Environment and Climate Change Canada
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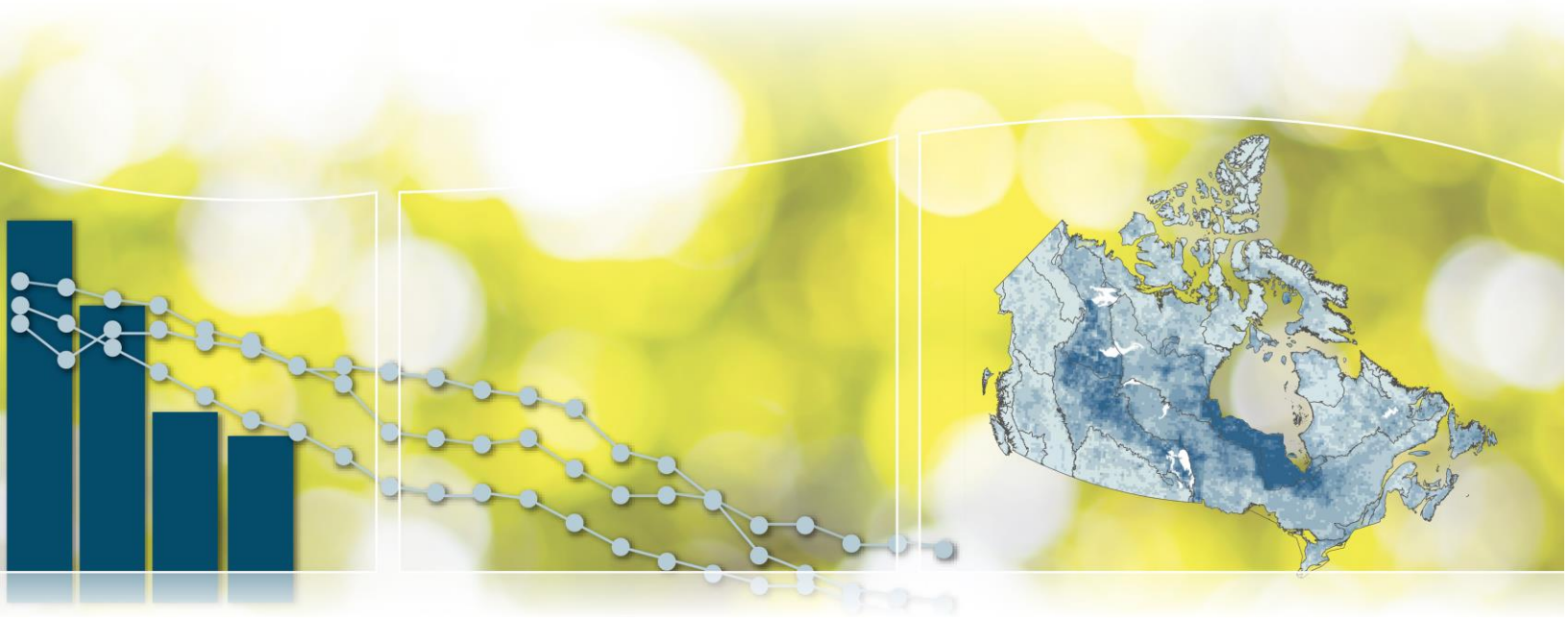
Canadian Environmental Sustainability Indicators

Water quantity in Canadian rivers



Canada

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Canadian Environmental Sustainability Indicators

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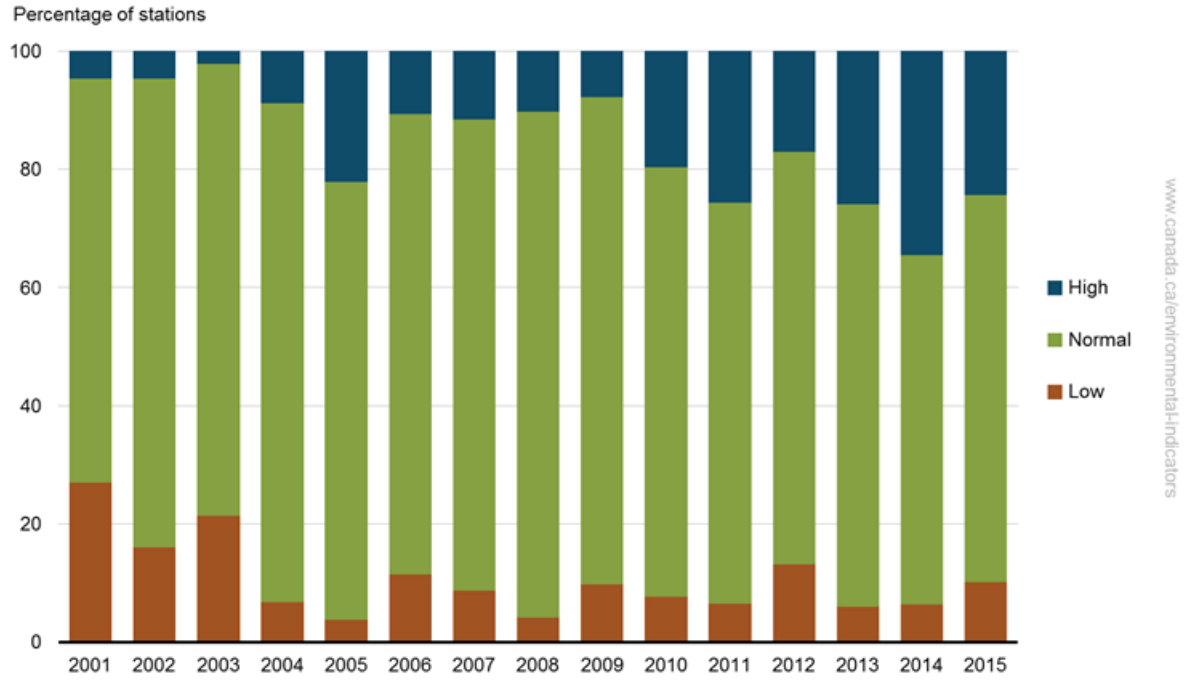
Water quantity in Canadian rivers indicators

