QRaven Documentation

Release 0.1

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You will find all the information about QRaven, from its installation to contributing to its development. If you find any errors or typos, please report them.

CHAPTER

ONE

INSTALLATION

1.1 Dependencies

To use QRaven, first install a recent version of QGIS (3.20 and above): https://qgis.org/en/site/forusers/download.html

Some features, such as the BasinMaker tools and the GridWeight Generator, require a containerization software to be installed. If you are not planning on using those features, you can skip this step. Otherwise, you can pick between Podman and Docker.

Get Podman : https://podman.io/getting-started/installation

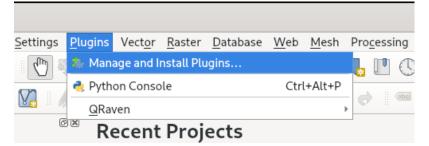
Get Docker : https://docs.docker.com/get-docker

Warning: command:		sers who choos	se Dock	er mus	t run it as a non root user. This can be done with the following				
sudo usermod -aG docker \$USER									
-	For more information, go to: https://docs.docker.com/engine/install/linux-postinstall/ #manage-docker-as-a-non-root-user https://docs.docker.com/engine/install/linux-postinstall/								

1.2 Plugin installation

1.2.1 Method 1 (recommended)

Open QGIS and go to the "Plugins" menu. Click on "Manage and Install Plugins".



Click on the "Settings" tab and click on the "Add" button to add a new plugin repository.

In the window that just opened, enter a name, such as "QRaven", enter the link below in the URL field and leave the remaining options to their defaults:

https://scriptbash.github.io/plugins.xml

		Plugins Settings	
🏊 All	✓ Check for Updates	on Startup	
installed		abled,QGIS will inform you whenever a plugin update is avail will be performed during opening of the Plugin Manager window.	
💁 Not installed	Show also Expension	rimental Plugins	
T Invalid	Experimental pluging	are in early stages 6 does not	
Install from ZIP	reco		
Settings	▼ □ Name	QRaven	
	URL	https://scriptbash.github.io/plugins.xml	unmaintained, and
	shou Parameters	?qgis=3.28	ns unless you still
	Authentication	Clear Edit	
	Plugin Enabled	\checkmark	
	State	Cancel OK	.xml?qgis=3.28 l?qgis=3.28
	Help		Close

After connecting to QRaven's repository, click on the "All" menu and search for QRaven. Click on QRaven and click on "Install".

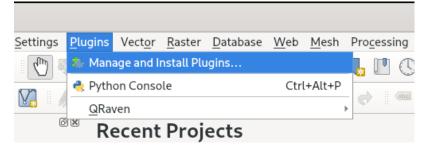
To update QRaven, simply head back to the plugins manager, search for QRaven and click on "Upgrade Plugin".

1.2.2 Method 2 (manual)

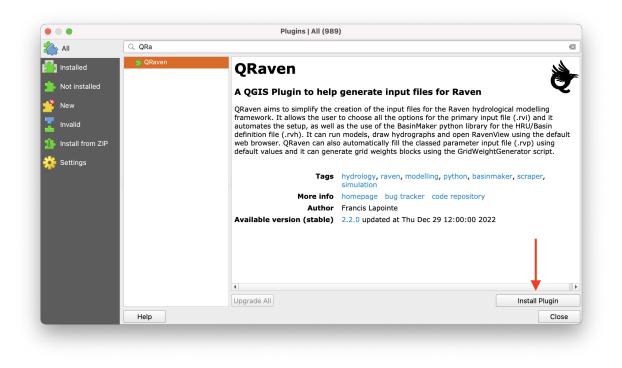
Download the latest release of QRaven here: https://github.com/Scriptbash/QRaven/releases/latest/download/qraven. zip

Alternatively, you can view all of QRaven versions here : https://github.com/Scriptbash/QRaven/releases

Next, open QGIS and go to the "Plugins" menu. Click on "Manage and Install Plugins".



Finally, click on "Install from ZIP", select the downloaded qraven.zip file and click on "Install".



	Plugin	ıs Installed (11)	8
à All	Q Search		
installed	B Manager Geometry Checker	There is a new version ava	illable
눩 Not installed	GRASS 7	QRaven	
🞾 Upgradeable	✓ 🖉 MetaSearch Catalog Client	A QGIS plugin to help	generate input files for Raven
Install from ZIP	🛛 🍪 OrfeoToolbox provider	(.RVH) for the Raven hydrolog	reation of the primary input file (.RVI) and HRU/E gical modelling framework. It allows the user to cl
🔆 Settings	 ✓ [*]/_* Processing ✓ [*]/_* QRaven 		tes the setup, as well as the use of the BasinMake drograph and open RavenView using the default v
	✓ SAGA GIS provider ₩ Topology Checker	Category	Plugins
		Tags	python, raven, hydrology, modelling, ravenview
		More info Author	homepage bug tracker code repository Francis Lapointe
		Installed version	2.0.2
		Available version (stable)	2.2.0 updated at Thu. Dec. 29 12:00:00 2022
		Upgrade All	Uninstall Plugin Upgrade Plugin
			Close Help

	Plugins Install from ZIP _ ×
All Installed Not installed New Install from ZIP	If you are provided with a zip package containing a plugin to install, please select the file below and click the <i>Install plugin</i> button. Please note for most users this function is not applicable, as the preferable way is to install plugins from a repository.
Settings	ZIP file: /home/francis/Documents/qraven.zip 🛛

To update QRaven, you will need to download the latest .zip file and repeat the same steps as above.

Note: The plugin will look for an update each time QGIS is started. If it finds one, you will have a notification in the notification bar and inside the "Settings" menu of QRaven.

