GloRiC-Canada

Global River Classification - Canada

Technical Documentation Version 1.0

prepared by Camille Ouellet Dallaire & Bernhard Lehner
(camille.ouelletdallaire@mail.mcgill.ca; bernhard.lehner@mcgill.ca)

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1. Background

The goal of the Global River Classification (GloRiC) framework is to establish a common vocabulary and standardized approach to the development of globally comprehensive and integrated river classifications that can be tailored to different goals and requirements. We define the GloRiC conceptual framework based on five categories of variables: 1) hydrology; 2) physiography and climate; 3) fluvial geomorphology; 4) water chemistry; and 5) aquatic biology. We previously applied this framework at the global scale (Ouellet Dallaire et al. 2019a). In this document, we present the application of this framework at the Canadian scale called GloRiC-Canada.

In Version 1.0 of GloRiC-Canada, unsupervised classifications were created using a mix of statistical analyses, including k-means clustering and principal component analysis, and expert interpretation to identify the classifier variables, the number of classes, and their thresholds. The required hydro-environmental attributes were provided mostly by the seamless high-resolution river reach database HydoATLAS at a spatial resolution of 15 arc-seconds. To tailor the classifications to the Canadian context, we adapted and supplemented HydroATLAS through the addition of Canadian-specific datasets.

Version 1.0 of GloRiC-Canada provides a baseline typology for all rivers of Canada and is expected to be particularly useful in remote or data-poor river basins, such as the High Arctic, or very small rivers. The dataset is primarily designed for broad and rapid applicability in assessments that require stratified analyses of river ecosystem conditions at global and regional scales.

Citations of GloRiC-Canada should refer to:

Ouellet Dallaire, C., B. Lehner, and I. Creed. 2019. Multidisciplinary classification of river reaches to support the assessment of environmental flow requirements: an application for Canada. Canadian Journal of Fisheries and Aquatic Sciences. Data available at http://www.hydrosheds.org/page/gloric-canada.

2. Methods and data characteristics

The methods used to create GloRiC-Canada are fully described in Ouellet Dallaire et al. (2019b).

a) River reach network

A global stream network delineation has been extracted from World Wildlife Fund's HydroSHEDS database (Lehner et al. 2008) at a grid resolution of 15 arc-seconds (approx. 500 m at the equator); for more information please refer to the Technical Documentation of HydroSHEDS at http://www.hydrosheds.org. Rivers were defined to start at all pixels where the accumulated upstream catchment area exceeds 10 km^2, or where the long-term average natural discharge exceeds 100 liters per second, or both. Rivers are broken into reaches at all confluences (Fig. 1), resulting in 570,920 individual river reaches for Canada with an average reach length of 4.4 km, representing 2.5 million river kilometers in total.

It should be noted that the quality of HydroSHEDS data is significantly inferior for regions above 60 degrees northern latitude as there is no underlying SRTM elevation data available and thus a coarser scale DEM has been inserted (HYDRO1k provided by USGS 2000).

The geospatial river reach network of HydroSHEDS is accompanied by a companion database, termed HydroATLAS, which provides a compendium of hydro-environmental attributes that were derived from existing global datasets and assigned to each river reach; for more information on HydroATLAS please refer to the Technical Documentation at http://www.hydrosheds.org/page/hydroatlas.

HydroATLAS offers an open and readily available registry from which pre-calculated attributes were selected or new ones calculated to serve as the variables in developing GloRiC's sub-classifications and river reach types. Note that version 1.0 of GloRiC-Canada is based on an unpublished beta version of HydroATLAS, and as a result some values may differ slightly between versions.

