

Data specifications for the North American lake-river routing product (version 2.1) catchment information shapefiles

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This file describes the four different attribute tables used in the routing product. Within any download of the routing product, the following eight GIS layers are included:

1. **finalcat_info.***: the GIS layer containing catchment/subbasin polygons which respect the lake inflow and outflow routing structures. Note that we use the words catchment and subbasin interchangeably in this document. This layer contains all the necessary information for hydrologic routing through the lake-river network.
2. **finalcat_info_riv.***: the GIS layer containing river network polylines in each catchment polygon from #1 above. Note that some catchments from #1 have no polylines (river channel length of zero in #1) and these catchments are not included in this layer. The columns in this layer's attribute table are the same as the columns in the finalcat_info.* attribute table.
3. **sl_connected_lake.***: the GIS layer containing the lake polygons of lakes that are connected by the finalcat_info_riv.*. Connected lakes (CL) outlets are explicitly connected to a downstream non-zero length river channel in the routing product. The lake polygons are obtained from HydroLAKES database (Messenger et al., 2016).
4. **sl_non_connected_lake.***: the GIS layer containing the lake polygons of lakes that are not connected by the finalcat_info_riv.*. Note that although a non-connected lake (NCL) outlet also defines a catchment outlet, and each such catchment is considered to be a contributing area to flows downstream, an NCL is not explicitly connected to the downstream routing network. The connection is more implicit. Users routing with our network are responsible for ensuring appropriate connections are established when routing with NCLs. See the NCL note below for

more details. The lake polygons are obtained from HydroLAKES database (Messenger et al., 2016).

5. **obs_gauges.*** : the GIS layer containing streamflow observation gauges included in the routing product. The stream flow observation gauges for watersheds in Canada are obtained from HYDAT database; While the streamflow observation gauges for watersheds in the USA are obtained from the USGS website. Note a small fraction of streamflow gauges are not included in the product because they could not be reasonably snapped to the river network. This includes any gauge 1 km or more away from the closest part of the routing product river network.

6. **drainage_region_outline_XXXX_YYYYY.*** : the GIS layer containing outline of sub-region YYYYY within region XXXX. Note: There is also a drainage_region_outline_XXXX_YYYYYY.geojson available

7. **catchment_without_merging_lakes.***: the GIS layer containing catchment polygons of an incomplete routing product. In this incomplete routing product catchment polygons covered by the same lake are not merged into one lake catchment yet. So, these polygons are not the same polygons in GIS file #1 above. This incomplete routing product layer is only intended as input to customize the routing product with our BasinMaker GIS toolbox (for example by defining new lake area thresholds and/or a new catchment minimum drainage area threshold). Although the attribute table columns are named the same as the columns in finalcat_info.*, attributes by the same name are not necessarily equivalent to one another.

8. **river_without_merging_lakes.***: the GIS layer containing river polylines of an incomplete routing product. In this incomplete routing product, the river polylines covered by the same lake are not merged into one river segment yet. So, these polylines are not the same polylines in GIS file #2 above. This incomplete routing product layer is only intended as input to customize the routing product with our BasinMaker toolbox. Note that some catchments from #7 have no polylines (river channel length of zero in #7) and these incomplete routing product catchments are not included in this layer. Although the attribute table columns are named the same as the columns in finalcat_info.*, attributes by the same name are not necessarily equivalent to one another. Attribute definitions are consistent here with GIS layer #7 above.

9. **finalcat_info_v1-0.geojson and routing_product_lake_river.geojson**: These are compatible for viewing upstream and downstream topological connectivity of subbasins on the freely available RavenView website: <http://raven.uwaterloo.ca/RavenView/RavenView.html>. Ravenview was developed by Dr. James Craig at the University of Waterloo.

1. Main attribute table for catchments and rivers

This attribute table is used by the following GIS shapefiles in the routing product:

- finalcat_info*
- finalcat_info_riv.*
- catchment_without_merging_lakes.*
- river_without_merging_lakes.*