Canada is a water-rich country. However, too much or too little water can lead to serious problems. When there is too little water, there may not be enough water to irrigate farmland and there may be drought. When there is too much, rivers may flood. These indicators provide information about water flows across Canada.

Key results

- From 2001 to 2015, most Canadian rivers had normal water quantity.
- Since 2010, there has been an increase in sites with a higher-than-normal quantity.
- The percentage of stations with a lower-than-normal quantity has declined since 2001.

Figure 1. Water quantity at monitoring stations, Canada, 2001 to 2015



Data for Figure 1

Note: The water quantity classification for a station is based on a comparison of the most frequently observed flow condition in a given year with typical water quantity at that station between 1981 and 2010. The 2014 and 2015 data include fewer results from Quebec and British Columbia because of delays in getting data into the database.
Source: Environment and Climate Change Canada (2017) Water Survey of Canada, HYDAT Database.

In 2015, just under 25% of water quantity stations across Canada had a higher-than-normal water quantity, 10% had a lower-than-normal quantity and 65% had a normal quantity.

Water quantity in Canadian rivers is measured as water flow, or the volume of water moving over a point, over a fixed period of time. Water flows in rivers generally follow changes in temperature, rainfall and snowfall throughout the year. More precipitation increases the amount of water in rivers, whereas warmer temperatures and less rainfall or snowfall will result in less water.

Generally, water flows are highest right after the snow melts in the early spring and gradually dry up through the summer and fall.

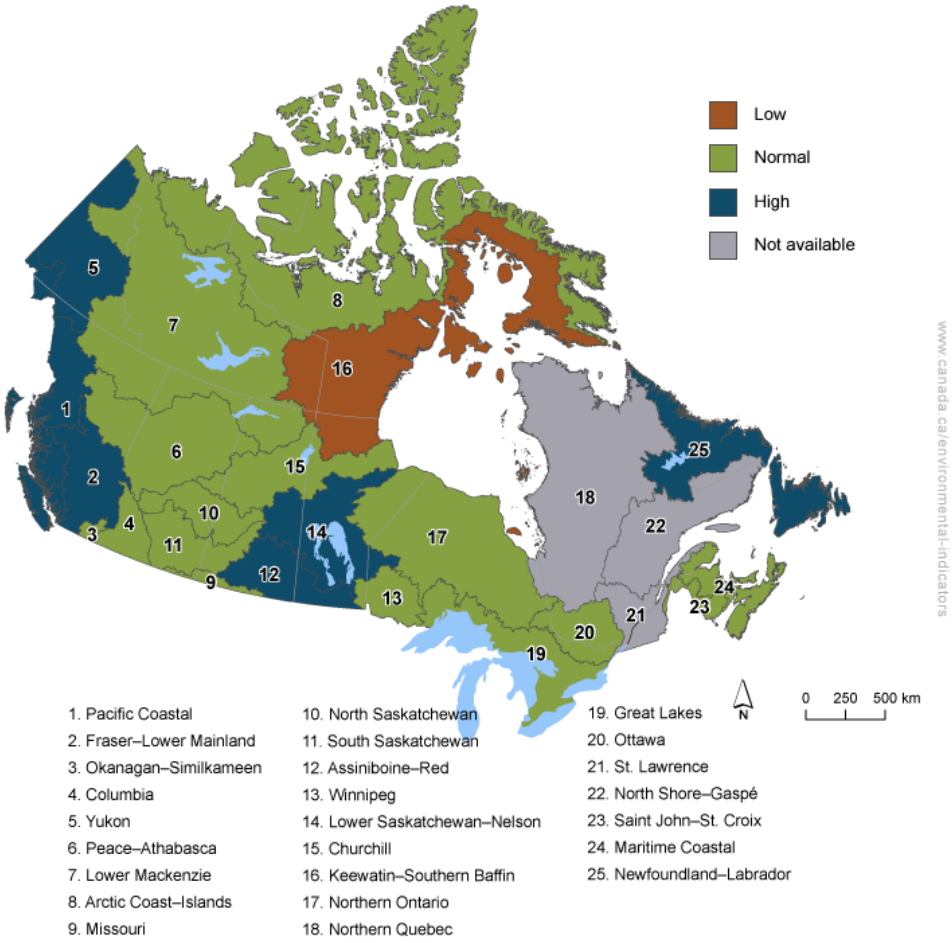
Over longer time scales, the amount of water in rivers is also affected by weather patterns and ocean surface temperatures which interact to influence the amount of rain or snow that falls. For example, extended summer droughts on the Prairies tend to take place when the southern Pacific Ocean warms during El Niño Southern Oscillation events. In an El Niño year, lower-than-normal water flows are generally seen on the Prairies. The Prairies experience more rain and snow when the ocean cools during La Niña events.[1] When this happens, higher-than-normal flows are found in the Prairies. Climate change may increase the strength and occurrence of the El Niño Southern Oscillations.

