Catalogue no. 16-510-X
ISBN 978-0-660-73056-1

Census of Environment: Spatial information products

Water Yield: Data Product Specification

by Ann-Helen Jean-Baptiste

Release date: September 19, 2024

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Water Yield: Data Product Specification

by **Ann-Helen Jean-Baptiste**

1. Overview

1.1 Title

Water Yield: Data Product Specification

1.2 Reference date

2024-09-19

1.3 Responsible party

Census of Environment

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1.4 Language

eng – English

fra – French

1.5 Terms and definitions

Drainage regions: are a variant of the Standard Drainage Area Classification (SDAC) 2003. This classification groups 974 sub-sub-drainage areas representing all land and interior freshwater bodies into 25 drainage regions.

Ecoprovinces: are the second level (under ecozones) of the Ecological Land Classification, a hierarchical classification of ecological areas in Canada. There are 15 ecozones at the top of the ecological land classification hierarchy, which are subdivided into 53 ecoprovinces. They cover the entire terrestrial extent of Canada.

HYDAT: is an Environment and Climate Change Canada – Water Survey Canada database that contains computed data for the stations where hydrometric data are collected. It contains information on streamflow, water level and sediments in Canada.

Hydrometric network: refers to Environment and Climate Change Canada – Water Survey Canada's network of stations where data on surface water quantity is collected.

North line: a line that delineates the North from the South in Canada based on social, biotic, economic and climatic variables. In this document, it delineates the northern extent of the annual datasets.

Renewable freshwater: refers to the water that regularly replenishes our rivers, lakes and aquifers. Non-renewable freshwater describes water that is stored in deep aquifers, ice caps and glaciers that have a negligible rate of recharge on a human time scale. Some freshwater in the Great Lakes and other major water bodies can also be considered non-renewable since the renewal rates are very low.

Runoff: 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.

Water yield: is an estimate of freshwater runoff into streams and rivers and provides information on Canada's renewable freshwater. It is derived from data on the unregulated flow of water in rivers and streams in Canada. Although the water yield provides an estimate of renewable freshwater, it can include some water that is considered non-renewable (e.g., melt water from receding glaciers).

1.6 Abbreviations and acronyms

CoE	Census of Environment
ECCC	Environment and Climate Change Canada
GeoTIFF	Geographic Tagged Image File Format
ISO	International Organization for Standardization
PFRA	Prairie Farm Rehabilitation program
RHBN	Reference Hydrometric Basin Network
SEEA	System of Environmental Economic Accounting
WSC	Water Survey of Canada

1.7 Informal description of the data product

This product contains gridded datasets of annual and 30-year average estimates of water yield. Tracking water yield—an estimate of renewable water supply derived from HYDAT streamflow data—provides information to help understand water resources available for human use and ecosystem needs. Annual datasets are available for the years 1971 to 2021 and cover southern Canada. Thirty-year averages are available for 1971-2000, 1981-2010, and 1991-2020. They cover the terrestrial and freshwater extent of Canada, except for the Arctic Archipelago.

This product supplements Statistics Canada's tabular estimates by providing users with more spatial data for visualization and spatial analytical uses. These raster datasets provide information to help assess water availability across regions. This can support understanding and monitoring of the sustainability of water use practices for user defined geographies.

These datasets are released as part of a suite of products associated with the Census of Environment (CoE). The CoE organizes data about Canada's natural environment based on the System of Environmental-Economic Accounting (SEEA) international statistical standard including the SEEA Central Framework and the SEEA Ecosystem Accounting that take a spatial approach to accounting for ecosystems and natural capital. Water yield is a variable that is relevant under the Water asset accounts of the SEEA Central Framework.

The datasets will be updated on an occasional basis.

2. Specification scope

In these specifications, only one scope is used.

2.1 Scope Identification

Main.

2.2 Level

Series.

2.3 Level name

Main scope of the water yield series.

2.4 Level description

Gridded datasets of water yield over terrestrial and freshwater areas of Canada.

