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Human Activity and the Environment

Freshwater supply and demand in Canada

2010 — Updated

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Symbols

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.	not available for any reference period
..	not available for a specific reference period
...	not applicable
0	true zero or a value rounded to zero
0^s	value rounded to 0 (zero) where there is a meaningful distinction between true zero and the value that was rounded
^{p}	preliminary
^{r}	revised
x	suppressed to meet the confidentiality requirements of the *Statistics Act*
^{E}	use with caution
F	too unreliable to be published
*	significantly different from reference category ($p < 0.05$)

Note to Readers

Corrections have been made to this product.

The publication has been reloaded on December 11, 2013.

Please take note of the following changes:

Data on water yield per capita have been corrected in the following sections: Highlights and “Water yield per capita” in section 3.

The publication has been reloaded on September 14, 2012.

Please take note of the following changes:

The 2007 data in "Manufacturing industries" in section 3 have been corrected.

The following table has been changed: Table 3.3 - "Selected water use parameters for manufacturing industries in Canada"

We regret any inconvenience this may have caused.

For more information please *contact us*.

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The main authors of the article "Freshwater supply and demand in Canada" were:

Heather Dewar

François Soulard

Major contributions were made by:

Robby Bemrose
Alison Clark Milito
Cindy DeCuypere
Gordon Dewis
Mark Henry
Laura Kemp
Hugo Laroque
Peter Meszaros
Terence Nelligan
Benoit Quenneville
Joe St. Lawrence
Michelle Tait
Jennie Wang

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Highlights

The *Human Activity and the Environment* (HAE) publications bring together a collection of environmental statistics from many sources, and paint a statistical portrait of Canada's environment. Special emphasis is given to the relationship of human activity to air, water, soil, plants and animals.

In the past, each annual issue of HAE began with a feature article on an environmental topic of concern to Canadians, followed by a compendium of statistical tables. Starting in 2010, the article and statistical tables will be published separately, with the article continuing to be released annually.

This analytical article "Freshwater supply and demand in Canada" provides information on Canada's freshwater supply as well as the demands placed on it. New research done within Statistics Canada is incorporated with information from other sources, including other federal government departments, international bodies and scientific journals. Selected terms used in this article are defined below (Textbox: **"Key terms"**).

Water supply

- Canada's average annual renewable freshwater supply, or water yield, is 3,472 km^3. To put this in perspective, this water yield amounts to almost as much water as there is in Lake Huron (which contains 3,540 km^3).
- This abundance in water yield is distributed unequally across the country. With an average annual water yield per unit area of 1.54 m^3/m^2, the Pacific Coastal drainage region has the highest water yield per unit area in the country. It is followed by the Newfoundland and Labrador and the Maritime Coastal drainage regions which have average annual yields per unit area of 0.86 m^3/m^2 and 0.85 m^3/m^2 respectively. Drainage regions in the Prairies and north of the Prairies produce the least water, with yields between 0.02 and 0.07 m^3/m^2.
- The southern part of the country, where 98% of the population is located, is responsible for 38% of the water yield or 42,661 m^3 of renewable freshwater per capita. In the North, water yield per capita is 98 times greater, or 4,193,014 m^3.
- The average annual water yield per unit area for the Prairies is 0.05 m^3/m^2, less than that for either Australia or South Africa. This is equivalent to 12% of the yield of the Great Lakes drainage region, 6% of the yield of the Maritime Coastal drainage region and only 3% of the Pacific Coastal drainage region.
- Brazil, which has the highest total water yield of any country in the world, provides 43,756 m^3 of water per person per year, 40% of the almost 110,000 m^3 that is annually available per person in Canada.
- While total water yield is comparable between the United States and Canada, the amount of renewable freshwater per American is only 9.1% of that per Canadian because the United States has a much larger population.

Trends in water supply

- From 1971 to 2004 water yield in Southern Canada decreased an average of 3.5 km^3 per year, which is equivalent to an overall loss of 8.5% of the water yield over this time period. This average annual decrease of 3.5 km^3 is almost as much as the 3.8 km^3 of water that is supplied to the residential population of Canada in a year.
- The area in Canada that had the lowest water yield, and the highest variability in water yield between 1971 and 2004, was the Prairies.

- From 1971 to 2004, water yield for the Prairies decreased by 0.56 km^3/yr. In perspective, this volume represents about 80% of the total volume of water that was produced by drinking water plants in these five drainage regions in 2005. Over the 34-year period, this represents a total reduction of 20 km^3 of water yield, equivalent to roughly half of the long term, average annual water yield for the Prairies.

- For most of the country the bulk of the water yield is produced in April, May and June, as snow and ice melt, and precipitation increases. In the North this peak occurs in late spring and early summer. In the South, where the preponderance of Canada's economic production takes place, water yield is highest in the spring. As spring turns into summer, yield declines and demand for water related to human activity increases.

Water use

- In 2005, an estimated 42 km^3 of water were withdrawn from the environment and used in household and economic activities in Canada. About 14% of this water flowed through the public utility water system, while about 86% was extracted from the environment directly by the end user.

- More than 90% of the water that was withdrawn went to support economic activity, and about 9% was used directly by the residential sector. The residential sector used 56% of the water that was supplied by the public utility water system. The sector that used the most water overall, by a considerable margin, was Thermal-electric power generation.

- Overall it is estimated that 25% of Canadians rely on groundwater as a source of drinking water. This varies depending on the region of the country: the population in the Saint John–St. Croix drainage region is the most reliant on groundwater, whereas the population in the South Saskatchewan drainage region is the least.

- The agricultural sector was responsible for 4.6% (almost 2 km^3) of total water withdrawals in 2005. The bulk of this water was used to irrigate crops, with a balance of 16% going to support livestock production.

- In 2005, the precipitation that supported crop growth was roughly twice the volume of water that was withdrawn annually by all sectors of the economy.

- Canada is one of the largest producers of hydro-electricity in the world, and the volume of water involved in hydro-electric generation in Canada is many times larger than all other uses of water in the country combined. In 2005 hydro-electric generation in Canada made use of approximately 3 trillion m^3 of water—more than 100 times the volume of water used by the Thermal-electric power generation sector, and just over 70 times the total volume of all water used in Canada in 2005.

Virtual water

- More water is embedded in forest products than food. When precipitation was included, the production of exported lumber, wood pulp, paper, and other forest products required seven times more water than the production of exported agricultural commodities.

- The production of exports required the largest share of the water use required to satisfy final demand, accounting for 66%, while personal expenditures accounted for 16%.

- When precipitation was excluded in the calculation of the water use required to satisfy final demand, personal expenditures were the largest contributor, accounting for 47% of water use, while exports accounted for 37%.

Supply and demand

- In 2005, total water withdrawals in Canada amounted to 1.2% of the average annual renewable water resources. More pressure however, is placed on water resources in some areas of the country than in others, with this pressure peaking in summer.

Key terms

The supply of freshwater, or Canada's renewable freshwater resources, is represented by water yield. Water yield is the amount of freshwater derived from unregulated flow measurements for a given geographic area over a defined period of time and is an estimate of the renewable water.

Water intake is used as a proxy for demand. Water intake refers to the total amount of water added to the water system of an establishment or household to replace water discharged or consumed. It may be broken down into the amounts withdrawn from various sources (for example, surface water or groundwater) and the amounts used for various purposes, or end uses. It is often also referred to as water withdrawal.

These, and other important terms, are defined in the glossary in Appendix A.

- In August 2005, more than 40% of the water yield in the Okanagan–Similkameen drainage region and the Prairies was withdrawn by agriculture, industry and households. In the Prairies, where stocks are limited, water demand must be met primarily by renewable water, and water shortages are evident when demand exceeds the renewable supply.

- The North Saskatchewan drainage region does not show a similar demand to supply ratio to that of the South Saskatchewan drainage region for August 2005, because it has a higher water yield, a smaller population and less irrigation.

- In August 2005 more than 40% of the water yield was also withdrawn in the Great Lakes drainage region in Canada. The Great Lakes themselves, however, contain more than 6.5 times Canada's annual water yield. Therefore, low summertime water yield in that drainage region has less potential to impose a constraint on human activities.

Related products

Selected publications from Statistics Canada

11-509-X	Human Activity and the Environment
11-526-S	Households and the Environment: Energy Use
11-526-X	Households and the Environment
16-001-M	Environment Accounts and Statistics Analytical and Technical Paper Series
16-002-X	EnviroStats
16-257-X	Environment Accounts and Statistics Product Catalogue
16-401-X	Industrial Water Use
16-403-X	Survey of Drinking Water Plants

Selected CANSIM tables from Statistics Canada

153-0035	Land cover by category, Canada, major drainage areas and sub-drainage areas
153-0036	Selected population characteristics, Canada, major drainage areas and sub-drainage areas, every 5 years (number unless otherwise noted)
153-0037	Selected population characteristics, Canada, provinces and territories, every 5 years (number unless otherwise noted)
153-0038	Selected agricultural activities, all major drainage areas and sub-drainage areas with agriculture, every 5 years
153-0039	Selected agricultural activities, provinces, every 5 years (square kilometres unless otherwise noted)
153-0040	Manure production, Canada, major drainage areas and sub-drainage areas, every 5 years
153-0047	Water use parameters in manufacturing industries, by North American Industry Classification System (NAICS), biennial
153-0048	Water use parameters in manufacturing industries, by provinces, territories and drainage regions, biennial
153-0049	Water intake in manufacturing industries, by month of intake and North American Industry Classification System (NAICS), biennial

153-0050	Water intake in manufacturing industries, by source and North American Industry Classification System (NAICS), biennial
153-0051	Water intake in manufacturing industries, by source and by provinces, territories and drainage regions, biennial
153-0062	Households and the environment survey, dwelling's main source of water, Canada and provinces, biennial
153-0063	Households and the environment survey, primary type of drinking water consumed, Canada and provinces, biennial
153-0066	Households and the environment survey, treatment of drinking water, Canada and provinces, biennial
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3881	Households and the Environment Survey
5120	Industrial Water Survey
5145	Agricultural Water Survey
5149	Survey of Drinking Water Plants
7525	Land Cover Statistics from Natural Resources Canada

Selected summary tables from Statistics Canada

- *Population served by drinking water plants, by source water type and drainage region*
- *Water use parameters in manufacturing industries, by industry group, Canada*

Section 1

Introduction

Bow River, Alberta, Mark Henry

Water is fundamental to the survival of every individual, species and ecosystem on Earth. Canada—more than most countries—benefits from readily available sources of freshwater. Freshwater is used to produce electricity, grow food, supply drinking water, as well as for transportation and recreation. How we use water, and how much of it we use, exerts pressure on water resources. When demand for water increases, ecosystem function can be impaired, and activities of communities can face limits.

Canada is often presented as a water-rich nation, and this notion is easy to understand: we do have one of the largest renewable water supplies in the world (Table 1.1) and have access to a considerable portion, perhaps as much as 20%, of the world's stock of surface freshwater.

Stocks of freshwater, in the form of lakes, rivers, wetlands and groundwater, are the quantities of water that have accumulated in the environment. Renewable water resources correspond to the amount of water that is supplied to the environment, primarily as precipitation. Water yield is an estimate of these renewable water resources (see Section 2).[1] For water use to be sustainable, water withdrawals must not exceed renewal over a given time period, and there must be sufficient water of appropriate quality to satisfy ecological requirements.

See footnote(s) at the end of the section.

Table 1.1
Renewable freshwater resources, water use and gross domestic product for selected countries

	Population	Area	Renewable freshwater resources: Volume		Volume per capita	Volume per unit area	Total water withdrawal	Gross Domestic Product	Gross Domestic Product per capita
	thousands	km^2	km^3 per year	global rank	m^3 per capita	m^3 per m^2	km^3 per year	millions of $U.S. (current prices)	$U.S. per capita
Brazil	188,158	8,514,880	8,233	1	43,756	0.967	59.3	1,089,398	5,790
India	1,147,746	3,287,260	1,892	9	1,648	0.576	645.9	911,376	794
France	63,236	549,190	204	43	3,226	0.371	40.0	2,266,137	35,836
Canada	**32,628**	**9,978,904**	**3,472**	**3**	**109,837** [1]	**0.348**	**42.0**	**1,278,682**	**39,189**
United States	305,697	9,632,030	3,051	4	9,980	0.317	473.6	13,116,500	42,907
China	1,297,847	9,598,090	2,830	6	2,181	0.295	630.4	2,779,871	2,142
Russian Federation	142,530	17,098,240	4,508	2	31,628	0.264	66.2	989,428	6,942
Mexico	106,411	1,964,380	457	25	4,295	0.233	78.2	945,644	8,887
Australia	20,628	7,741,220	492	21	23,851	0.064	23.9	787,418	38,172
South Africa	48,639	1,219,090	50	95	1,028	0.041	12.5	257,728	5,299

1. This value is calculated using population aggregates by drainage region, and is consistent with the value presented in Table 2.3. Population counts that adjust for Census undercount are not available by the drainage region geography.

Note(s): Population and Gross Domestic Product data are for 2006. Renewable water resource data are annual volumes listed in the United Nations AQUASTAT database for the period 2003 to 2007, with the exception of Canada, which is a long term average for 1971 to 2004 (Table 3). Total water withdrawal volumes are for 2000 for all countries except the Russian Federation which is for 2001, and Canada which is for 2005. Selected countries include six of the top ten countries in total volume of renewable freshwater resources and other countries representative of their geographic area.

Source(s): Food and Agriculture Organization of the United Nations, n.d., *AQUASTAT Database Query*, *www.fao.org/nr/water/aquastat/data/query/index.html* (accessed April 27, 2010). Statistics Canada, Environment Accounts and Statistics Division, 2010, special tabulation. United Nations Statistics Division, 2010, *National Accounts Main Aggregates Database*, *http://unstats.un.org/unsd/snaama/selbasicFast.asp* (accessed February 11, 2010).

The amount of water that is available to ecosystems and citizens across the world varies widely (Map 1.1, Table 1.1). Expressed as a depth, the average annual water yield of Brazil is 967 mm. Accumulated, this water would reach the waist of most adults, while the yield of South Africa, at 41 mm, would barely wet one's feet. In Canada, at 348 mm, the accumulated annual water yield would almost reach the knees.

Put another way, Canada's average annual water yield per unit area is 0.348 m^3/m^2, or 348 litres of renewable freshwater for every square metre of the country (Table 1.1). This yield is substantially higher than the yield in drier countries such as Australia and South Africa that have one-fifth and one-eighth of this amount, respectively. Brazil, a tropical country with significant precipitation, has 0.967 m^3/m^2, almost triple the production of water per unit area in Canada (Textbox: **"Selected units of measure for water")**.

This measure of water abundance is estimated on a national scale; however on a regional scale, there is as much disparity within Canada as there is between countries (Map 1.1). A lot of water is produced on the coasts, while the Prairies in particular, are relatively dry. Moreover, 98% of Canadians live in the southern part of the country which is responsible for only 38% of Canada's renewable freshwater.[2]

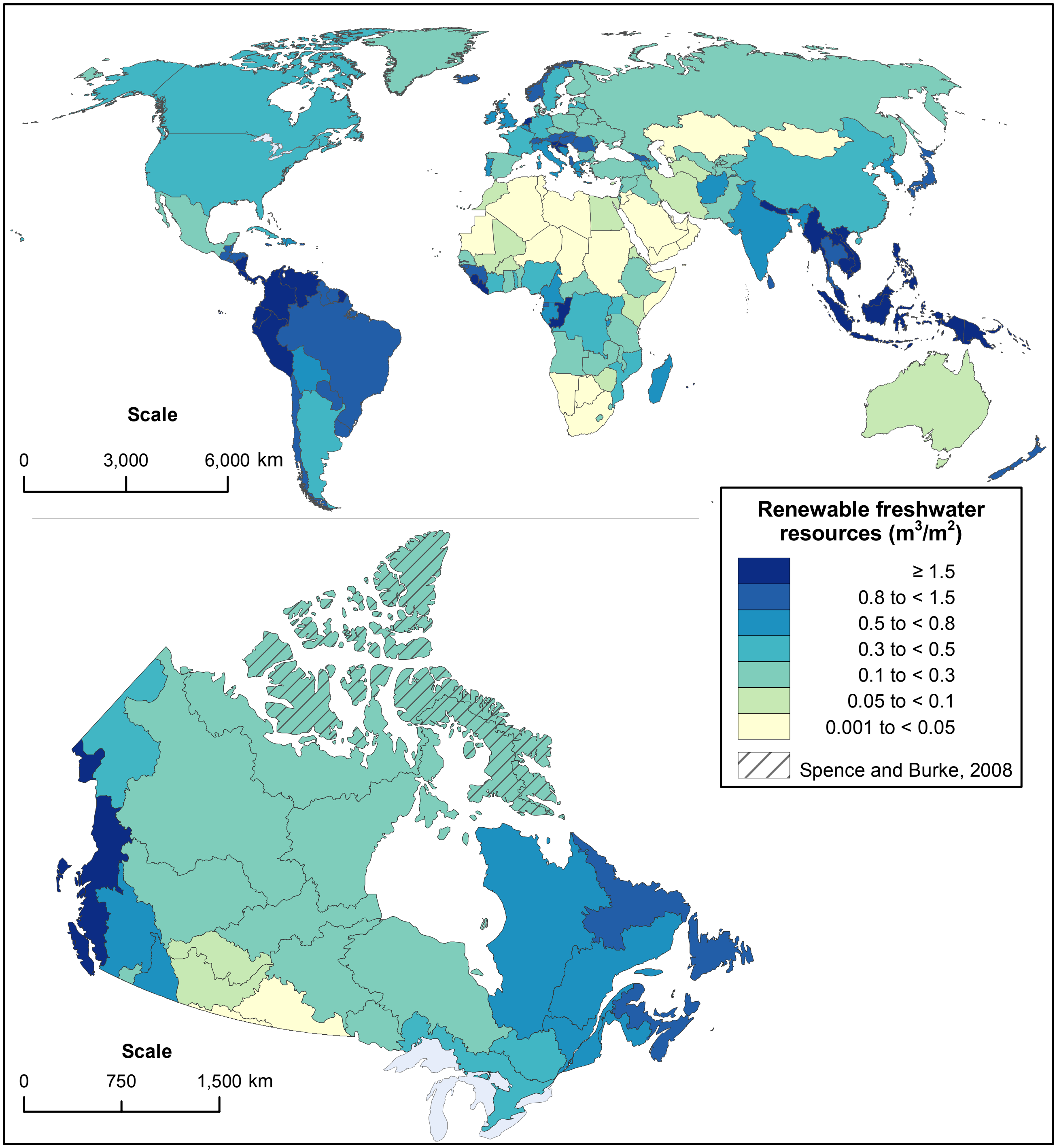
Water yield is also unequally distributed throughout the year. In much of Canada the bulk of the water yield comes in spring and greatly declines through the summer months. Demand, however, increases through the summer, with the highest demand in July and August.

Countries are often compared in terms of water production per capita, but expressing the information this way partially obscures the productive capacity of the land by tying it to its population. Comparing the water yield of a variety of geographic areas, and at different scales, allows us to evaluate the ability of the land, and its water resources, to support a population and its economic activities.

It is important to monitor water resources because climate change is having numerous water-related impacts. Precipitation patterns and surface water flows are being altered.[3] Extreme weather events, including severe droughts and floods are becoming more frequent: glaciers are melting more quickly and sea levels are rising.[4]

See footnote(s) at the end of the section.

Map 1.1
Renewable freshwater resources by country, and water yield by drainage region within Canada



Note(s) Data for Canada were derived from discharge values contained in Environment Canada, 2010, Water Survey of Canada, Archived Hydrometric Data (HYDAT) (www.wsc.ec.gc.ca/hydat/H2O/index_e.cfm?cname=main_e.cfm).

Source(s): Food and Agriculture Organization of the United Nations, 2009, *AQUASTAT main country database*, http://www.fao.org/nr/water/aquastat/dbase/index.stm (accessed December 15, 2009).
Spence C., and A. Burke, 2008, "Estimates of Canadian Arctic Archipelago Runoff from Observed Hydrometric Data," *Journal of Hydrology*, Vol. 362, pages 247 to 259.
Statistics Canada, Environment Accounts and Statistics Division, 2010, special tabulation.

In 2005, an estimated 42 km^3 of water were withdrawn and used in Canada (see **Section 3**). This represents about 1.2% of our annual national water yield. More than 90% of the water that was withdrawn went to support economic activity, and about 9% was used directly by households. The sector that withdrew the most water overall, by a considerable margin, was Thermal-electric power generation. The bulk of the water withdrawn by this sector is returned to the environment close to where it was extracted. The sector that consumed the most water, also by a considerable margin, was Agriculture.