Regional water quantity in Canadian rivers

Key results

- In 2015, water quantity conditions in most drainage regions across Canada were normal.
- Lower-than-normal water quantity was observed in the Keewatin–South Baffin drainage region.
- Higher-than-normal flows were observed along the west coast, in southeastern Saskatchewan, in much of Manitoba, and in Newfoundland and Labrador.

Figure 2. Water quantity status of drainage regions, Canada, 2015



[1] Bonsal B and Shabbar A (2010) Large-scale climate oscillations influencing Canada, 1900-2008. Canadian Biodiversity: Ecosystem Status and Trends 2010, Technical Thematic Report No. 4. Retrieved on August 15, 2015.

Data for Figure 2

Note: The 2015 water quantity classification for a drainage region is based on the category (low, normal, high) for the most downstream monitoring station in the drainage region with more than 30 years of data. The flows are for the Canadian portions of the drainage regions. There are not enough data to describe the Northern Quebec (18), St. Lawrence (21) and North Shore–Gaspé (22) drainage regions. The results for this indicator vary slightly from those in the Local water quantity in Canadian rivers indicator because it uses data for the most downstream site in the drainage region. For more information, please see Data sources and methods.
Source: Environment and Climate Change Canada (2017) Water Survey of Canada, HYDAT Database.

Every year in Canada is marked by weather extremes and 2015 was no exception. These extreme events do not always translate into major changes in seasonal or long term water quantity. For example, while the year was marked by very dry conditions in British Columbia and the western Prairies and the Maritimes experienced record snow fall,[2] most of these events are short lived and only impact the amount of water in streams for a few weeks out of the year. This indicator shows that, over the whole year, water quantity in these regions was normal.

For 2015, the results for the Newfoundland–Labrador drainage region are influenced by 1 site in Labrador. At the monitoring station level, the results show water quantity on the island of Newfoundland was normal at all stations in 2015 and high for the 1 site in Labrador.

Similarly, the classification of the Arctic Coast–Islands region is based on sites on the mainland only. It is difficult to be certain these conditions apply to the Arctic Islands as well.

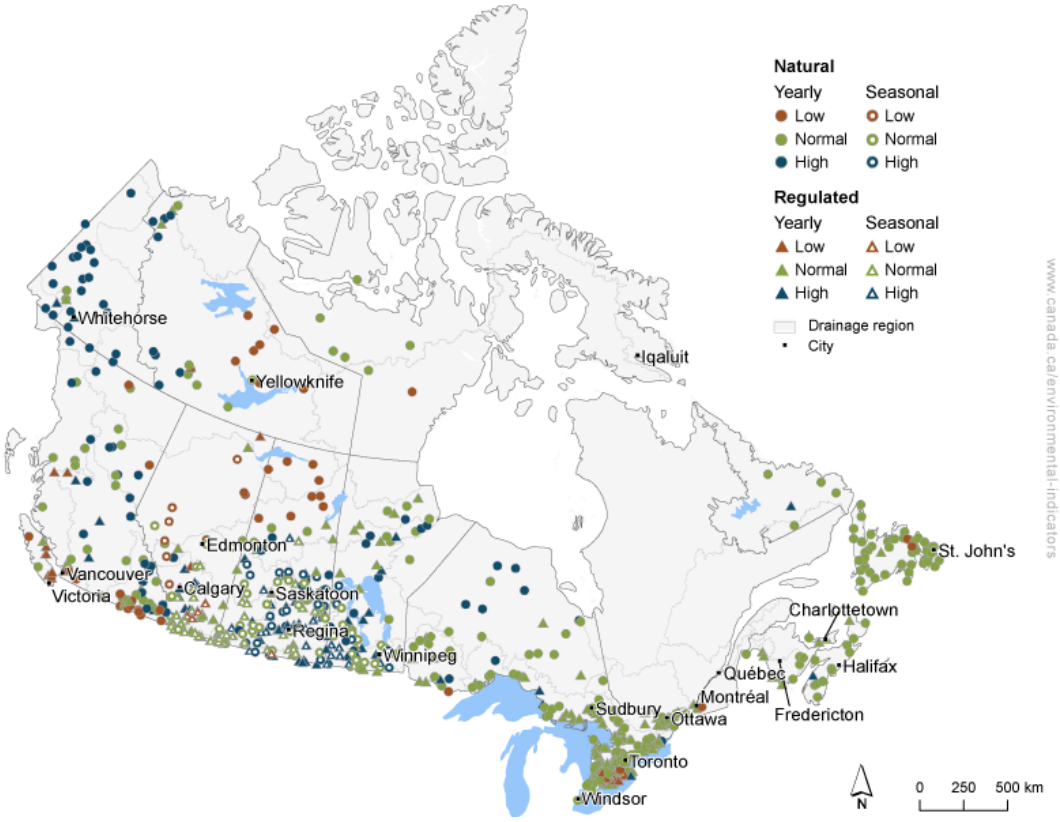
[2] Canadian Meteorological and Oceanographic Society (2015) Canada's Top Ten Weather Stories for 2015. Retrieved on September 27, 2017.

