



# APRIORA Workshop: apply the tool yourself!

Rostock – 15<sup>th</sup> June 2026

In today's workshop, we will go through some of the steps of the plugin, from exploring the internal APRIORA database until the calculation of API concentration in river sections and finally perform the risk assessment. The goal of the exercise is to take a first look at some functionalities of the tool and build confidence in using the plugin.

As first step, please open QGIS and follow the instructions:

1. Go to *Plugins/Manage and Install plugins*
2. Click on *All*
3. Look for "APRIORA" in the search bar
4. Click on *Install Plugin* (Fig. 1)

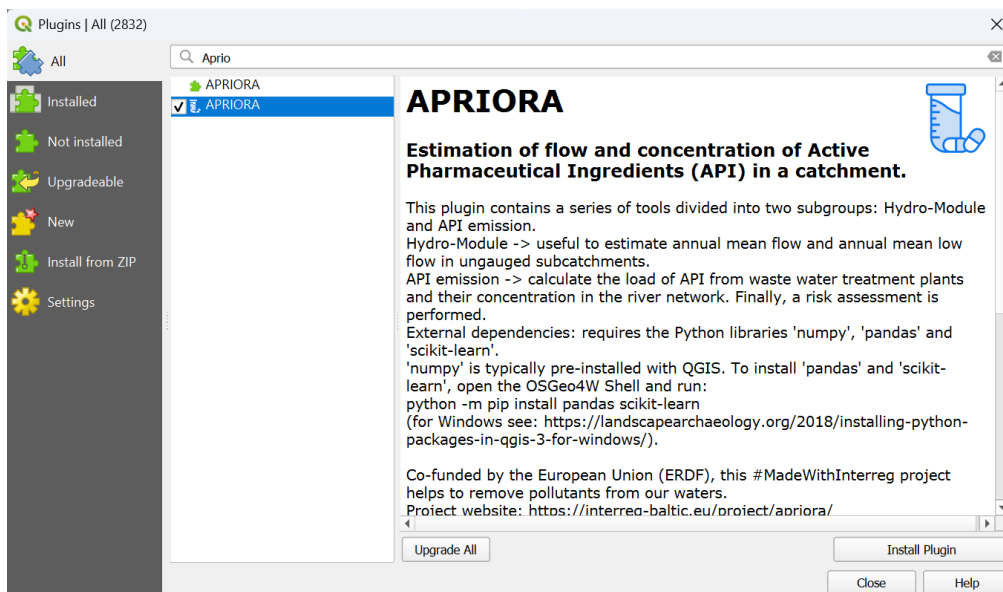


Figure 1. Install the APRIORA plugin.

After successfully installed the plugin, scroll down and in the **More info** section click on the *homepage* link (Fig. 2).