Further analysis into water use went beyond traditional sector breakdowns with the examination of the end users of Canada's water resources. Water is used both to satisfy the demands of our domestic economy, and to produce goods for export. Excluding water involved in the production of hydro-electricity, and including water supplied by precipitation, 66% of water was used to produce goods for export and 34% supported domestic demand in 2005. If precipitation was also excluded, 37% of water was used to produce goods for export and 63% was used to satisfy domestic demand. The importance of precipitation to the production of forestry and agricultural products, and the prevalence of these products in Canadian exports, explains why a greater proportion of water is directed towards exports when precipitation is included.

Section 1 of this article compares Canada's renewable water resources to those of other countries, introduces key highlights and presents a short water primer. **Section 2** quantifies Canada's renewable water resources (annual water yield), shows how water yield has changed from 1971 to 2004, and presents graphs of water yield by month for four regions of the country. **Section 3** quantifies economic and residential water use in Canada and concludes with an analysis of the relationship between supply and demand. A glossary of terms used in the publication is available in **Appendix A**.

See footnote(s) at the end of the section.

The scope of this article does not include water quality. The Canadian Environmental Sustainability Indicators project (CESI), a co-operative venture of Environment Canada, Health Canada and Statistics Canada, addresses this important topic, and information on this project is available at *www.ec.gc.ca/indicateurs-indicators /default.asp?lang=En*.

1.1 Geography used in this analysis

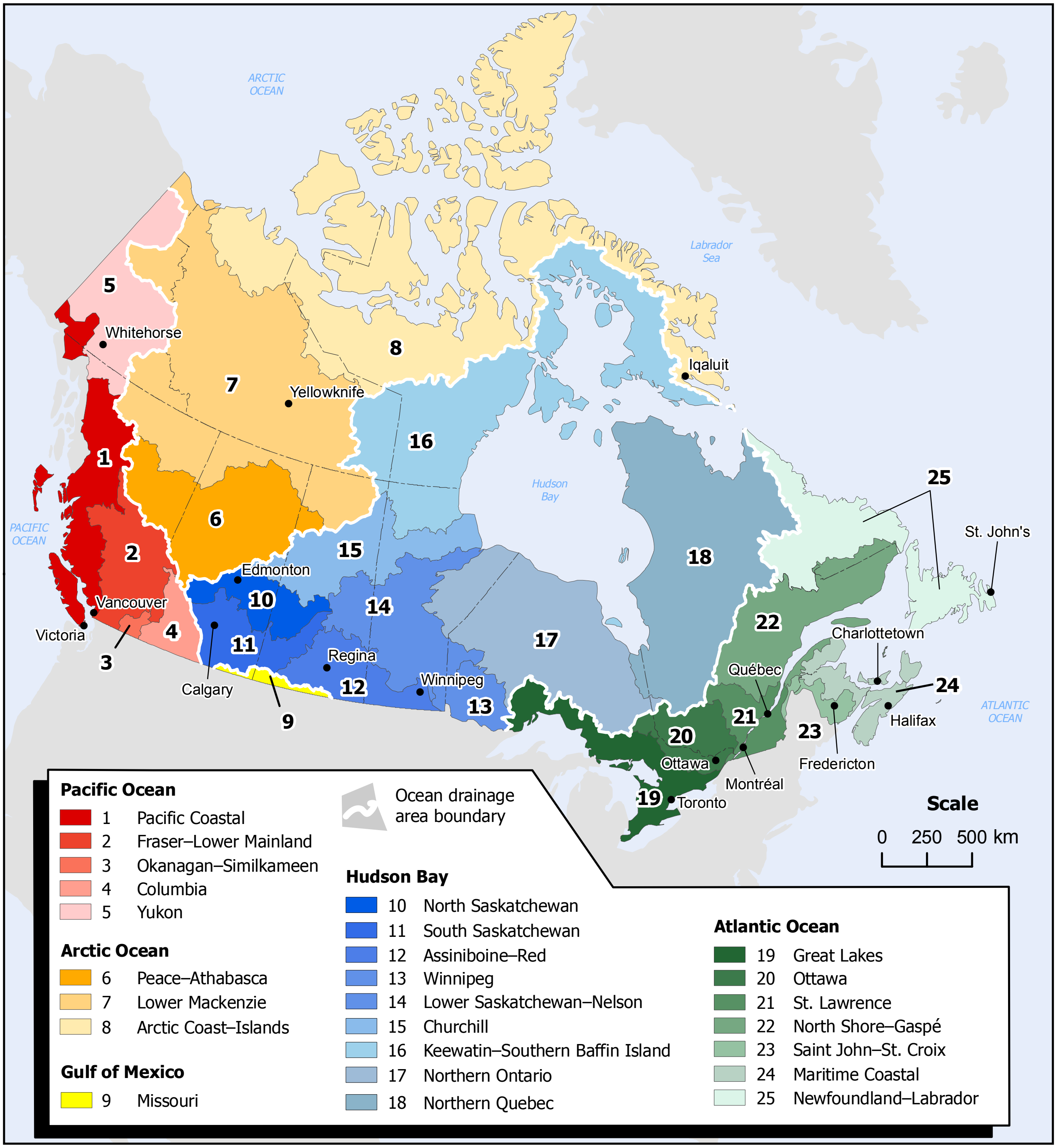
Flows of water in Canada occur within five ocean drainage areas: the Pacific Ocean, the Arctic Ocean, the Atlantic Ocean, Hudson Bay, and the Gulf of Mexico. These drainage areas are further subdivided into 25 drainage regions (Map 1.2). This geography is Statistics Canada's standard drainage area classification,[5] and many of the statistics provided in this report are classified according to this geography.

Selected units of measure for water

In this article various units of measure are used. Water yield is described as a volume in cubic kilometres (km^3) or a volume per unit area in cubic metres per square metre (m^3/m^2). When discussing yield for a specific geographic region it is also referred to as a depth expressed in millimetres (mm). Water use per person is expressed in cubic metres per year (m^3/yr) or litres per day (L/day). Water use by households, agriculture and industry, is generally reported in millions of cubic metres (Mm^3).

1 m^3	= 1,000 litres
1 m^3/m^2	= 1 m = 1,000 mm
1 km^3	= 1 cubic kilometre
1 km^3	= 1,000 m X 1,000 m X 1,000 m
1 km^3	= 1 billion cubic metres
1 km^3	= 1,000,000,000 m^3
1 km^3	= 1,000 million m^3 (1,000 Mm^3)

Map 1.2
Ocean drainage areas and drainage regions of Canada



Source(s): Pearse, P.H., F. Bertrand and J.W. MacLaren, 1985, *Currents of Change: Final Report of the Inquiry on Federal Water Policy*, Environment Canada, Ottawa.
Statistics Canada, Environment Accounts and Statistics Division, 2009, special tabulation.

1.2 Water primer

Approximately 70% of the surface of the earth is covered by water, and over 97% of this water is contained in saltwater oceans and seas. Freshwater, which is found in lakes, rivers, ice, snow and aquifers, constitutes the remaining water—but the greater portion of this is held in glaciers and permanent snow cover. It is generally understood that less than 1% of all the water in the world is present in freshwater ecosystems. Saltwater can be treated to make it suitable for drinking water and other purposes, but water is not desalinated in any appreciable quantity in Canada.

Freshwater plays an integral role in ecosystems. Rivers and lakes serve as habitat for fish and other aquatic species. Wetlands filter nutrients and bacteria, improving water quality, and help to temper the effects of flooding. The Great Lakes moderate the climate in Southern Ontario. Clouds, ice and snow reflect energy from the sun back into space, thereby influencing the climate.

Water is the only substance on Earth that occurs naturally in the three different states: liquid, solid and gas. Water passes through these states as it cycles in a continuous pattern called the hydrological cycle. Evaporation from the oceans and land, sublimation from ice and snow, evapo-transpiration from plants and transpiration from animals, create water vapour. This water vapour rises in warm air, condenses as the air cools, and forms clouds. Water is discharged from the atmosphere as precipitation—rain, snow, dew, fog or hail. When precipitation lands on the ground it is absorbed by soil particles (turning into soil moisture); is taken up by plants and animals; infiltrates through the ground to become groundwater; flows into rivers, lakes, or oceans; or evaporates back into the atmosphere. This process, fuelled by the heat of the sun, maintains water movement and renews freshwater resources.

The portion of precipitation that is stored in the soil or that temporarily stays on top of the soil or vegetation and eventually evaporates or transpires through plants is referred to as 'green' water. Green water is available to be taken up by crops for crop growth.[6] The portion of precipitation that runs off on land or recharges groundwater is referred to as 'blue' water. It can be found in freshwater lakes, rivers and aquifers. Blue water can be used for a variety of purposes including navigation, irrigation, and as a source of drinking water.

Whether green or blue, water is present in all aspects of our lives, and is embedded in the goods and services that we rely on continuously. This embedded water—also referred to as the 'virtual' water content—refers to the water used to make a product, including the generation of the energy used in manufacturing, as well as all the water in all the inputs used in production. For example, it takes approximately 15,500 litres of water to produce a kilogram of beef.[7] This includes the water used to grow the grains and roughage the cattle consume, the water the cattle drink, and other water needed for livestock rearing, such as washing.[8]

The concept of a water footprint takes the virtual water content of a product into account but also considers what source of water is used, when the water is used, and where the activities take place.[9]

See footnote(s) at the end of the section.

Notes

1. Water yield also includes a volume of water that is not renewable, specifically that portion of glacial melt water coming from receding glaciers.
2. Statistics Canada, Environment Accounts and Statistics Division, 2010, special tabulation.
3. Natural Resources Canada, 2008, *From Impacts to Adaptation: Canada in a Changing Climate 2007*, Lemmen, D.S., F.J. Warren, J. Lacroix and E. Bush (eds.), *http://adaptation.nrcan.gc.ca/assess/2007/index_e.php* (accessed April 16, 2010), pages 23 and 24.
4. Natural Resources Canada, 2008, *From Impacts to Adaptation: Canada in a Changing Climate 2007*, Lemmen, D.S., F.J. Warren, J. Lacroix and E. Bush (eds.), *http://adaptation.nrcan.gc.ca/assess/2007/index_e.php* (accessed April 16, 2010), page 9.
5. Statistics Canada, Standards Division, 2009, *Standard Drainage Area Classification (SDAC) 2003*, *www.statcan.gc.ca/subjects-sujets/standard-norme/sdac-ctad/sdac-ctad-eng.htm* (accessed April 16, 2010).
6. Water Footprint Network, 2009, *Water Footprint: FAQ: Technical questions*, *www.waterfootprint.org/?page=files/FAQ_Technical_questions* (accessed December 17, 2009).
7. Water Footprint Network, 2010, *Water Footprint: Product Gallery: Beef*, *www.waterfootprint.org/?page=files/productgallery&product=beef* (accessed April 21, 2010).
8. This particular estimate does not include water used in the slaughtering, rendering and food processing industries.
9. Water Footprint Network, 2009, *Water Footprint: Introduction*, *www.waterfootprint.org/?page=files/home* (accessed December 17, 2009).

Section 2

Canada's water supply—stocks and flows

Canada is surrounded on three sides by the Pacific, Arctic and Atlantic oceans and has over 243,000 km of coastline.[1] This, combined with the characteristics of Canada's topography and climate, results in abundant freshwater resources. These water resources however are not evenly distributed across the country—they are available in different amounts, and at different times throughout the year. This uneven distribution affects water availability in ecosystems, and water access and use by Canadians.

The total supply of water resources is dependent on the quantities of water accumulated in the environment, called the stocks, and the quantities of water that circulate in the system, called the flows. For water use to be sustainable it is necessary not to withdraw more water than is renewed over a given time period. The World Resources Institute defines renewable freshwater as "…water that is fully replaced in any given year through rain and snow that falls on continents and islands and flows through rivers and streams to the sea".[2] Most water contained in lakes and reservoirs, or coming from receding glaciers, is not renewable considering the time frame used in this definition.

2.1 Stocks of water

Water stocks represent the quantities of water accumulated in the environment, and are found either on or below ground-level. A very small portion of this water is locked underground in confined aquifers, and does not flow through the hydrological cycle. The water in lakes and unconfined aquifers is turned over or renewed, but only over a period of time that can be very long. Water renewal in Lake Superior, for example, occurs over a period of 191 years, while the water in Lake Erie, which is much shallower, is refreshed every three years.[3] Additionally, while rivers may physically 'flow,' at any given point in time the water they contain is considered a stock.

See footnote(s) at the end of the section.

Maligne Canyon, Alberta, Mark Henry and Golden Lake, Ontario, Alison Clark Milito

2.1.1 Surface water

Surface water refers to the water found in water bodies such as lakes, rivers, and wetlands, and bound up in snow, ice and glaciers. Canada's lakes and rivers cover about 12% of the country's surface area (Table 2.1).

Lakes and rivers

Lakes and rivers are fed by runoff from precipitation, snowmelt, glacier melt (in summer) as well as by contributions from groundwater, known as baseflow.

With 563 lakes larger than 100 square kilometres, Canada has more lake area than any other country in the world.[4] The Great Lakes, which Canada shares with the United States, are the largest group of freshwater lakes in the world and contain roughly 18% of the global stock of fresh surface water. The Great Lakes have a volume of 22,684 km^3 and cover a surface area of 244,160 km^2.[5]

Other large lakes include the Great Bear and Great Slave lakes in the Lower Mackenzie drainage region in the Northwest Territories and Lake Winnipeg in the Lower Saskatchewan–Nelson drainage region. These large lakes combined, however, hold only about one-fifth as much water as is contained in the Great Lakes.[6]

According to the Canadian Geographic Names Data Base, there are more than 8,500 named rivers in Canada.[7] The Mackenzie River in the Northwest Territories, Canada's longest river, has a length of 4,241 km and flows to the Beaufort Sea. The St. Lawrence River, important for shipping in Canada, is 3,058 km long and flows into the Gulf of St. Lawrence.[8]

Glaciers

Canada's glaciers are estimated to cover 200,000 km^2. About three-quarters of the area of glaciers in Canada is located on the Arctic Islands, with a further 24% located in the interior ranges of the Rocky Mountains, and along the coast of the Pacific Ocean drainage area.[9] Melt from glaciers in the Rockies is an important source of water in summer months; however, many of these glaciers are receding and thinning.[10,11]

Athabasca Glacier, Columbia Icefield, Alberta, Mark Henry

Wetlands

Wetlands include swamps, bogs, marshes, fens, and other areas where the soil is saturated either permanently or for part of the year. These areas cover approximately 14% of Canada's total land area. More northerly regions contain a greater proportion of wetland area than those in the south.[12,13] Wetlands are biologically diverse areas that provide habitat for fish; mammals; birds, such as ducks, geese, cranes and sandpipers; amphibians, such as frogs and salamanders; reptiles, such as turtles; and invertebrates, including insects and shellfish. Wetlands provide many ecological benefits including filtering nutrients from water and controlling flooding.

2.1.2 Groundwater

Groundwater refers to water located under the soil surface—soil moisture and water stored in aquifers. Aquifers are geological formations of sand, gravel or permeable rock that can store and transmit water. Baseflow, water that flows from underground to the surface, is a reliable source of water for many rivers.

Most shallow aquifers contain freshwater that can be accessed through wells. The water table is the upper boundary that separates non-saturated soil from the saturated soil in shallow unconfined aquifers. In Southern Canada, the water table lies within 20 m of the surface.[14] Confined aquifers are bounded by layers of impervious rock. When tapped by artesian wells,

See footnote(s) at the end of the section.

the pressurized water in these aquifers can rise above the level of the water table.

Groundwater also includes non-renewable water resources in deep aquifers. This water is recharged over a very long time period, and is therefore not renewable over human time scales. Water in these deep aquifers often contains dissolved solids, becoming saline at depth, making it less fit for consumption. The portion of unconfined aquifers that are recharged every year in Canada contributes to Canada's renewable water resources.

Overall it is estimated that 25% of Canadians rely on groundwater as a source of drinking water (Map 2.1). This includes Canadians supplied with water from drinking water plants that use groundwater sources and Canadians that rely on wells. This percentage varies depending on the region of the country. The population in the Saint John–St. Croix drainage region (drainage region 23) is the most reliant on groundwater, whereas the population in the South Saskatchewan drainage region (drainage region 11) is the least. The population of Prince Edward Island, which is part of the Maritime Coastal drainage region (drainage region 24) is 100% dependent on groundwater.

2.2 Flows of water

Most of Canada's surface freshwater flows northward—39% of the total area of the country drains into Hudson Bay and a further 36% drains into the Arctic Ocean. Fifteen percent of the total area of Canada is within the Atlantic Ocean drainage area and 10% is in the Pacific Ocean drainage area. A small portion of southern Alberta and Saskatchewan, covering 0.3% of Canada's total land area, is part of the Missouri drainage region, with waters flowing eventually to the Gulf of Mexico (Map 1.2). The direction and quantities of groundwater flows are not well understood at the national scale.

These flows can be considered the renewable portion of Canada's freshwater resources.[15] These resources are replenished each year through approximately 5,500 km^3 of precipitation, mainly composed of rain and snow (Table 2.1), and about 52 km^3 of water that flows into the country from the United States.[16]

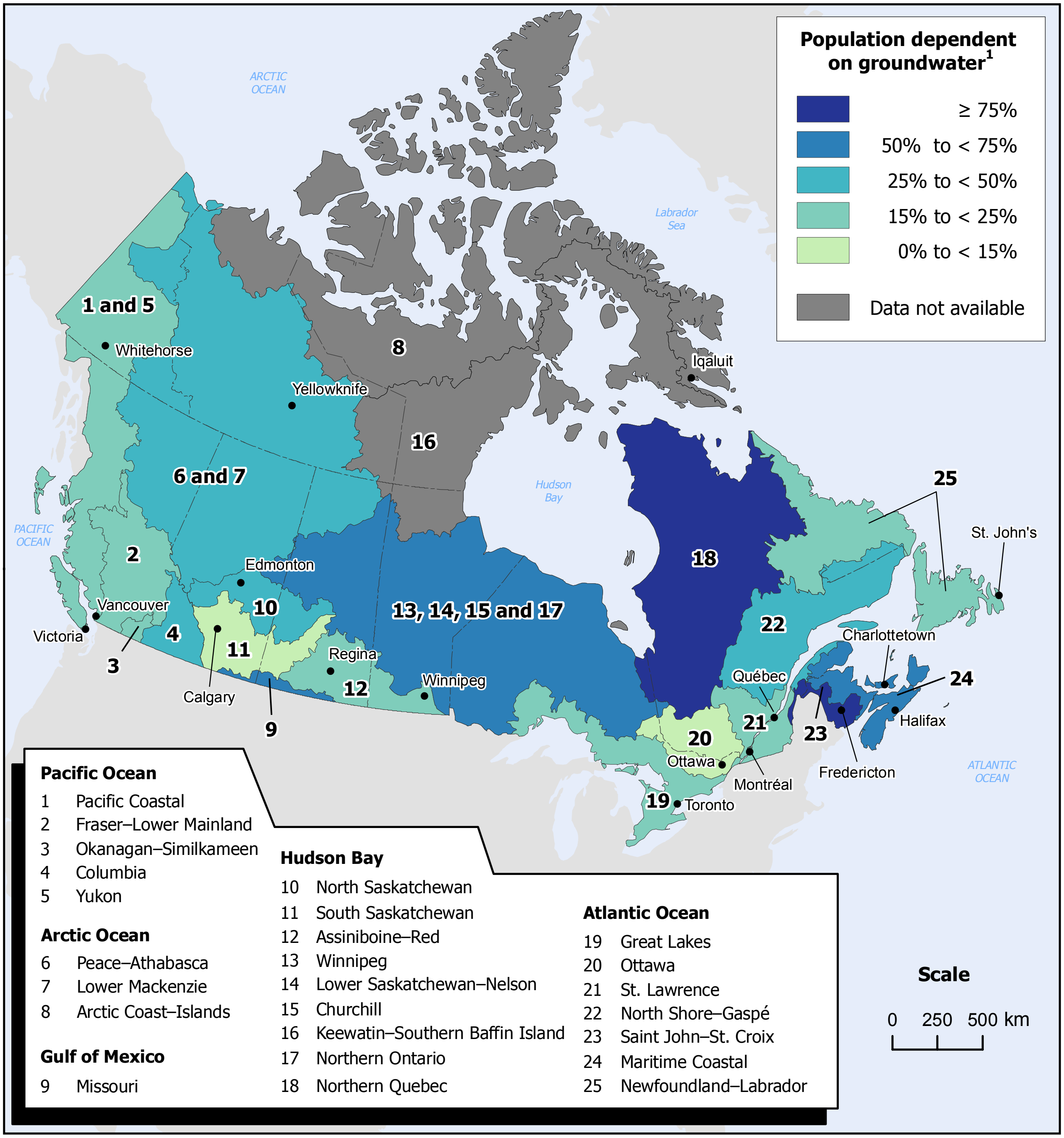
The geographic distribution of precipitation differs across the country. Generally, the Pacific and Atlantic coasts receive the most precipitation while the Prairies and the far North receive the least. The average annual amount of precipitation ranges from a high of 1,354 mm for the Pacific Coastal drainage region in British Columbia to a low of 189 mm for the Arctic Coast–Islands drainage region in the North (Table 2.1).