Local water quantity in Canadian rivers

Key results

- In 2015, a higher-than-normal water quantity was more frequent at monitoring stations in northern British Columbia, Yukon, south-central Saskatchewan and Manitoba, and north-western Ontario.
- A lower-than-normal water quantity was seen more frequently at monitoring stations in southern British Columbia and Alberta, northern Saskatchewan, central Northwest Territories and south-western Ontario.

Figure 3. Water quantity at monitoring stations, Canada, 2015



Navigate data using the interactive map

Note: The 2015 water quantity classification for a station is based on a comparison of the most frequently observed condition in that year with the typical water quantity at that station between 1981 and 2010. Normal water quantities are specific to each region and do not refer to the same amount of water in each drainage region (for example, the normal water quantity on the Prairies is different from the normal water quantity in the Maritimes). Data for 2015 for Quebec and some areas of British Columbia are missing because of delays getting data into the database. The results for this indicator vary slightly from those in the Regional water quantity in Canadian rivers indicator because of differences in the methods used to calculate the indicator. For more information, please see Data sources and methods.
Source: Environment and Climate Change Canada (2017) Water Survey of Canada, HYDAT Database.

Local changes in temperature, rainfall and snowfall cause water levels in rivers to rise and fall throughout the year. These changes can sometimes result in flooding or water shortages.

Where water quantity is classified as low, drought conditions likely exist. In Canada, droughts normally last for 1 or 2 seasons and can be very damaging. Agriculture, industry and municipalities

are especially affected by long-term droughts because they rely on water. Droughts can also affect water quality in lakes and rivers, and threaten fish survival.

High water quantity at a water quantity monitoring station indicates a wet year, but does not mean flooding has occurred. Floods tend to be short-lived, lasting on average about 10 days,[3] and may not change the water quantity classification in this indicator. For example, in 2015, Cache Creek, British Columbia, experienced a flash flood in May, yet the overall rating for the year for that station was low.

About the indicators

What the indicators measure

The national indicator provides a summary of trends in water quantity in rivers across Canada from 2001 to 2015.

The regional and local indicators present the status of water quantity at monitoring stations across Canada in 2015. At the drainage and monitoring station level, the indicators provide an illustration of whether water flows were normal, low or high in 2015.

A station's water quantity status is the category most often observed for a given year. Daily water quantity classifications are determined by comparing the measured value for a date to the flow observed at that site for 1981 to 2010. A station described as having a low water flows on January 31, for example, had a measured value ranking among the lowest 25% of values observed for each January 31 from 1981 to 2010. A station described as having a high water flow had a measured value ranking among the highest 25% of values observed on that date.

A drainage region was classified as having a low, normal or high water quantity by examining the water quantity classification at the most downstream monitoring station in the drainage region. Where more than one most downstream station was identified for a drainage region, such as in coastal areas, the classification representing the greatest percentage of the drainage region was used.

Why these indicators are important

Canada has 0.5% of the world's population and approximately 7% of the world's renewable freshwater supply. Canada may have a lot of water, but water is in short supply in some parts of the country. Humans use a lot of water in agriculture, in industry and in their homes.

These indicators provide information about the state of the amount of surface water in Canada and its change through time to support water resource management. They are used to provide information about the state and trends in water quantity in Canada. They are also used to assess progress toward the 2016–2019 Federal Sustainable Development Strategy.

Related indicators

The Water withdrawal and consumption by sector indicator shows how much water is used by 7 economic sectors in Canada.

The Residential water use indicator reports how much water is used in homes across Canada.

[3] Dartmouth Flood Observatory (2004) Interannual Evolution of Flood Duration (since 1985). Retrieved August 15, 2017.

Pristine lakes and rivers

These indicators support the measurement of progress towards the following 2016–2019 Federal Sustainable Development Strategy long-term goal: Clean and healthy lakes and rivers support economic prosperity and the well-being of Canadians.

