: some 40 km^3 is withdrawn for industrial uses (energy production, mining, and manufacturing); agriculture uses 4 km^3; and another 4 km^3 is withdrawn for household and institutional uses, as figure 3 illustrates (Soulard and Henry, 2009).

Figure 3: Water Uses by Type in Canada



Source: Environment Canada, 2006.

Figure 4: Household Uses of Water



Source: Environment Canada, 2006.

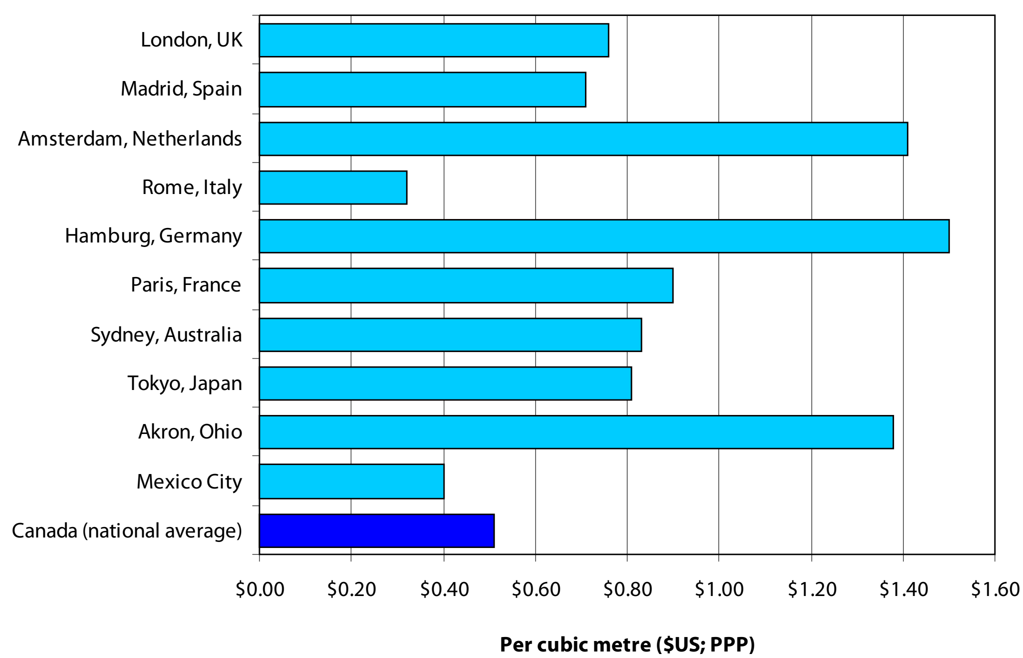
Households

On average, each Canadian uses 329 liters of fresh water for domestic uses each day, as detailed in figure 4 (Environment Canada, 2010, June 3). Canada thus ranks as second worldwide in urban domestic water use per capita, lagging behind only the United States (Environment Canada, 2009, Nov. 19).

About eight million Canadians rely on groundwater for household uses—four million people in urban areas and four million in rural areas (Environment Canada, 2006). The majority of urban households—92%—obtain water from municipal systems (Environment Canada, 2006).

The mean price in Canada for residential municipal water services (25 cubic metres per month) was $22.92 per month in 2004, the latest year for which figures are available (Environment Canada, 2009, Nov. 26). The mean price for municipal sewerage services was $19.95 per month in 2004 (Environment Canada, 2009, Nov. 26). Thus, Canadians pay among the lowest water rates among comparable countries (Environment Canada, 2009, Nov. 26)—about one-quarter of the average European

Figure 5: Prices of Water Supply in Major Cities



Source: OECD, 2006b.

rate and three-quarters of the average US rate (Environment Canada, 2006)—as figure 5 indicates.

Real prices have increased in recent years, but remain low compared to the actual cost of supplying the water (Environment Canada, 2009, Nov. 26). It is no surprise, then, that the rate of water use by Canadians is high.

Agriculture

Plants require water to grow, of course, but water also is an integral component of other aspects of agriculture, including frost protection, pesticide application, and food processing. Irrigation is necessary when natural precipitation is insufficient to sustain crops and livestock, or to increase yields.

Water use for Canadian agriculture totaled an estimated 4.8 billion cubic metres in 2001 (Beaulieu et al., 2007). The largest proportion—92.4% —was used for irrigation, followed by livestock watering (5.4%), and miscellaneous uses such as spraying and crop washing (2.2%) (Beaulieu et al., 2007). Alberta, Saskatchewan, and British Columbia accounted for 92% of the agricultural water use in Canada (Beaulieu et al., 2007).

Among all water uses, agriculture "consumes" the largest proportion of water—some 70% of all the water used in irrigation is consumed (Environment Canada, 2006). With most irrigation fees based on land area, as opposed to water volume, there's little incentive for farmers to reduce water consumption.

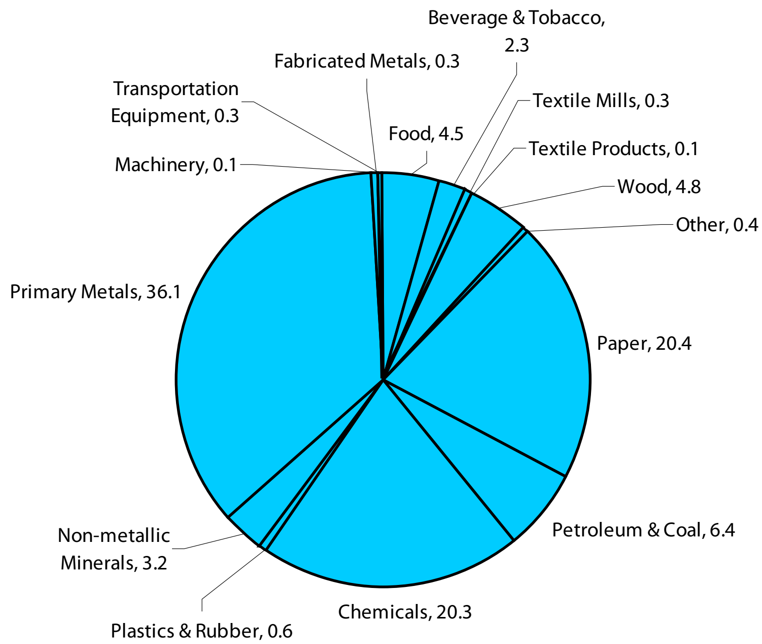
Manufacturing/Industrial

In 2005, five industries accounted for more than 92% of water withdrawals related to manufacturing: 44.8% by paper industries; 27.7% by metal industries; 8.7% by chemical industries; 6.2% by petroleum and coal; and 5.2% by food processing (Statistics Canada, 2008).

More than 85% of the water used for manufacturing and industry is discharged. As figure 6 shows, metals manufacturing consumes the single largest proportion of water in the industrial sector, followed in descending order by paper, chemicals, and petroleum/coal.

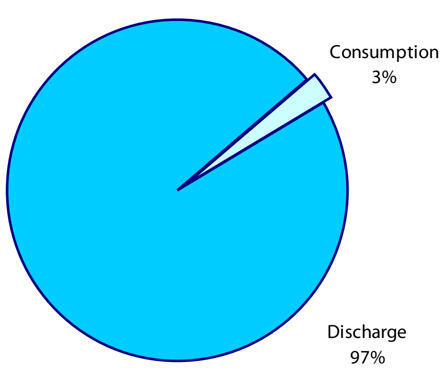
In most developed countries, water use by industry has been decreasing for the past three decades, a consequence of the decline of water-intensive heavy industry and technological advances (OECD, 2006b).

Figure 6: Water Consumption by Industry



Source: Statistics Canada, 2010.