CHAPTER

TWO

HOW TO USE QRAVEN

2.1 Open QRaven

Click on the QRaven icon 🐑 in your toolbar or go in the "Plugins" menu, select the QRaven option and click on "Generate Raven input files"

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	🜏 Pyth	on Conso	le		Ctrl	+Alt+P			(ab o (abc)	abo	(abc)	abc
	<u>Q</u> Ra	ven)	🕨 👌 Gener	ate Rav	en input f	iles	(abc)	
ð			D									

You will have seven main menus

- Raven RVI
- BasinMaker RVH
- GridWeights
- Streamflow
- *GIS*
- Run Model
- Settings

2.2 Create a RVI file

QRaven all started with this feature in mind. This tab can be used to create a rvi file from scratch or from a template. The templates available are UBCWM, HBV-EC, HBV-Light, GR4J, Canadian Shield, MOHYSE, HMETS, HYPR, HYMOD and AWBM. Those models structures were taken directly from the Raven official documentation.

This section of the plugin is pretty straight forward to use. Check/uncheck/ options, select entries in drop down lists, etc. When ready, click on the "Write" button to write the rvi file. Otherwise, you can click on "Reset" to revert the options back to their default values.

The parameters are separated in different sections. You can find an overview of the options below;

• Model info

- You can find templates buttons. Simply click on the one needed and the interface will load its configuration.
- Basic information like the name of the model, the start/end date, time step, etc.

• Sim. parameters

- Simulation parameters such as the catchment route, the routing method, evaporation, etc.

• Hydro. processes

- A table that allows to set up the hydrologic processes.
- Click on "Add process" to add a new row or "Remove selected process" to remove the selected row.
- After selecting a process, the available algorithms for that process will be inside the algorithm drop down list. The from and to compartments drop down list will contain the available compartments for the select process and algorithm.
- Transport cmd
 - This work the same way as the hydrologic processes, but for the transport commands.
- Optional I/O
 - All kind of optional options like CreateRVPTemplate, evaluation metrics, debug mode, etc.
- Custom output
 - This is similar to the hydrologic processes table, but for custom outputs.

• • •			QRave	n						
Raven RVI	Model info	Sim.parameters	Hydro.processes	Transp	ort cmd.	Optional I/O	Cu	stom output		
BasinMaker				Temp	lates					
Gridweights	U	BCWM	HBV-EC			HBV-Light			GR4J	
	Canad	dian Shield	MOHYSE			HMETS			HYPR	
Streamflow			HYMOD			AWBM				
GIS	Output direc	tory								
Run Raven	Model name									
Settings	StartDate									
- *	EndDate									
	🔲 Use Durat	tion instead								
			Hours		Minutes			Seconds		
	SoilModel		SOIL_MULTILAYER							
	DefineHRUG	roups								
	DisableHRUGroup									
	N	Vrite							Reset	

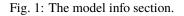


Image: Figure			ers Hydro.processes T			t					
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Image: state	Gridweights	SnowRefreeze	 FREEZE_DEGREE_DAY 	* SNOW_LIQ	* SNOW	•					
Run Raven Settings 4 Composite ShowBalance SUBLIM_ALL CANOPY_SNOW ATMOSPHERE Common Composite ShowBalance SNOW LIQ SnowBalance Snow LIQ Snow LIQ<	Streamflow	Precipitation	PRECIP_RAVEN	 ATMOS_PRECIP 	 MULTIPLE 	•					
Number NowBalance NOBAL_SIMPLE_MELT NOW NOW_LQ Image: Nome of the state of the			CANEVP_ALL	 CANOPY 	 ATMOSPHERE 	•					
Studys 6 Overflow RAVEN_DEFAULT SNOW_LIQ PONDED_WATER Image: Studys Image: Studys </td <td>Run Raven</td> <td></td> <td> SUBLIM_ALL </td> <td>CANOPY_SNOW</td> <td> ATMOSPHERE </td> <td>•</td> <td></td> <td></td> <td></td> <td></td> <td></td>	Run Raven		 SUBLIM_ALL 	CANOPY_SNOW	 ATMOSPHERE 	•					
Studys 6 Overflow RAVEN_DEFAULT SNOW_LIQ PONDED_WATER Image: Studys Image: Studys </td <td></td> <td></td> <td> SNOBAL_SIMPLE_MELT </td> <td>* SNOW</td> <td>▼ SNOW_LIQ</td> <td>•</td> <td></td> <td></td> <td></td> <td></td> <td></td>			 SNOBAL_SIMPLE_MELT 	* SNOW	▼ SNOW_LIQ	•					
8 GladerMelt GMELT_HBV GLACIER_ICE GLACIER Image: Stress of the	Settings		 RAVEN_DEFAULT 	SNOW_LIQ	PONDED_WATER	•					
9 GlacierRelease GRELEASE_HBV_EC GLACIER SURFACE_WATER Image: Comparison of the compar			 RAVEN_DEFAULT 	PONDED_WATER	 GLACIER 	•	HRU_TYPE	• IS	GLACIER		
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18 Baseflow BASE_POWER_LAW SOIL[1] SURFACE_WATER . <td></td> <td></td> <td> SOILEVAP_HBV </td> <td>· SOIL[0]</td> <td> ATMOSPHERE </td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>			 SOILEVAP_HBV 	· SOIL[0]	 ATMOSPHERE 						
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19 Baseflow BASE_LINEAR SOIL[2] SURFACE_WATER • 0.0 20 LateralEquilibrate RAVEN_DEFAULT AllHRUs SOIL[1] • 1.0			 BASE_POWER_LAW 	• SOIL[1]	 SURFACE_WATER 	•					
			· BASE_LINEAR	· SOIL[2]	 SURFACE_WATER 	•					
21 LateralEquilibrate RAVEN_DEFAULT AllHRUs SOIL[2]			RAVEN_DEFAULT	• AllHRUs	· SOIL[1]	•					1
			· RAVEN_DEFAULT	• AllHRUs	· SOIL[2]	•					1

Fig. 2: The hydrologic process table.

2.3 Create a RVH file

Warning: The Docker daemon must be running to use this feature. Podman users don't need to worry, as Podman is daemonless.

