GloRiC

Global River Classification

Technical Documentation Version 1.0

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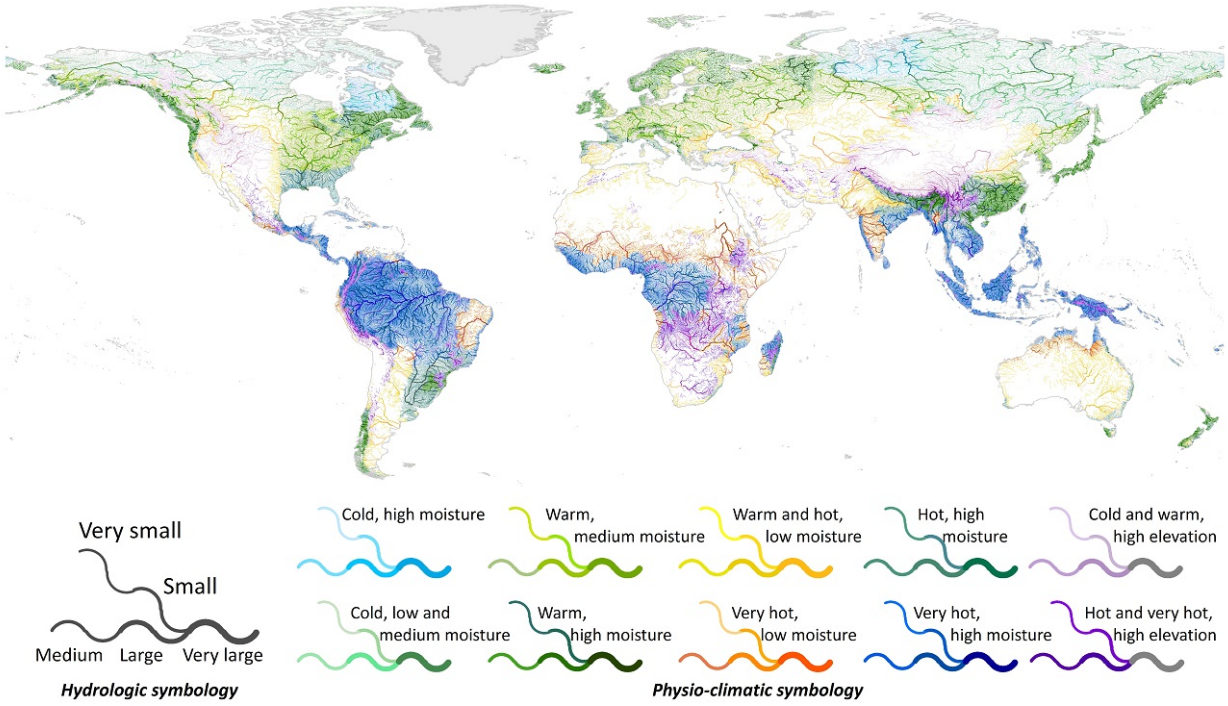

1. Background

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.

In Version 1.0 of GloRiC, both supervised and unsupervised classifications were created using a mix of statistical analyses and expert interpretation to identify the classifier variables, the number of classes and their thresholds. The required hydro-environmental attributes were provided by the seamless high-resolution river reach database RiverATLAS at a spatial resolution of 15 arc-seconds.

Version 1.0 of GloRiC provides a baseline typology for all rivers globally and is expected to be particularly useful in remote or data-poor river basins. 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 should refer to:

Ouellet Dallaire, C., Lehner, B., Sayre, R., Thieme, M. (2018): A multidisciplinary framework to derive global river reach classifications at high spatial resolution. Environmental Research Letters. Data available at http://www.hydrosheds.org/page/gloric.

2. Methods and data characteristics

The methods used to create GloRiC are fully described in Ouellet Dallaire et al. (2018).

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 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, resulting in a total global river length of 35.9 million kilometers (excluding Antarctica). Rivers are broken into reaches at all confluences, creating 8,477,883 million individual river reaches with an average reach length of 4.2 km (Fig. 1).

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 RiverATLAS, 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 RiverATLAS please refer to the Technical Documentation at http://www.hydrosheds.org/page/hydroatlas.