Figure 7: Water Use in Thermal-Electric Power Generation



Source: Statistics Canada, 2008.

Energy

Water is crucial to the generation of energy in Canada, where hydroelectricity supplies 62% of the country's power (Environment Canada, 2006). Hydroelectric utilities routinely are cited as among the largest users of Great Lakes water. In fact, all but about 1 percent of the billions of gallons of water used to drive turbine generators is returned to the basin (Great Lakes Commission, 2004), as figure 7 shows.

The rate of water consumption for all types of energy production totals just 2.8% of energy-related water withdrawals (Statistics Canada, 2008).

Pricing and Consumption

Government policy has a huge impact on water use. Rates that do not reflect the actual costs of supplying water, including the operation and maintenance of water lines and wastewater treatment, effectively dissuade water conservation. Pricing policies across the country actually value water below its cost, and thus undermine its conservation. International trade in bulk water would lead to more rational pricing and, therefore, encourage conservation and increase the overall sustainability of Canada's water supplies.

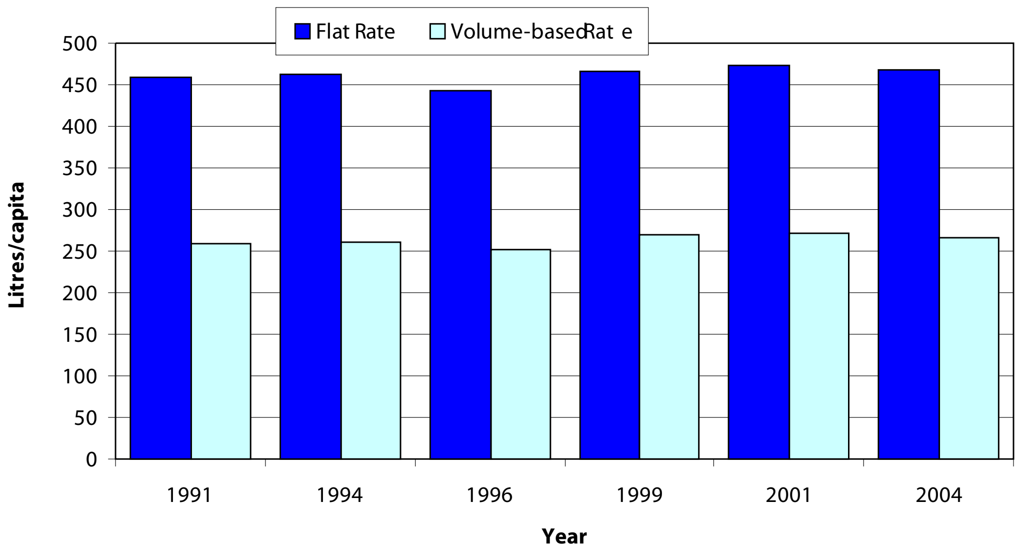
Historically, water rates in Canada have ranked among the lowest found in comparable countries. For example, a survey of 12 OECD-member countries revealed household water rates in Canada to be second lowest, with only Hungary charging less per cubic metre. Water rates in the Netherlands, France, and the United Kingdom were up to four times higher than the Canadian average, while the rates in the other seven countries were at least one and a half times higher (Environment Canada, 2008a).

Not only do Canada's absolute water rates undervalue the resource, but the pricing mechanism does so as well. Nearly one-third of residential ratepayers were charged flat rates for water in 2004 (Environment Canada, 2009, Nov. 26). Because flat-rate billing fails to encourage efficiency, water consumption can run 70% to 80% higher than it does under volume-based rates (Environment Canada, 2009, Nov. 26), whereby ratepayers are charged for the quantity of water they use. Thus, Canada, with roughly one-tenth of the US population, accounts for 35% of the water withdrawals in the Great Lakes basin, compared to 65 percent by the United States. Figure 8 illustrates the differences in water use per capita in Canada between those billed by flat rate compared with those who pay volume-based rates.

A number of Canadian municipalities have eliminated flat-rate pricing. For example, in 1991, 46.7% of residential ratepayers were billed with flat rates compared to 23% in 2004 (Environment Canada, 2009, Nov. 26). Some 46% of ratepayers are now billed by "constant unit charges," which apply a set rate for each unit of water used (Environment Canada, 2009, Nov. 26). Eight percent are billed according to "declining block rates," whereby the price of water drops as successive volumes of use increase, while only 23% of ratepayers pay increasing block rates (Environment Canada, 2009, Nov. 26).

An efficient pricing system would ensure that all users pay rates that reflect the actual cost of service for every unit of water consumed. Unless pricing reflects the

Figure 8: Water Use by Flat Rate vs. Volume-based Rates (litres per capita)



Source: Environment Canada, 2009, Nov. 26.

actual cost of service, there is no incentive to conserve, nor is there sufficient revenue to maintain and upgrade infrastructure.

Among conservation measures recently adopted by municipalities, volume-based pricing was used least, according to the latest federal survey of water systems (Environment Canada, 2009, Nov. 26). Nearly 40% of Canadian residential clients lack water metres by which to calculate water use (Environment Canada, 2009, Nov. 26). Yet areas with water metering use less water than areas lacking meters (Statistics Canada, 2009b).

The wasteful consumption of water is only one of the consequences of inadequate pricing. Another is the shortfall in revenues needed to cover the costs of operating and maintaining water systems. The National Research Council of Canada characterizes the repair deficit as “staggering” (National Research Council Canada, 2009a). Indeed, the price to clear the backlog of repairs and upgrades for municipal systems in Canada is estimated to be $23 billion over a decade (Environment Canada, 2006).

Antiquated systems routinely lose large volumes of water from leaks, as table 6 reveals. Leak detection systems have been implemented in only 73 municipalities, representing a mere 5.3 million people (Environment Canada, 2009, Nov. 26).

Table 6: Water Loss from Leaks

Province/Territory	Rate of Loss (%)
Newfoundland and Labrador	7.1
Prince Edward Island	14
Nova Scotia	12.7
New Brunswick	9.8
Quebec	19.1
Ontario	12
Manitoba	12
Saskatchewan	12
Alberta	7.2
British Columbia	9.1
Yukon	0
Northwest Territories	10.8
Nunavut	5.9

SOURCE: Environment Canada, 2010.

The opportunities for leakage run through the entire water network, including transmission pipes, distribution pipes, service connection pipes, joints, valves, and fire hydrants (Hunaidi, 2000). The causes of leaks are numerous: corrosion; material defects; faulty installation; excessive water pressure; ground movement; and excessive loads and vibration from traffic (Hunaidi, 2000). Furthermore, leaks beget worse leaks.

Leaks also increase the risk of water contamination (National Research Council Canada, 2009b). Contaminants enter the water lines through leak openings when water pressure drops.

Water that leaks from the distribution network is referred to as “non-revenue water,” i.e., the costs of water treatment and distribution go uncollected. In Toronto alone, the level of non-revenue water was calculated to be 52,433,000 m3—the equivalent of servicing a population of 250,000 people or filling more than 15,000 Olympic sized swimming pools every day (LaLonde). The water system in metropolitan Montreal loses a whopping 40% of its water to leaks and water pipe breaks (Champagne, 2009; Ville de Montréal, 2009). This equates to a water loss of 800,000 m3 per day, or 62% more than the total daily consumption by the citizens of Paris.

Water Law and Regulation

Water takes no notice of political boundaries, and history is replete with conflicts over control of the resource. Dating back some 4,500 years, the Sumerian city-states of Lagash and Umma fought over diversions from the boundary channels of the Tigris River (Cooper, 1983). But from that dispute emerged the first recorded water treaty, after which have come thousands of others—"many showing tremendous elegance and creativity" (Yoffee and Wolf, 1999).