*To-do

2.4 Associate a NetCDF grid to the HRUs

Warning: The Docker daemon must be running to use this feature. Podman users don't need to worry, as Podman is daemonless.

- 1. NetCDF file : The NetCDF file to process (inluding the file extension).
- 2. **Shapefile attribute** (Optional) : Only needed if the Netcdf file is a shapefile. It is the attribute containing the numbering of the subbasins.
- 3. Dim name longitude (x) : The dimension name for the longitude (e.g. rlon).
- 4. Dim name latitude (y) : The dimension name for the latitude (e.g. rlat).
- 5. Var name longitude (x) : The variable name for the longitude (e.g. lon).
- 6. Var name latitude (y) : The variable name for the latitude (e.g. lat).

- 7. HRUs file : The final shapefile created by the BasinMaker tools.
- 8. Use gauge ID and Use subbasins ID : Either use a gauge ID or subbasins ID. The ID must be entered manually in the field below these options.
- 9. Output path : The path and file name of the results.

	QRaven	×
Raven RVI BasinMa	ker RVH GridWeights Run Model	
NetCDF file	/home/francis/Documents/precip.nc	×
Shapefile attribute		
Dim name longitude (x)	rlon	
Dim name latitude (y)	rlat	
Var name longitude (x)	lon	
Var name latitude (y)	lat	
HRUs file	/home/francis/Documents/OIH_Output/network_after_gen_hrus/finalcat_hru_info.shp	×
	Use gauge ID Use subbasin ID	
	593	
Output path	/home/francis/Documents/RavenInput/dumoine.txt	×
Run		Delete image
		× Fermer

Fig. 3: Example of the gridweights generator interface.

2.5 Download streamflow data

QRaven can fetch hydrometric data from two providers at this time, which are the direction principale des prévisions hydriques et de la cartographie (DPPHC) and the Water office. Not only can it fetch data automatically, it can also generate rvt files from the data. Only flow data is supported, level data is unsupported.

Both data scrapers work the same way, but their search criterias differ a little bit. This documentation will only cover the Water office scraper.

- Search a station
 - 1. Select either "Station name" or "Province".
 - 2. If "Station name" is selected, type in the full or patial name of the station. If "Province" is selected, select a province in the drop down list.
 - 3. Use the "Regulation" and "Station status" drop down lists to refine your search if needed.
 - 4. Click on "Search".

5. Results will show up in the text area above the "Search" button.

Note: The station ID is always the first information in the search results. Simply copy/paste an ID into the "Station ID" field in the download section.

• Download hydrometric data

- 1. In the "Station ID" field, type in the hydrometric station ID from which the data will be downloaded.
- 2. In the "Output file" field, select a directory and name for the output file. The extension will always be ".rvt".
- 3. Click the "Download" button.

If you have already downloaded data from one of the two providers, use the following option.

• Process a local file

- 1. In the "Input file" field, select the file you want to process.
- 2. In the "Output file" field, select a directory and a name for the rvt file.
- 3. Click on the "Process" button.

		QRaven	
Raven RVI	CEHQ Water of		
BasinMaker		Station search	
Gridweights	🕒 Station name	coaticook	
Streamflow	Province		
	Regulation		
GIS	Station status		
Run Raven		020E022 - COATICOOK (RIVIERE) À 1,3 KM EN AVAL DU PONT-ROUTE 143 À WATERVILLE 1959-2021 QC Flow	
Settings		02OE009 - COATICOOK (RIVIERE) EN AMONT DE LA CENTRALE DE COATICOOK 1930-1931 QC Flow	
- w		020E010 - COATICOOK (RIVIERE) PRES DE NORTH-COATICOOK 1930-1939 QC Flow	
		Search	
	Start date	Download station data 1959-07-24	
	End date	2021-09-30	
	Station ID	020E022	Ë .
	Output file	/Users/francis/Documents/coaticook.rvt ×	
		Fetch date range	
		Download	
		Generate points of interest layer	
	Current IDs		
	la aut file	Process local file	
	Input file		
	Output file	Process	
		Plucess	

Fig. 4: Example of the Water office UI

2.6 Download GIS data

To write.

	•		QRaven		
	Raven RVI		Download data		
112	BasinMaker	DEM	/Users/francis/Documents/1-Directory_qrvn_downloads/DEM	X	
		Flow direction	/Users/francis/Documents/1-Directory_qrvn_downloads/Flowdir	×	
Ш	Gridweights	Lakes	/Users/francis/Documents/1-Directory_qrvn_downloads/Lakes	×	
\approx	Streamflow	Bankfull width	/Users/francis/Documents/1-Directory_qrvn_downloads/Bankfull	×	
(E)	GIS	Landuse	/Users/francis/Documents/1-Directory_qrvn_downloads/Landuse	X	
	Run Raven	Soil	/Users/francis/Documents/1-Directory_qrvn_downloads/Soil	×	
			Downloading DEM		
₩¢	Settings		25%		
			Download		
			Data processing		
			Use the same paths as above	_	
		Clip layer	s/francis/Documents/1-Directory_qrvn_downloads/bv_dumoine/bv_dumoine.shp	$\langle \mathbf{X} \rangle$	
		DEM	/Users/francis/Documents/1-Directory_qrvn_downloads/DEM/na_con_3stif	×	
		Flow direction	sers/francis/Documents/1-Directory_qrvn_downloads/Flowdir/hyd_na_dir_15stif	X	
		Lakes	icis/Documents/1-Directory_qrvn_downloads/Lakes/HydroLAKES_polys_v10.shp	X	
		Bankfull width	/Users/francis/Documents/1-Directory_qrvn_downloads/Bankfull/nariv.shp	X	
		Landuse	/Users/francis/Documents/1-Directory_qrvn_downloads/Landuse/landusetif	\mathbf{X}	
		Soil	lsers/francis/Documents/1-Directory_qrvn_downloads/Soil/slc_v2r2_canada.shp	×	
			Process		

Fig. 5: Example of the GIS UI

2.7 Run a Raven model

To run a Raven model, you need to provide three information.