The timing of precipitation also varies across the country. Throughout the continental interior, maximum precipitation generally occurs in summer, while this is the driest time of year on the west and east coasts.[17] The Prairies and Arctic receive very little precipitation in winter, partly due to cold temperatures that limit the air's capacity to hold water vapour. In comparison, in winter coastal British Columbia receives most precipitation as rain, and the east coast receives a mix of rain and snow, with more rain near the Atlantic Ocean and more snow further inland in southern Quebec and Labrador.[17]

See footnote(s) at the end of the section.

Map 2.1

Canadian population dependent on groundwater, by drainage region, 2006



1. Includes groundwater under the direct influence of surface water.

Note(s): Includes the population served by drinking water plants serving 300 or more people and households with a private well. Excludes Arctic Coast-Islands (8) and Keewatin-Southern Baffin Island (16) drainage regions due to low response. The population with a private well in Yukon (5) and Lower Mackenzie (7) drainage regions was estimated based on proportions in adjacent regions. The following drainage regions were aggregated to protect confidentiality; Pacific Coastal (1) with the Yukon (5); Peace-Athabasca (6) with the Lower Mackenzie (7); and the Winnipeg (13), Lower Saskatchewan-Nelson (14), Churchill (15) and Northern Ontario (17).

Source(s): Statistics Canada, Environment Accounts and Statistics Division, 2010, Survey of Drinking Water Plants and Households and the Environment Survey, special tabulation.

Table 2.1
Water resource characteristics, by drainage region

	Code	Land and water area [1]	Water area [2]			Precipitation [3]	
			Total	As a portion of total area	Share of national water area	Amount	Volume
		km2		percent		mm per year	km3 per year
Canada		9,978,923	1,169,561	11.7	100	545	5,451
Pacific Coastal	1	334,455	14,219	4.3	1.2	1,354	451
Fraser–Lower Mainland	2	233,104	8,937	3.8	0.8	670	156
Okanagan–Similkameen	3	15,603	585	3.7	0.1	466	7
Columbia	4	87,323	2,348	2.7	0.2	776	68
Yukon	5	332,906	9,540	2.9	0.8	346	115
Peace–Athabasca	6	485,145	16,725	3.4	1.4	497	241
Lower Mackenzie	7	1,330,490	177,000	13.3	15.1	365	486
Arctic Coast–Islands	8	1,764,280	175,804	10.0	15.0	189	333
Missouri	9	27,096	915	3.4	0.1	390	11
North Saskatchewan	10	150,151	7,242	4.8	0.6	443	67
South Saskatchewan	11	177,623	6,219	3.5	0.5	419	74
Assiniboine–Red	12	190,704	8,846	4.6	0.8	450	86
Winnipeg	13	107,655	20,525	19.1	1.8	683	74
Lower Saskatchewan–Nelson	14	360,887	67,617	18.7	5.8	508	183
Churchill	15	313,568	51,918	16.6	4.4	480	151
Keewatin–Southern Baffin Island	16	939,569	161,011	17.1	13.8	330	310
Northern Ontario	17	691,809	56,064	8.1	4.8	674	466
Northern Quebec	18	940,193	149,081	15.9	12.7	698	656
Great Lakes	19	317,860	111,577	35.1	9.5	925	292
Ottawa	20	146,353	14,550	9.9	1.2	947	139
St. Lawrence	21	118,733	8,801	7.4	0.8	1,057	125
North Shore–Gaspé	22	369,095	36,933	10.0	3.2	994	367
Saint John–St. Croix	23	41,903	1,716	4.1	0.1	1,147	48
Maritime Coastal	24	122,057	6,495	5.3	0.6	1,251	153
Newfoundland–Labrador	25	380,361	54,893	14.4	4.7	1,030	392

1. Area includes the Canadian portion of the Great Lakes.
2. Water area figures are calculated from the Canada-wide 1-km Water Fraction derived from National Topographic Data Base maps.
3. Precipitation values have been estimated from an Inverse Distance Weighted interpolation of the 1971 to 2000 normals.

Source(s): Environment Canada, Meteorological Service of Canada, 2008, *Canadian Climate Normals and Averages 1971-2000*, *http://climate.weatheroffice.gc.ca/climate_normals/index_e.html* (accessed April 27, 2010). Fernandes, R., G. Pavlic, W. Chen, and R. Fraser, 2001, *1-km Water Fraction From National Topographic Data Base Maps, Canada*, Natural Resources Canada, Earth Science Sector, *www.geogratis.ca/geogratis/en/option/select.do?id=8C3D34AE-5BD5-A83C-DB8C-895FB4AD86C6* (accessed April 28, 2010).

2.2.1 Water yield in Canada

Water yield estimates are derived from the monthly amounts of unregulated flows of surface water in Canada's rivers and streams. Measuring this part of the hydrological cycle over time provides insight into the status and trends of water resources in Canada, including monthly supplies and inter-annual changes. A complete discussion of the methodology, and the water yield results, is presented in a technical paper.[18]

The average annual water yield for Canada is 3,472 km^3 (Table 2.2). To put this in perspective, this water yield amounts to almost as much water as there is in Lake Huron (which contains 3,540 km^3), and is equivalent to a depth of 348 mm of water across the full extent of Canada's landmass.[3] This abundance, however, is distributed unequally across the country (Table 2.2, Chart 2.1 and Map 2.2). Generally, drainage regions on the Pacific coast, northern Quebec and the Atlantic coast have the highest water yields. Drainage regions in the Prairies and north of the Prairies produce the least water. Furthermore, areas of abundant water yield do not correspond with the highly populated regions of the country—98% of Canadians live in the southern part of the country, but this area is responsible for only 38% of the water yield (Map 2.3).[19]

Variation in water yield amongst the 25 drainage regions in Canada is considerable (Map 1.1, Table 2.2, and Chart 2.1). The largest yields of renewable fresh water are on the two coasts. With an average annual water yield per unit area of 1.54 m^3/m^2, the Pacific Coastal drainage region in British Columbia

See footnote(s) at the end of the section.

has the highest renewable freshwater per unit area in the country. It is followed by the Newfoundland and Labrador and the Maritime coastal drainage regions which have average annual yields per unit area of 0.86 m^3/m^2 and 0.85 m^3/m^2 respectively (Table 2.2).

Differences amongst regions are most pronounced when water yields in the Prairies are compared to yields in other parts of the country. Drainage regions 9, 10, 11 and 12 comprise most of the Prairies and stretch across the southern part of Alberta, Saskatchewan and Manitoba. The average annual yield of renewable freshwater per unit area for this collection of drainage regions is 0.05 m^3/m^2. This is equivalent to 12% of the yield of the Great Lakes drainage region, 6% of the yield of the Maritime Coastal drainage region and only 3% of the Pacific Coastal drainage region (Table 2.2). When the water yields for regions 9, 10, 11 and 12 are combined, and divided by the total area of these four regions, the resulting renewable fresh water per unit area is less than that for either Australia or South Africa (Table 1.1).

These four drainage regions generally correspond to the Prairies ecozone, which had a population exceeding 4.5 million people in 2006. The population in this ecozone increased by 1.6 million people from 1971 to 2006.[20]

Regional disparity can also be quite pronounced even within a province. In British Columbia, the annual yield of water per unit area of the Pacific Coastal drainage region is 1.54 m^3/m^2, while the Fraser–Lower Mainland produces 36% of this volume, and the Okanagan–Similkameen, only 18%.

See footnote(s) at the end of the section.

Table 2.2
Average annual water yield by drainage region, 1971 to 2004

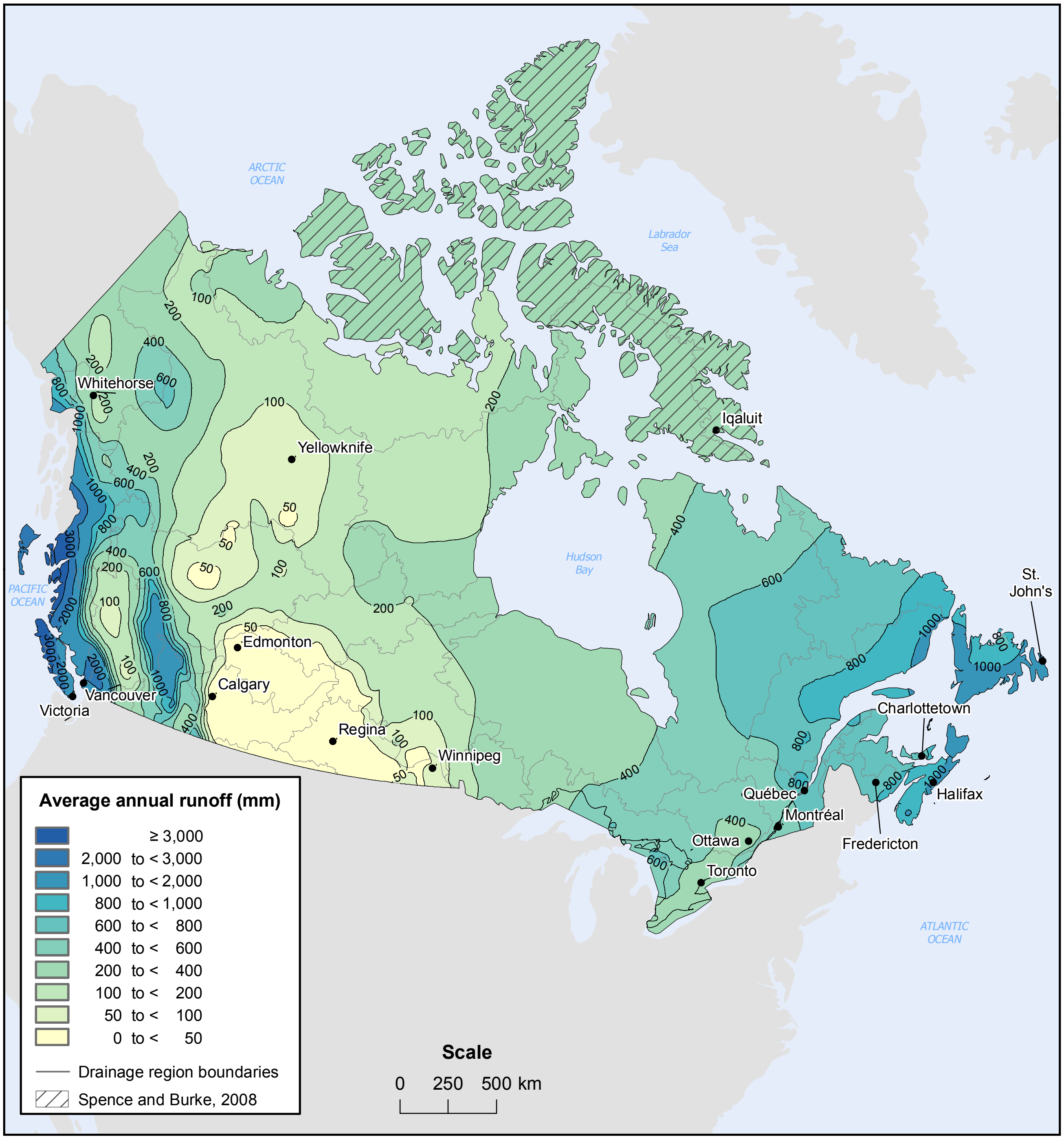
	Drainage region code	Water yield: Volume[1]	Water yield: Volume per unit area
	number	km^3	m^3 per m^2
Canada		**3,472.3**	**0.348**
Pacific Coastal	1	513.7	1.536
Fraser–Lower Mainland	2	128.6	0.552
Okanagan–Similkameen	3	4.2	0.270
Columbia	4	67.7	0.776
Yukon	5	106.0	0.318
Peace–Athabasca	6	99.9	0.206
Lower Mackenzie	7	246.3	0.185
Arctic Coast–Islands	8	231.3	0.131
Missouri	9	0.5	0.019
North Saskatchewan	10	10.2	0.068
South Saskatchewan	11	9.6	0.054
Assiniboine–Red	12	6.9	0.036
Winnipeg	13	25.4	0.236
Lower Saskatchewan–Nelson	14	47.6	0.132
Churchill	15	49.4	0.158
Keewatin–Southern Baffin Island	16	192.0	0.204
Northern Ontario	17	199.2	0.288
Northern Quebec	18	516.3	0.549
Great Lakes	19	133.1	0.419
Ottawa	20	62.6	0.428
St. Lawrence	21	71.3	0.600
North Shore–Gaspé	22	292.2	0.792
Saint John–St. Croix	23	29.2	0.697
Maritime Coastal	24	103.6	0.849
Newfoundland–Labrador	25	325.4	0.856

1. The water yield estimates are 34-year annual averages (1971 to 2004), with the exception of those estimates for drainage regions 5, 7, 16, 17, 18 and the Labrador portion of 25 which are based on 20 years of data (1975 to 1996); and drainage region 8 which is based on a 23-year annual average (1972-1994) for the Arctic Archipelago (Spence and Buke 2008), and on a 20-year annual average (1975 to 1996) for the remaining area.

Note(s): Data were derived from discharge values contained in Environment Canada, 2010, Water Survey of Canada, Archived Hydrometric Data (HYDAT) (*www.wsc.ec.gc.ca/hydat/H2O/index_e.cfm?cname=main_e.cfm*).

Source(s): Spence C., and A. Burke, 2008, "Estimates of Canadian Arctic Archipelago Runoff from Observed Hydrometric Data," *Journal of Hydrology*, Vol. 362, pages 247 to 259. Statistics Canada, Environment Accounts and Statistics Division, 2010, special tabulation.

Map 2.2
Average annual runoff in Canada, 1971 to 2004



Note(s): Data were derived from discharge values contained in Environment Canada, 2010, Water Survey of Canada, Archived Hydrometric Data (HYDAT) (www.wsc.ec.gc.ca/hydat/H2O/index_e.cfm?cname=main_e.cfm).

Source(s): Spence C., and A. Burke, 2008, "Estimates of Canadian Arctic Archipelago Runoff from Observed Hydrometric Data," *Journal of Hydrology*, Vol. 362, pages 247 to 259.
Statistics Canada, Environment Accounts and Statistics Division, 2010, special tabulation.

2.2.2 Water yield per capita

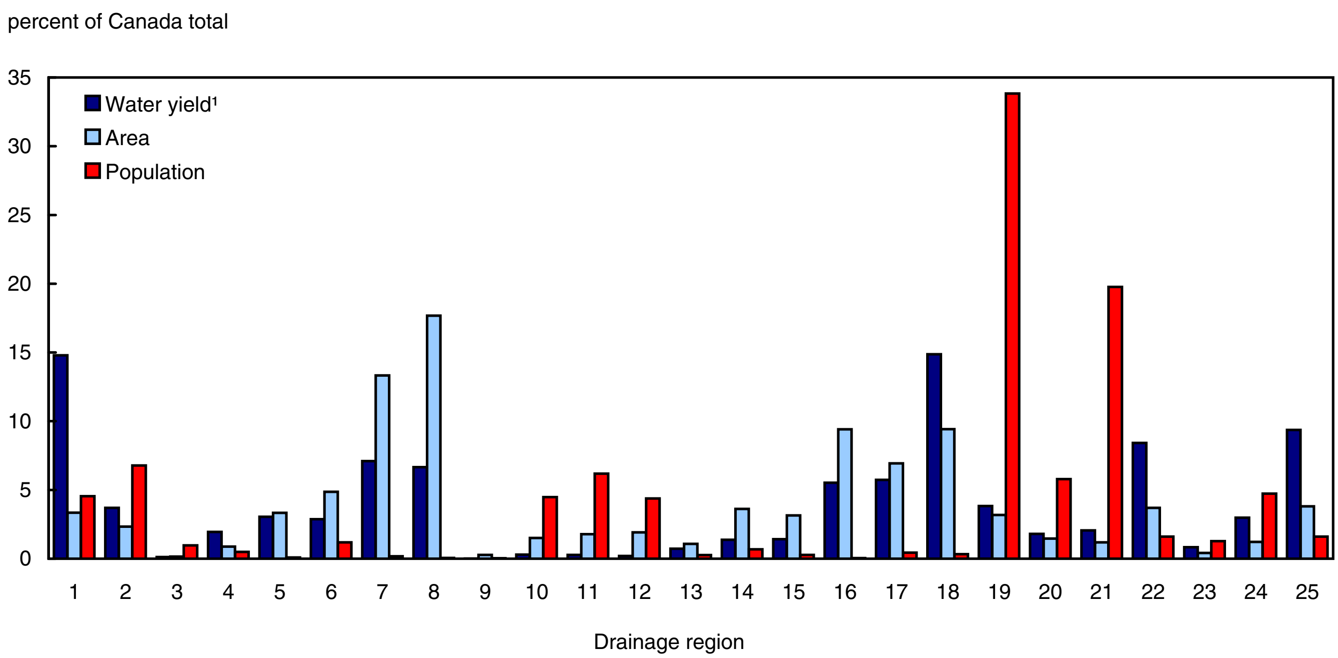
Examining population distribution in relation to water resources gives an indication of the pressures exerted on water resources. Calculating the water yield per capita is one way to show this relationship.

Dividing Canada's total water yield by its population reveals that almost 110,000 m^3 of renewable freshwater is produced per person each year (Table 2.3). Brazil, which has the highest water yield per unit area of any country in the world, provides 43,756 m^3 of water per person per year, 40% of what is annually available per person in Canada. While total water yield is comparable between the United States and Canada, the amount of renewable freshwater per American is only 9.1% of that per Canadian because the United States has a much larger population (Table 1.1).

This fact reinforces the notion that Canada has an abundance of renewable freshwater available to its population. However, this assumption is misleading: the more populated regions of the country do not typically correspond with the regions that produce the bulk of renewable water in the country (Chart 2.1, Table 2.3). The top five drainage regions in terms of water yield, produce 55% of the water, but have only 8% of the population. The Great Lakes drainage region where 34% of the population of the country resides, produces only 4% of the national renewable water yield (Chart 2.1). In the South, where most of the population is located, there are 42,661 m^3 of renewable freshwater available per capita, compared to 4,193,014 m^3 per capita in the North: water availability per capita is 98 times greater above the North-line than below it (Map 2.3).

Similarly in British Columbia, almost 360,000 m^3 of water are available per person in drainage region 1, while in the interior portion of the province only 4% of this amount is available per person in drainage region 3 (Table 2.3).

Chart 2.1
Contribution to national water yield, total land area and population, by drainage region



1. The water yield estimates are 34-year annual averages (1971 to 2004), with the exception of those estimates for drainage regions 5, 7, 16, 17, 18 and the Labrador portion of 25 which are based on 20 years of data (1975 to 1996); and drainage region 8 which is based on a 23-year annual average (1972-1994) for the Arctic Archipelago (Spence and Burke 2008), and on a 20-year annual average (1975 to 1996) for the remaining area. Data were derived from discharge values contained in Environment Canada, 2010, Water Survey of Canada, Archived Hydrometric Data (HYDAT) (www.wsc.ec.gc.ca/hydat/H2O/index_e.cfm?cname=main_e.cfm).

Source(s): Spence C., and A. Burke, 2008, "Estimates of Canadian Arctic Archipelago Runoff from Observed Hydrometric Data," *Journal of Hydrology*, Vol. 362, pages 247 to 259. Statistics Canada, Environment Accounts and Statistics Division, 2010, special tabulation.