Data sources and methods

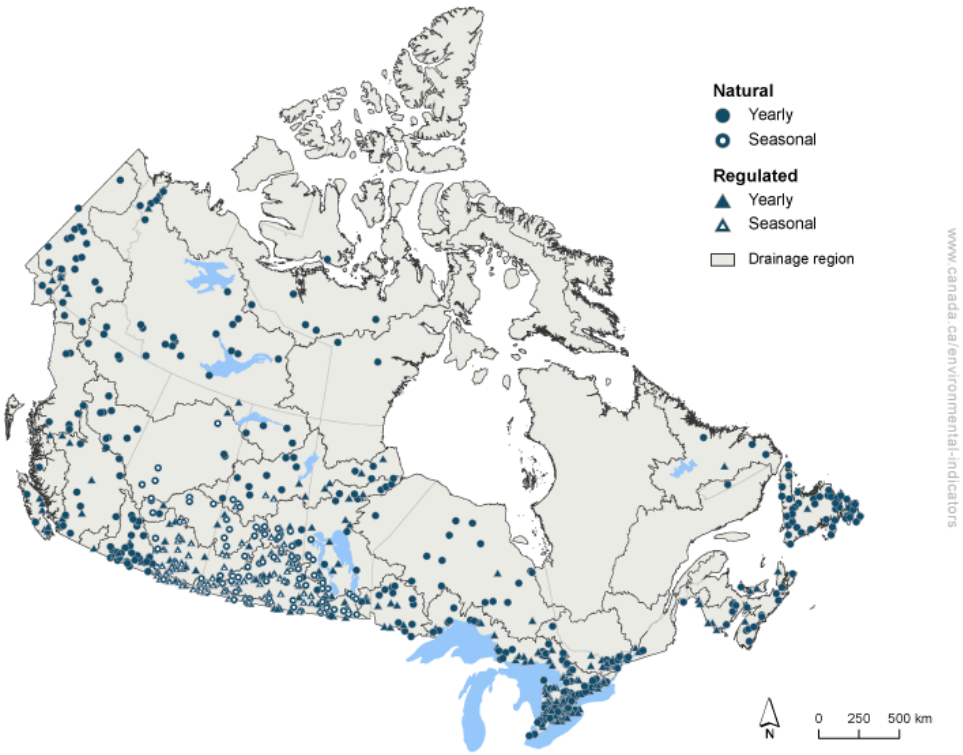
Data sources

Water flow data across Canada for 1981 to 2015 are taken from the Water Survey of Canada's National water data archive (HYDAT).

More information

For 2015, the indicators include data from 749 yearly and seasonal stations across Canada. At yearly stations, water flow data are collected 365 days per year. In general, seasonal stations operate 6 months of the year for a maximum of 217 days per year. Both natural and regulated rivers and all basin sizes were included (Figure 4).

Figure 4. Location of water quantity monitoring stations used for the Water quantity in Canadian rivers indicators, 2015



Note: Natural stations are those where human activity upstream of the station has little impact on water flow. Regulated stations have water withdrawals, dams, diversions or other structures upstream that may change the quantity of water in the river. Water quantity data at seasonal stations are only collected for part of the year.
Source: Environment and Climate Change Canada (2017) Water Survey of Canada.

Data completeness

Water flow data from each monitoring station are managed by their respective Environment and Climate Change Canada regional offices and stored in the federal HYDAT database. The data used in the indicators are subject to quality assurance and quality control procedures to ensure they adhere to Environment and Climate Change Canada's national standards. There is reduced certainty in water flow data when ice cover is present.

There are gaps in the water flow datasets due to periodic instrument failure. Where possible, regional offices use standardized protocols to estimate flow data to fill these gaps. Estimated flow values are considered to be reliable and are included in the calculation of the water quantity indicators.

Only when data cannot be estimated are they considered missing. A complete dataset was defined as missing no more than 20% of the year: 73 days out of 365 for yearly stations and 43 days out of 217 for seasonal stations. Stations not meeting these criteria for a year were not included in the calculation of the indicators.

Data for stations in the Northern Quebec, St. Lawrence and North Shore–Gaspé drainage regions are unavailable for 2015.

Data timeliness

Data for this indicator were taken from the July 2017 version of HYDAT.

There is a time lag of about 2 years between the last year reported and the publication of the indicators. This time lag is due to several factors, including the time required to verify the raw data, compile the data at the national level from all partners, and analyze, review and report the data.

Methods

The water quantity at a station is classified as low, normal or high by comparing daily water flow values for each station to the 30-year normal values for that station. The station's status for the year is the category most often observed for that year.

For the regional indicator, the water quantity in Canada's 25 drainage regions is classified by assessing water quantity at the most downstream station in the drainage region. Drainage in coastal regions requires more than one station to characterize flow in these areas.

More information

Data extraction

Basic station information and water flow data were extracted from HYDAT according to input parameters, such as record length, data type, and drainage area. The Environment and Climate Change Canada Data Explorer historical analysis tool was used to set the parameters for running statistical calculations and to calculate the percentiles.

Categorizing water quantity at a monitoring station

Water quantity at a monitoring station is classified based on historical data recorded at Water Survey of Canada hydrometric stations. To start, frequency distributions for each day of the year were calculated using water flow data collected from 1981 to 2010 at each monitoring station. A 30-year period is used to provide a picture of the hydrologic characteristics of a station, while maximizing the number of stations included in the indicators.