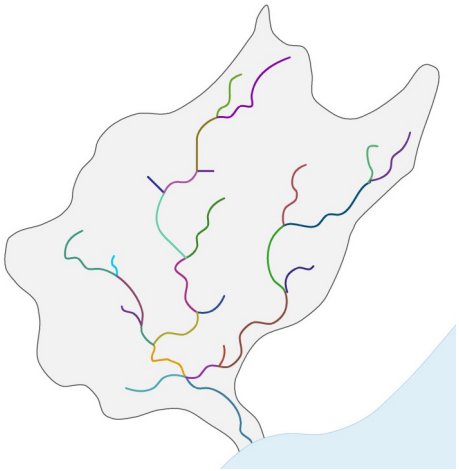

Figure 1: River reaches extracted from HydroSHEDS database. A river reach is defined as a stretch between two tributaries, or between the start/end of the network and a tributary.

RiverATLAS 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 is based on an unpublished beta version of RiverATLAS.

b) Classification

First, three sub-classifications were created in a supervised classification: 1) hydrologic, 2) physio-climatic, and 3) geomorphic. These sub-classifications were then combined into 127 river reach types at the global scale. In addition, an unsupervised, multivariable k-means statistical clustering of all river reaches was conducted, which resulted in 30 classified groups. For more details, please refer to Ouellet Dallaire et al. (2018).

Because the algorithm used for the k-means clustering of 30 river reach types cannot handle *NA* values, we removed all river reaches that had *NA* values due to missing records of the climate moisture index, mostly located in very dry or glacier regions. We also removed all river reaches that had a long-term average discharge of 0 (mostly in desert regions and Greenland).

3. Data format and distribution

a) Data format and projection

GloRiC is publicly available for download at http://www.hydrosheds.org/page/gloric. 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 data is 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 Technical Documentation.

b) Available columns and class names

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

As for the coding of classes, each digit of the class number (e.g. 132) represents a level/grouping from a classier variable or a sub-classification that was used to produce the class. For example, the river reach type '132' represents level '1' from the hydrologic sub-classification, level '3' from the physio-climatic sub-classification, and level '2' from the geomorphic sub-classification. The statistical classes of the k-means classification do not have any names associated.

GloRiC data is provided together with an Excel file (GloRiC_ClassNames_v10.xlsx) which contains the linkages between class numbers and class names needed to create map legends.

Table1. Attribute table of GloRiC river reach file. See Ouellet Dallaire et al. (2018) for more details.

Column	Description
Reach_ID	Unique identifier (ID) for every river reach *Note: the first digit identifies the region/continent: 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 / long-term average discharge'. See explanations of Log_Q_avg for more details on discharge data.*
Class_hydr	Classes of hydrologic sub-classification *(15 classes; see provided Excel file for legend)*
Temp_min	Long-term average of the minimum air temperature of the coldest month [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 datasets and mean annual precipitation from WorldClim.*
Log_elev	Log-10 of average 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 *(24 classes; see provided Excel file for legend)*
Lake_wet	Lake or wetland influence [binary: 0 = no; 1 = yes] *Data sources: Global Lakes and Wetlands Database GLWD (Lehner and Döll 2004)* *Lake-wetland influence was calculated as a binary index where reaches that were located partly or totally inside a wetland zone from GLWD would get a value of one. We used all of the classes from GLWD as wetland indicators, which include large lakes.*
Stream_pow	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 gradient 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 *(127 classes; see provided Excel file for legend)*
Reach_type	Combined river reach type *(4 classes; see provided Excel file for legend)*
Kmeans_30	Classes of k-means statistical clustering *(30 classes; no associated names)*

4. License and citations

a) License agreement

GloRiC is publicly available for download at http://www.hydrosheds.org/page/gloric 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 is held by the authors, 2018, all rights reserved.

b) Acknowledgement and citations

Citations and acknowledgements of GloRiC should be made as follows:

> *Ouellet Dallaire, C., Lehner, B., Sayre, R., Thieme, M. (2018): A multidisciplinary framework to derive global river reach classifications at high spatial resolution. Environmental Research Letters. Data available at http://www.hydrosheds.org/page/gloric.*

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

If users rely on GloRiC as the main data source for their studies, or if their findings depend on the GloRiC database in a fundamental way, it is requested that for scientific publications an offer of co-authorship is extended to the creators of GloRiC.

5. References

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