Name	Unit	Type	Description and Specific Values
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SubId	[-]	Integer	Subbasin (catchment) ID
DowSubId	[-]	Integer	ID of subbasin (catchment) downstream of current subbasin
RivSlope	m/m	Float	Slope of river channel in the subbasin. It is limited to a range of 0.000001 to 1
RivLength	m	Float	Length of river channel in the subbasin
BasSlope	degree	Float	Averaged slope over the subbasin. It is limited to a range of 0 to 60°
BasAspect	degree	Float	Averaged aspect over the subbasin, it is counterclockwise from East: 90 degrees is North, 180 is West, 270 is South, 360 is East
BasArea	[m ²]	Float	Area of subbasin
BkfWidth	m	Float	Bankfull width of river channel in the subbasin (width of river when full). If this catchment is a lake catchment, and the lake is not a reservoir, this should be used as an initial estimate of lake's effective crest width. It is limited to a range of 0.1 to 3000
BkfDepth	m	Float	Bankfull depth river channel in the subbasin (depth of river when full). It is limited to a range of 0.1 to 10
Lake_Cat	[-]	Integer	Lake category 0: subbasin without lake 1: subbasin with lake that is directly connected to a downstream river channel. 2: subbasin with lake that is not directly connected to a downstream river channel.
HyLakeId	[-]	Integer	The lake ID in HydroLAKES database
LakeVol	[km ³]	Float	Volume of lake in HydroLAKES database; 0.0 for subbasins without lake
LakeArea	[m ²]	Float	Area of lake in HydroLAKES database; 0.0 for subbasins without lake
Laketype	[-]	Integer	Type of lake (assigned by HydroLAKES) 0: Subbasin without lake 1: Subbasin with natural lake 2: Subbasin with lake that is reservoir 3: Subbasin with lake that is natural with regulation
Has_Gauge	[-]	Integer	Subbasin has streamflow gauge station at outlet 0: subbasin has no observation streamflow and/or water level gauge station 1: subbasin has streamflow and/or water level gauge station
MeanElev	m	Float	Subbasin average elevation
FloodP_n	[s/m ^{1/3}]	Float	Averaged flood plain Manning's coefficient (based on landcover along river channel). It is limited to a range of <i>Ch_n</i> to 1.5
Q_Mean	[m ³ /s]	Float	Subbasin outlet bankfull discharge (estimated). It is limited to a range of 0.00001 to 150000.
Ch_n	[s/m ^{1/3}]	Float	River channel Manning's coefficient. It is limited to a range of 0.025 to 0.15.
DrainArea	[m ²]	Float	Drainage area of subbasin outlet
Strahler	[-]	Integer	The Strahler order of river channel
Seg_ID	[-]	Integer	The unique river reach ID the subbasin belongs to (each river reach can include multiple river channels). Only useful as an internal variable for BasinMaker
Seg_order	[-]	Integer	The sequence of the river channel denoting the direction of water flow in the corresponding river reach. Only useful as an internal variable for BasinMaker
Max_DEM	m	Float	The maximum elevation along the river channel
Min_DEM	m	Float	The minimum elevation along the river channel

DA_Obs	[km ²]	Float	Subbasin drainage area reported by institution providing streamflow gauge observations. 0.0 for subbasins without streamflow gauge station
DA_error	[-]	Float	Relative ratio between drainage area based on routing product (DrainArea) and basin drainage area reported by institution providing streamflow gauge observations (DA_Obs). A value of 1.0 indicates DrainArea equals DA_Obs
Obs_NM	[-]	String	Streamflow/water level observation gauging station ID (Null for subbasins without streamflow gauging station) as reported by institution providing streamflow
SRC_obs	[-]	String	Country operating streamflow gauging station (CA=WSC, US=USGS or user supplied name. Null for subbasins without streamflow gauging station)
centroid_x	[deg_W]	Float	Subbasin centroid longitude
centroid_y	[deg_N]	Float	Subbasin centroid latitude

Although the attribute table columns are named the same in four GIS files, attributes by the same name are not necessarily equivalent to one another. Take ‘SubId’ as an example, differences between four GIS files are following:

- Difference between catchment_without_merging_lakes.* and river_without_merging_lakes.*:

These two GIS files represent catchment polygons and river polylines in an incomplete routing product. In this incomplete routing product, catchment polygons covered by the same lake are not merged into one lake catchment yet. This incomplete routing product can be used as input to customize the routing product with our BasinMaker toolbox (for example by defining new lake area thresholds and/or a new catchment minimum drainage area threshold).

The non-connected lake catchments in catchment_without_merging_lakes.* have no river polylines (river channel length of zero in catchment_without_merging_lakes.*). Thus ‘SubId’ of these catchments do not exist in river_without_merging_lakes.*.

- Difference between finalcat_info* and finalcat_info_riv.*

These two GIS files represent catchment polygons and river polylines in a final routing product which correctly represent the lake the lake inflow and outflow routing structures.