Owing to water's importance, nations of the world have cooperated far more than warred over its use. Notwithstanding alarmist claims about the looming threat of "water wars," there's little reason to fear that the future will deviate dramatically from the past. Indeed, Jerome Delli Priscoli, a US senior advisor on international water issues, describes water as "one of humanity's great learning grounds for building community" (Delli Priscoli, 1997).

According to research by Yoffee and Wolf, "shared interests along a waterway seem to overwhelm water's conflict-inducing characteristics." In modern times, they note, only seven minor skirmishes have been waged over international waters. Conversely, more than 3,600 treaties have been signed historically over different aspects of international waters—145 in this century (Yoffee and Wolf, 1999).

Multiple jurisdictions exercise authority over Canadian waters. The federal government holds jurisdiction over water in national parks and federal lands, on Indian reserves, in the Northwest Territories and Nunavut, as well as trans-boundary waters between Canada and the United States. The provinces oversee waters confined within their boundaries. Municipalities primarily are responsible for the delivery of water and wastewater treatment. Barriers to water export exist at every level of government, although provincial laws, in particular, provide government officials with some discretion in permitting allocations.

International treaties

The history of Canada-US cooperation in water stewardship dates back a century during which both countries have adapted to changing circumstances (Yoffee and Wolf, 1999). In the future, provisions to protect both water quality and quantities could be negotiated to facilitate water export. The existing treaties and bilateral institutions include:

- The Boundary Waters Treaty (1909) between the United States and Canada, signed by President Theodore Roosevelt and King Edward VII, established the International Joint Commission to prevent or settle disputes over the boundary waters between the United States and Canada. Article III of the treaty requires commission approval for any diversion or obstruction that would "affect … the natural level or flow of boundary waters." (The IJC does not exercise jurisdiction over Lake Michigan because it lies entirely within the United States.)
- The International Joint Commission oversees implementation of the Boundary Waters Treaty, and is authorized to regulate, undertake surveillance, investigate, and arbitrate. IJC approval must be obtained for the use, obstruction, or diversion of boundary and trans-boundary waters that affect the water's natural level or flow (Environment Canada, 2006).
- Niagara River Treaty (1950) limits the amount of water that may be diverted from the Niagara River by Canada and the US for power generation purposes
- Great Lakes Water Quality Agreement (1972) establishes goals for pollution control, research, and lake monitoring.
- The Great Lakes Charter (1985) is a "good-faith" agreement (legally unenforceable) between eight governors and two premiers of the Great Lakes-St. Lawrence River region to manage water resources. Under the charter, "diversions of Basin water resources will not be allowed if individually or cumulatively they would have any significant adverse impacts on lake levels, in-basin uses, and the Great Lakes Ecosystem." Nor are diversions permitted without "the consent and concurrence of all affected Great Lakes States and Provinces." In 2001, the governors and premiers of the signatory states and provinces proposed amending the charter to incorporate more stringent controls over withdrawals and diversions.
- Great Lakes Water Resources Compact (2005) signed by the governors and premiers of the Great Lakes region prohibits most new diversions and exports of water out of the basin. Permission for a diversion may be sought by a community that straddles the basin if it has no reasonable water supply alternative, including conservation, and the diverted water will be used only for public supply and returned treated to the watershed. Permission is only granted by unanimous approval.
- St. Croix Waterway Commission (1987) is an agreement between the province of New Brunswick and the state of Maine for mutual management and protection of the St. Croix boundary corridor, including "resource sharing and compatible development within an integrated, on-going management process."

In recent years, the debate about water export has focused on whether water in its natural state is a "good" under the terms of the North American Free Trade Agreement (NAFTA). If so, permitting any export would require Canada to accord all firms—domestic and foreign—the same rights. Consequently, opponents contend, the United States would have "unprecedented and irrevocable access rights to Canada's water resources in perpetuity" (Holm, 1993).

The issue is complex—all the more so because Canada did not negotiate an exemption for water in the agreement, as it did for "cultural" industries such as news media and film.[21] However, NAFTA does incorporate the exemption provisions within the General Agreement on Tariffs and Trade (GATT), which recognize trade restrictions "relating to the conservation of exhaustible natural resources, if such measures are made effective in conjunction with restrictions on domestic production or consumption" (Baumann, 2001). GATT also allows trade limitations "to preserve certain commodities in short supply," as well as measures "necessary to protect human, animal, or plant life or health."

In an attempt to settle the matter, Canada, the US, and Mexico issued a joint statement in 1993 asserting that NAFTA does not apply to fresh water unless it "has entered into commerce and become a good or product." Whether the statement actually carries legal weight is a matter of debate.

Canadian law

All provinces, with the exception of New Brunswick, prohibit bulk water exports. However, there exist a variety of exceptions. For example, Quebec law allows bulk exports for the production of electricity. The various water statutes in Alberta, Manitoba, and Nova Scotia also allow exceptions to be granted by the cabinet or legislature, as table 7 indicates. Given that the environmental impacts of water removal are the same if water is bottled, used for irrigation, or otherwise transferred "virtually," opposition to water export per se thus appears to be largely symbolic (McNiven, 2005).

21 Mexico negotiated an exemption for energy resources such as oil.

Table 7: Various Canadian Water Acts and their Exceptions

Alberta Water Act (2000)	A special Act of the Legislature is required for any transport of water out of the province, or any transfer of water between major river basins. Exceptions: "municipal water" and "processed water" (i.e., water packaged in Alberta as a beverage and water used in food processing or in manufacturing).
British Columbia Water Protection Act (1996)	Prohibits water removal from British Columbia, and construction of any large-scale project capable of transferring water from one major watershed to another. Exceptions: water packaged in British Columbia in containers with a capacity of not more than 20 liters each; water carried in vehicles, vessels or aircraft for the use of persons or animals while in transport; registered license holders.
Quebec Water Resources Preservation Act	No water taken in Quebec may be transferred outside Quebec. Exceptions: water taken to produce electric power; water for human consumption and packaged in Quebec in containers with a capacity of not more than 20 liters; water to supply establishments or dwellings in a bordering zone; water carried in vehicles, vessels or aircraft for the needs of the persons or animals being transported or for ballast or other needs related to the operation of the vehicles. An exception may also be granted by the Quebec government for humanitarian or other reasons considered to be in the public interest.
New Brunswick Clean Environment Act	Approval required to construct, modify or operate any waterworks (a private, public, commercial or industrial works for the collection, production, treatment, storage, supply or distribution of water). Any transfer of water between drainage basins requires an environmental impact assessment.
Manitoba Water Resources Conservation Act	Prohibits any removal of water as well as drilling, diverting, extracting taking or storing water for removal, or transporting water for removal. Exceptions: water packaged in a container of not more than 25 liters; water used in the ordinary operation of a vehicle, vessel or aircraft or for the use of persons or animals or the transportation of food or products on such forms of transport; water removed to meet short-term safety, security or humanitarian needs (with the approval of the minister); water used in Manitoba to manufacture or produce a product. Further exceptions may be made by the Lieutenant Governor in Council.
Yukon Devolution Transfer Agreement	As of April 2003, the federal government empowered the Yukon government with provincial-type responsibilities for water management in the territory. It is now the responsibility of the Yukon government to decide whether to prohibit bulk water removals in the territory.
Northern Territories/ Nunavut Northwest Territories Waters Act; Nunavut Waters and Nunavut Surface Rights Tribunal Act	The federal government is responsible for water management (except for health aspects of drinking water). Any major diversion or use of water requires a license issued by a water licensing board and approval by the minister of Indian Affairs and Northern Development. (The minister has stated he will not approve, under the current legislation, any license issued to allow bulk water removal out of a major river basin.)