2.5 Extent

2.5.1 Description

This product is a series of two-dimensional datasets (no elevation):

- The annual series covers the south of Canada from 1971 to 2021.
- The 30-year average series covers Canada's terrestrial and freshwater extent, except for the Arctic Archipelago, for periods between 1971 and 2020.

2.5.2 Vertical extent

The water yield data are two-dimensional. There is no elevation (z) associated with the data.

2.5.3 Horizontal extent

For the annual water yield series, the horizontal extent covers the area of Canada south of the north line. The thirty-year average datasets cover Canada's terrestrial and freshwater extent, except for the Arctic Archipelago.

Map 1
Arctic Archipelago and North line of Canada

Source: 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; Spence, C. and A. Burke, 2008, "Estimates of Canadian Arctic Archipelago Runoff from Observed Hydrometric Data," Journal of Hydrology, vol. 362, pp. 247-259.

Table 1
Longitude and latitude boundaries

	Annual water yield	Thirty-year average water yield
	degrees	
West bounding longitude	-133	-142
East bounding longitude	-52	-52
South bounding latitude	+41	+41
North bounding latitude	+58	+73

2.5.4 Temporal extent

The temporal extent covers the entire year from January 01 to December 31 for the annual series.

For the 30-year average series, the temporal extent covers a thirty-year period from January 01 of the first year to December 31 of the thirtieth year. Values are expressed as an average for the thirty years covered.

For the northern part of Canada, the temporal extent is limited because of a lack of coverage in the hydrometric network during certain years:

Table 2
Temporal extent for the thirty-year average series

	1971 to 2000	1981 to 2010	1991 to 2020
Southern Canada			
Number of years	30	30	30
Years	1971- 2000	1981-2010	1991-2020
Northern Canada			
Number of years	22	15	11
Years	1974-1995	1981-1995	1991-1995 2011 2014-2018

2.5.4.1 Beginning date

Annual series: 1971-01-01

Table 3
Beginning date for the thirty-year average series

	1971 to 2000	1981 to 2010	1991 to 2020
		date	
Southern Canada	1971-01-01	1981-01-01	1991-01-01
Northern Canada	1974-01-01	1981-01-01	1991-01-01

2.5.4.2 Ending date

Annual series: 2021-12-31

Table 4
Ending date for the thirty-year average series

	1971 to 2000	1981 to 2010	1991 to 2020
		date	
Southern Canada	2000-12-31	2010-12-31	2020-12-31
Northern Canada	1995-12-31	1995-12-31	2018-12-31

2.6 Coverage

The scope applies to all coverages.

3. Data product identification

Table 5
Data product identification for the annual water yield series

Title	Annual water yield for southern Canada
Alternate title	wy_sc_YYYY
Abstract	Renewable freshwater generated throughout the year in mm. Values are calculated across southern Canada by 10 x 10 km cells.
Purpose	This product provides users with geographic data on renewable freshwater estimates for each year.
Topic category	Environment, inlandWaters
Spatial representation type	Grid
Spatial resolution	10 km
Geographic description	Authority: International Organization for Standardization (ISO) ISO 3166-1:1997 Codes for the representation of names of countries and their subdivisions – Part 1: Country codes. Reference date of the ISO 3166-1 standard: 1997-10-01 Data type: Publication Code: CA – Canada Extent type code: inclusion
Specification scope	Main

Table 6
Data product identification for the thirty-year average water yield series

Title	Thirty-year average water yield
Alternate title	wy_30y_YYYY_YYYY
Abstract	Thirty-year average of annual renewable freshwater in mm. Values are calculated across Canada by 10 x 10 km cells.
Purpose	This product provides users with spatial data on renewable freshwater for 30-year time periods coinciding with the climate normal periods.
Topic category	Environment, inlandWaters
Spatial representation type	grid
Spatial resolution	10 km
Geographic description	Authority: International Organization for Standardization (ISO) ISO 3166-1:1997 Codes for the representation of names of countries and their subdivisions – Part 1: Country codes. Reference date of the ISO 3166-1 standard: 1997-10-01 Data type: Publication Code: CA – Canada Extent type code: inclusion
Specification scope	Main

4. Data content and structure

4.1 Description

This product is composed of two series of raster datasets that quantify renewable freshwater estimates over Canada's terrestrial and freshwater extent. These series contain 51 annual files and 3 thirty-year average files. This enables users to choose the data for the time period they require for their analytical purposes.