Table 2.3
Water yield per capita by drainage region, 1976 to 2006

	Drainage region code	Population 1976	Population 2006	Population Change 1976 to 2006	Population Density 2006	Water yield per capita 2006 [1]
	number	persons	persons	percent	persons per km²	m³ per person
Canada	**…**	**22,992,603**	**31,612,897**	**27.3**	**3.6**	**109,837**
Pacific Coastal	1	980,269	1,437,391	31.8	4.5	357,393
Fraser–Lower Mainland	2	1,130,068	2,144,661	47.3	9.6	59,950
Okanagan–Similkameen	3	161,142	305,011	47.2	20.3	13,832
Columbia	4	142,607	156,987	9.2	1.8	431,425
Yukon	5	20,728	28,706	27.8	0.1	3,691,180
Peace–Athabasca	6	232,736	375,036	37.9	0.8	266,457
Lower Mackenzie	7	40,639	53,973	24.7	0.0	4,563,560
Arctic Coast–Islands	8	8,991	18,358	51.0	0.0	12,599,851
Missouri	9	12,718	8,869	-43.4	0.3	56,683
North Saskatchewan	10	924,402	1,416,072	34.7	9.9	7,183
South Saskatchewan	11	1,058,505	1,953,874	45.8	11.4	4,909
Assiniboine–Red	12	1,282,763	1,383,937	7.3	7.6	4,964
Winnipeg	13	85,961	84,757	-1.4	1.0	299,422
Lower Saskatchewan–Nelson	14	229,470	215,255	-6.6	0.7	221,310
Churchill	15	63,951	88,638	27.9	0.3	557,622
Keewatin–Southern Baffin Island	16	5,997	13,261	54.8	0.0	14,476,588
Northern Ontario	17	150,768	137,806	-9.4	0.2	1,445,735
Northern Quebec	18	96,690	105,401	8.3	0.1	4,898,872
Great Lakes	19	7,174,755	10,695,503	32.9	51.8	12,442
Ottawa	20	1,270,448	1,828,878	30.5	13.9	34,244
St. Lawrence	21	5,076,416	6,248,199	18.8	58.8	11,410
North Shore–Gaspé	22	519,419	508,069	-2.2	1.5	575,060
Saint John–St. Croix	23	379,612	402,583	5.7	10.0	72,580
Maritime Coastal	24	1,384,759	1,494,940	7.4	13.0	69,305
Newfoundland–Labrador	25	558,789	506,732	-10.3	1.6	642,178

1. The water yield estimates are 34-year annual averages (1971 to 2004), with the exception of those estimates for drainage regions 5, 7, 16, 17, 18 and the Labrador portion of 25 which are based on 20 years of data (1975 to 1996); and drainage region 8 which is based on a 23-year annual average (1972-1994) for the Arctic Archipelago (Spence and Buke 2008), and on a 20-year annual average (1975 to 1996) for the remaining area.

Note(s): Data were derived from discharge values contained in Environment Canada, 2010, Water Survey of Canada, Archived Hydrometric Data (HYDAT) (*www.wsc.ec.gc.ca/hydat/H2O/index_e.cfm?cname=main_e.cfm*).

Source(s): Spence C., and A. Burke, 2008, "Estimates of Canadian Arctic Archipelago Runoff from Observed Hydrometric Data," *Journal of Hydrology*, Vol. 362, pages 247 to 259. Statistics Canada, Environment Accounts and Statistics Division, 2010, special tabulation.

2.2.3 Changes in water yield over time

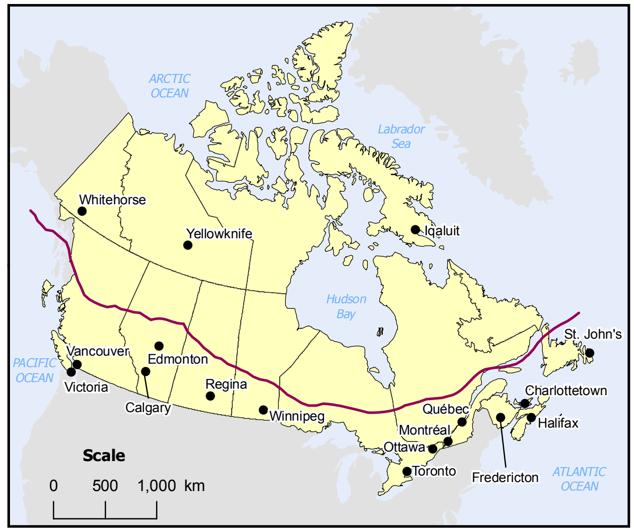
Trends in economic production, unemployment rates and temperature are often analyzed to better understand how the economy, society and the environment have changed during the period covered by the time series. Similarly, trends in water yield help understand changes in Canada's renewable water supply from 1971 to 2004.

Trends in water yield in Southern Canada, 1971 to 2004

Trends in water yield from 1971 to 2004 in southern Canada were derived using annual estimated flow volumes for this time period.[21] Although a national trend could not be derived because of insufficient data in the North (Map 2.3), it was possible to estimate it for the area below the North-line. This is the portion of the country where most economic activity takes place, and it has an area of almost 2.6 million km^2.

See footnote(s) at the end of the section.

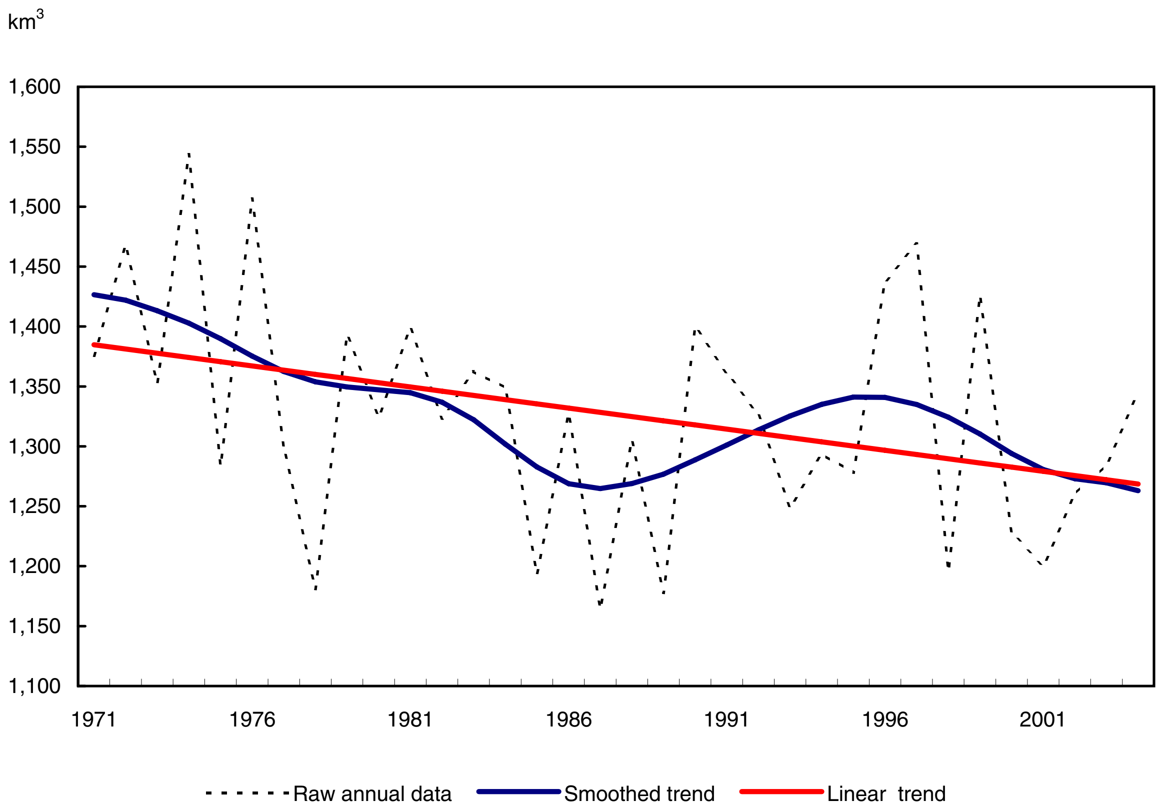
Map 2.3
Statistics Canada's North-line in relation to the land mass of Canada



Note(s): The North-line is a statistical area classification of the North based on 16 social, biotic, economic and climatic variables that delineates the North from the South in Canada.

Source(s): McNiven C., and H. Puderer, 2000, "Delineation of Canada's North: An Examination of the North-South Relationship in Canada," *Geography Working Paper Series*, Statistics Canada Catalogue no. 92F0138MIE.

Chart 2.2
Trends in water yield for Southern Canada, 1971 to 2004



Note(s): Southern Canada in delineated by the North-line which separates Canada into two regions based on 16 social, biotic, economic and climatic variables (Map 2.3).
Source(s): McNiven C., and H. Puderer, 2000, "Delineation of Canada's North: An Examination of the North-South Relationship in Canada", *Geography working Paper Series*, Statistics Canada Catalogue no. 92F0138M2000003. Statistics Canada, Environment Accounts and Statistics Division and Business Survey Methodology Division, 2010, special tabulation.

Chart 2.2 shows that in the southern portion of Canada, water yield decreased on average by 3.5 km^3 per year from 1971 to 2004, which is equivalent to an overall loss of 8.5% of the water yield over this time period. This average annual decrease of 3.5 km^3 is almost as much as the 3.8 km^3 of water that is supplied to the residential population of Canada in a year (Table 3.1).

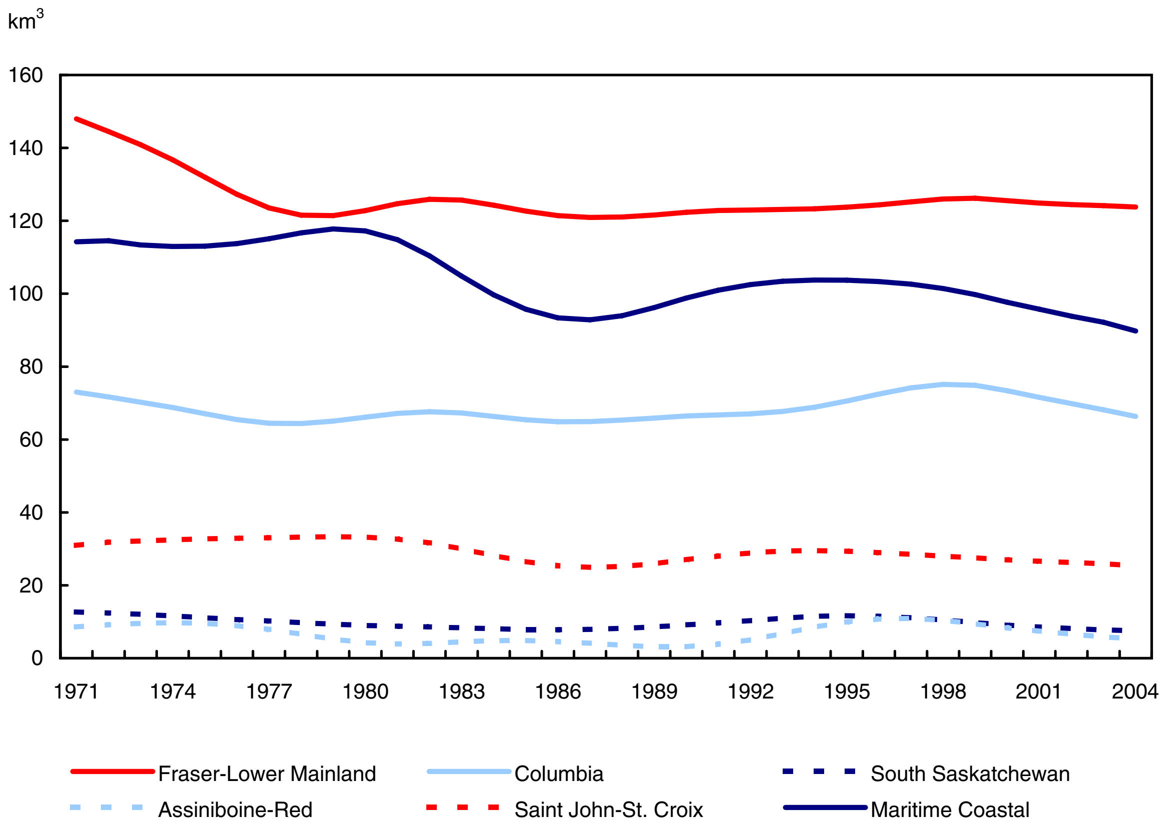
The smoothed trend line in Chart 2.2 shows a decrease in water yield from 1971 to 1987, followed by an increase until 1996, when it reverts back to a decrease until the end of the time period. Chart 2.3 compares the smoothed trends for selected drainage regions using a common scale, and shows how the water yield volumes of these drainage regions have changed over time.

The downward trend in Southern Canada was not distributed equally (Charts 2.3 and 2.4). Specifically, in British Columbia, water yield in the Columbia (drainage region 4) remained relatively constant over the 34-year period while volumes in the Fraser–Lower Mainland (drainage region 2) declined from 1971 to 1977, before levelling out. This resulted in a decrease of 9%, or 0.35 km^3 of water per year in this drainage region from 1971 to 2004 (Chart 2.4).

While the volume of the water yield in the South Saskatchewan drainage region is roughly 8% that of the Fraser–Lower Mainland, both drainage regions showed a marked decrease in water yield in the early years of the period under study.

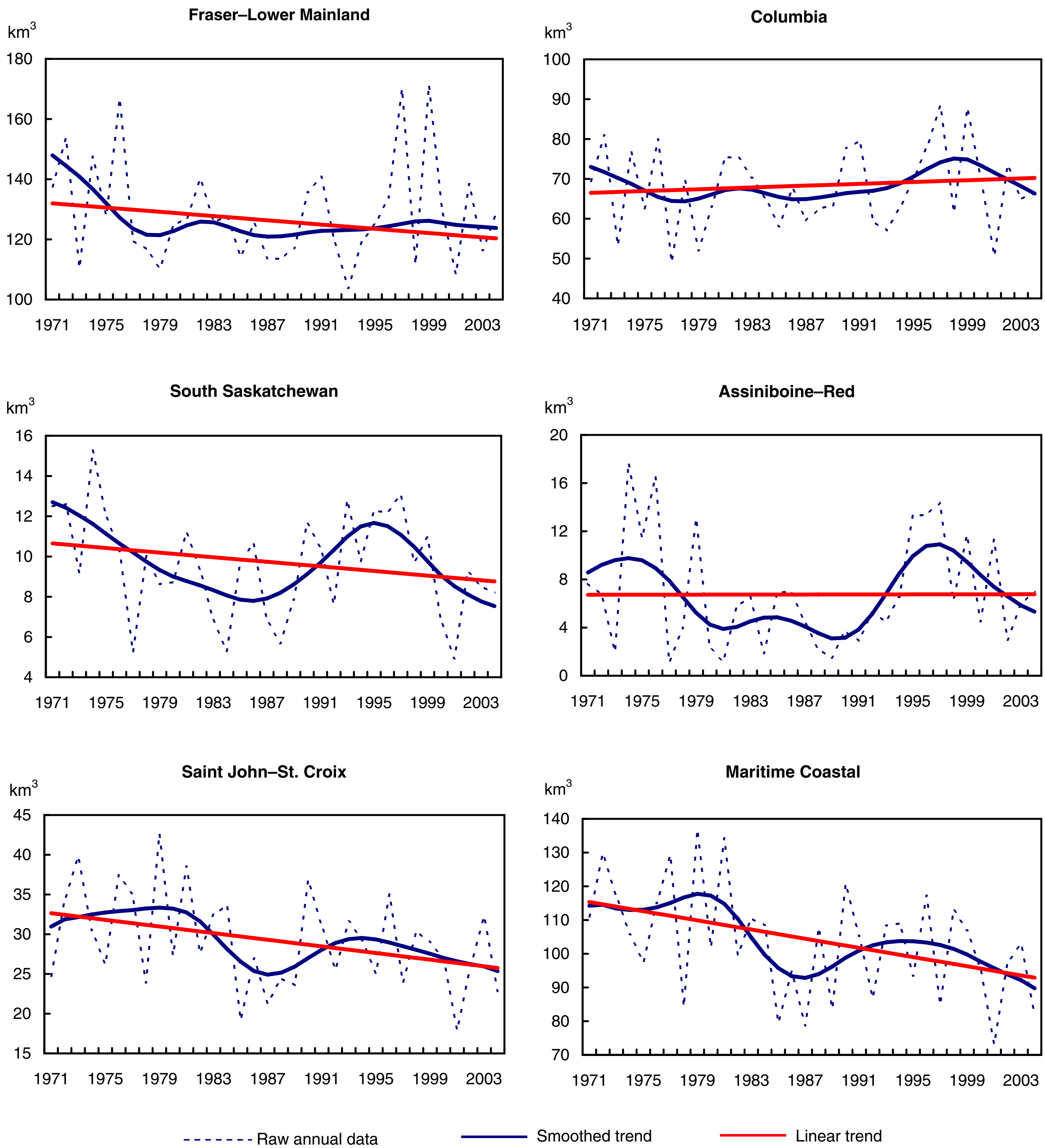
The sharpest decline occurred in eastern Canada: water yield in the Maritime Coastal drainage region decreased 19.6% from 1971 to 2004, and water yield in the St. John–St. Croix drainage region declined 21.5%.

Chart 2.3
Relative contribution of selected drainage regions to Canada's water yield, 1971 to 2004



Note(s): Lines depicted are the smoothed trends for each drainage region.
Source(s): Statistics Canada, Environment Accounts and Statistics Division and Business Survey Methodology Division, 2010, special tabulation.

Chart 2.4
Trends in water yield for selected drainage regions, 1971 to 2004



Source(s): Statistics Canada, Environment Accounts and Statistics Division and Business Survey Methodology Division, 2010, special tabulation.

Trends in water yield in the Prairies, 1971 to 2004

From 1971 to 2004 the highest variability in water yield in Canada was detected in the Prairies (Map 2.4).[18,22] This area includes drainage regions 9, 10, 11, and 12, that is to say, the Missouri, North Saskatchewan, South Saskatchewan, and Assiniboine–Red drainage regions, respectively; and part of drainage region 6, the Peace–Athabasca.

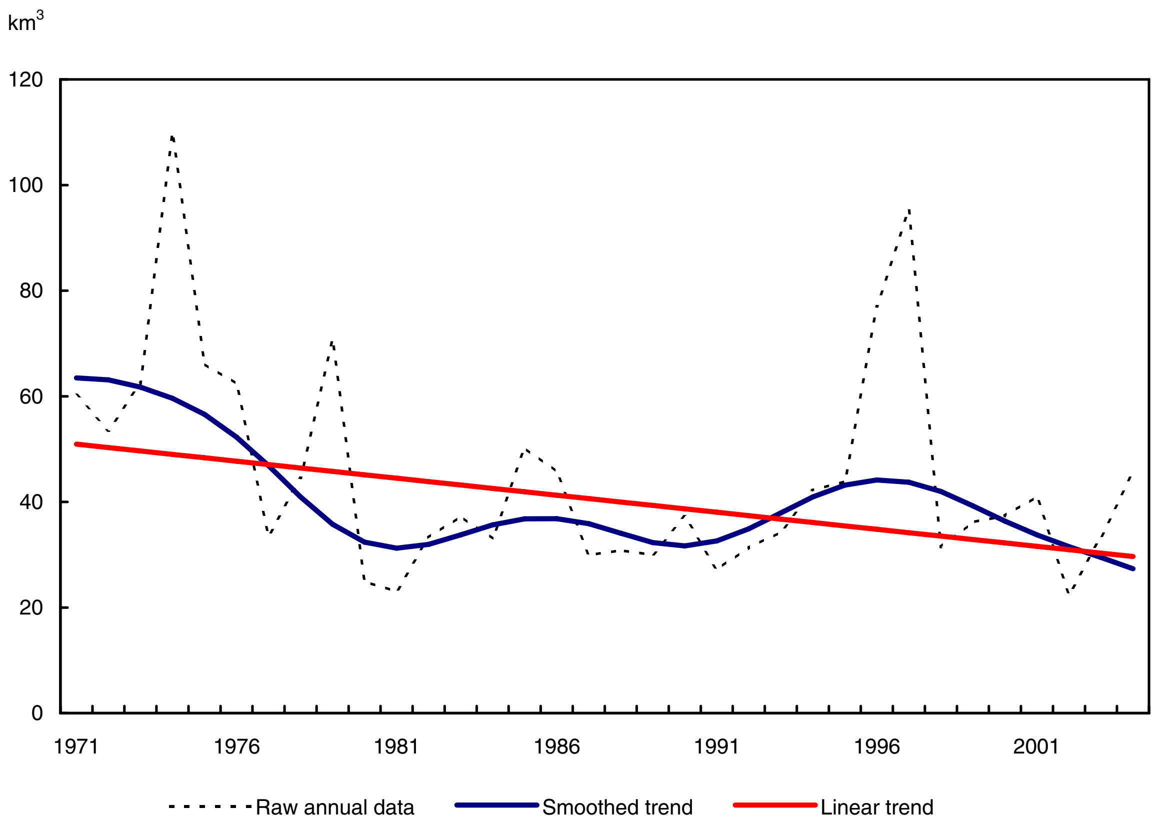
This variability in the flows of renewable water resources is of interest because the lack of predictability affects economic activities, including agriculture.