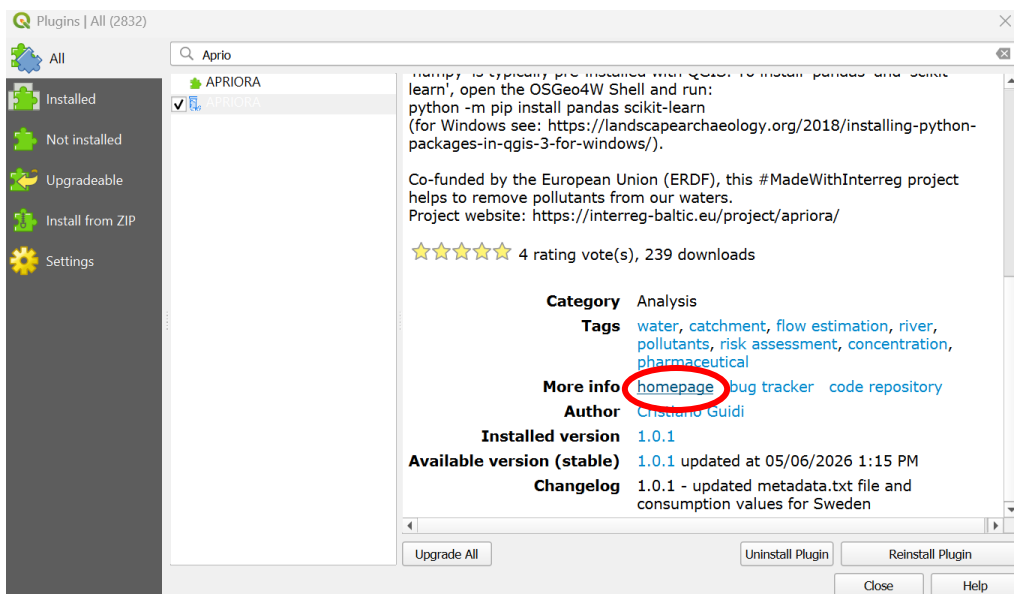


Figure 2. Where to find the homepage link.

The link brings to the plugin's manual. In this document you can find important information related to the structure of the tool and the theory behind it.

In the menu on the left side, you will find a chapter called "Dummy data". Please go to that section and click on the link within the text.

Here you can find the data that we will use for the workshop. Download the folder called "15\_06\_26\_Workshop" and then extract all the files. After extracting all the files, open the QGIS project folder and click on the "workshop.qgz" file.

## Exercise 1 – "API parameter selection"

In this exercise we will learn how to use the "API parameter selection" tool. This tool is giving the user the access to the APRIORA's internal database related to consumption data, removal rates and PNEC values. It is also possible to add new substances and removal rates in the database or edit the original ones.

The APRIORA plugin with all its tools can be found in the "Processing Toolbox" on the right-side menu (Fig.3) . If you have problems finding the tool, please contact one of the teachers.

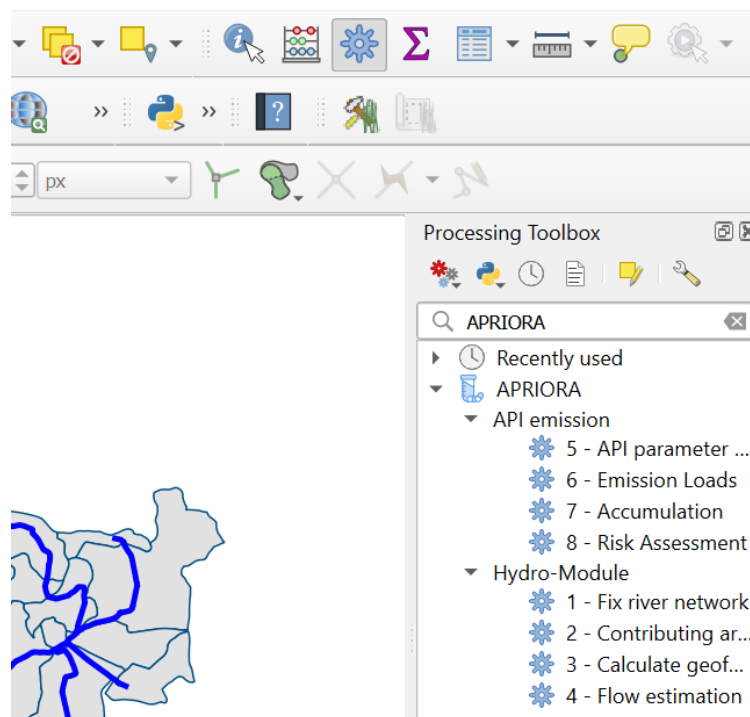


Figure 3. How to find the APRIORA plugin.

### Input data:

- WWTP.shp

### Workflow:

1. Go in the Processing Toolbox and look for the APRIORA plugin. Click on API emission and open "5 – API parameter selection"

2. If you notice, there are 4 windows:

- Consumption data
- Removal rate
- PNEC values
- WWTP locations

We will go through each one of them.

### Consumption data

3. In the table containing all the consumption data, select the row containing “Diclofenac” for 2023, Germany, Mecklenburg-Vorpommern.

4. Click on “Add to the selection”.

Now let’s imagine that we want to add a custom substance that is not in the database or update an already existing one (e.g., Clarithromycin consumption in 2025).