4.2 Feature information

Not applicable.

4.3 Coverage information

4.3.1 Description

Technical description: The water yield rasters contain estimates of renewable freshwater expressed as a depth (mm) of water for each corresponding time period at a 10 km resolution. This product is a result of a modeling process designed to provide estimates at large scales such as those of the ecoprovinces and drainage regions of Canada.

Type of coverage content: modelResult.

4.3.2 Coverage type

Continuous quadrilateral grid coverage.

4.3.3 Specification

4.3.3.1 Domain extent

Refer to section 2.5 of this document.

4.3.3.2 Range type

Name: Water yield

Value data type: Float (0-10000)

4.3.3.3 Common point rule

Not applicable.

4.4 Reference to the specification scope

Main.

5. Reference systems

5.1 Spatial reference system

Table 7
Spatial reference system

Projected Coordinate System	NAD83 / Statistics Canada Ecosystem Register Albers
Geographic Coordinate System	GCS_North_American_1983
Datum	D_North_American_1983
Spheroid	GRS_1980
Semimajor Axis	6378137.0
Inverse Flattening	298.257222101
Prime Meridian	Greenwich (0,0)
Angular Unit	Degree (0.0174532925199433)
Projection	Albers
False Easting	6200000.0
False Northing	3000000.0
Central meridian	91.86666667
Standard Parallel 1	49.0
Standard Parallel 2	90.0
Latitude of origin	63.390675
Linear unit	Meters (1.0)

5.2 Linear reference system

Not applicable.

5.3 Temporal reference system

Gregorian calendar.

5.4 Reference to specification scope

Main.

6. Data quality

6.1 Completeness

Annual water yield estimates cover southern Canada at a 10 km resolution. Thirty-year average water yield data cover Canada's terrestrial and freshwater extent at a 10 km resolution but exclude the Arctic Archipelago because of poor network coverage. Estimates in the north are only provided for the years when sufficient data were available.

6.1.1 Commission

Not applicable.

6.1.2 Omission

The annual series excludes the north of Canada, and some years are omitted for the north in the thirty-year averages. Results are included when data points are dense enough to support estimation and sufficient data

are available for validation. Few northern results are included because northern networks are much sparser, with significantly fewer stations and available data. Estimates for the Arctic Archipelago are excluded for these reasons. For further details on spatial and temporal extent, see section 2.5 of this document.

6.2 Logical consistency

6.2.1 Conceptual Consistency

Although the water yield provides an estimate of renewable freshwater, it can include some water that is considered non-renewable (e.g., meltwater from receding glaciers). Unregulated flow was prioritized, and most stations were selected on this basis. However, to account for changes in the regulation status in HYDAT, for data after 2014, the Reference Hydrometric Basin Network (RHBN) of the Water Survey of Canada (WSC) was used to identify stations for inclusion. The RHBN is a set of stations with minimal human influence.

6.2.2 Domain consistency

Verification and validation procedures, including the definition of selection criteria for the input data, the identification and removal of outliers and the comparison with streamflow data, ensure that the range of values remain coherent.

6.2.3 Format consistency

The use of well-established commercial software to generate formats for dissemination supports proper format consistency.

6.2.4 Topological consistency

The annual and 30-year rasters were aligned to the CoE 10 km grid. The annual rasters were generated with the same method and cover the exact same extent. The same process was applied to the 30-year rasters.

6.3 Positional accuracy

Unknown. The water yield is modeled using an interpolation method. Water flows from each WSC hydrometric station are assigned to the drainage basin centroid. The accuracy of the data depends on the data sources: the HYDAT dataset and the hydrometric network basins polygons from the Prairie Farm Rehabilitation program (PFRA) and WSC which provide the drainage basin area and location for each hydrometric station.

6.4 Temporal accuracy

Unknown. Information on the accuracy of the time measurement can be found in the data source (HYDAT) metadata. Visit ECCC-WSC HYDAT database for further details.