This variability of flows is illustrated by the severe floods and droughts that occur in this region. For example, the flood of the Red River in 1997, which brought about the worst flooding the region had seen since 1852, forced 75,000 people to abandon their homes, and caused $450 million in damages (Map 2.5).[23] At the other end of the spectrum, the drought of 2002 (Map 2.6) had adverse impacts on the agricultural community. In 2002, crop yields in Alberta declined compared to average yields for 1981 to 2000—the yield of spring wheat was down 29%, barley was down 27% and canola was down 13%.[24] Additionally, cattle inventories in Alberta declined by 10.4% (605,000 head) from January 2002 to January 2003.[25]

From 1971 to 2004, water yield for this area decreased by 0.56 km^3/yr (Chart 2.5). To put this in perspective, this volume represents about 80% of the total volume of water that was produced by drinking water plants in these five drainage regions in 2005.[19] Over the 34-year period, this represents a total reduction of 20 km^3 of water yield, equivalent to roughly one half of the long-term, average annual water yield.

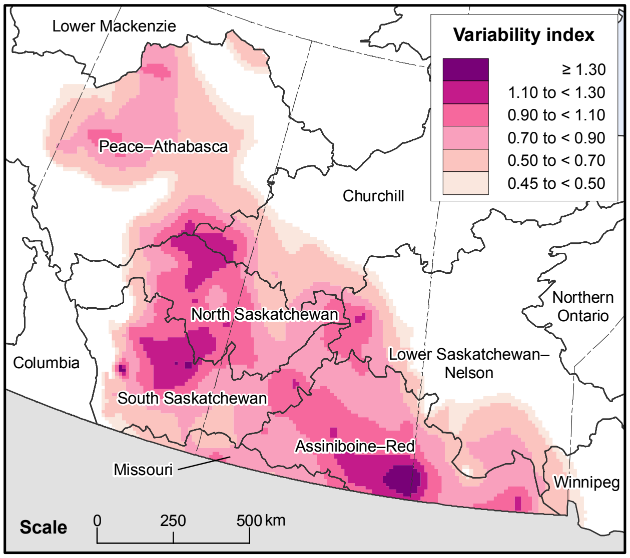
See footnote(s) at the end of the section.

Chart 2.5
Trends in water yield for the Canadian Prairies, 1971 to 2004



Note(s): The trend shown is for the area with the highest variability in water yield in Canada, 1971 to 2004. This area includes drainage regions 9, 10, 11, and 12, the Missouri, North Saskatchewan, South Saskatchewan, and Assiniboine–Red, and part of drainage region 6, the Peace–Athabasca.
Source(s): Statistics Canada, Environment Accounts and Statistics Division and Business Survey Methods Division, 2010, special tabulation.

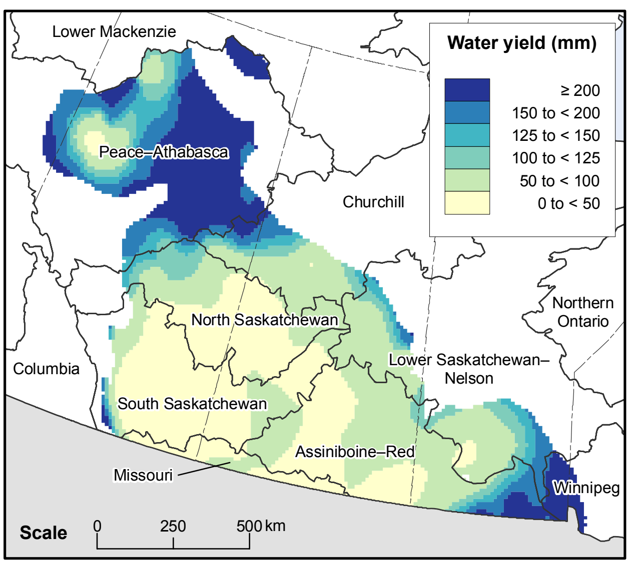
Map 2.4
Area with the highest variability in water yield in Canada, 1971 to 2004



Note(s): Includes all or part of drainage regions 6, 9, 10, 11, and 12, the Peace–Athabasca, Missouri, North Saskatchewan, South Saskatchewan, and Assiniboine–Red.

Sources(s): Statistics Canada, Environment Accounts and Statistics Division, 2010, special tabulation.

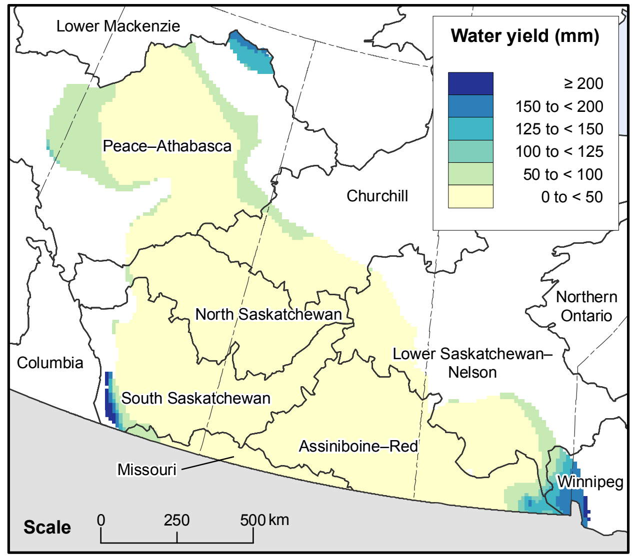
Map 2.5
Annual water yield in the Canadian Prairies, Red River flood of 1997



Note(s): Includes all or part of drainage regions 6, 9, 10, 11, and 12, the Peace–Athabasca, Missouri, North Saskatchewan, South Saskatchewan, and Assiniboine–Red.

Sources(s): Statistics Canada, Environment Accounts and Statistics Division, 2010, special tabulation.

Map 2.6
Annual water yield in the Canadian Prairies, drought of 2002



Note(s): Includes all or part of drainage regions 6, 9, 10, 11, and 12, the Peace–Athabasca, Missouri, North Saskatchewan, South Saskatchewan, and Assiniboine–Red.

Sources(s): Statistics Canada, Environment Accounts and Statistics Division, 2010, special tabulation.

2.2.4 Monthly water yield

Analysis of the annual water yield in Canada has shown that there was a decrease from 1971 to 2004, and that annual water yield was particularly variable in the Prairies, an area prone to floods and droughts. Monthly flows of renewable water can also be highly variable. Analysis of long-term monthly maximum and minimum water yields for 1971 to 2004 revealed that volumes can vary by more than 200% in both May and August. Therefore, analysis of the temporal distribution of water yield during the year is critical to understand the challenges that Canada faces in managing this resource.

For most of the country, the bulk of the water yield is produced in April, May and June, as snow and ice melt, and precipitation increases. These parts of the hydrological cycle generate more water yield than at any other time of the year. In the North this peak occurs in late spring and early summer. In the South, water yield is highest in the spring. As spring turns into summer, water yield declines and demand related to human activity increases.

By late summer the disparity between renewable supply and demand is typically at its greatest. In the interior and southern drainage regions of British Columbia (drainage region 2, 3 and 4), 56% of the water yield comes before July 1st in a typical year. In the Okanagan–Similkameen (drainage region 3) however, 80% comes before July 1st (Chart 2.6), and there is a 93% decline in water yield from a peak in May to the high demand month of August.

In the Prairies, spring freshets in the Assiniboine–Red and Missouri (drainage regions 12 and 9) bring a large quantity of water in spring with a sharp drop shortly thereafter, resulting in very dry summer months. In drainage region 12, the average year has a 96% decrease in water yield from the peak supply in April to the high-demand month of August (Chart 2.6).

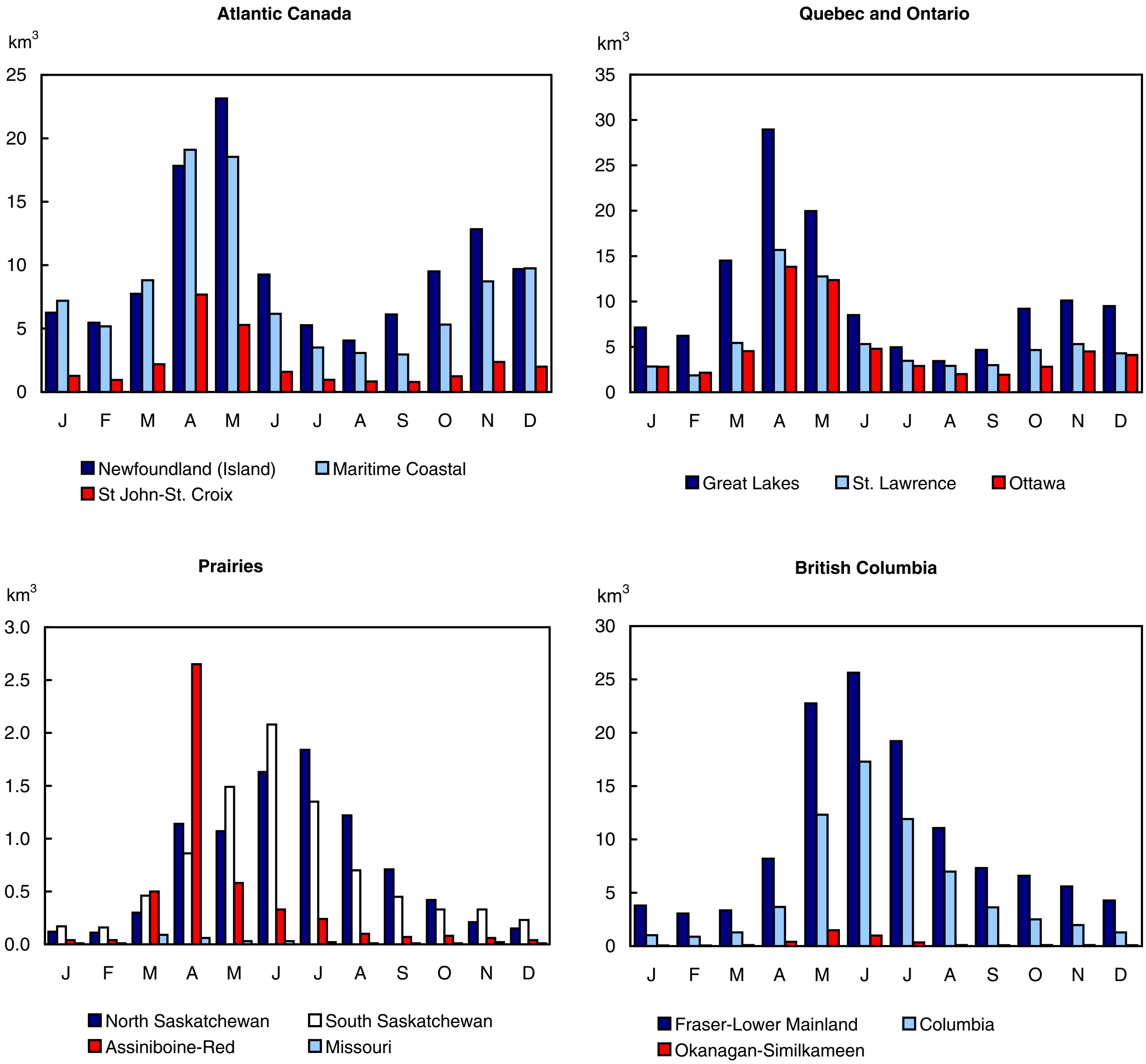
The water yield in the North and South Saskatchewan drainage regions (drainage regions 10 and 11), is highest in June and July. Nevertheless, differences between supply and demand are often acute —in the South Saskatchewan drainage region there is a 48% decline in water yield from July to August (Chart 2.6). This decline can be larger in areas where glacial melt does not supply summer flows, or where there is a significant distance between the glacial melt and downstream locations. In these Prairie areas, evaporation removes a great deal of water from the land, rivers, streams, lakes and reservoirs over the hot and dry summer months.

Generally the pattern of higher spring water yield holds through Ontario, Quebec and Atlantic Canada. In the Great Lakes drainage region, water yields decline 88%, from a high in April to a low in August, when demand can be near its peak. In the St. Lawrence drainage region, home to both Montréal and Québec City, yield is at a high in April and declines by 82% to a low in August (Chart 2.6).

On the island of Newfoundland, and in the Maritime Coastal and Saint-John–St. Croix drainage regions, water yields peak in April and May, decline through the summer months and increase again to another smaller peak in November or December (Chart 2.6).

Understanding the temporal relationship between supply and demand provides insight into when pressure is exerted on water resources in specific regions. In some jurisdictions, to deal with immediate demands, water boards have been formed to licence and regulate water withdrawals and to inform the public of the need to conserve water. To manage longer-term water-supply demands, decisions have also been made to hold water that has been produced in spring for use during the summer months. This has been accomplished by creating dams, diversions and reservoirs such as Lake Diefenbaker in Saskatchewan.

Chart 2.6
Monthly water yield for selected drainage regions, 1971 to 2004



Note(s): Data were derived from discharge values contained in Environment Canada, 2010, Water Survey of Canada, Archived Hydrometric Data (HYDAT) *(www.wsc.ec.gc.ca/hydat/H2O/index_e.cfm?cname=main_e.cfm*).
Source(s): Statistics Canada, Environment Accounts and Statistics Division, 2010, special tabulation.

Notes

1. Natural Resources Canada, 2009, *Coastline and Shoreline*, *http://atlas.nrcan.gc.ca/site/english/learningresources/facts/coastline.html/#c5* (accessed October 26, 2009).
2. World Resources Institute, 2003, *World Resources 2002-2004: Decisions for the Earth: Balance, voice, and power*, *http://archive.wri.org/governance/pubs_pdf.cfm?PubID=3764* (accessed February, 10, 2010).
3. United States Environmental Protection Agency, 2008, *Great Lakes Factsheet No.1: Physical Features and Population*, *www.epa.gov/glnpo/atlas/gl-fact1.html* (accessed February, 10, 2010).
4. Environment Canada, 2002, *Water – Here, There and Everywhere*, *www.environmentcanada.gc.ca/eau-water/default.asp?lang=En&n=C3BCB399-1* (accessed January 19, 2010).
5. United States Environment Protection Agency, 2008, *The Great Lakes: An Environmental Atlas and Resource Book*, *www.epa.gov/greatlakes/atlas/* (accessed May 5, 2010).
6. LakeNet, 2004, *Lakes at a Glance*, *www.worldlakes.org/lakeprofiles.asp?anchor=volume* (accessed January 19, 2010).
7. Natural Resources Canada, 2003, *Geographical Name Search Service*, *http://gnss.nrcan.gc.ca/gnss-srt/advancedSearch.jsp* (accessed January 25, 2010).
8. Natural Resources Canada, 2009, *The Atlas of Canada: Frequently Asked Questions about Canada*, *http://atlas.nrcan.gc.ca/site/english/learningresources/facts/faq.html/#rivers* (accessed January 21, 2010).
9. Natural Resources Canada, 2009, *The Atlas of Canada: Glaciers*, *http://atlas.nrcan.gc.ca/site/english/learningresources/facts/glaciers.html* (accessed April 27, 2010).
10. Natural Resources Canada, 2007, *Climate Change Impacts and Adaptation: A Canadian Perspective: Impacts on Water Supply*, *http://adaptation.nrcan.gc.ca/perspective/water_3_e.php* (accessed April 21, 2010).
11. Comeau, L.E.L., A. Pietroniro and M. Demuth, 2008, *Glacier Contribution to the North and South Saskatchewan River Basins*, presented at the Canadian Geophysical Union's Annual Meeting entitled Canadian Geophysical Sciences: Present and Future (11 to 14 May 2008) at Banff Park Lodge, *http://people.ucalgary.ca/~cguconf/2008webs/Abstracts/SESSIONS/L.HydroCryo/L.Comeau.S.pdf* (accessed April 28, 2010).
12. Natural Resources Canada, 2009, *The Atlas of Canada: Wetlands*, *http://atlas.nrcan.gc.ca/site/english/learningresources/theme_modules/wetlands/index.html* (accessed November 12, 2009).
13. Wulder, M.A., J.C. White, M. Cranny, R.J. Hall, J.E. Luther, A. Beaudoin, D.G. Goodenough and J.A. Dechka, 2008, "Monitoring Canada's forests. Part 1: Completion of the EOSD land cover project," *Canadian Journal of Remote Sensing.* vol. 34, no.6, pages 549 to 562.
14. Cherry, J.A., 1987, "Groundwater Occurrence and Contamination in Canada," pages 387 to 424 in Healey, M.C. and R.R. Wallace (eds.), *Canadian Aquatic Resources*, no. 215 of *Canadian Bulletin of Fisheries and Aquatic Science*, Department of Fisheries and Oceans, Ottawa.
15. The portion of this yield coming from receding glaciers is unsustainable.
16. Food and Agriculture Organization of the United Nations, AQUASTAT, 2010, *Review of water resource statistics by country*, *www.fao.org/nr/water/aquastat/water_res/index.stm* (accessed February 9, 2010).
17. Natural Resources Canada, 2009, *The Atlas of Canada: Mean Total Precipitation*, *http://atlas.nrcan.gc.ca/site/english/maps/environment/climate/precipitation/precip* (accessed November 10, 2009).
18. 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," *Environment Accounts and Statistics Analytical and Technical Paper Series*, Statistics Canada, Catalogue no. 16-001-M2009007.
19. Statistics Canada, Environment Accounts and Statistics Division, 2010, special tabulation.
20. Statistics Canada, CANSIM Table 153-0057 (accessed June 1, 2010).

21. Bemrose, R., P. Meszaros, B. Quenneville, M. Henry, L. Kemp and F. Soulard, 2010, “Using a Trend-Cycle Approach to Estimate Changes in Southern Canada’s Freshwater Yield, from 1971 to 2004," *Environment Accounts and Statistics Analytical and Technical Paper Series*, Statistics Canada, Catalogue no. 16-001-M2010014.

22. Soulard, F. and M. Henry, 2009, “Measuring renewable water assets in Canada: Initial results and research agenda," *EnviroStats*, vol. 3, no. 2, Statistics Canada Catalogue no. 16-002-X200900210889.

23. Standing Senate Committee on Agriculture and Forestry, 2003, *Climate Change: We Are at Risk: Final Report, www.parl.gc.ca/37/2/parlbus/commbus/senate/Com-e/agri-e/rep-e/repfinnov03-e.htm* (consulted April 15, 2010).

24. Statistics Canada, CANSIM Table 001-0010 (accessed May 10, 2010).

25. Statistics Canada, 2003, *Livestock Statistics: Fourth Quarter 2002*, Catalogue no. 23-603-X.

Section 3

The demand for water in Canada

Water is implicated in all facets of human life: in the home, at work and at play. Some demands make use of water without removing it from the natural environment, while other demands require water to be extracted. Commercial fishing, shipping and recreational boating are examples of activities that are carried out in-stream. Household and most industrial activities, however, rely on water that is withdrawn from the environment. Measuring key socioeconomic uses of water provides information to support water management.

Some of the water that is withdrawn is used directly from the source, while other water is treated prior to its use. Treatment, which is done to improve water quality, may be done on-site by the user, or at a centralized facility. For example, treatment to make water suitable for paper manufacturing is typically done on-site, while in 2007 85% of the population of Canada received water that had been centrally treated and then distributed to households.[1,2]

See footnote(s) at the end of the section.

3.1 Water use

In 2005, an estimated 42 km^3 of water were withdrawn from the environment and used in household and economic activities in Canada (Table 3.1). About 14% of this water flowed through the public utility water system, and about 86% was extracted from the environment directly by the end user. About 10.5% of the water extracted directly from the environment was not freshwater (either brackish or salt-water), the bulk of which was used by the Thermal-electric power generation sector.[3]

More than 90% of the water that was withdrawn went to support economic activity, and about 9% was used directly by the residential sector. The residential sector used 56% of the water that was supplied by the public utility water system. The sector that used the most water overall, by a considerable margin, was Thermal-electric power generation (Table 3.1).

