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Data Sources and Methods for the Water Quantity Indicator

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Canada

1 Introduction

The Water Quantity Indicator forms a portion of the Canadian Environmental Sustainability Indicators (CESI) program, which provides data and information to track Canada's performance on key environmental sustainability issues.

2 Description and rationale of the Water Quantity indicator

2.1 Description

The national indicator classifies yearly water quantity for Canada's 25 drainage regions as high, normal or low for 2000-2009. Water quantity classifications are determined by comparing daily water levels or flows to normal values for 1978-2007 for each water quantity monitoring station in a drainage region.

2.2 Rationale

Canada has only 0.5% of the world's population but its landmass contains approximately 7% of the world's renewable water supply. The Water Quantity Indicator has been designed to highlight issues around water quantity in Canada. It provides information about the state of and trends in current surface water supply to inform proper future management of water resources.

2.3 Changes since last report

Changes to the indicator since the last CESI report include the addition of water flow data in the calculation of the indicator. For the 2010 report, water levels for many stations were estimated from flow data where electronic archives do not exist. The estimation was done using the most current stage-discharge curve for the water quantity monitoring station. These curves change through time and using the most current curve to estimate data from 30 years ago was considered dubious. To overcome this issue, it was decided to use the flow data directly in the indicator calculation. This change resulted in the addition of 301 water quantity monitoring stations to the national analysis.

3 Data

3.1 Data source

The Water Survey of Canada collects and publishes data for 2792 hydrometric stations across Canada through different partnerships. Daily water levels and flows were used directly from the Water Survey of Canada's hydrological database (HYDAT) (http://www.ec.gc.ca/rhc-wsc/default.asp?lang=En&n=9018B5EC-1).