5. Click on the “+” icon

6. Go to the bottom of the table and fill out the fields as follow (mandatory fields are marked with (\*)):

- “Excreted emission” = 54.4 (double as the 2023 value)
- “API name” = Clarithromycin
- “year” = 2025
- “country” = Germany
- “region” = Mecklenburg-Vorpommern
- The other fields can be kept empty.

7. Add to the selection the newly added API by repeating the steps 4 and 5 (Fig. 4).

The screenshot shows a window titled "5 - API parameter selection" with a close button (X) in the top right corner. The window has four tabs: "Consumption data" (selected), "Removal rate", "PNEC values", and "WWTP locations". Below the tabs, there is a "Consumption data available" dropdown menu, a minus sign (-), a plus sign (+), a "Restore original" button, and a "Help" button. The main area contains a table with the following columns: "Excreted emission (mg/inh./a) (\*)", "API name (\*)", "CAS No.", "year (\*)", "country (\*)", and "region (\*)". The table has 7 rows, with the 7th row (index 51) highlighted in blue. Below the table, there is a note "(\*) mandatory field". Underneath, there is a section titled "Selected consumption data" with an "Add to the selection" button. The selected data list contains two entries: "Diclofenac, 2023, Germany, Mecklenburg-Vorpommern, 369.65" and "Clarithromycin, 2025, Germany, Mecklenburg-Vorpommern, 54.4". At the bottom of the window, there are "Clear selection" and "Remove" buttons, a progress bar showing 20%, and "Back", "Next", and "Close" buttons.

|    | Excreted emission (mg/inh./a) (*) | API name (*)     | CAS No.     | year (*) | country (*) | region (*)             |
|----|-----------------------------------|------------------|-------------|----------|-------------|------------------------|
| 45 | 13.40                             | Fluconazole      | 86386-73-4  | 2023     | Sweden      | -                      |
| 46 | 310.69                            | Metoprolol       | 37350-58-6  | 2023     | Sweden      | -                      |
| 47 | n.d.                              | Primidone        | 125-33-7    | 2023     | Sweden      | -                      |
| 48 | 48.08                             | Sulfamethoxaz... | 129378-89-8 | 2023     | Sweden      | -                      |
| 49 | 65.18                             | Trimethoprim     | 738-70-5    | 2023     | Sweden      | -                      |
| 50 | 37.87                             | Venlafaxine      | 93413-69-5  | 2023     | Sweden      | -                      |
| 51 | 54.4                              | Clarithromycin   | nan         | 2025     | Germany     | Mecklenburg-Vorpommern |

Figure 4. Interface of the “Consumption data” window within the API parameter selection tool.

## Removal rate

- Go to the "Removal rate" window. Here are displayed the removal rates for each substance included in the APRIORA database. In case you would like to change or add the removal rate for a specific substance, here it is possible to do so. During this workshop, we will not change or add any value.

## PNEC values

- Go to the "PNEC values" window. Here are displayed the PNEC values for each substance included in the APRIORA database. Three different types of risk are considered: Environmental (ERA), Human Health (HHRA) and Antimicrobial Resistance Risk Assessment (AMR-RA). In case you would like to change or add the removal rate for a specific substance, here it is possible to do so. During this workshop, we will not change or add any value.
- Click on "Export table" and select a folder where it will be saved. This table will be an input for tool 8 and it is possible to share it with other users too.

## WWTP locations

- Go to the "WWTP locations" window
- Fill out the fields as follow:
  - Select WWTP file: WWTP
  - ID field: gid
  - Name field: ka\_name
  - Technical Class: tech\_class
- Click on "Load Table"
- Change the removal rate of Diclofenac in KA Groß Lüsewitz to 0.75.
- After all the edits, click on "Export Table" and save the output. This table will be an input for tool 6 and it is possible to share it with other users too (Fig. 5).