Table 3.1
Water use in Canada, by sector, 2005

	Public utility water system	Self-supplied water system	Total	Share of total water use
	Mm3			percent
Total, all sectors	**5,706.2**	**36,352.1**	**42,058.3**	**100.0**
Thermal-electric power generation	X	X	27,825.1	66.2
Manufacturing	618.5	5,101.0	5,719.5	13.6
Residential [1]	3,195.5	575.6	3,771.1	9.0
Agriculture				
Irrigation [2]		1,631.7	1,631.7	3.9
Livestock [3]		321.3	321.3	0.8
Commercial and institutional [4]	1,127.8		1,127.8	2.7
Water treatment and distribution systems [5]	X	X	981.9	2.3
Mining (except oil and gas)	7.5	448.4	456.0	1.1
Oil and gas extraction		224.0	224.0	0.5

1. Includes an estimate for residential use of water produced by drinking water plants and for well water.
2. Data for all provinces except Alberta are from the 2007 Agricultural Water Use Survey. Alberta values are based on data reported by Alberta Agriculture and Rural Development and have been adjusted for uses other than irrigation, transportation losses and other sources of water for irrigation.
3. Sources for livestock data are documented in Table 3.5.
4. Estimated using the volume of water produced by drinking water plants in Canada and subtracting municipal water intake estimates for industrial use, the residential water intake estimate, and losses.
5. Includes an estimate for water use and leakages by water treatment and distribution systems.

Note(s): Water use is defined as water intake. Figures may not add up to totals due to rounding.

Source(s): Alberta Agriculture and Rural Development, Water Resources Branch, Irrigation and Farm Water Division, 2009, *Alberta Irrigation Information Facts and Figures for the Year 2008.* Canadian Association of Petroleum Producers, personal communication, 2009. Environment Canada, 2007, *Municipal Water Use: 2004 Statistics*, Ottawa. Statistics Canada, 2008, *Industrial Water Survey, 2005*, Catalogue no. 16-401-X. Statistics Canada, 2009, *Survey of Drinking Water Plants, 2005 to 2007*, Catalogue no. 16-403-X. Statistics Canada, 2009, “Agricultural Water Use Survey 2007, Methodology Report,”*Environment Accounts and Statistics Analytical and Technical Paper Series*, Catalogue no. 16-001-M2009008.

3.1.1 Water use by sector

Thermal-electric power generation

The Thermal-electric power generation sector, which is composed of nuclear and fossil fuel powered generating stations, withdrew the most freshwater in Canada in 2005. These generating stations draw large quantities of water, usually from surface water bodies, to aid in the cooling processes required for electricity generation. The use of water for cooling results in evaporation, accounting for much of the water consumed by this sector. Thermal-electric power generation used 66% (27.8 km^3) of a total of 42 km^3 of freshwater withdrawn in 2005 (Table 3.1). This sector recirculates a considerable portion of the water it withdraws. In 2005 the volume of water recirculated was about 15% of the total water that was withdrawn from the environment by this sector.[3]

Manufacturing industries

Manufacturing industries use water in numerous production activities, such as processing, cleaning and cooling. Water can also be added to the content of final products. In 2005, the manufacturing sector used the second largest amount of water, accounting for 14% (5.7 km^3) of total water withdrawals (Table 3.1). Public utilities provided 10.8% of this water in 2005 and 13.2% in 2007.[4] The largest user within the manufacturing sector in 2005 was Paper manufacturing with total water withdrawals of 45%, or 2.56 km^3, of the manufacturing share, followed by Primary metal industries with 28%, and Chemical manufacturing with 9% (Table 3.2).

As a group the manufacturing industries re-circulated just over one half of their water intake. In 2005, the Petroleum and coal product manufacturing industry had the highest recirculation rate at 140%—it reused water withdrawn from the environment more than any other manufacturing industry, before this water was either discharged or consumed by its manufacturing processes. The portion of intake water consumed by this industry, at 12%, was comparable to the rates of other industries in this sector (Table 3.2).

See footnote(s) at the end of the section.

From 2005 to 2007, water intake decreased in 13 of the 16 industries surveyed (Table 3.3). Two manufacturing industries have notably higher water use than any other industries in this sector (Table 3.3). Water intake for the Paper manufacturing industry was 1,960 Mm^3 in 2007 followed by 1,183 Mm^3 for the Primary metal manufacturing industry. Industries with the next highest water intakes were Chemical manufacturing, with an intake of 437 Mm^3, Petroleum and coal product manufacturing, with an intake of 373 Mm^3, and Food manufacturing, with an intake of 291 Mm^3 in 2007.

Table 3.2

Characteristics of water use in manufacturing industries in Canada, by water use parameter, 2005

	Intake	Share of intake	Recirculation	Share of intake recirculated	Gross water use	Discharge	Consumption	Consumption as share of intake
	Mm^3	percent	Mm^3	percent	Mm^3			percent
Total, all industries	**5,719.5**	**100.0**	**3,164.1**	**55.3**	**8,883.6**	**5,069.4**	**650.1**	**11.4**
Paper manufacturing	2,564.8	44.8	976.3	38.1	3,541.0	2,432.3	132.5	5.2
Primary metal manufacturing	1,582.7	27.7	1,221.5 E	77.2	2,804.3	1,347.8	234.9	14.8
Chemical manufacturing	497.1	8.7	F	F	F	365.1	132.1	26.6
Petroleum and coal product manufacturing	356.6	6.2	498.4	139.8	855.0	315.0	41.6	11.7
Food manufacturing	297.5	5.2	51.1	17.2	348.6	268.5	29.0	9.7
Wood product manufacturing	123.6 E	2.2	F	F	F	92.2 E	31.4	25.4
Beverage and tobacco product manufacturing	83.0	1.5	2.5	3.0	85.5	67.9	15.1	18.2
Non-metallic mineral product manufacturing	63.6	1.1	47.2 E	74.2	110.8	42.7	21.0	32.9
Fabricated metal product manufacturing	38.4	0.7	x	x	x	36.8	1.6	4.3
Plastics and rubber products manufacturing	35.2	0.6	F	F	F	31.5	3.7	10.5
Transportation equipment manufacturing	30.6	0.5	0.4	1.2	30.9	28.6	1.9	6.3
Other manufacturing industries [1]	21.2 E	0.4	F	F	F	18.8 E	2.4	11.5
Textile mills	11.4	0.2	3.0 E	26.8	14.4	9.7	1.7	14.6
Machinery manufacturing	5.7	0.1	0.1	1.8	5.8	5.4	0.3	6.0
Textile product mills	5.2 E	0.1	0.4	7.7	5.6	4.6 E	0.6	11.5
Miscellaneous manufacturing	2.8	0.0	F	F	F	2.5	0.3	9.9

1. Includes Clothing, Leather, Printing, Computer and electronic product manufacturing, Electrical equipment, appliance and component manufacturing and Furniture in 2005. Computer and electronic product manufacturing and Electrical equipment, appliance and component manufacturing appear separately in 2007.

Note(s): Figures may not add up to totals due to rounding.

Source(s): Statistics Canada, CANSIM table 153-0047 (accessed August 9, 2010).

Table 3.3
Selected water use parameters for manufacturing industries in Canada

	Intake			Consumption		
	2005	2007	Change 2005 to 2007	2005	2007	Change 2005 to 2007
	Mm^3		percent	Mm^3		percent
Manufacturing	**5,719.5**	**4,573.1**	**-20.0**	**650.1**	**451.6**	**-30.5**
Paper manufacturing	2,564.8	1,959.8	-23.6	132.5	86.9	-34.4
Primary metal manufacturing	1,582.7	1,182.9	-25.3	234.9	132.7	-43.5
Chemical manufacturing	497.1	436.9	-12.1	132.0	89.9	-31.9
Petroleum and coal product manufacturing	356.6	372.8	4.5	41.6	42.3	1.7
Food manufacturing	297.5	291.2	-2.1	29.0	36.5	25.9
Wood product manufacturing	123.6 E	96.4	-22.0	31.4	15.2	-51.6
Beverage and tobacco product manufacturing	83.0	65.6	-21.0	15.1	16.6	9.9
Non-metallic mineral product manufacturing	63.6	43.0	-32.4	20.9	15.2	-27.3
Fabricated metal product manufacturing	38.4	26.2 E	-31.8	1.6	2.4	50.0
Transportation equipment manufacturing	30.6	24.5	-19.9	2.0	2.1	5.0
Plastics and rubber products manufacturing	35.2	22.1 E	-37.2	3.7	3.6	-2.7
Other manufacturing industries [1]	21.2 E	21.7 E	2.4	2.4	3.4	41.7
Computer and electronic product manufacturing [2]	..	6.7	..	..	0.4	..
Miscellaneous manufacturing	2.8	5.8	107.1	0.3	0.4	33.3
Textile mills	11.4	5.3 E	-53.5	1.7	0.5	-70.6
Machinery manufacturing	5.7	4.6	-19.3	0.3	0.6	100.0
Electrical equipment, appliance and component manufacturing [2]	..	4.4	..	..	2.1	..
Textile product mills	5.2 E	3.1	-40.4	0.6	0.6	0.0

1. For 2005 includes Clothing, Leather, Printing, Computer and electronic product manufacturing, Electrical equipment, appliance component manufacturing and Furniture. For 2007, Computer and electronic product manufacturing and Electrical equipment, appliance component manufacturing appear separately.
2. Included in Other manufacturing industries in 2005.

Note(s): Figures may not add up to totals due to rounding.
Source(s): Statistics Canada, CANSIM table 153-0047 (accessed September 7, 2012).

Wastewater

Wastewater refers to water that is returned to the environment after being used during some activity or process. Treatment to remove contaminants may occur before wastewater is discharged into the environment or it may be discharged untreated. Treatment can occur on-site, however wastewater discharged to a sanitary sewage system may travel long distances before it reaches a treatment system and is released into the environment.

Sewage systems carry more than domestic wastewater—they may also receive waste from the commercial, industrial and institutional sectors, as well as water that runs off of roofs and pavement and enters storm sewers.[5] More than three-quarters of Canadian households were connected to a municipal sewage collection system in 2006.[6] According to an inventory done in 2009 there are over 2,100 sewage treatment plants in Canada (Table 3.4).

Different wastewater treatment systems provide varying levels of wastewater treatment, using physical, biological and chemical processes. Primary treatment involves basic sedimentation of solid materials. Secondary and tertiary treatment can use a variety of other processes to improve effluent quality, including secondary sedimentation (aeration), filtration, nutrient removal and disinfection. In 2004, wastewater treatment was at secondary level or better, for approximately 74% of the population connected to sanitary sewers.[7] Larger communities are more likely to have higher levels of wastewater treatment.

Some substances are difficult to remove from wastewater. For example, scientists have discovered residues from pharmaceutical products in bodies of water.[8] These substances may be excreted or flushed down the drain, ending up in wastewater and ultimately in rivers and lakes. In 2005, 11% of households with leftover or expired medications reported that they disposed of these drugs by flushing them down the drain or toilet or burying them.[9]

In 2006, 19% of Canadian households not living in apartments used private septic systems.[10] Septic systems release nitrogen and phosphorus into the environment, and can be a source of groundwater contamination. However, septic tank maintenance can minimize these environmental impacts. In 2006, one-quarter of households with septic systems reported they performed maintenance every four or more years, 43% reported performing maintenance every two to three years, and 21% performed maintenance at least annually. Six percent of households reported they had never pumped or maintained their septic system.[10] The Canadian Mortgage and Housing Corporation recommends that maintenance be done every three to five years or when one-third of the tank volume is filled with solids.[11]

Industry is also a major water user and often needs to treat effluent prior to discharge. In 2006, industry invested $249 million on pollution abatement and control to reduce pollution of surface water.[12] The Manufacturing, Mineral extraction and Thermal-electric power generation industries discharged 32,793 Mm^3 of water in 2007. Thermal-electric plants were responsible for the majority (83%) of this discharge. Most water (88%) was discharged into surface water bodies and was not treated before discharge.[3]

Manufacturers discharged 4,122 Mm^3 of water in 2007, mostly into surface water bodies (77%) and into public sewer systems (11%).[4] Of the water discharged by manufacturers, 33% was not treated before being released. Seventeen percent of effluent received primary treatment, 44% underwent secondary or biological treatment and 7% underwent tertiary treatment.

Mineral extraction industries discharged 755 Mm^3 of water in 2007. Most of this wastewater was discharged into surface water bodies (66%), with 16% going into groundwater and 11% into tailing ponds. More than half the wastewater discharged into surface water bodies and groundwater was not treated.[3]

Residential

Drinking water plants treat water that is supplied to commercial, institutional, industrial and residential users. In the residential sector, water is distributed to households for personal use, and some examples of how this water is used include drinking, bathing, cleaning, and watering lawns. In 2007, 86% of households received their water from a municipal water supply and 12% had a private well.[13]

According to an inventory of drinking water plants that serve communities of 300 or more people, there were more than 2,000 drinking water plants in Canada in 2009 (Table 3.4), serving 28 million Canadians. Drinking water plants, and the associated distribution systems, are run by water utility operators, who test and treat water to ensure it is safe for human consumption. Provincial and territorial governments have enacted legislation to ensure safe and high-quality drinking water based on Health Canada published *Guidelines for Canadian Drinking Water Quality*.[14,15] Approximately 88% of water processed by drinking water plants was from surface water sources, 10%

was from groundwater and 2% was from groundwater under the direct influence of surface water (GUDI).[1]

In 2007, $807 million were spent on operation and maintenance for the acquisition and treatment of water at drinking water plants. The largest component of these expenses was labour ($302 million), while materials and energy costs represented $198 million and $199 million, respectively.[1]

Water withdrawals for the residential sector were the third largest overall with 9% of total water use (3.8 km^3) in 2005 (Table 3.1). This volume represents a per capita residential water use of 117 m^3 per year or 320 litres per person per day (L/day) in 2005. This value overestimates household use however, as some of the water allocated to the residential sector is used by other sectors of the economy, such as businesses or institutions. Additionally, national estimates of leakages from water distribution systems are difficult to determine as some provinces do not meter water to the same extent as others. Quebec is one of the most populated provinces in Canada but only meters 17% of residential clients and 37% of business clients using public water utilities.[16] The National Water and Wastewater Benchmarking Initiative looked at water use in households supplied by 34 water utilities across Canada, and found that the median volume of water used was 243 L /day in 2007.[17]

Conventional plants and direct filtration plants produced 55% of treated water in 2007, and provided water to 16.5 million people. Conventional water treatment has been established for over 100 years, and was responsible for treatment of 47% of water produced by drinking water plants in Canada in 2007. Conventional and direct filtration treatment plants use various physical and chemical processes to filter water. The only difference between the two is that conventional plants use sedimentation processes, while direct filtration plants do not.[18] These plants also use processes of disinfection, typically chlorination, to destroy pathogens in the water. A further 24% of water is treated using disinfection processes without filtration. Other more advanced membrane filtration technologies were used in the production of 4% of treated water. In 2007 operating and maintenance costs for conventional and direct filtration plants were $161 and $139 per thousand cubic metres of production, while these costs for systems that used only membrane filtration were $315 per thousand cubic metres of production.[1]

Agriculture

The agricultural sector was responsible for 4.6% (almost 2 km^3) of total water withdrawals in 2005 (Table 3.1). The bulk of this water was used to irrigate crops, with a balance of 16% going to support livestock production.

Crops rely on soil moisture for growth. Soil moisture is replenished by precipitation or through irrigation. Irrigation helps to make up for a lack of moisture in the soil during periods of little rain, and contributes to higher and more predictable crop yields. While most crops in Canada are rain-fed, some are dependent on irrigation.

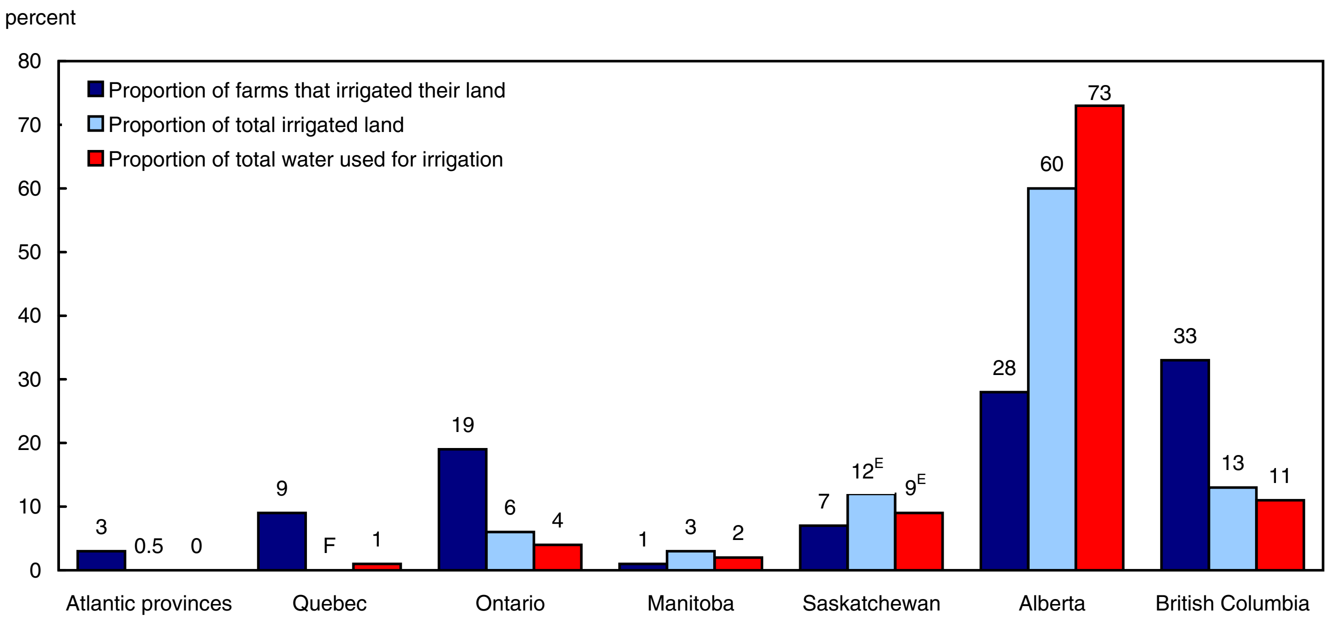
See footnote(s) at the end of the section.

Table 3.4
Drinking water plants and sewage treatment plants in Canada, by population served, 2009

	Drinking water plants	Sewage treatment plants
	number	
Population served		
Total	**2,018**	**2,113**
300 to 500	364	390
501 to 5,000	1,226	1,272
5,001 to 50,000	337	366
more than 50,000	91	85

Note(s): Includes public facilities that serve communities of 300 or more people. It does not include Federal systems nor facilities administered by Indian and Northern Affairs Canada.
Source(s): Statistics Canada, Environment Accounts and Statistics Division, 2009, special tabulation.

Chart 3.1
Distribution of irrigation, by province, 2007



Source(s): Statistics Canada, 2009, "Agricultural Water Use Survey 2007, Methodology Report," *Environment Accounts and Statistics Analytical and Technical Paper Series*, Catalogue no. 16-001-M2009008.

According to the 2006 Census of Agriculture, 844,975 hectares of farmland were irrigated in Canada in 2005.[19] In 2007, according to the Agricultural Water Use Survey, the bulk of irrigation withdrawals occurred in the more arid Western regions. Sixty percent of the area irrigated in Canada was found in Alberta, followed by British Columbia (13%) and Saskatchewan (12%) (Chart 3.1). Farms in Alberta also used more water per unit of irrigated land than farms in other provinces.

Alberta was also the lead water user when it came to the volume of water used for irrigation, accounting for 73% of the total volume of water used for irrigation in 2007 (Chart 3.1). Together, British Columbia and Saskatchewan used an additional 20%. In comparison, farms in the Atlantic provinces and Quebec used very little water for irrigation. Agriculture occurs in these provinces, but farms tend to receive more rainfall than their counterparts to the west.

System of Environmental–Economic Accounting for Water (SEEA-W)

The System of Integrated Environmental and Economic Accounting,[20] developed by the United Nations, brings together economic and environmental information in a common framework to measure the contribution of the environment to the economy and the impact of the economy on the environment. A number of different types of accounts, including stocks, assets, and flows, are described in this system, and these accounts can be measured in physical or monetary terms. The data presented in Table 3.1 are physical flows of water and document national water use for the whole economy. Returns of water from the economy to the environment are included for manufacturing industries (Table 3.2).