Water quantity categories were defined from the frequency distributions:

low < 25th percentile

25th percentile ≤ normal ≤ 75th percentile

high > 75th percentile

Daily water quantity records for 2001 to 2015 were categorized as low, normal or high by comparing the measured value to the percentiles calculated for the corresponding station and day of the year over the normal period. Accordingly, a station described as having a low water flow on January 31, for example, had a measured value ranking among the lowest 25% of the values observed for each January 31 from 1981 to 2010.

A station's status for a year is the category most often observed (the mode) at a given station in a given year. Thus, a low classification does not mean that water quantity was consistently low throughout the year; it only means that low water quantity conditions were most often observed.

For the national indicator, the percentage of stations classified as low, normal and high was calculated for each year from 2001 to 2015.

Table 1. Number of water quantity monitoring stations grouped by drainage region, 2015

Drainage region	Number of stations
Pacific Coastal (1)	28
Fraser–Lower Mainland (2)	13
Okanagan–Similkameen (3)	1
Columbia (4)	38
Yukon (5)	20
Peace–Athabasca (6)	17
Lower Mackenzie (7)	34
Arctic Coastal–Islands (8)	7
Missouri (9)	45
North Saskatchewan (10)	18
South Saskatchewan (11)	56
Assiniboine–Red (12)	89
Winnipeg (13)	21
Lower Saskatchewan–Nelson (14)	54
Churchill (15)	24
Keewatin–Southern Baffin (16)	2
Northern Ontario (17)	17
Northern Quebec (18)	n/a
Great Lakes (19)	162
Ottawa (20)	18
St. Lawrence (21)	n/a
North Shore–Gaspé (22)	n/a
Saint John–St. Croix (23)	9
Maritime Coastal (24)	17

Drainage region	Number of stations
Newfoundland–Labrador (25)	53

Note: n/a = not available.

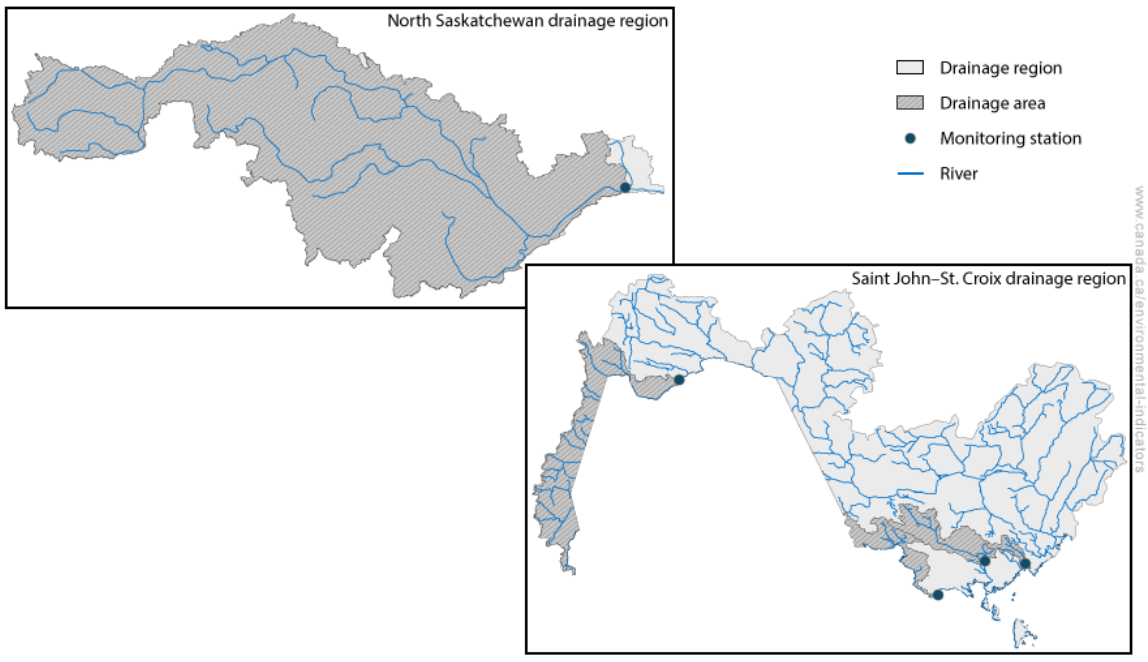
For 2015, there were not enough data to represent water quantity for the Northern Quebec (18), St. Lawrence (21), and North Shore–Gaspé (22) drainage regions.

Calculating the Regional water quantity in Canadian rivers indicator

The Regional water quantity in Canadian rivers indicator generalizes the water quantity classification across Canada's drainage regions.[4] For this indicator, where possible, the most downstream monitoring station of an inland drainage region was chosen to determine the water quantity category for that drainage basin. Where more than one most downstream station was identified for a drainage region, such as in coastal areas, the classification representing the greatest percentage of the drainage region was used. For example, 1 water quantity monitoring station at the most downstream point of the North Saskatchewan drainage region is sufficient to characterize water flowing out of this drainage region. In contrast, 4 stations were necessary to characterize water quantity in the Saint John–St. Croix drainage region (Figure 5). This selection resulted in data from 260 stations being used to calculate the indicator.