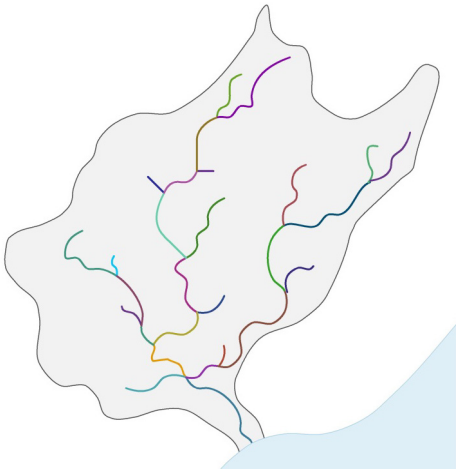

Figure 1: River reaches extracted from HydroSHEDS database. A river reach is defined as a stretch between two tributaries, or between the start/end of the network and a tributary.

b) Classification

All classifications were created using an unsupervised, multivariable k-means statistical clustering of all Canadian river reaches, which resulted in eight hydrological classes, ten physio-climatic classes, six geomorphic classes and 23 combined k-means groups. For more details, please refer to Ouellet Dallaire et al. (2019b).

In addition to the unsupervised statistical classifications, GloRiC-Canada also contains a column listing the river reach types that were derived through supervised classification as part of the global GloRiC database (version 1.0). These global river reach types were created based on the combination of three supervised sub-classifications (hydrologic, physio-climatic, and geomorphic) and resulted in 127 combined classes at the global scale (for more information on the methodology see Ouellet Dallaire et al. 2019a). In Canada, 72 of the 127 global river reach types exist.

3. Data format and distribution

a) Data format and projection

GloRiC-Canada is publicly available for download at http://www.hydrosheds.org/page/gloric-canada. All map data layers, including attribute tables, are provided in ESRI© Geodatabase and Shapefile formats. The data is projected in a Geographic Coordinate System using the World Geodetic System 1984 (GCS_WGS_1984). The attribute table can also be accessed as a stand-alone file in dBASE format which is included in the Shapefile format.

GloRiC-Canada data are available electronically in compressed zip file format. To use the data files, the zip files must first be decompressed. Each zip file includes a copy of the GloRiC-Canada Technical Documentation.

b) Available columns and class names

The attribute table of the GloRiC-Canada river reach layer contains the hydro-environmental attributes that were used to create version 1.0 of GloRiC-Canada, as well as the resulting sub-classifications and river typologies. Table 1 describes all data columns provided.

GloRiC-Canada data is provided together with an Excel file (GloRiC_Canada_ClassNames_v10.xlsx) which contains the linkages between class numbers and class names needed to create map legends.

Table1. Attribute table of GloRiC-Canada river reach file. See Ouellet Dallaire et al. (2019b) for more details.

Column	Description
Reach_ID	Unique identifier (ID) for every river reach *Note: the first digit identifies the region/continent as assigned in the global GloRiC database: 1: Africa; 2: Europe; 3: Siberia; 4: Asia; 5: Australia & Oceania; 6: South America; 7: North America; 8: American Arctic; 9: Greenland*
Next_down	ID of next downstream river reach *Note: the next downstream ID can be used to trace the river network by navigating from reach to reach. Values of 0 indicate reaches with no further downstream connection (pour points).*
Length_km	Length of individual river reach [km] *Data source: HydroSHEDS (Lehner et al. 2008)*
Log_Q_avg	Log-10 of long-term average discharge [m^3/sec] *Data sources: WaterGAP (Döll et al. 2003) and HydroSHEDS (Lehner et al. 2008)* *Long-term average of monthly discharge is available for all reaches of the HydroSHEDS river network at 500 m resolution. WaterGAP data was spatially downscaled from its original 0.5 degree pixel resolution (~50 km at the equator) to the 15 arc-second (~500 m) resolution of the global HydroSHEDS river network (Lehner et al. 2008) using geo-statistical approaches (Lehner & Grill 2013).*
Log_Q_var	Log-10 of flow regime variability [-] *Data sources: WaterGAP (Döll et al. 2003) and HydroSHEDS (Lehner et al. 2008)* *Calculated as 'maximum long-term average monthly discharge / minimum long-term average monthly discharge'. See explanations of Log_Q_avg for more details on discharge data.*
JD_ab_0	Julian date of the first frost-free day (first day above 0°C) [Julian date] *Data source: Pedlar et al. (2015)*
Class_hydr	Classes of hydrologic sub-classification *(8 classes; see provided Excel file for legend)*
Temp_av	Long-term average of annual air temperature [degrees Celsius] *Data source: WorldClim (Hijmans et al. 2005)* *WorldClim provides data in grid format at 30 arc-second resolution (approx. 1 km x 1 km at equator).*
Temp_rg	Long-term range of annual air temperature [degrees Celsius] *Data source: WorldClim (Hijmans et al. 2005)* *WorldClim provides data in grid format at 30 arc-second resolution (approx. 1 km x 1 km at equator).*