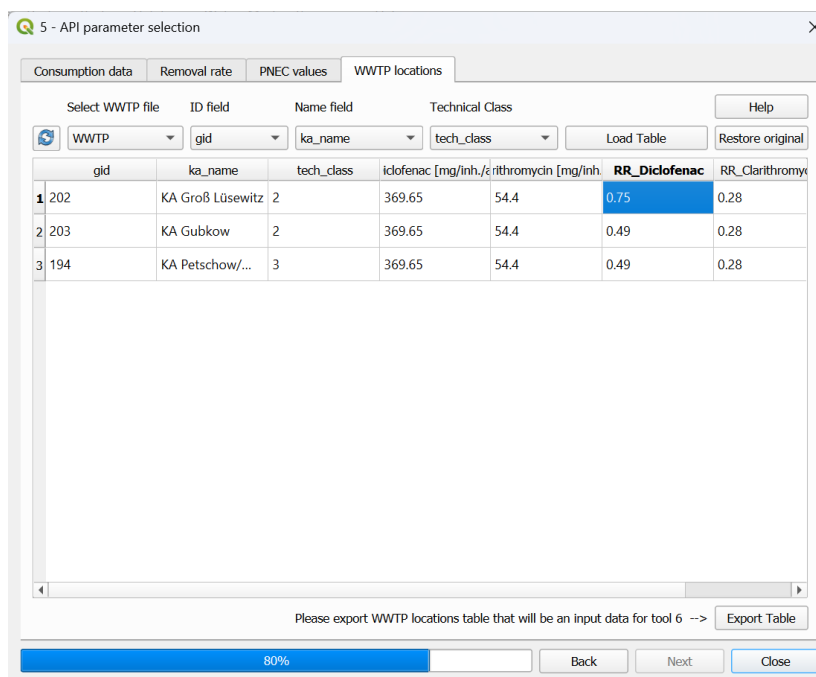


Figure 5. Interface of the "Custom table" window within the API parameter selection tool.

## Output:

- PNEC.csv
- API\_paramters.csv

## Exercise 2 – “Emission Loads”

In this exercise we will get our hands on the second tool, “Emission Loads”. What exactly does this tool do? The tool calculates the emission loads (in kg/a) from the WWTP emission points for each substance selected by the previous tool.

### Input data:

- WWTP.shp
- API\_parameters.csv (from Exercise 1)

### Workflow:

1. Go in the Processing Toolbox and look for the APRIORA plugin. Click on API emission and open “6 – Emission Loads”
2. Choose “WWTP.shp” as input for *Emission Points of WWTP*
3. Select “conn\_inh.” as Connected Inhabitant field
4. Select “Wastwater\_” as WWTP annual effluent flow [m<sup>3</sup>/a]
5. Select “API\_parameters” as API Parameters Table
6. Click on *Run* (Fig. 6)