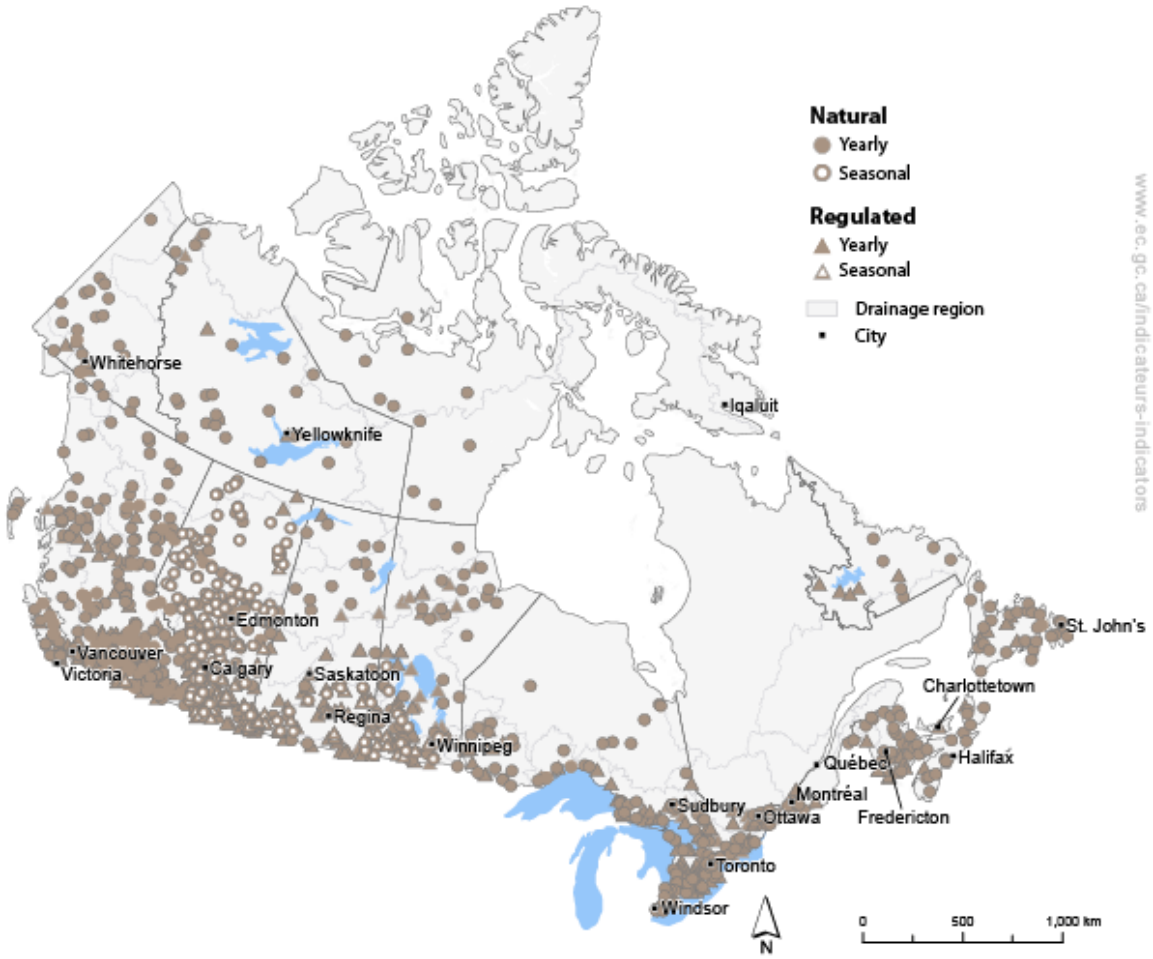
3.2 Spatial coverage

Water quantity monitoring stations active from 1978–2009 were chosen for this analysis. To ensure an adequate number of stations with data of a sufficient time span, both natural and regulated rivers and all basin sizes were included. These criteria resulted in the selection of 1179 stations across Canada. There are more stations in the more heavily populated southern portion of the country.

Final, approved data for the North-Shore–Gaspé drainage region in southern Quebec were not available in time for this publication. There are no results for 2008 and 2009 for this region included in this publication.

Water levels for the Great Lakes were not included in the analysis as they are tracked through a separate Environment Canada program.[1] The Great Lakes regional data includes water quantity monitoring stations on rivers draining into the Great Lakes.

Locations of 1179 water quantity monitoring stations for the 2009 Water Quantity indicator



Note: Natural stations are those with little or no human development upstream of the station that could impact water quantity. Regulated stations have dams, diversions or other structures upstream. Water quantity data for seasonal stations are only collected for part of the year.

Source: Water Survey of Canada, Environment Canada

[1] Environment Canada (2010) Great Lakes Water Levels and Related Data. Retrieved 28 November, 2011. Available from: http://www.ec.gc.ca/eau-water/default.asp?lang=En&n=79962112-1.

3.3 Temporal coverage

The national Water Quantity indicator is calculated using data collected daily between 1978 and 2009. The regional and local Water Quantity Indicators place emphasis on 2009 as it is the latest year for which quality-assured data are available. Both continuous and seasonal stations were included in the calculation of the indicator. At continuous stations, water level or flow data are collected 365 days a year. In general, seasonal stations operate for six months of the year.

3.4 Data completeness

Water level and flow data from each monitoring station are managed by their respective Environment Canada regional offices and are stored in the federal HYDAT database (http://www.ec.gc.ca/rhc-wsc/default.asp?lang=En&n=9018B5EC-1). The data used in this report were subject to quality assurance and quality control procedures to ensure they adhere to Environment Canada's national standards.

Basic station information (e.g., name and location) and water level or flow data were extracted from HYDAT. The HYDAT database (http://www.ec.gc.ca/rhc-wsc/default.asp?lang=En&n=9018B5EC-1) allows for station selection according to input parameters, such as the record length, data type, drainage area, etc. The data were transferred to a MSO Access database designed to calculate the percentiles used to define reference conditions for this indicator.

3.5 Data timeliness

There is a time lag of two years between 2009, the last year reported, and the publication of this indicator. This time lag is due to several intertwining factors, including the time required to verify the raw data, compile the data at the national level from all partners, analyze, review and report the data. The time period also aligns with 2007-09 the time period used to calculate the CESI Water Quality Indicator.

4 Methods

Water quantity at a monitoring station is defined based on historical data recorded for Water Survey of Canada hydrometric stations. Percentiles for each day of the year were calculated using water level or flow data collected at each monitoring station between 1978 and 2007. This normal period was chosen to correspond to the normal period used to report on climate. A 30-year period is required to provide a picture of the hydrologic characteristics of a station. Water quantity categories were defined as:

$$\text{Low} < 25^{\text{th}} \text{ percentile}$$
$$25^{\text{th}} \text{ percentile} \geq \text{Normal} \leq 75^{\text{th}} \text{ percentile}$$
$$\text{High} > 75^{\text{th}} \text{ percentile}$$

Daily water quantity records for 2000–2009 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. Thus, a station described as having a "low" water level on a specific day had a measured value ranking among the lowest 25% of values observed for that same day between 1978 and 2007.

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

Using the 25 drainage regions defined by Pearse et al. (1985)[2] allows generalization of water quantity across Canada. Hydrometric stations were identified in each drainage region and the

[2] Pearse PH *et al.* (1985) Currents of Change: Final Report of the Inquiry on Federal Water Policy. Environment Canada.

historical water level and flow data were used to determine the catetgory. The number of stations within each category (low, normal, high) was calculated for each drainage region (Table 1). The mode was used to categorize each drainage region.