Table 7: Various Canadian Water Acts and their Exceptions

Saskatchewan Watershed Authority Act (2005)	Prohibits any license or approval to construct or operate works for the transferring water out of a watershed. Exceptions: water packaged in containers; water for transfer between watersheds within Saskatchewan; water used for the ordinary operation of a vehicle, vessel or aircraft, or for the use of persons or animals or for the transportation of food or products on such forms of transport.
Ontario Water Resources Act (1990)	Prohibits the transfer of water out of the water basins; prohibits new and increased water transfers of 379,000 liters per day from one Great Lakes watershed to another. Exceptions: water packaged in a container having a volume of 20 liters or less; water used in the basin to manufacture or produce a product that is transferred out of the water basin; a transfer of water that is necessary for the operation of the vehicle, vessel or other form of transport it is being transferred in, including water that is for the use of people, livestock or poultry in or on the vehicle, vessel or other form of transport; a transfer for firefighting or other emergency purposes; transfers commenced before January 1, 1998 (subject to limitations); water taken pursuant to an Order of the Lieutenant Governor in Council dated October 2, 1913 respecting the Greater Winnipeg Water District.
Nova Scotia Water Resources Protection Act (2000)	Prohibits drilling for, diverting, extracting, taking or storing water for removal or sale. Exceptions: water packaged in a container of not more than 25 liters; water transported in a motor vehicle, vessel or aircraft and that is necessary for the operation of the motor vehicle, vessel or aircraft or is intended for the use of animals or persons; water used to transport fish or any other product; water used for a non-commercial purpose approved by the Minister of the Environment, e.g., for short-term safety, security, fire-fighting or humanitarian needs; water included in manufactured, produced or packaged foods or other products.
Newfoundland & Labrador Water Resources Act (2002)	Prohibits removal of water from the province. Exceptions: water in containers of not more than 30 liters in volume; water used in the operation of, or for the use by or consumption of persons in, a motor vehicle, vessel or aircraft; water used to transport food or an industrial product out of the province; water removed for a non-commercial purpose approved by the Minister of Environment, including for safety or humanitarian purposes.
Prince Edward Island Environmental Protection Act (1988)	Prohibits extracting, taking or using surface water or groundwater for the transfer or removal from the Province. Exceptions: water used for drinking purposes and packaged in Prince Edward Island in containers having a capacity of not more than 25 liters; water in a vehicle, vessel, or aircraft used by persons or animals while they are being transported or for the operation of the vehicle, vessel or aircraft; to transport food or products; water removed, with the written permission of the minister of Environment and Energy for short-term safety, security or humanitarian needs.

Source: Library of Parliament, 2008.

Water diversions and transfers

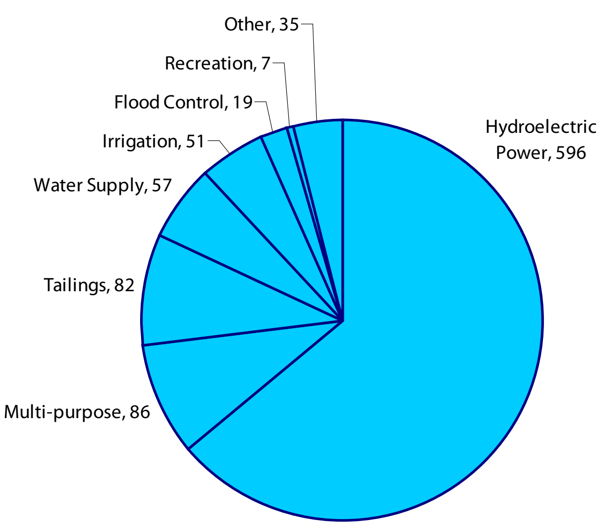
Water resources have been managed for a variety of uses throughout Canada's history. Water from the Niagara River was first diverted to generate electricity in 1893, for example (US Army Corps of Engineers, 2006), and hundreds of diversions and transfers both big and small have been executed since for hydroelectric projects, irrigation, municipal water supplies, and industrial output, among other purposes (Quinn, 2007).

Canada also ranks among the top 10 dam builders in the world (Environment Canada, 2009, Nov 27). As figure 9 shows, there are nearly 600 large dams in the country in addition to many thousands of small dams.

There currently exist 12 diversions of Great Lakes waters of varying size: six move water within the basin; three divert water out of the basin; two draw water into the basin; and one diverts water both into and out of the basin. The following five are the largest of the 12 by a significant degree:

- Welland Canal (5,946 million gallons per day). Water from the Lake Erie basin is diverted to the Lake Ontario basin. Originally constructed to support navigation, the diversion now facilitates hydropower generation. The project was completed in 1932.
- The Long Lac and Ogoki diversions (3,606 million gallons per day). Both diversions send water from Hudson Bay to Lake Superior for hydropower generation and log transport. The Long Lac was completed in 1941, and Ogoki was completed in 1943.
- Chicago (2,068 million gallons per day). In 1889, the Illinois legislature approved construction of a 28-mile canal to replace the puny Chicago River to transport the city's growing loads of sewage to the Mississippi. The canal was engineered to draw water from Lake Michigan with which to wash the diluted waste westward (in effect, creating the world's only backward-flowing river). The canal was completed in 1900. (Because Lake Michigan does not share a boundary with Canada, this diversion is not under the jurisdiction of the International Joint Commission.)

Figure 9: Number of Large Dams in Canada (higher than 15 meters), and their Purpose



Source: Environment Canada, 2006.

- The New York State Barge Canal (450 million gallons per day). Water from the upper Niagara River at Buffalo is diverted to Lake Ontario to facilitate navigation between Lake Erie, Lake Ontario, and the Erie Canal. The project was completed in 1918.

  More recent proposals for large-scale diversions and water export projects have failed to secure government approvals. Critics have ridiculed most as unfeasible and unaffordable. But then, some of North America's most remarkable feats of engineering likewise once met with scorn. Some of the more dramatic proposals include:

- Great Recycling and Northern Development Canal. This proposal called for building a dyke across James Bay to separate it from Hudson Bay. The separation would transform James Bay from salt water to fresh water, which would then be pumped incrementally into the Great Lakes and, from there, diverted to parched regions of the United States and Canada.
- North American Water and Power Alliance (NAWAPA). First proposed in 1964 by the Ralph Parsons Engineering Co. of Pasadena, California, the project would entail the damming of eight major rivers: the Yukon, Susitna, Tanana, Skeena, Peace, Churchill, MacKenzie, and Fraser. The "excess" water would be diverted into the natural depression of the Rocky Mountain Trench. Water would then be diverted through various channels, including southeast to the Great Lakes and the Mississippi River to augment hydropower and shipping; some to the Columbia basin for hydropower; most to Idaho, Texas, California, and Mexico.
- Sun Belt Water/Snowcap Waters. In 1986, the British Columbia government approved plans to permit the export by tanker of small volumes of water from coastal streams. In 1991, Sun Belt Water contracted with BC-based Snowcap Waters to ship water from the province to California. But before the export could take place, the province effectively rescinded the permit. Sun Belt sued and won $220 million in damages.
- In 1998, a regional office of the Ontario Ministry of the Environment actually granted a permit to the Nova Group to export 10 million liters of water per day for up to 60 days a year from Lake Superior to Asia. Regulators across both Canada and the United States protested until the province rescinded the permit.
- The Canadian firm of Global Water Corp. has negotiated an agreement with the city of Sitka, Alaska, to ship 18 billion gallons of glacier water by tanker to China for bottling. Sitka is projected to reap between $30 million and $80 million per year, depending upon the actual volume exported. The city acquired the rights to the water through a permit transfer from a former pulp mill.