- 1. Input directory : The directory containing your Raven model files.
- 2. Output directory : The directory where the results of the simulation will be saved.
- 3. Raven executable location : The path to the Raven.exe file (including the filename).

Two other fields are also available, but they should be automatically filled by reading the .rvi file of your model. If an error occurs and they are not filled automatically, please submit a bug report.

- 1. Filename prefix : The name of the .rvi file (without the file extension)
- 2. RunName : The text following the command ":RunName" if used in the .rvi file.

		QRaven		×
Raven RVI BasinMaker F	RVH GridWeights	Run Model		
Input directory	/home/francis/Downlo	oads/RavenTutorialFiles/Irond		×
Output directory	/home/francis/Downlo	pads/RavenTutorialFiles/Irond/output		×
	, none, nanes, e ou na	sasharen atonar neshronajoatpat		
Raven executable location	/home/francis/Docum	ents/Raven.exe		×
File name prefix	Irond			
RunName	run1			
Run Raven	Model	Draw hydrograph	RavenView	
				× Fermer

Fig. 6: Example of the Run Model interface.

2.8 Draw the hydrograph

After running a Raven model successfully (with or without QRaven), you will be able to draw the resulting hydrograph. To do so, all that is required is the "Output directory" field and a click on the "Draw hydrograph" button.

In the graph window, multiple buttons are available. They will allow you to zoom in and out, modify the graph size, customize the axis and export the graph as an image.

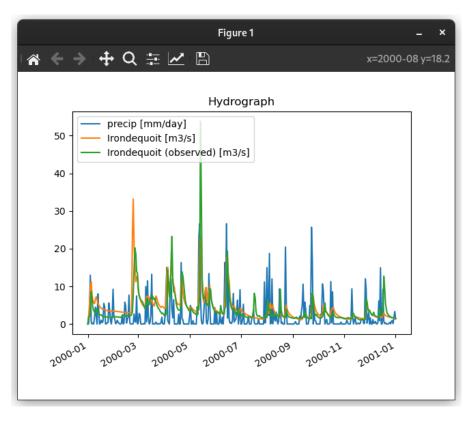


Fig. 7: Example of an hydrograph produced by QRaven.

2.9 Autofill a .rvp template file

A cool feature based on a RavenR function is available to attempt to automatically fill a .rvp template file.

In order to use this feature, a few steps are required.

- 1. Make sure the ":CreateRVPTemplate" command is used inside the .rvi file.
- 2. Run the model.
- 3. Click on the "Auto fill rvp template".
- 4. Review the generated .rvp file for any values that do not have a default value. Those values will show as "0.12345".

Note: This feature needs more testing and could have many oversights. To help improve it, please submit any problems you encounter by opening a new issue. If possible, also send your Raven model so the issue can be easily reproduced.

2.10 Settings

The Settings menu allows some slight customization of QRaven for the moment. More settings may come later on.

As per now, you can select which containerization software and which image you want to use. You can also select a side menu style.

Containerization software: By default, Docker is selected, but if you want to use Podman, simply select the Podman option in the drop down list.

Image: This option lets you pick between the regular container image and the ARM based image. By default, MacOS will be running the ARM based image. If your MacBook is Intel based, switch to the regular image. Linux and Windows both default on the regular image.

Menu bar style: Allows you to choose between the default menu (icons with text) or a collapsed menu (icons only).

Warning: After making changes to the settings, do not forget to click on the "Save" button. Otherwise, your changes will be lost after closing QGIS.

• • •)	QRaven	
		Containers	
112	Containerization software	Podman •	
	Image		
		placeholder login	
*	username		
(\tilde{s})	password		
		Misc	
	Menu bar style	Collapsed •	
$\mathbf{Q}_{\mathbf{Q}}$			
		Pre-release version.Please report any issues on GitHub.	
		Save	

Fig. 8: The settings menu as of version 2.3.0

CHAPTER

THREE

HOW TO CONTRIBUTE TO QRAVEN

There are many ways you can contribute to QRaven and not only by coding!

3.1 Bug reporting

Reporting bugs and problems is very important, since even though I try to test as much as possible the plugin, I can't run into every problems possible.

If you find any possible bugs, errors, typos, please open an issue on GitHub.

3.2 Feature requests

I'm trying to add as many useful features to create Raven models and also ease the use of Raven in general. If there are features you would like or you think would be useful, please submit your request by either opening an issue or a discussion.

3.3 Development

If you want to contribute to the code, by adding new features, fixing bugs, optimizing the code, you're welcome to do so!

QRaven is written in Python and uses PyQt for the graphical user interface. Here is a small guide on how to setup your environment :

3.3.1 Setting up the environment

Note: The folder "QRaven" is not the QGIS plugin, it is the repository name. The folder "qraven" is the plugin. If it is zipped, it can be installed directly in the QGIS extension manager.

Before starting, find where the QGIS plugins folder is.

- 1. Open QGIS.
- 2. Click on the "Settings" menu.
- 3. Hover "User Profiles" and click on "Open Active Profile Folder".
- 4. Go inside the "Python" folder, then inside "Plugins".

- 5. Remember this path, as this is where the "qraven" folder needs to be.
- 6. Clone QRaven's repository.

```
git clone https://github.com/Scriptbash/QRaven.git
```

You now have two options, either copy/paste the graven folder into the QGIS plugins folder or create a symbolic link. I prefer to create a symlink, as it allows to:

- modify the code.
- reload the plugin.
- see the changes.

as opposed to:

- modify the code.
- copy and paste the graven folder into the plugins folder.
- reload the plugin.
- see the changes.
- 1. So, to create a symlink, open a "terminal" or "command prompt" depending on your operating system.
- 2. Type:

for Linux and MacOS

```
ln -s <path to qraven directory> <path to qgis plugins folder>
```

for Windows

mklink /D <path to qraven directory> <path to qgis plugins folder>

Now that the development version of QRaven is installed in QGIS, we will install another QGIS plugin. The plugin will allow to reload QRaven after changes are made to it, without the need to close QGIS and reopen it.