Abstraction is defined as the amount of water used for the purpose of production and consumption activities, and includes water abstracted from the soil, and water used for hydro-electric generation. Furthermore, once the water used in the generation of hydro-electricity is returned to the environment it is to be included in subsequent abstraction downstream. The implication for hydro-electric generation is that the same volume of water can be counted several times as it passes through successive downstream turbines. Water resources are defined as the water found in fresh and brackish surface water and groundwater bodies within the national territory. The water of the oceans and open seas is excluded on the grounds that the volumes involved are so enormous that any measure of their stock becomes meaningless and that extraction for human use has no measurable impact on these volumes.

Source(s): United Nations Statistics Division, 2007, *System of Environmental-Economic Accounting for Water*, *http://unstats.un.org/unsd/statcom/doc07/SEEAW_SC2007.pdf* (accessed August 10, 2010).

The international water accounting guidelines (Textbox: "**System of Integrated Environmental and Economic Accounting for Water**") uses the term 'abstracted water' to measure both water used by crops that falls as precipitation and water applied through irrigation. Irrigation estimates reflect only the water withdrawn from a water body and applied to crops, while water abstraction is a calculation of all the water that contributes to the crop production. Estimates were calculated, with crop yield data and coefficients specific to Canada, to determine how much water the environment contributed to crop growth, i.e. to estimate how much water was required by crops.

In 2005, irrigation accounted for only 1.8% of the total abstracted water that contributed to crop growth.[21] Water requirements vary by crop type, with wheat, oilseed and feed grain using the most water in both 2005 and 2007 due to the large area of these crops that was planted (Table 3.5). The decrease in water embedded in crops in 2007 can be explained by lower wheat yields. In 2007, wheat yields were down 400 kg compared to the 2,700 kg per hectare realized in 2005.[22] In 2005, the precipitation that supported crop growth was roughly twice the volume of water that was withdrawn annually by all sectors of the economy (Table 3.1).

See footnote(s) at the end of the section.

Table 3.5
Total water requirements for agricultural production in Canada

	Total water supplied by the environment	
	2005	2007
	Mm3	
Total	**89,590.3**	**80,120.8**
Crop production (except greenhouse, nursery and sod)	89,077.5	79,612.0
Wheat	38,390.4	29,900.5
Feed grain	19,357.2	20,264.8
Oilseed	22,863.3	21,793.6
Potatoes	470.0	529.9
Fruits and vegetables	5,964.4	5,100.0
Other Crops	2,032.1	2,023.1
Greenhouse, nursery and sod	191.5	202.5
Animal production (excluding aquaculture)	321.3	306.4
Dairy	44.2	42.2
Cattle	192.6	182.6
Hogs	55.3	52.4
Poultry and eggs	12.6	12.9
Other livestock	16.6	16.2

Note(s): Figures may not add up to totals due to rounding.
Source(s): Alberta Agriculture, Food and Rural Development, 2000, "Farm water supply requirements,"*Agri-Facts*. BPR Groupe-conseil, 2003, *Analyse des questions d'approvisionnement en eau pour le secteur de l'agriculture*, Rapport préparé pour Agriculture et Agroalimentaire Canada. British Columbia Ministry of Agriculture and Lands, 2006, "Livestock watering factsheet,"*Livestock Water Requirements – Quantity and Quality*. Chapagain, A.K. and A.Y. Hoekstra, 2004, "Water footprints of nations,"*Value of Water Research Report Series*, no. 16, UNESCO-IHE, Delft, the Netherlands. Ecologistics Limited, 1993, *A Review of Water Use and Water Use Efficiency in Ontario Agriculture - Final Report*, Water Efficiency Ontario, Agricultural Working Group, Ontario Ministry of Agriculture and Food, Guelph, Ontario. Fournier, Alain, 1999, *Guide d'estimation des besoins d'eau pour les bovins laitiers*, Ministère de l'agriculture, des pêcheries et de l'alimentation du Québec, *www.agrireseau.qc.ca/bovinslaitiers/* (accessed March 24, 2010). Ontario Ministry of Agriculture, Food and Rural Affairs, 2007, *Water Requirements of Livestock*, *www.omafra.gov.on.ca/english/engineer/facts/07-023.htm* (accessed March 24, 2010). Prairie Farm Rehabilitation Administration, 2003, *Water requirements for pastured livestock*, *www4.agr.gc.ca/AAFC-AAC/display-afficher.do?id=1237489569438&lang=eng* (accessed March 24, 2010). Statistics Canada, CANSIM tables 001-0009, 001-0010, 001-0013, 001-0014, 003-0004, 003-0018, 003-0031 and 003-0032 (accessed July 10, 2009). Statistics Canada, 2008, *Alternative Livestock on Canadian Farms*, Catalogue no. 23-502-X. Statistics Canada, 2007, *Farm Data and Farm Operator Data*, 2006 Census of Agriculture, Catalogue no. 95-629-X. Statistics Canada, *Greenhouse, Sod and Nursery Industries*, Catalogue no. 22-202-X, various issues. Beaulieu, M.S., C. Fric and F. Soulard, 2007, "Estimation of Water Use in Canadian Agriculture in 2001,"*Agriculture and Rural Working Paper Series*, Statistics Canada Catalogue no. 21-601-M2007087.

3.1.2 In-stream water use

Sectors that use in-stream water are also very important to the Canadian economy. Results of the Travel Activity and Motivation Survey indicated that 31% of adult Canadians reported swimming or boating while on an out-of-town, leisure trip of one or more nights in 2004 or 2005, and 27% reported that this activity was the main reason for taking at least one trip in those two years.[23] Similarly, 18% of adult Canadians went fishing while on an out-of-town trip of one or more nights in 2004 or 2005, and 49% reported that fishing was the main reason for taking at least one trip in those two years.[24]

See footnote(s) at the end of the section.

Dams and reservoirs

The first large dam in Canada (the Jones Falls Masonry Dam on the Rideau Canal in Ontario) was completed in 1832. However, it was the development of commercial hydro-electric power in the early 1900s that resulted in the growth in the number of these massive structures.[25] In 2008, hydro-electricity represented 62% of all electricity generated in Canada.[26]

The Daniel Johnson Dam, with 12 generating units capable of producing 2,660 MW of electricity,[27] holds the largest reservoir by volume in Canada. This reservoir, located on the Manicouagan River in Quebec, has a gross capacity of 142 km^3 of water, making it one of the largest in the world.[25]

In recent years, the creation of tailing ponds has become an important new reason for building large dams.[28]

Water transportation and fishing

Water transportation and fishing are important in-stream water uses. Shipping relies on both natural water ways and canal systems. In 2007, 468.6 million tonnes of freight were handled and 38 million passengers were carried across Canadian waters (Table 3.6). Forty-one percent of this freight was handled by Canadian ports in the Great Lakes and St. Lawrence regions.[29,30]

Fishing includes commercial and recreational activities. Commercial fish landings from freshwater sources contribute to the Canadian food supply, and are also exported. In 2007, 32,303 tonnes were caught and landed nationally (Table 3.7). In 2005, recreational fishers spent a total of 39.8 million days fishing in Canada—90% were Canadians and 10% were non-Canadians. Anglers who fished within the same jurisdiction as they lived spent an average of 15.4 days fishing in 2005, while tourists from outside the country fished for an average of 7 days.[31]

See footnote(s) at the end of the section.

Table 3.6
Water transport

	Freight loaded		Freight unloaded		Total freight handled	Containerized freight handled		Movement of freight	Passengers transported by ferry
	Domestic	International	Domestic	International		Domestic	International		
	millions of tonnes							millions of tonne-kilometres [1]	millions of passengers
1988	70.0	171.1	70.0	78.9	389.9	1.6	12.6	1,711,417	..
1989	62.0	159.1	62.0	80.3	363.4	1.4	12.1	1,644,117	38.7
1990	60.4	159.0	60.4	73.3	353.1	1.3	12.3	1,614,007	40.8
1991	57.9	168.0	57.9	66.1	349.9	0.8	12.2	1,708,082	40.4
1992	52.3	153.8	52.3	69.3	327.7	1.0	12.6	1,578,228	40.0
1993	50.4	152.6	50.4	71.6	325.0	0.9	13.3	1,561,072	41.2
1994	52.2	170.0	52.2	76.9	351.3	0.8	14.7	1,697,225	43.2
1995	50.4	176.5	50.4	83.2	360.5	0.8	15.6	1,775,238	42.0
1996	48.8	174.3	48.8	85.6	357.5	0.8	17.1	1,781,143	39.8
1997	46.7	187.9	46.7	94.7	376.0	1.0	18.8	1,967,095	38.2
1998	48.3	179.0	48.3	100.4	376.0	0.9	19.7	1,876,328	37.3
1999	52.2	179.6	52.2	101.6	385.6	0.9	22.5	1,881,141	39.2
2000	54.5	187.8	54.5	105.9	402.7	0.9	24.0	1,969,105	38.5
2001	53.9	174.7	53.9	112.1	394.6	0.9	23.5	1,872,856	39.0
2002	62.8	174.3	62.6	108.5	408.2	1.0	25.6	1,765,822	39.4
2003	68.6	191.4	68.5	115.3	443.8	1.0	28.2	1,966,611	38.9
2004	69.1	196.0	69.1	119.0	453.3	1.1	31.2	2,045,068	38.8
2005	70.1	201.8	70.2	129.2	471.3	1.0	31.9	2,206,469	38.4
2006	68.1	206.0	68.1	124.1	466.3	1.0	33.0	2,257,962	38.4
2007 p	67.5	214.0	67.4	119.7	468.6	1.0	36.2	2,218,259	38.0 [2]

1. The movement of one tonne over a distance of one kilometre.
2. Estimated

Source(s): Statistics Canada, Transportation Division, *Shipping in Canada*, Catalogue no. 54-205-X, various issues. Transport Canada, Surface and Marine Statistics and Forecasts, 2009, special tabulation.

Table 3.7
Landed catch and value of freshwater fisheries

	Catch	Value
	tonnes (live weight)	thousands of dollars
1990	44,718	66,413
1991	49,179	73,403
1992	38,009	71,794
1993	37,855	59,529
1994	36,077	72,337
1995	38,756	77,737
1996	38,295	69,249
1997	38,798	70,505
1998	40,744	83,092
1999	40,566	82,505
2000	40,573	86,820
2001	38,025	79,618
2002	40,531	85,418
2003	36,969	71,504
2004	36,207	63,793
2005	32,286	66,117
2006	32,234	67,885
2007	32,303	63,570

Source(s): Fisheries and Oceans Canada, 2009, *Commercial Fisheries, Landings, Summary Tables*, *www.dfo-mpo.gc.ca/stats/commercial/land-debarq/sum/sum-tab-eng.htm* (accessed March 24, 2010).

3.2 Using final demand to estimate virtual water content

The virtual water associated with a commodity, an industry or even the entire economy of a nation, expresses the amount of water that has contributed to economic production. It makes water use explicit, and also allows comparisons of the amount of water required to produce commodities in different locations. Furthermore, looking at the virtual water content of a nation's exports provides insight into how this natural resource is being drawn on and allows some quantification of how it contributes to the economy.

Industry uses water as part of the process of providing goods and services to consumers. By using the industry and commodity relationships detailed in the input-output model (Textbox: **"Application of the Input-output model to water use"**), it is possible to associate industrial uses of water with the commodities that are produced and with the consumers that purchase those commodities.[32] These final deliveries to consumers in the economy are termed final demand (Textbox: **"Final demand"**).

According to the United Nations System of Integrated Environmental–Economic Accounting for Water (SEEA-W), total water use includes water that is directly abstracted and water that is received from other economic units (Textbox: **"System of Integrated Environmental–Economic Accounting for Water")**. This accounting includes water-use for hydro-electric generation and the water absorbed by forests and agricultural crops, from both irrigation and precipitation.

Application of the Input-output model to water use

The data used to produce estimates of the water use to satisfy final demand are derived from Statistics Canada's *Material and Energy Flow Accounts* (MEFA), which integrate environmental data with the economic data from the Canadian System of National Accounts (CSNA). The CSNA is the source of a number of Statistics Canada's most important indicators of economic activity, including gross domestic product. The input-output (I/O) accounts are one of the main components of the CSNA, and produce highly detailed production and consumption statistics for 303 industries, 719 goods and services and 170 categories of final demand.

The MEFA follow the I/O accounting framework to track the use of water by each industry and final demand sector. The flows are linked through the common industrial and commodity classification of the I/O tables. This linkage allows analysis of the interplay between economic activity and water use.

Final demand

Domestic demand

Personal expenditure: Household spending on new consumer goods and on consumer services, plus any mark-up on used goods. This includes expenditures by individuals, families and private non-profit organizations serving households.

Machinery and equipment: Capital expenditures on durable, tangible goods with an expected service life of one year or more, such as furniture, motor vehicles, office machines and equipment not permanently installed (permanently built-in equipment belongs to non-residential construction). Includes installation and delivery costs.

Construction: Construction of industrial, commercial and institutional buildings, dwellings, garages, cottages and mobile homes. Includes new construction, conversions resulting in a structural change, major renovations, permanently built-in equipment and site preparation.

Government expenditure: Economic activities of the federal government (including defence), the provincial and territorial governments, local (municipal) governments, universities, colleges, vocational and trade schools, publicly funded hospitals and residential care facilities, and publicly funded schools and school boards.

Inventories: Stocks of outputs that are still held by the units that produced them prior to their being further processed, sold or delivered to other units or used in other ways, and stocks of products acquired from other units that are intended to be used for intermediate consumption or for resale without further processing.

External demand

Exports: The sale of goods and services to buyers in other countries. Services include travel, freight and shipping, business services, government transactions, financial intermediation and other services.

Source(s): Statistics Canada, 2008, Guide to the *Income and Expenditure Accounts*, Catalogue no. 13-017-X.

3.2.1 Water use to supply final demand

Canada is one of the largest producers of hydro-electricity in the world. In 2008, hydro-electricity represented 62% of all electricity generated in Canada (Table 3.8). The volume of water used for hydro-electric generation in Canada is many times larger than all other uses of water in the country. Hydro-electric generation in Canada made use of approximately 3 trillion cubic metres of water in 2005.[21] This is more than 100 times the volume of water used by the Thermal-electric power generation sector, and just over 70 times the total volume of all water used in Canada in 2005 (Table 3.1).

Including hydro-electric water use in the analysis of water use elevates the importance of the use of electricity in the estimates. Any use of electricity in provinces with hydro-electric generation triggers large amounts of indirect water use by the electricity consumers. The proportion that utilities contribute to personal expenditure and exports increases considerably if in-stream water used for hydro-electric generation is included (Table 3.9). Including this volume in the water use estimates quickly changes the story of water use into a story of electricity consumption.

The following analysis estimates water use to satisfy final demand, and excludes the water used for hydro-electric generation. Estimates are shown with and without precipitation to allow for the comparison of the use of water provided by the environment (an ecosystem service) with the water withdrawn from the environment. For details of the methodology please consult the textbox "**Estimates of abstracted water".**

When water used to generate hydro-electricity was excluded the total domestic demand for water decreased by 82%. When precipitation was also excluded, domestic demand for water was only 1.1% of the water use value that included hydro and precipitation (Table 3.10). Personal expenditures were the largest contributor to water use from a demand perspective—industrial production to meet household demand for goods and services was the cause of 47% of water use.

Estimates of abstracted water

The estimates of industrial water use include both water extracted by drinking water plants and provided to industry, and water extracted by industries for their own use.[3]

Estimates of the amount of water that supports agricultural production are detailed in Section 3.1.1 under *Agriculture*, and in Table 3.5.

For forestry, Natural Resources Canada estimates that approximately 4,000 m^3 of water are required per hectare (ha) each year to maintain the trees on forested land.[33] This is equivalent to a water abstraction estimate of about 500 million m^3 when applied to the 128.7 million ha of productive, accessible and non-reserved forest land.[34] This figure represents the total amount of water required to maintain the productive stock of trees in Canada, from which timber is extracted to contribute to the economy.

The challenge in estimating forest water use is compounded by conceptual issues related to water flows through time. Clearly, the entire forest is not harvested each year, so the amount of water flowing through that total area is not representative of the water required to produce a given year's timber harvest. Instead, the virtual water related to a given quantity of harvested wood is represented by the total amount of water required throughout the lifetime of the tree prior to harvesting. Based on figures from Natural Resources Canada, the 2005 timber harvest of 203,325,000 m^3 required between 400 and 600 billion m^3 of lifetime water uptake. Thus the estimate of 500 km^3 of water used for forestry approximates both the current flow estimate for the entire productive, non-reserved accessible area, and the virtual water content of the harvested wood.

Table 3.8
Electric and hydro-electric power generation by province and territory

	1996			2008		
	Total hydro generation	Overall total generation	Hydro as share of total	Total hydro generation	Overall total generation	Hydro as share of total
	megawatt hours		percent	megawatt hours		percent
Canada	**351,156,044**	**551,888,213**	**63.6**	**372,883,539**	**603,059,380**	**61.8**
Newfoundland and Labrador	35,335,636	36,816,509	96.0	41,733,865	43,161,902	96.7
Prince Edward Island	.	8,824	.	.	106,019	.
Nova Scotia	1,151,343	9,985,274	11.5	1,090,126	12,164,400	9.0
New Brunswick	3,472,200	15,367,673	22.6	3,489,092	14,156,182	24.6
Quebec	164,470,105	170,520,308	96.5	186,400,534	192,569,564	96.8
Ontario	41,268,967	146,584,844	28.2	39,892,188	159,530,002	25.0
Manitoba	30,865,154	31,172,371	99.0	34,588,507	35,144,419	98.4
Saskatchewan	4,385,764	16,512,150	26.6	4,029,843	18,955,933	21.3
Alberta	2,254,239	51,816,853	4.4	2,311,236	60,236,096	3.8
British Columbia	67,329,201	71,764,713	93.8	58,773,685	65,824,059	89.3
Yukon	361,175	499,962	72.2	345,872	369,934	93.5
Northwest Territories including Nunavut	262,260	838,732	31.3	..	..	..
Northwest Territories	..	..	..	228,591	685,607	33.3
Nunavut	..	..	..	0	155,263	0.0

Note(s): Figures may not add up to totals due to rounding.
Source(s): Statistics Canada, CANSIM tables 127-0001 and 127-0002 (accessed May 1, 2009).

See footnote(s) at the end of the section.

Table 3.9
Water use to satisfy final demand, including hydro, 2005

	Including precipitation and hydro-electric power generation	
	Mm^3	percent
Internal demand	**2,043,138**	**58.0**
Personal expenditure	1,516,777	43.1
Machinery and equipment	57,978	1.6
Inventories	181,986	5.2
Construction	42,693	1.2
Government	243,703	6.9
External demand		
Exports	1,476,898	42.0
Total demand for water	**3,520,036**	**100.0**

Source(s): Statistics Canada, Environment Accounts and Statistics Division, Material and Energy Flow Accounts, 2010, special tabulation.

Table 3.10
Water use to satisfy final demand, excluding hydro-electric power generation, 2005

	Including precipitation		Excluding precipitation	
	Mm^3	percent	Mm^3	percent
Internal demand	**211,068**	**33.7**	**24,118**	**63.0**
Personal expenditure	98,727	15.8	18,003	47.0
Machinery and equipment	6,890	1.1	731	1.9
Inventories	71,107	11.4	1,732	4.5
Construction	19,417	3.1	483	1.3
Government	14,927	2.4	3,169	8.3
External demand				
Exports	414,857	66.3	14,169	37.0
Total demand for water	**625,925**	**100.0**	**38,287**	**100.0**

Source(s): Statistics Canada, Environment Accounts and Statistics Division, Material and Energy Flow Accounts, 2010, special tabulation.

3.2.2 Water use to satisfy domestic demand

Households use water directly whenever a tap is turned on. Water is used indirectly when goods and services are purchased that contain water, or are produced using water. Direct water use is a small portion of total household water requirements. It is either 3.7% or 17.3% of total water use depending whether or not precipitation is included in the analysis (Table 3.11).

The inclusion or exclusion of precipitation in the calculations is one way of illustrating the contribution that the natural environment makes to our economy. Without precipitation the production of many exports would not be possible, but typically water in this form is not acknowledged as an input. Further delineation and description of these ecosystem services is needed in order to fully understand the interaction between human activity and the environment.

When precipitation is included, manufactured products other than food account for 36.8% of the domestic demand for water—compared with only 3.6% when precipitation is not included. This reflects both the prevalence of wood and paper products in domestically consumed manufactured goods, and the large amount of water required by forests. Manufacturing of forest products contributed $25.8 billion to Canada's gross domestic product (GDP) in 2005, almost 14% of all manufacturing.[35]

Food products, which accounted for 10% of manufacturing GDP in 2005,[35] and which also require large amounts of water to produce, accounted for 30% of household indirect water use. When precipitation was excluded, electricity consumption triggered the largest indirect water use by households because it is used in Thermal-electric power generation.