Water Export Reconsidered

Two myths largely drive opposition to water export: the notion that the environment would be irreparably harmed, and the claim that Canada does not possess adequate supplies of water to sell.

The opposition to the proposed export of water from Newfoundland's Gisborne Lake typifies the misunderstandings that confuse the issue. Entrepreneur Gerry White had proposed to draw 500,000 cubic metres of water from the lake each week for sale overseas. The withdrawal would have lowered the lake level by about an inch—a loss that would be replenished naturally within 10 hours, according to proponents. With unemployment running at 40%, officials of Grand Le Pierre embraced the plan. As Mayor Edward Fizzard said at the time, "The water is just running into the Atlantic Ocean. No one is getting one nickel out of it. Why shouldn't it help us?" (CBC, 2004). But public opposition, largely fueled by alarmists' contempt for the commoditization of water, killed the proposed venture.

Despite the voluminous supply of water in Canada, a good many politicians propagate misunderstanding by claiming the country is beset by water shortages. For example, in his introduction to the 1987 release of the Federal Water Policy, then-Environment Minister Tom McMillan said: "(T)o the extent that we Canadians have lots of water, most of it is not where it is needed, in the populated areas of the country."

By the same logic, enormous quantities of water exist elsewhere that are not in use.

It also is reasonable to consider that the absence of water export evidently has not prevented spot shortages in Canada from occurring. Therefore, shortages will not be prevented or remedied by prohibiting uses of water where it is abundant.

Opponents also claim that exports should be prohibited because water is one of Canada's most precious resources and is an integral part of Canadian heritage and national identity. It also is argued that water is essential to life and, therefore, national supplies should be preserved intact. For example, Meera Karunananthan, the national water campaigner for the Council of Canadians, says: "Markets are antithetical to the principles of water as a human right and a public resource" (Karunananthan, 2010).

But water export would not preclude assistance to any Canadian unable to pay market prices for water. Just as assistance for food and shelter is widely available, so, too, can water assistance be provided.

Our analysis of water supplies and demand suggests there are substantial opportunities for the sustainable export of renewable fresh water, as well as for the redistribution of water from conventional uses through increased efficiencies.

Support for water commoditization is growing elsewhere as the environmental feasibility and economic benefits increasingly are recognized. The "Dublin Statement," issued from the International Conference of Water and the Environment (ICWE) held in Dublin, Ireland, in January of 1992, included within it the principle that, "Water has an economic value in all its competing uses and should be recognized as an economic good" (ICWE, 1992, Guiding Principle No. 4).

But opposition will continue as long as water is not properly valued, e.g., priced via market mechanisms. As explained by economists Terry Anderson and Clay Landry, the resistance to water export will continue until Canadians are able reap the value of water sales and, conversely, bear the costs of not selling water (Anderson and Landry, 2001).

Such a change requires full-cost recovery for water services.[22] An analysis by the European Union (Water Information System for Europe, 2008) identified the following elements as integral to such costing:

- Operational and maintenance costs
- Capital costs
- Opportunity costs
- Resource costs
- Social costs
- Environmental damage costs
- Long run marginal costs

The basic premise of full-cost recovery is that the representation of the true costs of water in all sectors will cause users to value water at its real cost and will help to allocate it where it is most valued nationally and internationally. As noted previously, full-cost recovery has been endorsed by organizations such as the OECD[23] and the

22 Full-cost recovery refers to the pricing of a good in such a way that the entire cost of that good is recovered.

23 "(I)n terms of both quantity and quality, water resources have not been given a high enough value. Consequently, the concept of water as an economic good is becoming more widely accepted in OECD countries, as increased emphasis is placed on the need to allocate water resources efficiently and to operate water services cost-effectively" (OECD, 2006b).

United Nations,[24] which historically have not advocated market-based approaches to the stewardship of natural resources.

The only accurate means of pricing is establishment of a market. According to Elizabeth Brubaker, "There's nothing like a market to give us a better understanding of a resource's value to competing users" (Brown, 2009).

There exists a variety of means for apportioning water rights to maximize sustainability of the resource. Whether by leasing, auction, or privatization, well-defined property rights to water are fundamental to giving people the proper incentives for sustainable management" (Landry and Phoenix, 2003).

Given the wide variation in annual volumes of renewable water, water rights can be defined in terms of "unitization," i.e., a proportion of water volume based upon specific environmental standards such as in stream flows for fish and volumes sufficient for dilution of contaminants. Such a calculation would necessarily be customized to the particular body from which water is to be withdrawn. Distinctions can be drawn between renewable and non-renewable volumes in lakes, rivers, glaciers, and groundwater.

Water rights also can be apportioned based upon the volume of water conserved. For example, those who hold water rights can be authorized to sell the water they conserve from their allotment. The tort system would provide relief to those whose water rights were abridged by pollution or illegal withdrawals.

Water export and attendant rational pricing of the resource also would improve monitoring of water levels and water quality. That is, precise hydrologic data are required to allocate and enforce water rights.

Water export examples

There are numerous examples from around the globe where water has been traded successfully. For example:

- The Port of Marseille moved 45,000 m^3 to drought-stricken areas in Spain and Italy in the 1980s (Cope, 2005).
- The Bahamas Water and Sewerage Corp., after problems with desalination in 1976, began using barges to ship 20,000 m^3 of water per day from Andros Island, 60 km away (Cope, 2005).

24 In similar fashion, the United Nations also is advocating market mechanisms to "accord water its proper economic value" (United Nations [n.d.]).

- Aquarius Water Trading and Transportation Ltd. fills water bladders at the Greek port of Piraeus for towing by tugs to islands suffering summer droughts (Cope, 2005).
- Korea and Taiwan import some of their water through tanker shipments.
- During a severe drought in 1994, Japan imported water by tankers from Alaska, Vietnam, South Korea, Hong Kong and China (Gleick, 2002).
- Singapore and Hong Kong buy water from neighboring territories.
- Caribbean islands import fresh water by tankers/barges.
- Water trading among Australian states is extensive, totaling nearly 3,500 megalitres since 1998.
- California instituted a "water bank" to allow water transfers from farms to drought-plagued areas of the state.
- Montana allows property owners adjacent to waterways to lease their water rights to anyone wishing to maintain stream flows for fish.
- Interstate water trading has been established for the Colorado River Basin, which allows Arizona to bank its allocation of water for California and Nevada. The upper basin states of Colorado, Utah, New Mexico, and Wyoming, which are not currently using their full river allotment provided under the Colorado River Compact, would like to see the interstate banking program include them.

Conclusion

Canada possesses remarkable stores of fresh water, of which it uses only a fraction. Compared to the effects of natural forces, Canadians' use of water has limited impact on supplies. Therefore, Canada's reluctance to engage in water export appears to be symptomatic of a generalized aversion to private sector participation in water services. Such an aversion to bulk exports is based on flawed, emotionally driven arguments and inaccurate facts. Arguments based on future risks are highly speculative and apply to all types of natural resource exports. Proper clauses in the contracts can protect the public should those risks occur.

Government can hardly be considered a model steward of water resources. The sorry state of so many Canadian water systems exposes the inadequacy of conventional water policy, and highlights the need for better valuation of the resource, i.e., market pricing.

That shortages do exist does not reflect an overall water deficit; they are largely a consequence of government mismanagement and the absence of market pricing that otherwise would signal the need for allocation adjustments due to potential scarcity.

Experience elsewhere suggests a variety of means by which water exports can be undertaken in sustainable ways. Thus, the myriad benefits of water export merit rational re-evaluation.

Recommendations

1 *Improve public understanding of water issues.* Public policies based on misinformation are inherently unsound. Ottawa and the provinces should contract for an independent information "audit" of government web sites, curriculum materials, and other documents to identify inaccuracies about water resources in Canada. Inaccuracies should be removed and replaced with science-based facts. There may be a host of reasons Canadians oppose bulk water exports, but the issue should not be decided on the basis of environmental propaganda.