There are limitations in the data for the north, which were included in the thirty-year average datasets. Any change for the north must be interpreted with caution because of differences in the number of years and stations included. These time series datasets are intended to provide an average water yield for their specified time periods. For further details on the time coverage, see section 2.5 of this document.

6.5 Thematic accuracy

Unknown. The water flows reported at WSC hydrometric stations in the HYDAT dataset are inputs to the water yield spatial interpolation model. The accuracy of the data depends on the density of the network and on the quality of the data sources (water flow and area of the stations' drainage basin).

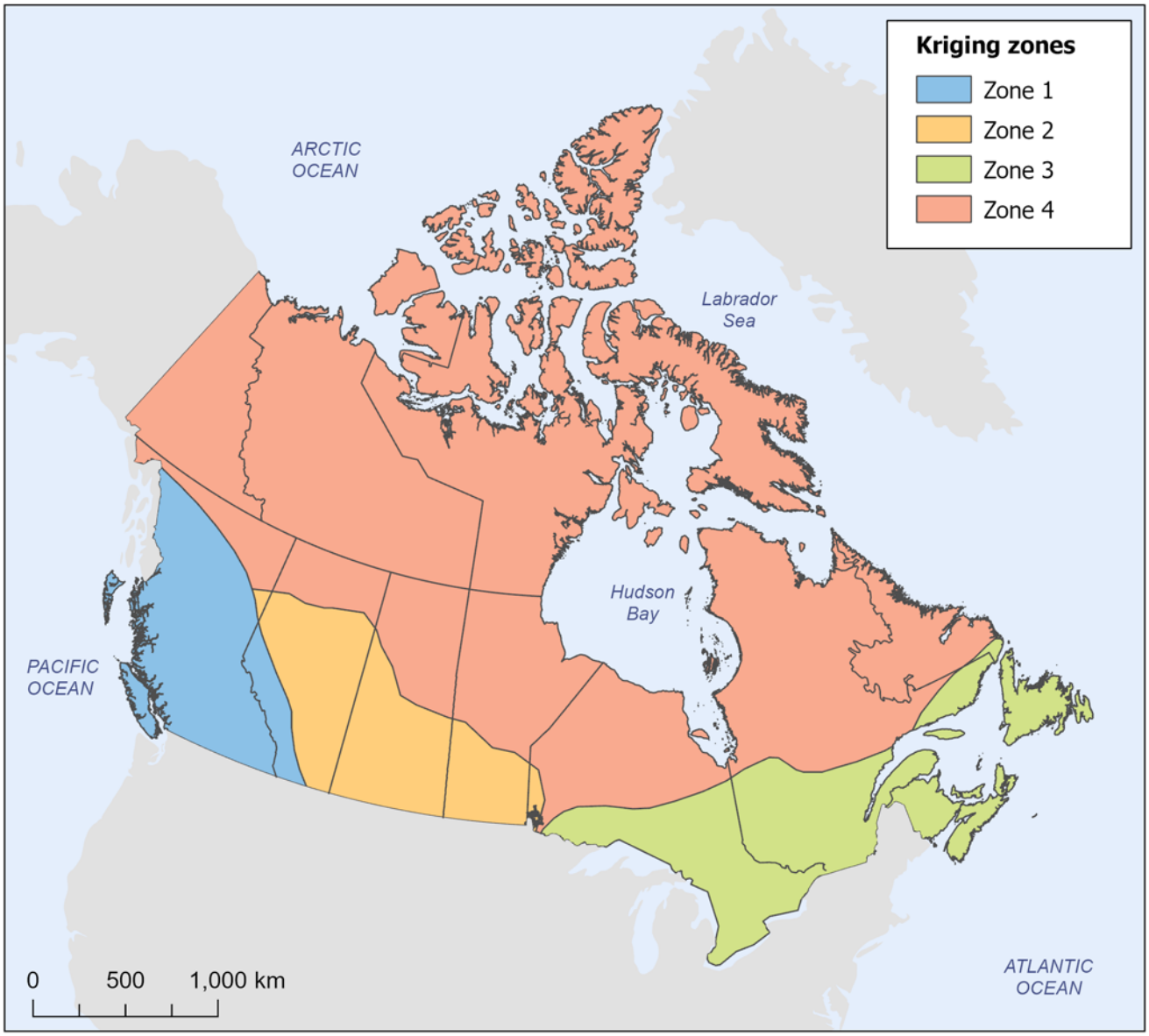
Mean standard error maps are produced using the ordinary kriging model that give some information on uncertainty. The uncertainty largely reflects network coverage and density issues within and unique to each of the different zones (models). Mean standard error maps can be provided upon request as there are too many to practically release at this time.