3.2.3 Water use to satisfy demand for exports

When precipitation was included, exports required a much larger proportion of total water use, largely due to the water requirements of agricultural crops and trees (Table 3.10). In 2005, exports of forest products amounted to $37.5 billion or 8.6% of total exports, and exports of agricultural commodities amounted to $25.7 billion or 5.9% of total exports.[36] More water however is embedded in forest products than food: the production of exported lumber, wood pulp, paper, and other forest products required seven times more water than the production of exported agricultural commodities. When precipitation was not considered, the share of the Other manufactured goods category decreased, and the Utilities category increased, again because of water use by the Thermal-electric power generation sector (Table 3.12).

See footnote(s) at the end of the section.

Table 3.11
Water used to satisfy the demand of households for goods and services, 2005

	Including precipitation		Excluding precipitation	
	Mm^3	percent	Mm^3	percent
Indirect household water use	**98,727**	**96.3**	**18,003**	**82.7**
Food [1]	29,290	28.6	2,468	11.3
Other manufactured goods	37,716	36.8	786	3.6
Utilities	10,063	9.8	9,479	43.6
Other services	21,658	21.1	5,271	24.2
Direct household water use	**3,771**	**3.7**	**3,771**	**17.3**
Total	**102,498**	**100.0**	**21,774**	**100.0**

1. Includes accommodation and meal services
Source(s): Statistics Canada, Environment Accounts and Statistics Division, Material and Energy Flow Accounts, 2010, special tabulation.

Table 3.12
Water used to satisfy foreign demand, 2005

	Including precipitation		Excluding precipitation	
	Mm^3	percent	Mm^3	percent
Total	**414,857**	**100.0**	**14,169**	**100.0**
Food [1]	52,796	12.7	1,525	10.8
Other manufactured goods	349,203	84.2	9,304	65.7
Utilities	2,682	0.6	2,496	17.6
Other services	10,176	2.5	844	6.0

1. Includes accommodation and meal services.
Source(s): Statistics Canada, Environment Accounts and Statistics Division, Material and Energy Flow Accounts, 2010, special tabulation.

3.3 Relationship between water supply and demand in Canada

As shown in Sections 1 and 2, Canada is endowed with large volumes of renewable freshwater but this supply is unevenly distributed and changing over time. As presented earlier in this section, every aspect of Canada's society relies on water, placing demands on our water resources. The following analysis combines demand and supply by looking at water intake, a proxy for demand, as a proportion of water yield.

The relationship between the timing of demand and supply can be an indicator of the pressure exerted on water resources. When renewable water resources are insufficient to satisfy demand people increase their use of water stocks.

In 2005, total water withdrawals in Canada amounted to 1.2% of the average annual renewable water resources. More pressure, however, was placed on water resources in some areas of the country than in others, with this pressure peaking in summer. Hydrographs presented in Chart 2.6 demonstrate that monthly water yield is lowest in August, which generally coincides with peak municipal demand.

This relationship between supply and demand is illustrated in Map 3.1, which compares water intake for August 2005 with the 34-year median water yield for August by drainage region. The information presented in this map was compiled from Statistics Canada surveys that collected water intake data from Manufacturing, Thermal- electric power generation, Mining and Agriculture (irrigation) industries and from drinking water plants, as well as data on household reliance on non-municipal water. Water intake from the Oil and gas industry was not included in this analysis, as the data for this industry could not be compiled by drainage region. Intake from all sectors was summed for the country by drainage region, divided by the water yield produced in each drainage region, and presented as a categorized ratio.

Greater pressure was exerted on water resources in the Okanagan–Similkameen (drainage region 3), and the Prairies (drainage regions 9, 11 and 12)—where water yield is generally low (Map 3.1). In the Prairies, where stocks are limited, water demand must be met primarily by renewable water, and water shortages are evident when demand exceeds the renewable supply.

The North Saskatchewan (drainage region 10) does not show a similar demand-to-supply ratio to that of the South Saskatchewan (drainage region 11) because it has a higher water yield (Table 2.2), a smaller population (Table 2.3) and less irrigation.

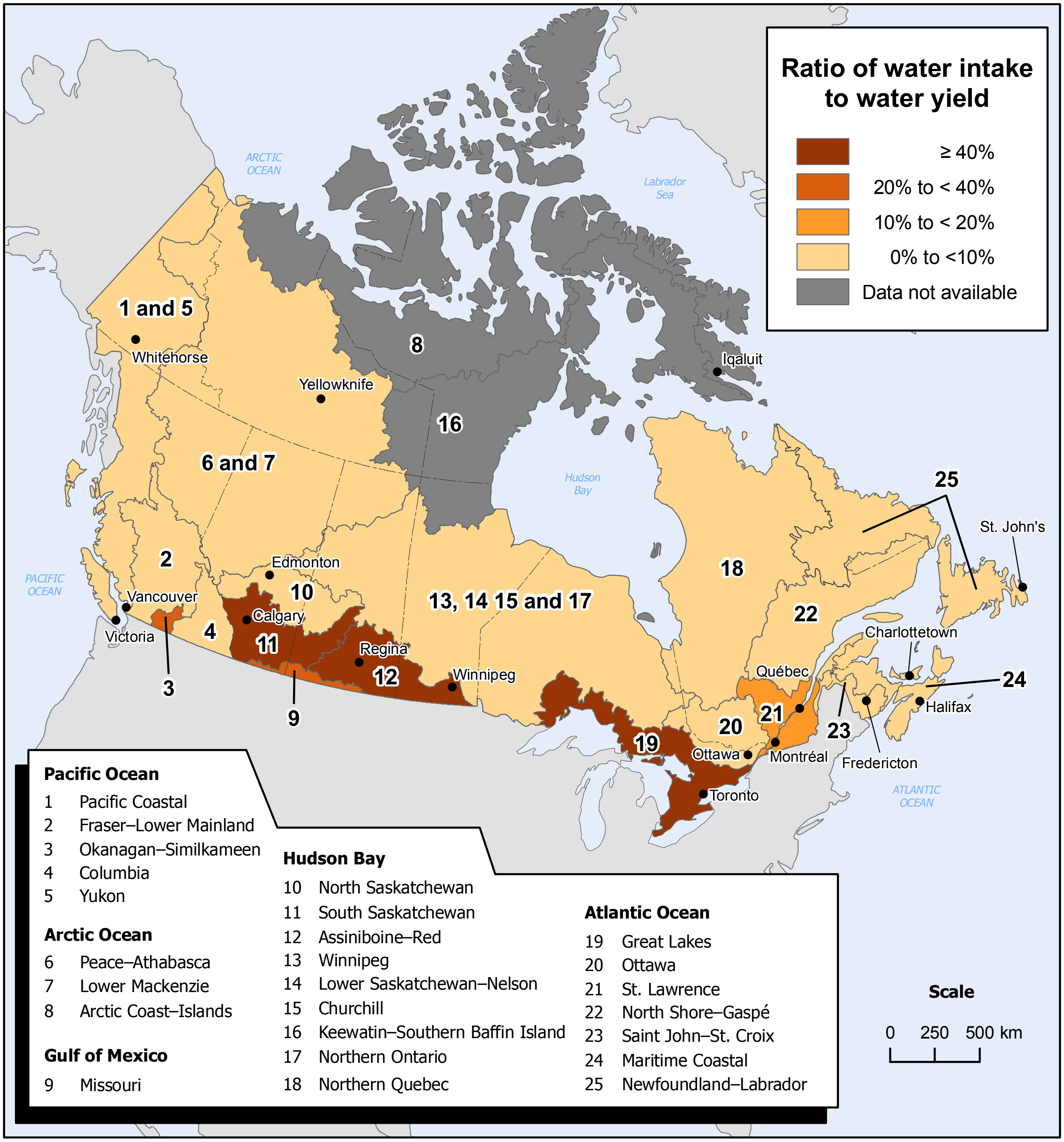
Greater pressure was also noted in the Great Lakes (drainage region 19) and St. Lawrence (drainage region 21)—where population density is highest (Chart 2.1, Table 2.3). The high ratio for the Great lakes (drainage region 19) can be explained by the large volumes of water withdrawn by the Thermal-electric power generation industry that provides power to this region. In contrast, the demands for electricity in the St. Lawrence (drainage region 21) are largely met by hydro-electric power generation—an in-stream water use that was not considered in this analysis.

Even though the Great Lakes drainage region (region 19) has a slightly lower per capita water yield in 2006 (Table 2.3), its residents may not have the same awareness of pressure exerted on their water resources as residents of the Okanagan–Similkameen (drainage region 3). When more freshwater is withdrawn than is generated by the renewable flow within an area, the remainder must be removed from its lake, river and groundwater stocks. In drainage regions 19, 20, and 21 there are significantly more reserves, in the form of the Great Lakes and St. Lawrence River, than are found in the Prairies and interior of British Columbia. The Great Lakes contain more than 6.5 times Canada's total water yield, but less than 1% of this volume is renewed each year.[37] Therefore in the Great Lakes region, where renewable supply is supplemented with stock water, it is less evident when needs are not met through renewable water resources.

Since demand for water is not synchronized with supply, data are needed by geographic region and at a time scale that allows tracking of water use and monitoring of water resources.

See footnote(s) at the end of the section.

Map 3.1
Ratio of August 2005 water intake to the August median water yield for 1971 to 2004



Note(s): The following drainage regions were aggregated to protect confidentiality; Pacific Coastal (1) with the Yukon (5); Peace-Athabasca (6) with the Lower Mackenzie (7); and the Winnipeg (13), Lower Saskatchewan-Nelson (14), Churchill (15) and Northern Ontario (17). Data that contributed to intake volumes (demand) were compiled from Statistics Canada: Industrial Water Survey, 2005; Households and the Environment Survey, 2006; Survey of Drinking Water Plants, 2005 to 2007; and Agricultural Water Use Survey 2007. Data from Agriculture and Agri-Food Canada and Canada Mortgage and Housing Corporation were used to help allocate and derive some intake volumes. Water yield volumes (supply) used for each drainage region are a 34-year median (1971 to 2004) for the month of August.

Source(s): Canada Mortgage and Housing Corporation, 2007, *Household Guide to Water Efficiency*, Product number 61924.
Statistics Canada, Environment Accounts and Statistics Division, 2010, special tabulation.

Notes

1. Statistics Canada, 2009, *Survey of Drinking Water Plants*, *2005 to 2007*, Catalogue no. 16-403-X.
2. Statistics Canada, CANSIM Table 051-0001 (accessed April 15, 2010).
3. Statistics Canada, 2008, *Industrial Water Survey, 2005*, Catalogue no. 16-401-X.
4. Statistics Canada, Industrial Water Survey 2007, special tabulation.
5. Environment Canada, 2008, *Water Pollution*, *www.ec.gc.ca/eau-water/default.asp?lang=En&n=E86BC86A-1* (accessed April 29, 2010).
6. Nelligan, T., 2008, "Household's use of water and wastewater services," *EnviroStats*, vol.2, no. 4, Catalogue no. 16-002-X200800410752.
7. Environment Canada, 2007, *2007 Municipal Water Use Report : Municipal Water Use 2004 Statistics*, *www.ec.gc.ca/water-apps/MWWS/pdf/e_mun2004.pdf* (accessed July 16, 2010).
8. Environment Canada, 2009, *Emerging threats—Pharmaceuticals polluting lakes and rivers*, *www.ec.gc.ca/scitech/default.asp?lang=En&n=64B32D19-1* (accessed June 4, 2010).
9. Statistics Canada, 2008, *Households and the Environment Survey, 2006*, Catalogue no. 11-526-X.
10. Statistics Canada, Households and the Environment Survey, 2006, special tabulation.
11. Canada Mortgage and Housing Corporation, 2010, *Your Septic System*, *www.cmhc-schl.gc.ca/en/co/maho/gemare/gemare_009.cfm* (accessed June 4, 2010).
12. Statistics Canada, 2008, *Environmental Protection Expenditures in the Business Sector*, Catalogue no. 16F0006X.
13. Statistics Canada, CANSIM Table 153-0062 (accessed May 10, 2010).
14. Health Canada, 2010, *Environmental and Workplace Health – Drinking Water*, *www.hc-sc.gc.ca/ewh-semt/water-eau/drink-potab/index-eng.php* (accessed May 7, 2010).
15. Health Canada, 2007, *Water Talk – Drinking Water Quality in Canada*, Catalogue no. H128-1/07-514E, *www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/drink-potab-eng.php* (accessed November 24, 2009).
16. Environment Canada, 2010, *Municipal Water and Wastewater Survey: Municipal Water Use 2006 Summary Tables*, *www.ec.gc.ca/Water-apps/MWWS/pdf/MWWS_2006_WaterUse_May2010.pdf* (accessed May 7, 2010).
17. National Water and Wastewater Benchmarking Initiative, 2009, *Public Report*, *www.nationalbenchmarking.ca/public/docs/Public%20Report%202009.pdf* (accessed July 16, 2010).
18. Department of National Health and Welfare, 1993, *Guidelines for Canadian Drinking Water Quality: Water Treatment Principles and Applications: A Manual for the Production of Drinking Water*, Canadian Water and Wastewater Association, Ottawa.
19. Statistics Canada, 2007, Census of Agriculture: *Farm Data and Farm Operator Data*, Catalogue no. 95-629-X.
20. United Nations Statistics Division, 2010, *Handbook of National Accounting: Integrated Environmental and Economic Accounting 2003 (SEEA)*, *http://unstats.un.org/unsd/envaccounting/seea.asp* (accessed April 28, 2010).
21. Statistics Canada, Environment Accounts and Statistics Division, 2009, special tabulation.
22. Statistics Canada, CANSIM Table 001-0010 (accessed May 4, 2010).
23. Canadian Tourism Commission, 2006, *TAMS—Canadian activity profile: Swimming and boating while on trips*, *http://dsp-psd.pwgsc.gc.ca/collection_2009/ic/Iu86-31-8-2006E.pdf* (accessed on May 13, 2010) .
24. Canadian Tourism Commission, 2006, *TAMS—Canadian activity profile: Fishing while on trips*, *http://dsp-psd.pwgsc.gc.ca/collection_2009/ic/Iu86-31-1-2006E.pdf* (accessed on May 13, 2010) .
25. Canadian Dam Association, 2003, *Dams in Canada CD*, *www.cda.ca/cda_new_en/publications/damCD/damCD.html* (accessed April 21, 2010).
26. Statistics Canada, CANSIM Table 127-0002 (accessed April 30, 2010).

27. Hydro-Québec, 2010, *Hydroelectric Generating Stations*, *www.hydroquebec.com/generation/centrale-hydroelectrique.html* (accessed April 28, 2010).

28. Statistics Canada, 2003, *Human Activity and the Environment*, Catalogue no. 16-201-X, Map 2.1.

29. Statistics Canada, Transportation Division, 2010, special tabulation.

30. The Great Lakes region consists of Canadian ports located along the St. Lawrence River west of the Ontario-Quebec border, and on the Great Lakes. The St. Lawrence River region consists of Canadian ports located on the St. Lawrence River from the Ontario-Quebec border eastward, along the north shore to 63° west longitude and along the south shore to Cap des Rosiers.

31. Fisheries and Ocean Canada, 2007, *Survey of Recreational Fishing in Canada, 2005*, Catalogue No Fs23-522/2005E, *www.dfo-mpo.gc.ca/stats/rec/canada-rec-eng.htm* (accessed February 19, 2010).

32. There are significant regional variations in water use, due to agricultural production and thermal-electric power generation. In order to account for these differences, the standard national input-output table was expanded for this analysis. For agriculture, the crop and livestock industries were expanded into individual crop and livestock types using a detailed study of this industry produced by the Industry Accounts Division at Statistics Canada in cooperation with Agriculture and Agri-Food Canada. For electricity production, the electric power industry was expanded into 5 regions (Atlantic, Quebec, Ontario, Prairies, and B.C/Territories) following the grouping presented in the Industrial Water Survey data. The expansion of the electric power industry was based on production and output data from the provincial input-output tables.

33. Derek Sidders, Natural Resources Canada, personal communication.

34. Natural Resources Canada, n.d. (no date), *Canada's National Forest Inventory*, *https://nfi.nfis.org/history.php?lang=en* (accessed June 29, 2010).

35. Statistics Canada, CANSIM table 379-0027 (accessed June 1, 2010).

36. Statistics Canada, CANSIM Table 228-0003 (accessed March 11, 2010).

37. United States Environmental Protection Agency, 2008, *Great Lakes Factsheet No. 1: Physical Features and Population*, *www.epa.gov/glnpo/atlas/gl-fact1.html* (accessed December 16, 2009).

Appendix A

Glossary

Abstracted water is used for production and consumption activities. It comprises water intake, water withdrawn or removed from the soil, and water used for hydro-electric generation.

Aquifer is an underground stratum of rock or sediment that contains water and transmits water readily.

Baseflow is that part of streamflow that is sustained by groundwater discharge.

Groundwater is located beneath the soil surface. It includes soil moisture and water stored in aquifers, and supplies springs and wells.

Gross water use is the sum of **water intake** and **recirculated water**.

In-stream water uses do not remove water from its source.

Renewable water is the volume of water that supplies aquifers and/or surface water bodies that is replenished in an average year by precipitation.

Runoff is the portion of precipitation, and melt from snowpack and glaciers, that, by a variety of paths above and below the surface of the ground, reaches the stream channel. Once it enters a stream channel runoff becomes streamflow.

Streamflow is the flow rate, or discharge, of water in a water course. Streamflow is generated from a combination of baseflow and runoff.

Wastewater refers to water that is returned to the environment after being used during some activity or process, and it may be treated or untreated at the location of use prior to being discharged.

Water consumption is calculated as the difference between **water intake** and **water discharge** and is the portion of water not returned directly to the water environment.

Water demand is the amount of water that society would like to withdraw from water resources. In this article, **water intake** is a taken as a proxy for **demand**. If not all demands are met then **water intake** would underestimate demand.

Water discharge refers to water that is returned to the environment in its liquid state, usually close to an industrial establishment. Discharged water may be treated or untreated. Evaporation is water consumption, not water discharge.

Water intake refers to the total amount of water added to the water system of an establishment or household to replace water discharged or consumed. It may be broken down into the amounts withdrawn from various sources (for example, surface water or groundwater) and the amounts used for various purposes, or end uses. It is often also referred to as **water withdrawal**. In this article, **water intake** is taken as a proxy for **demand**. If not all demands are met then **water intake** would underestimate demand.

Water recirculation refers to the process of using water more than once in an industrial establishment. It applies mainly to industrial cooling and processing activities.

Water supply comprises the major sources that contribute to our water resources—precipitation, surface water and groundwater.

Water use is the amount of water withdrawn from water resources to support society in both the economic and residential sectors.

Water withdrawal is synonymous with **water intake**.

Water yield is the amount of freshwater derived from unregulated flow measurements for a given geographic area over a defined period of time and is an estimate of the **renewable water**. Water yield also includes a volume of water that is not renewable, specifically that portion of glacial melt water coming from receding glaciers.

Wetlands are areas of marsh, fen, swamp, bog, peatland or shallow water that include permanent or temporary areas with static or flowing water that is fresh, brackish, or marine. The areas may be naturally occurring or artificial.

Appendix B

Abbreviations and equivalences

Abbreviations

GDP	gross domestic product
ha	hectare
H_20	water
kg	kilogram
km	kilometre
km^2	square kilometre
km^3	cubic kilometre
L	litre
m^2	square metre
m^3	cubic metre
mm	millimetre
NAICS	North American Industry Classification System
t	tonne
t-km	tonne kilometre

Equivalences

1 hectare =	1 km^2 / 100
1 km^2 =	100 hectares
1 tonne =	1,000 kilograms

Prefixes of the Metric System

Prefix and abbreviation	Multiplication factor
exa (E)	10^{18}
peta (P)	10^{15}
tera (T)	10^{12}
giga (G)	10^{9}
mega (M)	10^{6}
kilo (k)	10^{3}
hecto (h)	10^{2}
deca (da)	10^{1}
deci (d)	10^{-1}
centi (c)	10^{-2}
milli (m)	10^{-3}
micro (µ)	10^{-6}
nano (n)	10^{-9}
pico (p)	10^{-12}
femto (f)	10^{-15}
atto (a)	10^{-18}