Table 1. Number of water quantity monitoring stations for 2009 in each drainage region. Results for Arctic Coastal–Islands (8), Keewatin–Southern Baffin (16), were not included because there were not enough stations to describe the land area. There were not enough data to calculate the indicator for Northern Quebec (18) and North Shore–Gaspé (22).

Drainage Region	Number of stations
Pacific Coastal (1)	76
Fraser–Lower Mainland (2)	95
Okanagan–Similkameen (3)	27
Columbia (4)	59
Yukon (5)	20
Peace–Athabasca (6)	108
Lower Mackenzie (7)	47
Arctic Coastal–Islands (8)	9
Missouri (9)	47
North Saskatchewan (10)	49
South Saskatchewan (11)	135
Assiniboine–Red (12)	92
Winnipeg (13)	34
Lower Saskatchewan–Nelson (14)	52
Churchill (15)	29
Keewatin–Southern Baffin (16)	6
Northern Ontario (17)	9
Northern Quebec (18)	0
Great Lakes (19)	155
Ottawa (20)	18
St. Lawrence (21)	17
North Shore–Gaspé (22)	1
Saint John–St. Croix (23)	24
Maritime Coastal (24)	32
Newfoundland and Labrador (25)	47

5 Caveats and limitations

5.1 Measurement error

All monitoring instruments used in the collection of data for calculation of this indicator undergo standard quality-control and quality-assurance procedures to ensure sources of measurement error are controlled and minimized. There is reduced certainty in water flow data when ice cover is present.

5.2 Data completeness

There are gaps in the water level and flow datasets due to periodic instrument failure. Where possible, regional offices use standardized protocols to estimate missing flow data. Estimated flow values are considered to be reliable and are included in the water quantity indicator calculations.

In some cases, missing data cannot be estimated. For a water quantity monitoring station to be included in this indicator, a complete data set 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 indicator calculation.

5.3 Establishing normal conditions

Percentiles for a specific day of the year and station were computed only for stations for which 25-or-more years of data were available. Exceptions to this rule included unmonitored periods at seasonal stations.

While 30 years represents 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. The status of water levels and flows assessed by the present indicator is a reflection of its time period and does not necessarily reflect longer-term trends at the station.

5.4 Coverage/aggregation

Most water quantity monitoring stations in Canada are located in populated areas and, as such, they do not represent the country's entire geographic extent nor all its watersheds. More stations are needed in areas such as the North to compute complete, nationally-representative indicators.

The data used to compute the indicators come from local hydrometric stations which may not be representative of their entire drainage region. For example, most hydrometric stations are located on the mainstem of the largest river in the region. The water quantity in tributaries may differ from that described by the indicator. Also, variability within a drainage region is not necessarily reflected. For example, the headwaters of a river may have very different hydrological characteristics than downstream sections. Professional judgement was used to determine whether there were sufficient stations to describe a drainage region. For example, the nine stations in the Arctic Coast–Islands basin region were deemed insufficient to categorize water quantity for the region in 2009.

5.5 Calculation approach

Water levels and flows generally follow a predictable seasonal pattern; however, there is natural year to year variability. An indicator that compares daily values assumes water quantity is approximately the same from one year to the next for the same calendar day. A shift in the hydrograph one year will influence the results. Some of this natural variability is accounted for by the large range of percentiles used to define normal conditions.

6 References

6.1 References

Statistics Canada (2003) Information on Drainage Regions. Retrieved on 12 November, 2011. Available from: http://www.statcan.gc.ca/subjects-sujets/standard-norme/sdac-ctad/sdacinfo2-ctadinfo2-eng.htm

Environment Canada (2011) HYDAT Database. Retrieved on 4 July, 2011. Available from: http://www.ec.gc.ca/rhc-wsc/default.asp?lang=En&n=9018B5EC-1

Pearse PH, Bertrand F, and MacLaren JW (1985) Currents of Change: Final Report of the Inquiry on Federal Water Policy. Environment Canada.

6.2 Further reading

Water Survey of Canada (http://www.ec.gc.ca/rhc-wsc/default.asp?lang=En&n=4EED50F1-1)

Environment Canada - Water
(http://www.ec.gc.ca/eau-water/default.asp?lang=En&n=CD467AE6-1)

Environment Canada's Water Office - Real-time Hydrometric Data
(http://www.wateroffice.ec.gc.ca/index_e.html)