2 *Conduct groundwater mapping and fresh water inventories.* An accurate assessment of surface water and groundwater locations and volumes is necessary to determine the sustainable allocation of water for trade and/or export. The availability and reliability of water inventories vary across the provinces, which raises the costs of obtaining the information necessary to calculate accurately sustainable water withdrawals and consumption levels. A centralized private sector database should be funded by reprioritizing current expenditures (such as eliminating projects premised on hypothetical global warming scenarios) as well as the imposition of user fees.

3 *Determine sustainable water levels.* Establish processes by which water rights are unitized and adjusted periodically for natural variations in water yields. The calculations should account for both in-stream and out-stream uses and historical variations, and be determined by an independent third party awarded a concession through competitive bidding.

4 *Reform public subsidies of water use.* Water users of every type—residential, industrial and agricultural—benefit in varying degrees from water subsidies. In some cases, the subsidies take the form of low water rates controlled through regulation, while other types involve publicly financed infrastructure and water services for select groups, such as farmers. These subsidies were well-intended, but the consequences are problematic, e.g., highly inefficient water use that contributes to groundwater depletion, contaminated run-off, and soil salinity. While the elimination of all such subsidies would rationalize water pricing and thus encourage the highest and best uses of water, that option is not realistic at present. However, artificially low residential and industrial rates should be phased out in favor of full-cost recovery, at the very least. As for agriculture, irrigation subsidies should require adoption of water conservation measures such as water-sensor technology.

5 *Repeal prohibitions against water exports.* Myriad federal and provincial statutes and regulations bar water export. These should be eliminated and replaced with institutional mechanisms for assigning private water rights. As an interim measure, such mechanisms could duplicate the existing procedures for leasing of crown land and royalty payments for development of minerals, timber, and other natural resources. (Rights exercised to maintain in-stream flows should be permitted.) Ultimately, however, the benefits of water exports will be fully realized only when water rights are made secure, i.e., perpetual, enforceable, and transferable.

References

Adler, Jonathan (2008-2009). Warming Up to Water Markets. *Regulation* (Winter 2008-2009). <http://www.cato.org/pubs/regulation/regv31n4/v31n4-3.pdf>, as of Feb. 2, 2010.

Agriculture and Agri-Food Canada (2009, March 25). *The Canadian Bottled Water Industry*. Web page. <http://www4.agr.gc.ca/AAFC-AAC/display-afficher.do?id=1171644581795&lang=eng>, as of March 25, 2010.

Anderson, Terry, and Clay Landry (2001). Exporting Water to the World. *Water Resources Update*, 118 (January). <http://www.ucowr.siu.edu/updates/pdf/V118_A8.pdf>, as of Feb. 2, 2010.

Anderson, Terry and Peter Hill, eds. (1997). *Water Marketing: The Next Generation.* Rowman and Littlefield.

Barlow, Maude and Tony Clarke (2002). Who Owns Water? *The Nation* (Sept. 2-9). <http://www.thirdworldtraveler.com/Water/Who_Owns_Water.html>, as of April 1, 2010.

Baumann, Cynthia (2001). Water Wars: Canada's Upstream Battle to Ban Bulk Water Export. *Minnesota Journal of Global Trade*, vol. 10.

Beaulieu, Martin, Caroline Fric, and Francois Soulard (2007). *Estimation of Water Use in Canadian Agriculture in 2001*. Statistics Canada, Catalogue No. 21-601-M. Government of Canada. <http://www.statcan.gc.ca/pub/21-601-m/21-601-m2007087-eng.pdf>, as of Nov. 30, 2009.

Bemrose, R., L. Kemp, M. Henry, and F. Soulard (2009). *The Water Yield for Canada as a Thirty-year Average (1971 to 2000): Concepts, Methodology and Initial Results*. Statistics Canada, Catalogue No. 16-001-M, no. 7. Government of Canada. <http://www.statcan.gc.ca/pub/16-001-m/16-001-m2009007-eng.pdf>, as of Dec. 1, 2009.

Blue Planet Project. *Right to Water.* Web page. <http://www.blueplanetproject.net/RightToWater/index.html>, as of May 10, 2010.

Boyer, Marcel (2008, Aug. 27). *Freshwater Exports for the Development of Quebec's Blue Gold.* Montreal Economic Institute. <http://www.iedm.org/uploaded/pdf/cahier0808_en.pdf>, as of June 14, 2010.

Brown, Alexis (2009, Feb. 15). The Commodification of 'Blue Gold.' *North Shore News* via Environment Probe. <http://environment.probeinternational.org/comment/reply/133>, as of June 10, 2010.

CBC News Online (2004, August 25). Selling Canada's Water. <http://www.cbc.ca/news/background/water/>, as of Jan. 19, 2010.

Champagne, Sara. (2009, April 21). Les Contacts Etaient Interdits. *La Presse.*

Cooper, J. (1983). *Reconstructing History from Ancient Inscriptions: The Lagash-Umma Border Conflict*. Undena Publications.

Cope, Jonathan (2005). Bulk Transport: A Solution to Scarcity? *Global Water Intelligence* 6, 12 (December). <http://www.globalwaterintel.com/archive/6/12/general/bulk-transport-a-solution-to-scarcity.html>, as of June 1, 2010.

Council of Canadians (2009, Jan. 19). *The Right to Water.* Web page. <http://www.canadians.org/water/issues/right/index.html>, as of May 10, 2010.

Delli Priscoli, Jerome (1997). *Water and Civilization: Reframing the Debate on Water and Conflict.* Paper delivered at the Ninth World Water Congress, Montreal, Canada, September 1-6.

Devarajan, S., M. Miller, and E. Swanson (2002). *Goals for Development: History, Prospects, and Costs.* World Bank Policy Research Working Paper. <http://www-wds.worldbank.org/external/default/WDSContentServer/IW3P/IB/2002/04/26/000094946_02041804272578/Rendered/PDF/multi0page.pdf>, as of March 29, 2010.

Edwards, Chris (2007). *Ten Reasons to Cut Farm Subsidies.* The Cato Institute. <http://www.cato.org/pub_display.php?pub_id=8459>, as of March 29, 2010.

El Ayoubi, Farah, and James D. McNiven (2006). Political, Environmental and Business Aspects of Bulk Water Exports: A Canadian Perspective. *Canadian Journal of Administrative Sciences* 23, 1 (March). <http://www3.interscience.wiley.com/journal/121479332/issue>, as of May 25, 2010.

Environment Canada (1987). *Federal Water Policy*. Web page. Government of Canada. <http://www.ec.gc.ca/eau-water/default.asp?lang=en&n=D11549FA-1>, as of June 10, 2010.

Environment Canada (2004). *Threats to Water Availability in Canada*. National Water Research Institute. NWRI Scientific Assessment Report Series No. 3 and

ACSD Science Assessment Series No. 1. <http://www.ec.gc.ca/inre-nwri/default.asp?lang=En&n=0CD66675-1&offset=1&toc=show>, as of June 1, 2010.

Environment Canada (2006). *A Primer on Fresh Water: Questions and Answers.* Government of Canada. <http://www.ec.gc.ca/eau-water/25F6C7A2-91FC-4B2D-ADE3-EDFFB7933F7D/e_primer.pdf>, as of June 1, 2010.

Environment Canada (2009a). *Prohibition of Bulk Water Removal for the Purpose of Water Export.* Web page. Government of Canada. <http://www.ec.gc.ca/eau-water/default.asp?lang=En&n=1356EC91-1>, as of June 3, 2010.