7. Data capture

7.1 Description

To estimate water yield, a database of natural streamflow observations was compiled from the WSC HYDAT database. Stations with natural flow were identified through the regulation status in HYDAT. For data after 2014, the Reference Hydrometric Basin Network (RHBN) of the Water Survey of Canada (WSC) was used to identify stations with minimal human influence. The monthly streamflow values were converted to a runoff depth using the drainage area of the stations, then interpolated using ordinary kriging to produce spatial estimates of water yield. The interpolation method was applied to areas of Canada (kriging zones) that reflect network weaknesses and areas of the country where estimates can be expected to be more homogenous at the national scale.

Map 2
Zones in the kriging model for the water yield



Source: 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-MWE2009007 (accessed on July 19, 2024).

Kriging results for the different zones were then combined to produce the final gridded product. The annual rasters integrate results from zones 1, 2 and 3 and the 30-year average rasters include results from all four zones. Results along the borders of each zone were blended to address differences between adjacent zones and improve spatial consistency.

Results were included where data points are dense enough to support estimation and sufficient data are available for validation. Fewer northern results were included because networks in the north are generally sparser, with fewer stations available.

7.2 Reference to the specification scope

Main.

8. Data maintenance

8.1 Description

The data series is updated on an occasional basis.

8.2 Reference to the specification scope

Main.

9. Portrayal

Not applicable.

10. Data product delivery

10.1 Delivery format information

GeoTIFF

10.1.1 Format name

GeoTIFF: Geographic Tagged Image File Format.

10.1.2 Version

GeoTIFF 6.0

10.1.3 Specification

GeoTIFF is a format extension for storing georeference and geocoding information in a TIFF 6.0 compliant raster file by tying a raster image to a known model space or map projection.

10.1.4 File structure

Not applicable.

10.1.5 Language

eng – English

10.1.6 Character Set

utf8

10.2 Delivery medium information for Static Files

10.2.1 Units of delivery

Each dataset from the time series is delivered by year or 30-year period following these naming conventions:

Annual water yield: wy_sc_YYYY.tif

Ex. Water yield dataset for the year 2005 in southern Canada: wy_sc_2005.tif

Thirty-year average water yield: wy_30y_YYYY_YYYY.tif

Ex. Water yield dataset for the 30-year average between 1971 and 2000 for Canada: wy_30y_1971_2000.tif

10.2.2 Transfer size

The file size changes according to the year. On average, an annual file is about 1.2 MB and a thirty-year average file is about 1 MB.

10.2.3 Medium name

File transfer.

Open Government of Canada website

www.geo.ca

10.2.4 Other delivery information

Information regarding the use of the data is defined in the Statistics Canada Open Licence.

10.3 Reference to specification scope

Main.

11. Additional information

Statistics Canada also produces tabular estimates of water yield in cubic kilometres and cubic metres per square metre by drainage regions and ecoprovinces as part of the CoE. These estimates can differ from those obtained by using the annual water yield rasters to generate estimates because of smoothing done at model or zone boundaries to make a more spatially consistent raster dataset. Details on the method applied to generate tabular estimates on water yield can be found on the Physical asset accounts page from the Methodological Guide on the Canadian System of Environmental-Economic Accounting.

12. Metadata

Supplemental information on the method used to generate water yield estimates can be found in The Water Yield for Canada As a Thirty-year Average (1971 to 2000): Concepts, Methodology and Initial Results.

12.1 Reference to specification scope

Main.