An example of catchment-based lake and river routing product for hydrologic and land surface models in Canada

Ming Han[1], Juliane Mai[1], Bryan A. Tolson[1], James R. Craig[1], Étienne Gaborit[2], Hongli Liu[3], Konhee Lee[4]

1 University of Waterloo, Waterloo, Ontario, Canada.

2 Environment and Climate Change Canada, Dorval, Quebec, Canada.

3 University of Waterloo, Waterloo, Ontario, Canada, now at: National Center for Atmospheric Research, Boulder, CO, United States

4 University of Waterloo, Waterloo, Ontario, Canada, now at: Ontario Power Generation, Niagara on the Lake, Ontario, Canada.

1. Overview

This file describes the data available and provides an example of the pan-Canadian lake and river routing products as summarized in the publication below:

Han, M, J. Mai, B. A. Tolson, J. R. Craig, E. Gaborit, H. Liu, K. Lee
in preparation to be submitted to *Canadian Water Resources Journal*.

This catchment-based lake and river routing product combines catchment polygons from the HydroBASINS product (Lehner and Grill, 2013) and lakes from the HydroLAKES product (Messager et al., 2016) to obtain pan-Canadian routing products that consider lakes. In total, ten routing products are developed within this work, using five watershed delineations (HydroBASINS product from level 8 to level 12) and two lake-selection strategies (all lakes in HydroLAKES and only lakes with an area larger than 1 km^2). All routing products cover all of Canada.

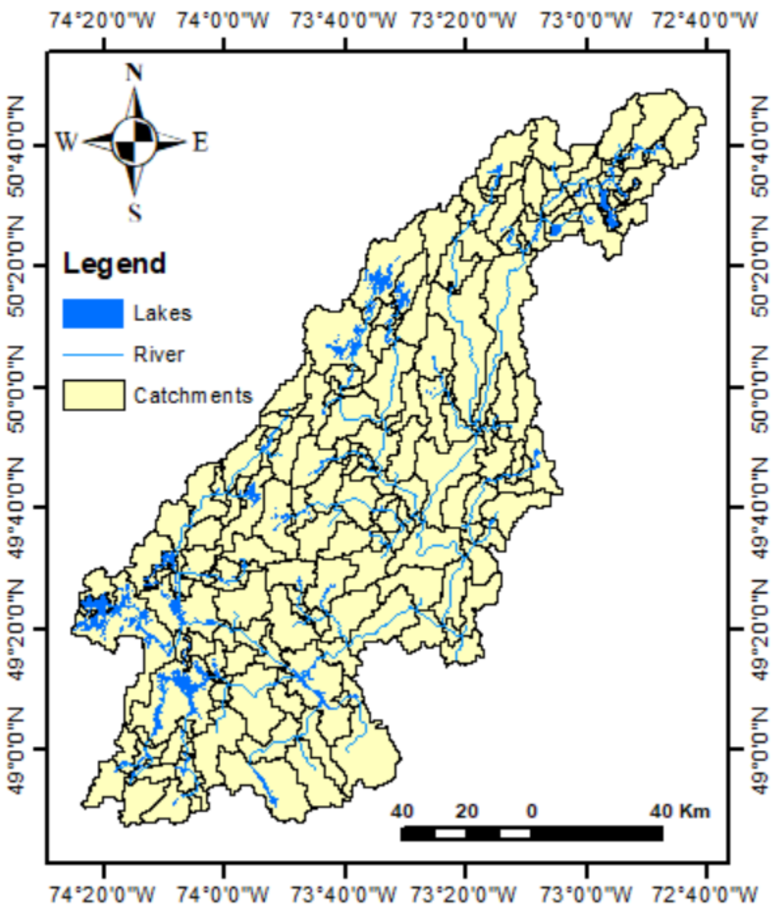
The major differences between the developed routing product and HydroBASINS with inserted lakes are following:

- **Lakes are represented differently**.
  In this routing product, each lake is represented by a lake catchment and a lake catchment includes an entire lake polygon from HydroLAKES as well as some land area immediately adjacent to the lake. A lake catchment is delineated with pour points from the lake outlet, pour points from intersections between the lakes and rivers, and the HydroSHEDS 15 arc-second flow direction, flow accumulation, and digital elevation map product (Lehner and Grill, 2013).