- 1. In QGIS, go to the "Plugins" menu.
- 2. Click on "Manage and Install plugins"
- 3. Click on "All" and search for "Plugin Reloader"
- 4. Open the "Plugin Reloader" and set it to reload QRaven

You are now good to go! Make changes to the code, reload QRaven with the plugin reloader and submit pull requests!

3.3.2 Files explanation

Not sure where to start? No worries, here is a quick overview of the important files :

- Inside the root folder of the repository, there is Dockerfile and create_RVH.py
 - Dockerfile is the file used to create the Docker image used for BasinMaker and the GridWeights generator
 - create_RVH.py file is the script that lies inside the Docker container. In other words, it is the script that
 runs the BasinMaker functions.
- In the "qraven" folder, you will find many important files.
 - qraven.py is the main python file used for the plugin.

- qraven_dialog_base.ui is the graphical user interface of QRaven. You can open it with QtDesigner.

• In the "modules" folder, there are several python files that are imported inside the "qraven.py" file.

CHAPTER

CREATE A RAVEN MODEL STEP BY STEP

This tutorial will explain how to build a Raven model from scratch using QRaven. The HBV-EC template will be used to model the watershed of Dumoine river.

4.1 Get the required data

The data needed can be separated for two uses;

- 1. for Raven (Temperature, precipitations, streamflow, etc.)
- 2. for BasinMaker (Landuse polygons, rivers network, DEM, etc.)

4.1.1 Data for Raven

Streamflow

Downloading streamflow data for Canada is quite easy in QRaven.

- 1. Click on the Streamflow menu.
- 2. Since the watershed is in the province of Quebec, we will use the DPPHC data scraper. Make sure the DPPHC tab is active.
- 3. Search for "Dumoine, Rivière" in the "River or lake" field.
- 4. Click on the "Search button".

	•		QRaven	
	Raven RVI	DPPHC Wate	ar office 2	
臣	BasinMaker		Station search	
Ē	Gridweights	Municipality	•	
\approx	Streamflow	River or lake	Dumoine, Rivière •	
\approx	Streamnow	Region		
(F)			041901 - Dumoine à 1,6 km de la rivière des Outaouais Fermé Les Lacs-du-Témiscamingue	
Á	Run Raven		Abitibi-Témiscamingue Dumoine, Rivière Débit	
Ż	OSTRICH	3	041902 - Dumoine à la sortie du lac Robinson Ouvert Les Lacs-du-Témiscamingue Abitibi- Témiscamingue Dumoine,Rivière Débit	
.	Settings		Search	

- 5. Next, copy the station ID of the only operational station.
- 6. Paste the ID into the "Station ID" field

- 7. Click on fetch date range. This will set the start date and end date widgets with the first and last date of observation data available.
- 8. By clicking on fetch date range, the download button will be made available. Select a path where to save the data and click on Download.

	QRaven
Raven RVI	DPPHC Water office
BasinMaker	River or lake Uumoine, Rivière •
Gridweights	Region
Streamflow	041902 - Dumoine à la sortie du lac Robinson Ouvert Les Lacs-du-Témiscamingue Abitibi- Témiscamingue Dumoine,Rivière Débit
GIS	041903 - Dumoine à la sortie du lac Dumoine Fermé Lac-Nilgaut Outaouais Dumoine, Rivière Débit
Run Raven	Search
STRICH	Download station data
Settings	Start date 2000-01-01 :
	End date 2023-01-01 :
	Station ID 041902
	Output file /Users/francis/Documents/1-Directory_qrvn_downloads/041902.rvt ×
	Fetch date range
	Download

Note: The streamflow will already be transformed into a .rvt file. We will only need to edit the basin/HRU ID later. You will also notice some information about the station has been added below the download button. Each time you download data from a station, its information will be added there.

9. Click on "Create layer". This will generate a points layer to be used with BasinMaker.

	•		QRaven	
	Raven RVI	DPPHC Wate	er office	
出	BasinMaker		041902 - Dumoine à la sortie du lac Robinson Ouvert Les Lacs-du-Témiscamingue Abitil Témiscamingue Dumoine,Rivière Débit	pi-
	Gridweights		041903 - Dumoine à la sortie du lac Dumoine Fermé Lac-Nilgaut Outaouais Dumoine, Rivière Débit	
\approx	Streamflow		Search	
(SP)				
	Run Raven		Download station data	
1	Kull Kaven	Start date		
R	OSTRICH	End date		
$\mathbf{\dot{Q}}_{0}$	Settings	Station ID		
		Output file	/Users/francis/Documents/1-Directory_qrvn_downloads/041902.rvt ×	
			Fetch date range	
			Generate points of interest layer	
		Current IDs	['041902',46.3463888888888889,-77.8155555555555555,'3756']	
			Create layer	

Precipitations and Temperature

For this tutorial we will only use data coming from the Daymet services. To do so, we will use the Daymet component of QRaven.

- 1. Download and extract the shapefile of the Dumoine river here: https://github.com/Scriptbash/QRaven/raw/main/ bv_dumoine.zip
- 2. Click on the "Daymet" menu.
- 3. Select an output folder where the files will be saved.
- 4. In the "Input polygon" field, select the extracted shapefile from step 1.
- 5. Set the start date to 2010-01-01 and the end date to 2020-12-31.
- 6. In the variable list, select "tmin", "tmax" and "prcp".
- 7. Leave both the "Insert missing dates" and "Merge downloaded files" checkboxes checked. Since Daymet strips december 31st from the NetCDF files during leap years to include february 29, this will automatically fix the problem for us.
- 8. Click on the "Download" button and wait for the process to finish. It could take quite a while to finish.