Environment Canada (2009b). *Wise Water Use*. Government of Canada. <http://www.ec.gc.ca/eau-water/default.asp?lang=En&n=F25C70EC-1>, as of June 2, 2010.

Environment Canada (2009, Nov. 19). *How Much Do We Have?* Web page. Government of Canada. <http://www.ec.gc.ca/eau-water/default.asp?lang=En&n=51E3DE0C-1>, as of June 2, 2010.

Environment Canada (2009, Nov. 26). *2008 Municipal Water Pricing Report*. Web page. Government of Canada. http://www.ec.gc.ca/eau-water/default.asp?lang=En&n=AE97B7F3-1, as of June 10, 2010.

Environment Canada (2009, Nov. 27). *Dams and Diversions*. Web page. Government of Canada. <http://www.ec.gc.ca/eau-water/default.asp?lang=En&n=9D404A01-1>, as of June 2, 2010.

Environment Canada (2010, May 3). *Municipal Water Use 2006 Summary Tables.* Government of Canada (January). <http://www.ec.gc.ca/Water-apps/MWWS/pdf/MWWS2006_Summary_Tables_updatedJan22.pdf>, as of June 2, 2010.

Environment Canada (2010, June 3). *Water Conservation—Every Drop Counts*. Web page. Government of Canada. <https://www.ec.gc.ca/eau-water/default.asp?lang=En&n=F25C70EC-1#s3>, as of June 10, 2010.

Freeman, Aaron (1999). Blue Gold: The Political Economy of Water Trading in Canada. *Multinational Monitor* (April 1).

Fritz, Gary, and Matthew J. McKinney (1994). Canadian Water Export Policy and Continental Water Marketing. In Terry L. Anderson (ed.), *Continental Water Marketing* (The Fraser Institute): 71-92.

Gleick, Peter (2002). *The World's Water 2002-2003*. Island Press.

Gleick, Peter (2008). *The World's Water 2008-2009*. Island Press (Dec. 26). <http://www.worldwater.org/data.html>, as of Feb. 9, 2010.

Global Environmental Management Initiative [n.d.]. Water Trends. Web page. <http://www.gemi.org/water/watertrends.htm>, as of June 10, 2010.

Great Lakes Commission (2004). *Annual Report of the Great Lakes Regional Water Use Database Repository* (August).

Great Lakes Information Network [GLIN] (2009). Invasive Species in the Great Lakes Region. Web page. <http://www.great-lakes.net/envt/flora-fauna/invasive/invasive.html#overview>, as of March 29, 2010.

Hardie, David, and Alessandro Alasia (2009). *Domestic Water Use: The Relevance of Rurality in Quantity Used and Perceived Quality*. Rural and Small Town Canada Analysis Bulletin 7, 5. Statistics Canada, Catalogue no. 21-006-X. Government of Canada (January). <http://www.statcan.gc.ca/pub/21-006-x/21-006-x2007005-eng.pdf>, as of June 1, 2010.

Herndon, Roy (1999). Cleaning Up after Communism. *Research in Review*. Florida State University. <http://www.rinr.fsu.edu/fallwinter99/features/sb_cleaningup.html>, as of March 29, 2010.

Hoekstra, A.Y., and P.Q. Hung (2002). *Virtual Water Trade: A Quantification of Virtual Water Flows Between Nations in Relation to International Crop Trade*. Value of Water Research Report Series No. 11. National Institute of Public Health and the Environment. The Netherlands. <http://www.waterfootprint.org/Reports/Report11.pdf>, as of June 1, 2010.

Holm, Wendy (1993). Water and Free Trade. *NAFTA and Water Exports.* Canadian Environmental Law Association (October).

Hunaidi, Osama (2000). *Detecting Leaks in Water-Distribution Pipes.* Construction Technology Update 40 (October). Institute for Research in Construction, National Research Council Canada. <http://www.nrc-cnrc.gc.ca/obj/irc/doc/ctu-n40_eng.pdf>, as of June 1, 2010.

International Joint Commission (2000). *Protection of the Waters of the Great Lakes* (February).

Karunananthan, Meera (2010, March 18). *Water Markets: The Alberta Government will Face a Battle.* rabble.ca. <http://rabble.ca/blogs/bloggers/mvk/2010/03/water-markets-alberta-government-will-face-battle>, as of April 1, 2010.

LaLonde, Alain, et al. (2009). City of Toronto Water Loss Study & Pressure Management Pilot. Veritec. <http://www.cla-val.com/announcement/CITYOFTORONTOPMARTICLEVERITEC.PDF>, as of June 1, 2010.

Landry, C.J., and L.E. Phoenix (2003). Forging New Rights to Water. *Water Resources IMPACT* 5, 2 (March).

Library of Parliament (2008). *Bulk Water Removals: Canadian Legislation.* <http://www2.parl.gc.ca/Content/LOP/ResearchPublications/prb0213-e.pdf>, as of June 2, 2010.

McNiven, James (2005). *Bulk Water Exports: Environmental Concerns and Business Realities*. Universities Council On Water Resources conference proceedings, July 12, session 12. <http://opensiuc.lib.siu.edu/cgi/viewcontent.cgi?article=1035&context=ucowrconfs_2005>, as of April 1, 2010.

Michigan Department of Environmental Quality, Office of the Great Lakes (2000). *Great Lakes Trends: Into the New Millennium* (May). <http://mich.gov/documents/deq/deq-ogl-gltrends_249050_7.pdf>, as of June 1, 2010.

Michigan State University (1997, Jan. 28). *Introductory Land and Water Learning Module: The Hydrologic Cycle*. Web page. Institute of Water Research. <http://www.iwr.msu.edu/edmodule/water/cycle.htm>, as of June 2, 2010.

Nanos, Nik (2009). Canadians Overwhelmingly Choose Water as Our Most Important Natural Resource. *Policy Options* (July-August). <http://www.irpp.org/po/archive/jul09/nanos.pdf>, as of March 26, 2010.

National Research Council Canada (2009a). *Help for Cities: Early Warning for Leaky Pipes.* Web page. Government of Canada (Oct. 7). <http://www.nrc-cnrc.gc.ca/eng/dimensions/issue1/wirelesssensors.html>, as of June 1, 2010.

National Research Council Canada (2009b). *Leak Detection Methods for Plastic Water Distribution Pipes.* Government of Canada, Oct. 15, 2009. http://www.nrc-cnrc.gc.ca/eng/projects/irc/leak-detection.html, as of Dec. 8, 2009.

Natural Resources Canada (2010, April 23). *Important Facts on Canada's Natural Resources.* Web page. Government of Canada. <http://www.nrcan-rncan.gc.ca/stat/index-eng.php>, as of May 26, 2010.

Organization for Economic Co-Operation and Development [OECD] (2006a). *Improving Water Management: Recent OECD Experience.* Policy Brief (February). <http://www.oecd.org/dataoecd/31/41/36216565.pdf>, as of June 1, 2010.

Organization for Economic Co-Operation and Development (OECD) (2006b). *Water: The Experience in OECD Countries* (March). <http://www.oecd.org/dataoecd/18/47/36225960.pdf>, as of June 2, 2010.

Pentland, Ralph (2009). The Future of Canada-US Water Relations: The Need for Modernization. *Policy Options* (July-August). <http://www.irpp.org/po/archive/jul09/pentland.pdf>, as of June 1, 2010.

Quinn, Frank (2007). *Water Diversion, Export and Canada-US Relations: A Brief History.* Program on Water Issues, Munk Centre for International Studies (August). <http://www.powi.ca/pdfs/waterdiversion/waterdiversion_briefhistory.pdf>, as of Feb. 1, 2010.

Sanitary District of Chicago v. United States, 266 US 405, 45 S. Ct. 176, 69 L Ed 352 (1925).