- **Additional hydrologic routing parameters are included**.

  1. The bankfull width, depth, and mean annual discharge for each catchment, in the region below the 60° N, are obtained from the product developed by Andreadis et al. (2013) and added as attributes to the product. The bankfull width, depth, and mean annual discharge for regions above the 60° N, are estimated by following methodology presented in Andreadis et al. (2013).
  2. The flood plain manning's coefficient is calculated based on the landuse (from MCD12Q1 product (DAAC, 2009)) along the river channel and typical Manning's n coefficients for those landuse types.

3. The channel manning's n is calculated based on the bankfull width, depth, and mean annual discharge, and an assumed trapezoidal channel shape.



2. List of example files within the folder

We use the example Chamouchouane river watershed of size 11,504 km^2 located in the North-east of Canada to demonstrate the information provided in the routing product. The routing product we use here is the level 12 HydroSHEDS product combined with lakes that are larger than 1 km^2. The Chamouchouane river watershed was extracted from the pan-Canadian product for this example. In this example watershed, 97 lakes are included in the lake-river routing product.

- **finalcat_info.shp:** An example of delineated catchments in a small watershed in polygon format. ***The routing product will be distributed in this format***.

3. Attribute table of delineated catchments (finalcat_info.shp)

Name	Description	Unit
SubId	Subbasin ID	-
DowSubId	Downstream subbasin ID	-
Area	Area of the catchment	m^2
Rivlen	The length of the river within catchment	m
RivSlope	The river slope	-
BasinSlope	The averaged slope within catchment	m/m
BkfWidth	The bankfull width	m
BkfDepth	The bankfull depth	m
IsLake	-9999 catchment is not a lake catchment otherwise, 1	-
HyLakeId	The HydroLAKES ID of the lake (from HydroLAKES)	-
LakeVol	The lake volume (from HydroLAKES)	km^3
LakeDepth	The lake depth (from HydroLAKES)	m
LakeArea	The lake area (from HydroLAKES)	km^2
Laketype	The lake type (from HydroLAKES)	-
IsObs	-9999 means no streamflow observations at subbasin outlet, otherwise, 1	-
MeanElev	The mean elevation of the catchment	m
FloodP_n	The flood plain manning’s coefficient	-
Q_Mean	The annual averaged discharge	m^3/s
Ch_n	The channel manning’s coefficient	-
INSIDE_X	The longitude of the center of the catchment	degree
INSIDE_Y	The latitude of the center of the catchment	degree
INSIDE_Y	The latitude of the center of the catchment	degree

Reference

Andreadis, K.M., Schumann, G.J.-P., Pavelsky, T., 2013. A simple global river bankfull width and depth database. Water Resources Research 49, 7164-7168.

DAAC, L., 2009. Land Cover Type Yearly L3 Global 500 m SIN Grid (MCD12Q1). Land Processes Distributed Active Archive Center (LP DAAC), located at the US Geological Survey (USGS) Earth Resources Observation and Science (EROS) Center (lpdaac. usgs. gov), Sioux Falls. URL: https://lpdaac. usgs. gov/lpdaac/products/modis_products_table/land_cover/yearly_ l3_global_500_m/mcd12q1.

Lehner, B., Grill, G., 2013. Global river hydrography and network routing: baseline data and new approaches to study the world's large river systems. Hydrological Processes 27, 2171-2186.

Messager, M.L., Lehner, B., Grill, G., Nedeva, I., Schmitt, O., 2016. Estimating the volume and age of water stored in global lakes using a geo-statistical approach. Nature Communications 7, 13603.