	•		QRaven		
	Raven RVI				
ČÁ.	Daymet	Output folder	/Users/francis/Documents/2-Demo_ECCC/Donnees_geo	×	
\sim		Input polygon	/Users/francis/Documents/2-Demo_ECCC/Donnees_geo/bv_dumoine/bv_dumoine_wgs84.shp	×	
\approx	Streamflow	Start date			
		End date			
出	BasinMaker		tmin tmax		
Ħ	Gridweights		prcp srad		
Ą	Run Raven	Variables	νρ swe dayl		
Z	OSTRICH				
O _o	Settings				
			Insert missing dates 📲 Merge downloaded files		
			Download		

4.1.2 Data for BasinMaker

Data needed to run BasinMaker can be fetch automatically by QRaven (Canada only for now).

- 1. Click on the GIS menu
- 2. Select a path where to save the files. Do this for all of the Data.
- 3. Click on "Download". This could take a while depending on the files being downloaded.

		QRaven				
Raven RVI		Download data				
BasinMaker	DEM	/Users/francis/Documents/1-Directory_qrvn_downloads/DEM	$\langle \mathbf{X} \rangle$			
	Flow direction	/Users/francis/Documents/1-Directory_qrvn_downloads/Flowdir	\mathbf{X}			
Gridweights	Lakes	/Users/francis/Documents/1-Directory_qrvn_downloads/Lakes	×			
Streamflow	Bankfull width	/Users/francis/Documents/1-Directory_qrvn_downloads/Bankfull	(\mathbf{X})			
GIS	Landuse	/Users/francis/Documents/1-Directory_qrvn_downloads/Landuse	×			
Run Raven	Soil	/Users/francis/Documents/1-Directory_qrvn_downloads/Soil	(\mathbf{X})			
STRICH						
Settings		Download				

- 4. Once the download is finished, check the "Use the same paths as above" checkbox. This tells QRaven where the files to process are.
- 5. In the "Clip layer" field, select the watershed's polygon shapefile.
- 6. Click on "Process"

		QRaven				
Raven RVI		Download data				
BasinMaker	DEM	/Users/francis/Documents/1-Directory_qrvn_downloads/DEM	×			
	Flow direction	/Users/francis/Documents/1-Directory_qrvn_downloads/Flowdir	×			
Gridweights	Lakes	/Users/francis/Documents/1-Directory_qrvn_downloads/Lakes	×			
Streamflow	Bankfull width	/Users/francis/Documents/1-Directory_qrvn_downloads/Bankfull	\mathbf{X}			
GIS	Landuse	/Users/francis/Documents/1-Directory_qrvn_downloads/Landuse	×			
Run Raven	Soil	/Users/francis/Documents/1-Directory_qrvn_downloads/Soil				
STRICH						
Settings		Download				
		Data processing Use the same paths as above				
	Clip layer	/Users/francis/Documents/1-Directory_grvn_downloads/bv_dumoine/bv_dumoine.shp	×			
	DEM	/Users/francis/Documents/1-Directory_grvn_downloads/DEM/na_con_3s.tif	×			
	Flow direction	/Users/francis/Documents/1-Directory grvn downloads/Flowdir/hyd na dir 15s.tif	×			
	Lakes	/Users/francis/Documents/1-Directory_grvn_downloads/Lakes/HydroLAKES_polys_v10.shp				
			~			
	Bankfull width	/Users/francis/Documents/1-Directory_qrvn_downloads/Bankfull/nariv.shp	×			
	Landuse	/Users/francis/Documents/1-Directory_qrvn_downloads/Landuse/landusetif				
	Soil	/Users/francis/Documents/1-Directory_qrvn_downloads/Soil/slc_v2r2_canada.shp	\mathbf{X}			
		Process				

7. The results will be saved inside each data folder and inside a folder named "Results".

4.2 Setup the Raven files

Now that we have all the required data and some model files, we can start setting up the Raven model files.

4.2.1 Generate a .rvi file

- 1. Click on the "Raven RVI" menu.
- 2. Make sure the selected tab is "Model info".
- 3. Click on the "HBV-EC" template button. This will load a basic template with the HBV-EC structure.
- 4. Select an output directory where the generated .rvi file will be saved.
- 5. In the model name, type "Dumoine".
- 6. Set the simulation start date to 2010-01-01 and the end date to 2020-12-31. Leave the hours to 0:00:00.
- 7. Set the "TimeStep" to 1 hour.

	•		QRaven		
	Raven RVI	Model info Sim.parameters	Hydro.processes Trar	sport cmd. Geochem. O	otional I/O Custom output
<u></u>	Daymet		Ten	plates	
i and the second	$\stackrel{\bullet}{\underset{\sigma}{\underset{\sigma}{\underset{\sigma}{\underset{\sigma}{\underset{\sigma}{\underset{\sigma}{\underset{\sigma}{\underset$	UBCWM	HBV-EC	HBV-Light	GR4J
\approx		Canadian Shield	MOHYSE	HMETS	HYPR
(Ŷ)		HYMOD	AWBM		Routing-only
E	BasinMaker	Output directory	/Users/francis/Documents/1-	Demo_greaus/Model/Dumoine	×
	Gridweights	Model name	Dumoine		
	Run Raven	StartDate			
لم	OSTRICH	EndDate			
\mathcal{Z}		Use Duration instead			
Ŷ	Settings		Hours	Minutes	Seconds
		TimeStep		0	
		SoilModel	SOIL_MULTILAYER		
		Solimodel			
		DefineHRUGroups			
		DisableHRUGroup			
		Write			Reset

- 8. Next, click on the "Optional I/O" tab.
- 9. Check the "CreateRVPTemplate" checkbox. This will allow us to generate an .rvp file with the required parameters for HBV-EC when we will first run the model.
- 10. While we are in the "Optional I/O", we will select an evaluation metric. Let's select Nash-Sutcliffe.