Soulard, F., and M. Henry (2009). Measuring Renewable Water Assets in Canada: Initial Results and Research Agenda. *EnviroStats* 3, 2 (Summer). Statistics Canada, Catalogue No. 16-002-X. Government of Canada. <http://www.statcan.gc.ca/pub/16-002-x/16-002-x2009002-eng.pdf>, as of June 1, 2010.

Statistics Canada (2005a). *The Great Lakes, Dimensions.* Web page. Government of Canada (Feb. 2). <http://www40.statcan.ca/l01/cst01/phys04-eng.htm>, as of June 1, 2010.

Statistics Canada (2005b). *Land and Freshwater Area, by Province and Territory.* Web page. Government of Canada (Feb. 1). <http://www40.statcan.ca/l01/cst01/phys01-eng.htm>, as of June 1, 2010.

Statistics Canada (2006). *Households and the Environment.* Catalogue no. 11-526-X. Minister of Industry, Government of Canada. <http://www.statcan.gc.ca/pub/11-526-x/11-526-x2009001-eng.pdf>, as of June 1, 2010.

Statistics Canada (2010). *Industrial Water Use, 2005*. Statistics Canada, Catalogue no. 16-401-X. Minister of Industry, Government of Canada (March). <http://www.statcan.gc.ca/pub/16-401-x/16-401-x2008001-eng.pdf>, as of June 10, 2010.

Statistics Canada (2009). *Human Activity and the Environment: Annual Statistics.* Statistics Canada, Catalogue no. 16-201-X. Government of Canada (June). <http://www.statcan.gc.ca/pub/16-201-x/16-201-x2009000-eng.pdf>, as of Feb. 2, 2010.

United Nations, Secretariat of the Convention to Combat Desertification [n.d.]. *Draft UN Convention to Combat Desertification Water Policy Advocacy Framework for: Securing water resources in water scarce ecosystems in the face of desertification, land degradation and drought (DLDD) imperatives.* <http://www.unccd.int/publicinfo/pagi/docs/EnhancingwaterresourcesprotectionDraftpolicydocument.pdf>, as of June 1, 2010.

United States Environmental Protection Agency [US EPA] (2010). *Aquatic Biodiversity: Exotic Species.* Web page. <http://www.epa.gov/bioiweb1/aquatic/exotic.html>, as of March 29, 2010.

United States Geological Service [USGS] (2010, May 11). *Water Science for Schools. Glaciers and Icecaps: Storehouses of Freshwater.* US Department of the Interior (Oct. 20). <http://ga.water.usgs.gov/edu/earthglacier.html>, as of June 10, 2010.

Ville de Montréal (2009). *Mesure de la consommation de l'eau et optimisation du réseau de distribution.* <http://pdf.cyberpresse.ca/lapresse/presentationcompteurs.pdf>, as of June 1, 2010.

Water Information System for Europe (2008, March). *Economics in Water Policy: The Value of Europe's Waters.* Water Note #5. <http://ec.europa.eu/environment/water/water-framework/pdf/water_note5_economics.pdf>, as of June 10, 2010.

World Health Organization (2010). *Water Sanitation and Health: Water-related Disease.* Web page. <http://www.who.int/water_sanitation_health/diseases/en/>, as of June 1, 2010.

Yoffe, S.B., and A.T. Wolf (1999). Water, Conflict and Cooperation: Geographical Perspectives. *Cambridge Review of International Affairs* 12, 2 (Spring/Summer): 197-213. <http://www.transboundarywaters.orst.edu/publications/geographical_perspectives/>, as of April 2, 2010.

Younos, Tamim (2005). The Economics of Desalination. *Journal of Contemporary Water Research & Education* 132 (December): 39-45. <http://www.ucowr.siu.edu/updates/132/6.pdf>, as of Feb. 1, 2010.

About the Author

Diane S. Katz is Director of Risk, Environment, and Energy Policy for the Fraser Institute. She has more than two decades of experience in research and writing about public policy, including six years as Director of Science, Environment, and Technology for the Mackinac Center for Public Policy and nine years as a member of the *Detroit News* editorial board specializing in science and the environment, telecommunications and technology, and the auto industry. Diane has been awarded several fellowships, including the Jack R. Howard Science Reporting Institute at the California Institute of Technology; the Paul Miller Washington Reporting Program; the Kinship Conservation Institute; and the Political Economy Research Center. She has testified before Congress as well as a number of state legislatures, and was appointed to represent the State Policy Network, a coalition of more than 50 think tanks across the United States, on the American Legislative Exchange Council. She has been published by the *Wall Street Journal*; the *Washington Times*; *National Review*; the *Weekly Standard*; *Reason Magazine* and dozens of regional and local newspapers. Diane graduated with a B.Ph. from Thomas Jefferson College and a M.A.from the University of Michigan.

Publishing Information

Periodically, the Fraser Institute publishes timely and comprehensive studies of current issues in economics and public policy. This study is one such example belonging to a series of related publications.

Distribution

These publications are available from <http://www.fraserinstitute.org> in Portable Document Format (PDF) and can be read with Adobe Acrobat® 7 or later, or with Adobe Reader® 7 or later. Adobe Reader® 9, the most recent version, is available free of charge from Adobe Systems Inc. and may be down-loaded from: <http://get.adobe.com/reader/>. We encourage you to install the most recent version.

Ordering publications

For information about ordering the Fraser Institute's printed publications, please contact the publications coordinator

- e-mail: sales@fraserinstitute.org
- telephone: 604.688.0221 ext. 580 or, toll free, 1.800.665.3558 ext. 580
- fax: 604.688.8539

Media

For media inquiries, please contact our Communications Department

- telephone: 604.714.4582
- e-mail: communications@fraserinstitute.org

Disclaimer

The author of this publication has worked independently and opinions expressed by her are, therefore, her own, and do not necessarily reflect the opinions of the supporters, trustees, or other staff of the Fraser Institute. This publication in no way implies that the Fraser Institute, its trustees, or staff are in favor of, or oppose the passage of, any bill; or that they support or oppose any particular political party or candidate.

Copyright

ISSN

1918-8323 (online version)

Date of issue

June 2010

Editing and production

Kristin McCahon

Design

Lindsey Thomas Martin

Cover design

Bill Ray

Cover images

Sous les dossiers © Karl Bolf, Fotolia;
red tape © Stockbyte, Punchstock;
Balance © Alon Othnay, Fotolia;
Question mark © Stephen Coburn, Fotolia;
Treehugger © Leah-Anne Thompson, Fotolia;
Stop © Alexander Samoilov, Fotolia

Supporting the Fraser Institute

To learn how to support the Fraser Institute, please contact

- Development Department,
  The Fraser Institute,
  Fourth Floor, 1770 Burrard Street,
  Vancouver, British Columbia,
  Canada V6J 3G7
- telephone, toll-free: 1.800.665.3558 ext. 586
- e-mail: development@fraserinstitute.org

About the Fraser Institute

Our vision is a free and prosperous world where individuals benefit from greater choice, competitive markets, and personal responsibility. Our mission is to measure, study, and communicate the impact of competitive markets and government interventions on the welfare of individuals. Founded in 1974, we are an independent Canadian research and educational organization. Our work is financed by tax-deductible contributions from thousands of individuals, organizations, and foundations. In order to protect its independence, the Institute does not accept grants from government or contracts for research.

Nous envisageons un monde libre et prospère, où chaque personne bénéficie d'un plus grand choix, de marchés concurrentiels et de responsabilités individuelles. Notre mission consiste à mesurer, à étudier et à communiquer l'effet des marchés concurrentiels et des interventions gouvernementales sur le bien-être des individus.

Editorial Advisory Board