CMI_indx	Climate moisture index [-] *Data sources: Global-PET (Trabucco and Zomer 2009) and WorldClim (Hijmans et al. 2005)* *The CMI was calculated at 30 arc-second resolution as '(precipitation/potential evapotranspiration)-1' using the mean annual potential evapotranspiration from the Global-PET dataset and mean annual precipitation from WorldClim.*
Log_elev	Log-10 of surface elevation of the reach [meters a.s.l.] *Data sources: SRTM (Farr et al. 2007) and HydroSHEDS (Lehner et al. 2008)*
Class_phys	Classes of physio-climatic sub-classification *(10 classes; see provided Excel file for legend)*
Lake_pc	Percentage of upstream watershed area covered by lakes [%] *Data sources: HydroLAKES (Messager et al. 2016)* *The percentage of upstream watershed area covered by lakes was calculated by dividing the total upstream area covered by lakes by the total upstream watershed area at the location of each river reach.*
Peat_pc	Percentage of area covered by peatland [%] *Data sources: Peatland map of Canada (Tarnocai et al. 2011)* *The percentage of area covered by peatland was taken from the Peatland map of Canada and represents the amount of peatland per soil unit at the location of the river reach.*
Log_spow	Log-10 of total stream power [kW/m^2] *Data sources: HydroSHEDS (Lehner et al. 2008), WaterGAP (Döll et al. 2003) and SRTM (Farr et al. 2007)* *Total stream power was calculated as 'water density [kg/m^3] x gravitational acceleration [m/s^2] x discharge [m^3/s] x stream gradient [m/m]'; with stream gradients calculated as the maximum minus the average elevation of the reach, divided by the length of the reach.*
Class_geom	Classes of geomorphic sub-classification *(6 classes; see provided Excel file for legend)*
Kmeans_23	Classes of combined k-means statistical clustering *(23 classes; see provided Excel file for legend)*
Glob_type	Global river reach type based on supervised classification *(73 classes; see provided Excel file for legend)* *Data source: GloRiC v1.0 (Ouellet Dallaire et al. 2019a)* *Global river reach types were derived in the global version of the GloRiC database (version 1.0) based on the supervised classification of three sub-classifications (hydrologic, physio-climatic, and geomorphic); 72 of the original 127 global river reach types exist within Canada.*

4. License and citations

a) <u>License agreement</u>

GloRiC-Canada is publicly available for download at http://www.hydrosheds.org/page/gloric-canada and is free for scientific, educational, and other uses.

The geometric information of the river reach lines used in GloRiC is covered by the same License Agreement as the HydroSHEDS database, which is available at http://www.hydrosheds.org. For all regulations regarding license grants, copyright, redistribution restrictions, required attributions, disclaimer of warranty, indemnification, liability, waiver of damages, and a precise definition of licensed materials, please refer to the HydroSHEDS License Agreement.

By downloading and using the data the user agrees to the terms and conditions of this license. The copyright © of GloRiC-Canada is held by the authors, 2019, all rights reserved.

b) Acknowledgement and citations

Citations and acknowledgements of GloRiC-Canada should be made as follows:

Ouellet Dallaire, C., B. Lehner, and I. Creed. 2019. Multidisciplinary classification of river reaches to support the assessment of environmental flow requirements: an application for Canada. Canadian Journal of Fisheries and Aquatic Sciences. Data available at http://www.hydrosheds.org/page/gloric-canada.

We kindly ask users to cite GloRiC-Canada in any published material produced using the data. If possible, online links to the GloRiC-Canada website (http://www.hydrosheds.org/page/gloric-canada) should be provided.

5. References

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