•		QRaven			
Raven RVI	Model info Sim.parameter	s Hydro.processes	Transport cmd. Geo	chem. Opti	onal I/O Custom output
Daymet	Chunksize			‡ Evaluati	onMetrics
Streamflow	OutputDirectory			ABSERR ABSMAX	
GIS	OutputDump			CUMUL_	
	OutputInterval			* KLING_	
BasinMaker	ReadLiveFile				GUPTA_DEVIATION
Gridweights	ReservoirDemandAllocation			, MBF	UTCLIFFE
Run Raven	RunName			NASH_S	UTCLIFFE_DER
OSTRICH	rvc_filename			NSC	UTCLIFFE_RUN
	rvh_filename			NSE4 PCT_BIA	s
Settings	rvp_filename			PDIFF PERSIND	DEX
	rvt_filename			R2 R4MS4E	
	WaterYearStartMonth			RABSER COEF	R
	AssimilateStreamflow	SilentMode	WriteEnsimForma	RMSE RMSE_D	ER
	AssimilateReservoirStage			- KSK	
	CreateRVPTemplate		WriteForcingFunctions		
	DebuqMode				
	EndPause	WriteDemandFile	WriteMassLoadings		
	NoisyMode	WriteEnergyStorage			
	Write				Reset

- 11. Click on the "Custom output" tab.
- 12. Click on the "Add output" button to add a new row.
- 13. Select the proper options to get a custom output that will be "DAILY AVERAGE SNOW BY_HRU".
- 14. Generate the .rvi file by clicking on the "Write" button.

4.2.2 Run BasinMaker to create a .rvh file

Before using BasinMaker, we will verify the QRaven settings. Since this component uses a containerization software, we will need to make sure the proper options are selected.

- 1. Click on the "Settings" menu.
- 2. Select the software you have installed on your computer (either Docker or Podman).

Warning: If you are using Docker, make sure it's running in the background. If you are on Linux, You will need to take an extra step to run Docker without sudo. Please refer to the *Dependencies* section.

- 3. You can leave the "Registry" option to the default "ghcr.io". The choice of the registry should not have any impacts unless one of the website is down.
- 4. Make sure the "Image" is set on "scriptbash/qraven:latest", as the unstable version is used for development and may have breaking changes.
- 5. Click on the "Save" button when you are ready.

		QRaven	×
Raven RVI		Containers	
🔿 Daymet	Containerization software		
Streamflow	Registry		
G GIS	Image		
BasinMaker		Delete image	
Gridweights		Executables	
Run Raven	Raven	Flatpak •	
	OSTRICH	Container •	
Ö. Settings	OSTRICT		
		Miscellaneous	
	Reset behavior		
	RavenView		
	Menu bar style	Default	
	Connection timeout	600 🔹 seconds	
		Save	
	Documentation		<u>Report an issue</u>
	Documentation		Report an issue

Note: If you have made changes to the containers settings, you will need to close QRaven and restart QGIS for the changes to apply.

Now that the settings are properly set up, let's head back to the "BasinMaker" menu.

- 1. Select an output folder where the BasinMaker results will be saved.
- 2. In the "DEM", "Landuse (polygons)", "Soil", "Lakes" and "Bankfull width" widgets, select the corresponding file previously downloaded in the "GIS" menu.

Note: The files should be in a folder named "Results" and the files should have "qrvn" as a prefix.

- 3. For the "Points of interest", we will select the file created after streamflow data was acquired.
- 4. You can leave the "Max memory (MB)" to the default value.
- 5. Under "Define project spatial extent", verify that the "using_dem" button is checked.

	QRaven ×						
Raven RVI	Delineate lake-river routing product tool	s Postprocessing tools					
🔿 Daymet		Mandatory files					
Streamflow	Output folder	ments/Projet/Dumoine/BasinMaker/Output ×					
G GIS	DEM	$asinMaker/Data/DEM/results/qrvn_DEM.tif imes$					
BasinMaker	Landuse (polygons)	ı/Landuse/results/qrvn_landuse_proper.shp ×					
Gridweights	Soil	BasinMaker/Data/Soil/results/qrvn_soil.shp 🛛 🗙					
Run Raven	Points of interest	iker/Data/Points_interest/qrvn_stations.shp ×					
7,		Optional files					
		Optionat mes					
O _O Settings	Landuse (raster)						
	Lakes	.inMaker/Data/Lakes/results/qrvn_lakes.shp ×					
	Bankfull width	<pre>cer/Data/Bankfull/results/qrvn_bankfull.shp ×</pre>					
	Max memory (MB)	4096					
	Max memory (Mby						
		Define project spatial extent					
	🕒 using_dem						
	using_hybasin						
	using_outlet_pt						
	using_provided_ply						
		Run					

- 6. Leave the "fac_threshold" to the default value (9000).
- 7. Select "using_fdr" as the mode for "Delineate routing structure without lakes". The field under the option will unlock. Select the flow direction file.
- 8. For the lake_attributes, select the corresponding shapefile attributes.
- 9. Just like for the lakes, select the corresponding shapefile attributes for the "point_of_interest_attributes".
- 10. Select the corresponding "bkfwd_attributes" for the bankfull width shapefile.