Although all water flowing from a drainage basin may not be captured by this collection of long-term stations, the percentage area of the basin gauged provides an estimate of the level of certainty associated with the results.

Figure 5. Illustration of regional station selection



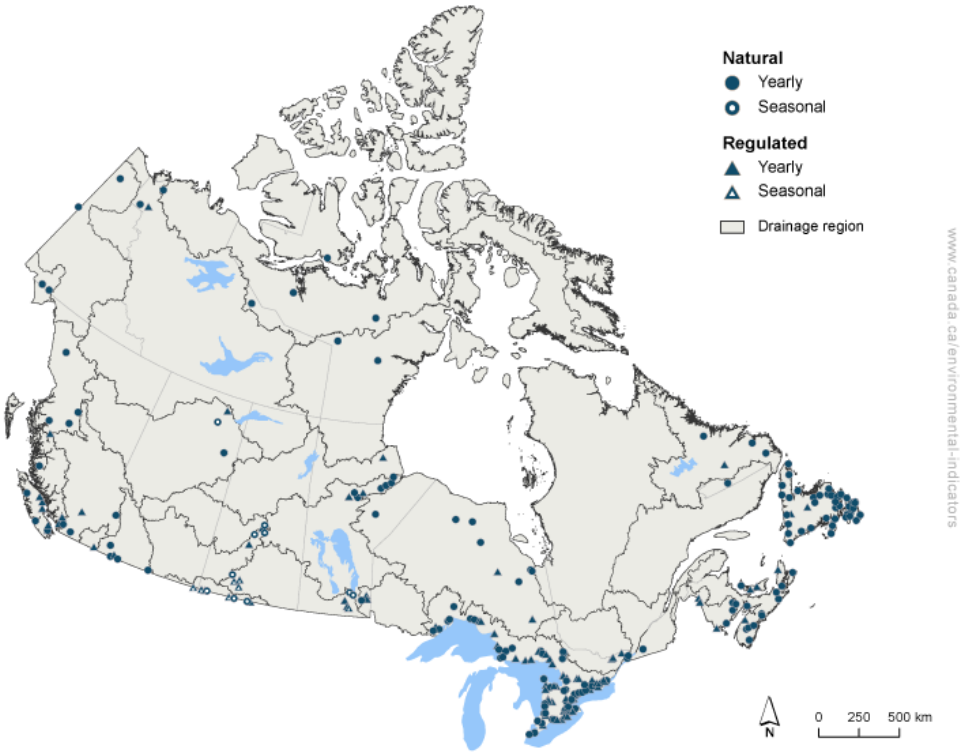
[4] Statistics Canada (2003) Standard Drainage Area Classification. Retrieved on July 27, 2017.

Table 2. Number of most downstream, long-term water quantity monitoring stations used to classify water quantity for each drainage region, 2015

Drainage region	Regional water quantity category	Number of monitoring stations used	Percentage of drainage region area gauged
Pacific Coastal (1)	High	20	21
Fraser–Lower Mainland (2)	High	4	67
Okanagan–Similkameen (3)	Normal	1	48
Columbia (4)	Normal	5	88
Yukon (5)	High	2	83
Peace–Athabasca (6)	Normal	3	90
Lower Mackenzie (7)	Normal	2	96
Arctic Coastal–Islands (8)	Normal	5	8
Missouri (9)	Normal	8	65
North Saskatchewan (10)	Normal	2	98
South Saskatchewan (11)	Normal	3	88
Assiniboine–Red (12)	High	9	80
Winnipeg (13)	Normal	3	94
Lower Saskatchewan–Nelson (14)	High	8	96
Churchill (15)	Normal	1	92
Keewatin–Southern Baffin (16)	Low	2	15
Northern Ontario (17)	Normal	9	37
Northern Quebec (18)	n/a	n/a	n/a
Great Lakes (19)	Normal	96	34
Ottawa (20)	Normal	3	67
St. Lawrence (21)	n/a	3	2
North Shore–Gaspé (22)	n/a	1	1
Saint John–St. Croix (23)	Normal	6	34
Maritime Coastal (24)	Normal	17	4
Newfoundland–Labrador (25)	High	47	38

Note: n/a = not available. The percentages of the drainage regions gauged are based on the number of long-term, water quantity monitoring stations with more than 30 years of data used for this analysis and do not reflect the actual percentage of the drainage region gauged by Environment and Climate Change Canada's water quantity monitoring network. Values are based on the Canadian portion of the drainage basins only.

Figure 6. Location of water quantity monitoring stations used to calculate the Regional water quantity in Canadian rivers indicator, 2015



Note: Natural stations are those where human activity upstream of the station has little impact on water flows. Regulated stations have water withdrawals, dams, diversions or other structures upstream that may change the water quantity in the river. Water quantity data for seasonal stations are only collected for part of the year.
Source: Environment and Climate Change Canada (2017) Water Survey of Canada.

Recent changes

This indicator has been updated to include data from 2014 and 2015.

Caveats and limitations

Large-scale events of short duration, such as a flood, may not influence the final classification of a station.