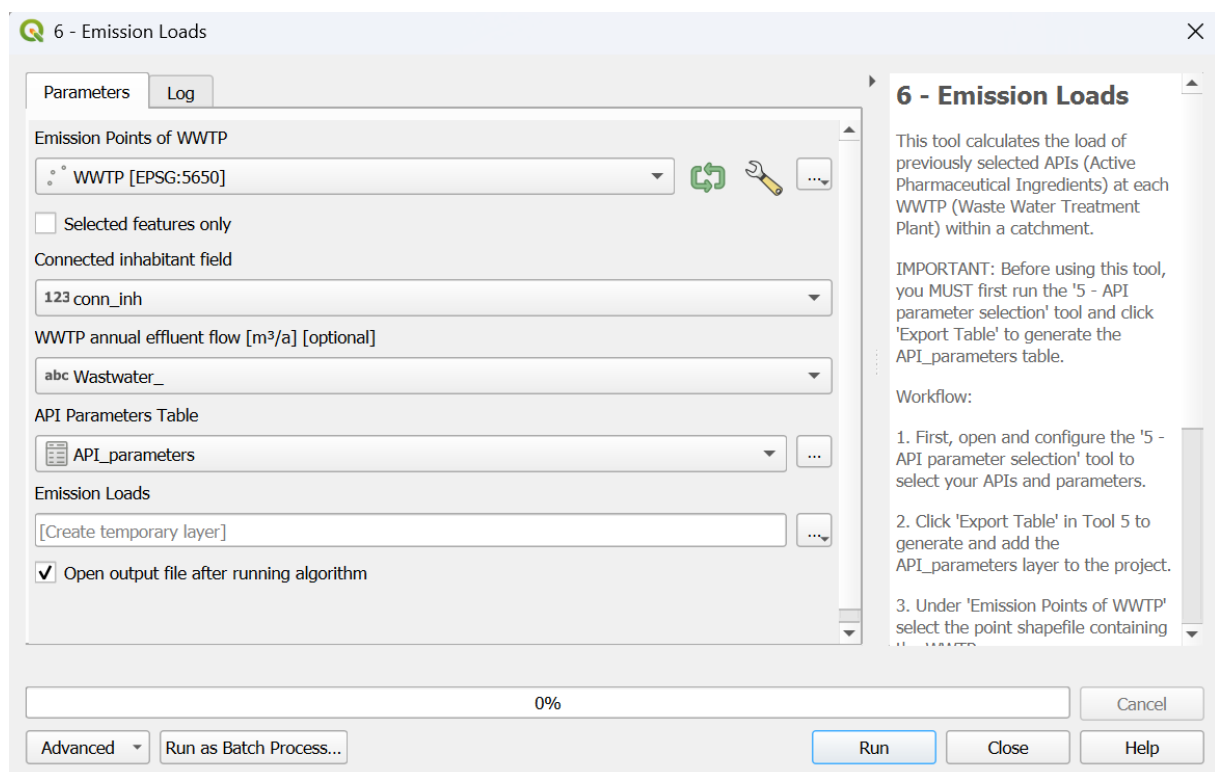
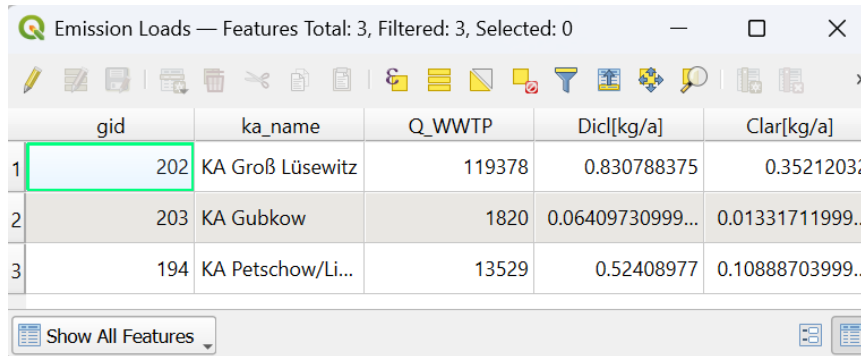


Figure 6. Configuration of the Emission Loads tool.

## Output:

- Emission Loads.shp

Open the attribute table of “Emission Load.shp” and check its features (Fig. 7). You will notice that the ID, the name field and the WWTP effluent from the original file have been kept. On top of that, you will find 2 new columns that represents the load calculated for the substances selected. Each row refers to the load calculated at each WWTP emission point.



|   | gid | ka_name           | Q_WWTP | Dicl[kg/a]       | Clar[kg/a]       |
|---|-----|-------------------|--------|------------------|------------------|
| 1 | 202 | KA Groß Lüsewitz  | 119378 | 0.830788375      | 0.35212032       |
| 2 | 203 | KA Gubkow         | 1820   | 0.06409730999... | 0.01331711999... |
| 3 | 194 | KA Petschow/Li... | 13529  | 0.52408977       | 0.10888703999... |

Figure 7. Attribute table of “Emission Load.shp”

## Exercise 3 – “Accumulation”

In this exercise we will learn how to use the “7 – Accumulation” tool. This tool calculates load and concentration in river sections of APIs selected with Exercise 1.

The tool can be found under “Processing Toolbox” → “APRIORA” → “API emission” → “7 – Accumulation”.

### Input data:

- Emission Loads.shp (from Exercise 2)
- river\_level.shp

### Workflow:

1. Go in the Processing Toolbox and look for the APRIORA plugin. Click on API emission and open “7 – Accumulation”
2. Under *API Load* select the *Emission Loads.shp* from “6 – Emission Loads”.
3. In *Select APIs to accumulate*, click on fields containing the API load that you want to accumulate (Fig. 8).