	QRaven ×							
Raven RVI	Delineate lake-river routing product tool	ls Postprocessing tools						
🔿 Daymet		Delineate routing structure without la	kes					
🗱 Streamflow	fac_threshold	9000.000000						
(နှို့) GIS	mode	using_dem	💮 using_fdr					
BasinMaker			vn_flowdir.tif ×					
Gridweights		Add lake and obs control points						
Run Raven	lake_attributes		 Lake_type 					
		Depth_avg	• Lake_area •					
O. Settings		Vol_total						
	connected_lake_area_threshold	0.00						
	non_connected_lake_area_threshold	0.00						
	Point_of_interest_attributes							
		Add hydrology related attributes						
	projected_epsg_code							
	bkfwd_attributes	WIDTH	• DEPTH •					
		DISCHARGE	• AREA •					
	к							
		Run						

- 11. Click on the "Postprocessing tools" tab.
- 12. In the "path_landuse_info, select the "landuse_info.csv" file which should be inside the folder with the qrvn_landuse shapefile.
- 13. In the "path_soil_info, select the "soil_info.csv" file which should be inside the folder with the qrvn_soil shape-file.
- 14. In the "path_veg_info, select the "veg_info.csv" file which should be inside the folder with the qrvn_landuse shapefile.
- 15. Enter "Dumoine" in the "model_name" text field.
- 16. Finally, click on the "Run" button

QRaven ×			
Raven RVI	Delineate lake-river routing product tool	s Postprocessing tools	
♂ Daymet Streamflow		Filter lakes	
GIS	connected_lake_area_threshold	0.00	
BasinMaker Gridweights	non_connected_lake_area_threshold selected_lake_ids	0.00 ÷	
Run Raven		Increase catchment area	
	minimum_subbasin_drainage_area	0.00 ‡	
🗙 Settings		Generate HRUs	
	path_landuse_info	:s/Projet/Dumoine/BasinMaker/Data/Landuse/results/landuse_info.csv ×	
	path_soil_info	ocuments/Projet/Dumoine/BasinMaker/Data/Soil/results/soil_info.csv ×	
	path_veg_info	nents/Projet/Dumoine/BasinMaker/Data/Landuse/results/veg_info.csv ×	
		Generate Raven input files	
	model_name	Dumoine	
		Run	

Note: It will take a significant amount of time to complete. At times, it may look like QGIS is completely frozen, but it's not actually the case. Please do not force close QGIS, wait for the process to finish by itself. If you must absolutely stop BasinMaker, you can stop the container instead. The process should end shortly after and QGIS will unfreeze.

4.2.3 Generate grid weights

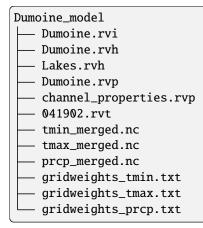
Since the format of the data taken from Daymet is netCDF, we need to use the GridWeightsGenerator.

- 1. Click on the "Gridweights" menu.
- 2. Select one of the netCDF files.
- 3. Enter the dimensions and variables names. It should be x and y.
- 4. In the "HRUs file" widget, select the BasinMaker final output. The file name should be "finalcat_hru_info.shp".
- 5. Check the "Use subbasin ID" button.
- 6. Below the button we just checked, we need to enter the ID of the most downstream subbasin. This information can be found in the attributes table of the "finalcat_hru_info.shp" shapefile. The column should be called "SubId".
- 7. Select an output file.
- 8. Click on the "Run" button.
- 9. repeat the previous steps for the other netCDF files.

QRaven ×				
Raven RVI				
Daymet	NetCDF file	/home/francis/Documents/Tutorial/prcp_merged.nc ×		
Streamflow GIS BasinMaker Gridweights Ann Raven STRICH Settings	Shapefile attribute Dim name longitude (x) Dim name latitude (y) Var name longitude (x) Var name latitude (y) HRUs file	<pre>x x y y x moine/BasinMaker/Output/OIH_Output/network_after_gen_hrus/finalcat_hru_info.shp ×</pre>		
	Output path	Use subbasin ID Use gauge ID 624 /home/francis/Documents/Tutorial/gridweights_prcp.txt Run		

4.2.4 Finishing up the files setup

We now have almost all the required files to make the Raven model. The file structure of the model should look like this for now :



Before being able to run the model, we will need to make some manual changes.

First, we need to update the HRU Id in the 041902.rvt file.

- 1. Open the file 041902.rvt
- 2. Replace the text <Basin_ID or HRU_ID> in the first line for the HRU Id in which the station is located. In my case it is 602.
- 3. The first line of the file should now be like this :ObservationData HYDROGRAPH 602 m3/s

Next, we must create an .rvt file that will tell Raven where to look for the observations and the gridded data.

- 1. Create a file called Dumoine.rvt
- 2. Enter the following text:

:GriddedForcing	precipitations
:ForcingType	PRECIP
:FileNameNC	prcp_merged
:VarNameNC	prcp
:DimNamesNC	x y time
:RedirectToFile	gridweights_prcp.txt
:EndGriddedForcing	
:GriddedForcing	Min_temp
:ForcingType	TEMP_MIN
:FileNameNC	tmin_merged.nc
:VarNameNC	tmin
:DimNamesNC	x y time
:RedirectToFile	gridweights_tmin.txt
:EndGriddedForcing	
:GriddedForcing	Max_temp
:ForcingType	TEMP_MAX
:FileNameNC	tmax_merged.nc
:VarNameNC	tmax
:DimNamesNC	x y time
:RedirectToFile	gridweights_tmax.txt
:EndGriddedForcing	
:RedirectToFile	041902.rvt

4.3 Run the raven model

Before being able to run the model, we will need to create a .rvp file. Since we checked the option ":CreateRVPTemplate" in the .rvi file, Raven will generate a template file the first time we run the model.

Warning: The Raven executable path must be set the in the "Settings" menu. If you want to use a container or Flatpak, you must select those options before running the model.

- 1. Click on the "Run Raven" menu.
- 2. In the "Input directory", select the folder that contains all the model files.
- 3. Select an output directory.
- 4. The "File name prefix" and "RunName" fields will be filled automatically.
- 5. Click on the "Run Raven model" button.

We should now have a template file called "Dumoine.rvp_temp.rvp". Since this file only contains the required parameters without their values, we can automatically fill it using QRaven. To do so, click on "Auto fill rvp template". Now that we have a .rvp template, click on "Overwrite :CreateRVPTemplate". This will remove the command from the .rvi file and will allow us to run the actual model. Since BasinMaker already generated an .rvp file, we will need to add its content to the new .rvp file. Open the new file file and add the following line:

:RedirectToFile channel_properties.rvp

The model is now ready, click on the "Run Raven model" button once again.

4.4 Calibration with OSTRICH

to-do