Note that non-connected lake catchments in finalcat_info.* have no river polylines (river channel length of zero in finalcat_info.*). Thus ‘SubId’ of these catchments do not exist in river_without_merging_lakes.*.

- Difference between catchment_without_merging_lakes.* and finalcat_info*

Subbasins covered by the same lake in `catchment_without_merging_lakes.*` are merged and represented as one single subbasins in `finalcat_info*`. So some subbasin IDs existing in `catchment_without_merging_lakes.*` do not exist in `finalcat_info*`.

2. Attribute table for observation gauges

This is the attribute table for obs_gauges_*, which is a point shapefile indicating the streamflow observation gauges included in the routing product. The XXXX in the following table represent four digit code for a drainage region, and YYYYY in the following table represent five number digit code for a drainage subregion. The extent and the drainage regions and drainage subregions can be found in the map-based download tool [here on the Basin Maker website](#).

Name	Unit	Type	Description and Specific Values
DA_obs	[km ²]	Float	Subbasin drainage area reported by agency providing streamflow gauge observations. 0.0 for subbasins without streamflow gauge station
SRC_obs	[-]	String	Country operating streamflow gauging station (CA=WSC, US=USGS or user supplied name. Null for subbasins without streamflow gauging station.
SubId	[-]	Integer	Subbasin (catchment) ID.
DrainArea	[m ²]	Float	Drainage area of subbasin outlet.
DA_error	[%]	Float	Relative ratio between drainage area based on routing product (DrainArea) and basin drainage area reported by institution providing streamflow gauge observations (DA_Obs). A value of 1.0 indicates DrainArea equals DA_Obs.
Obs_NM	[-]	String	Streamflow observation gauging station ID as reported by agency providing streamflow. Null for subbasins without streamflow gauging station.
Use_region	[-]	Integer	Defines the spatial extent of the routing product required to cover the drainage area of the streamflow gauge (a guide for users). 1: drainage_region_XXXX is required in order to cover entire gauge drainage basin (because the drainage area of this gauge covers more than one sub-region); 0: A single drainage subregion can cover the entire gauge drainage basin. Downloading the entire drainage region is not required if only interested in this gauge.
Region	[-]	String	Drainage region code XXXX which contains the gauge. Note each drainage region drains into an ocean directly, not to another drainage region.
Sub_Reg	[-]	String	Drainage subregion code YYYYY which contains the gauge. Used to split up some of the larger drainage regions.

3. Attribute table for lake polygons

This is the attribute table for both `sl_connected_lake.*` and `sl_non_connected_lake.*`, which is directly coming from the HydroLAKES database. Detailed explanation of each attributes in this attribute table can be found in HydroLAKES website (<http://wp.geog.mcgill.ca/hydrolab/hydrolakes/>).

Five attributes from the HydroLAKES database are included as attributes of each lake subbasin. However, the attribute names and units of HydroLAKES database attributes have been changed in the routing product. The following table highlights the difference between attribute table in HydroLAKES database and attribute table in the routing product catchment information shapefiles.

Routing product		HydroLAKES		Type	Description and Specific Values
Name	Unit	Name	Unit		
HyLakeId	[-]	Hylak_id	[-]	Integer	The unique lake ID in HydroLAKES database
Laketype	[-]	Lake_type	[-]	Integer	Type of lake (assigned by HydroLAKES) 0: Subbasin without lake 1: Subbasin with natural lake 2: Subbasin with lake that is reservoir 3: Subbasin with lake that is natural with regulation
LakeArea	[m ²]	Lake_area	[km ²]	Float	Area of lake in HydroLAKES database; 0.0 for subbasins without lake
LakeVol	[km ³]	Vol_total	[km ³]	Float	Volume of lake in HydroLAKES database; 0.0 for subbasins without lake
LakeDepth	[m]	Depth_avg	[m]	Float	Averaged depth of lake in HydroLAKES database; 0.0 for subbasins without lake

4. Attribute table for drainage region outline

This is the attribute table for `drainage_region_outline*`, which is a polygon shapefile indicating the spatial extent of this drainage region product (`drainage_region_outline_XXXX`) or drainage subregion product (`drainage_region_outline_XXXX_YYYYY`). The extent and the drainage regions and drainage subregions can be found in the map-based download tool [here on the Basin Maker website](#).

Name	Unit	Type	Description and Specific Values
Region	[-]	String	Unique drainage region code XXXX
Sub_Reg	[-]	String	Unique drainage subregion code YYYYY