There are not enough stations in areas such as the North to compute complete, nationally representative indicators.

The status of water quantity assessed by the present indicators is a reflection of the 30-year time period used for the calculations and does not necessarily reflect longer-term trends at the station.

Water flow data collected at a monitoring station are representative of the average conditions of the upstream drainage area. Professional judgment is used to determine whether there were enough stations to describe water quantity in a drainage region.

More information

Extreme short-term events may not be detected with the indicators, since the focus is on frequency of observations in different categories through the year.

While 30 years represent a long time series for water quantity data, it represents a relatively short historical time frame for a given river and does not account for all natural variability in a river system.

Most water quantity monitoring stations in Canada are located in populated areas and do not represent the country's entire geographic extent or all its watersheds.

The variability of conditions across a drainage region may not be reflected, and water quantity classifications of tributaries may differ from that described by the indicators. For example, the 3 stations in the St. Lawrence drainage region, which cover 2% of the entire drainage region, were considered insufficient to categorize water quantity for the region in 2015.

The number of water quantity monitoring stations included in these indicators fluctuates from year to year because stations may be closed as monitoring networks are optimized. Whether or not the data have been verified and uploaded into HYDAT by the time the data are extracted to calculate the indicator also influences whether the station is included in the calculation that year.

The water quantity for the Great Lakes drainage region is based on rivers draining into the Great Lakes and not on the water contained within the Great Lakes themselves.

Water quantity generally follows a predictable seasonal pattern with natural, year-to-year variability. The indicators compare daily values to the 30-year normal and assume that water quantity is approximately the same from one year to the next for the same calendar day. A shift in the predictable seasonal pattern (the hydrograph) for one year will influence the results.

Resources

References

Environment and Climate Change Canada (2017) Water Survey of Canada. Retrieved on July 27, 2017.

Environment and Climate Change Canada (2017) Real-time Hydrometric Data. Retrieved on July 27, 2017.

Statistics Canada (2003) Standard Drainage Area Classification. Retrieved on July 27, 2017.

Related information

Changes to water quantity: drivers and impacts

El Niño

Large-scale climate oscillations influencing Canada

Ratio of surface freshwater intake to water yield

Annex

Annex A. Data tables for the figures presented in this document

Table A.1. Data for Figure 1. Water quantity at monitoring stations, Canada, 2001 to 2015

Year	Total number of stations	High quantity (percentage of stations)	Normal quantity (percentage of stations)	Low quantity (percentage of stations)
2001	1 241	5	68	27
2002	1 237	5	79	16
2003	1 254	2	77	21
2004	1 253	9	85	7
2005	1 247	22	74	4
2006	1 242	11	78	11
2007	1 248	12	80	9
2008	1 245	10	86	4
2009	1 256	8	82	10
2010	1 252	20	73	8
2011	1 226	26	68	7
2012	1 279	17	70	13
2013	1 224	26	68	6
2014	991	35	59	6
2015	749	24	65	10

Note: The water quantity classification for a station is based on a comparison of the most frequently observed flow condition in a given year with typical water quantity at that station between 1981 and 2010. The 2014 and 2015 data include fewer results from Quebec and British Columbia because of delays in getting data into the database. Percentages may not add up to 100 due to rounding.
Source: Environment and Climate Change Canada (2017) Water Survey of Canada, HYDAT Database.

Table A.2. Data for Figure 2. Water quantity status of drainage regions, Canada, 2015

Drainage region name	Drainage region number	Water quantity classification
Pacific Coastal	1	High
Fraser–Lower Mainland	2	High
Okanagan–Similkameen	3	Normal
Columbia	4	Normal
Yukon	5	High
Peace–Athabasca	6	Normal
Lower Mackenzie	7	Normal
Arctic Coast–Islands	8	Normal
Missouri	9	Normal
North Saskatchewan	10	Normal
South Saskatchewan	11	Normal

Drainage region name	Drainage region number	Water quantity classification
Assiniboine–Red	12	High
Winnipeg	13	Normal
Lower Saskatchewan–Nelson	14	High
Churchill	15	Normal
Keewatin–Southern Baffin	16	Low
Northern Ontario	17	Normal
Northern Quebec	18	n/a
Great Lakes	19	Normal
Ottawa	20	Normal
St. Lawrence	21	n/a
North Shore–Gaspé	22	n/a
Saint John–St. Croix	23	Normal
Maritime Coastal	24	Normal
Newfoundland–Labrador	25	High

Note: n/a = not available. The 2015 water quantity classification for a drainage region is based on the category (low, normal, high) for the most downstream monitoring station in the drainage region with more than 30 years of data. The flows are for the Canadian portions of the drainage regions. There are not enough data to describe the Northern Quebec (18), St. Lawrence (21) and North Shore–Gaspé (22) drainage regions. The results for this indicator vary slightly from those in the Local water quantity in Canadian rivers indicator because it uses data for the most downstream site in the drainage region. For more information, please see Data sources and methods.
Source: Environment and Climate Change Canada (2017) Water Survey of Canada, HYDAT Database.

Additional information can be obtained at:

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