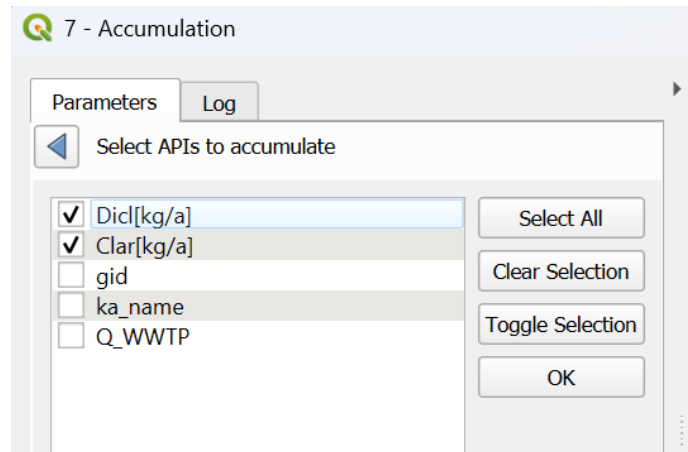


Figure 8. Configuration of Select APIs to accumulate.

4. Under *River network* select *River level.shp*
5. Fill the following field as follow (Fig. 9):
  - a. *ID Field*: NET\_ID (id of the river section)
  - b. *Next Field*: NET\_TO (id of the downstream river section)
  - c. *Acc. Mean Flow*: calc\_Mean\_ (accumulated mean flow)
  - d. *Acc. Mean Low Flow*: calc\_M\_Low (accumulated mean low flow)

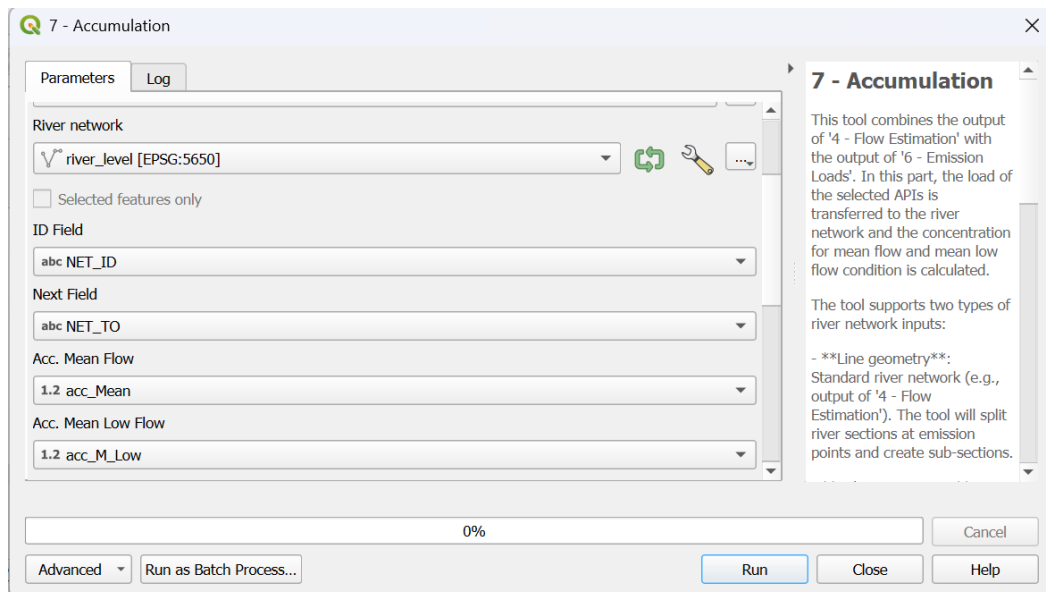


Figure 9. Configuration of the Accumulation tool (Part A)

6. Click on the three dots in the *Dilution Ratio* output and select “Create Temporary Layer” (Fig. 10)
7. Click on *Run*

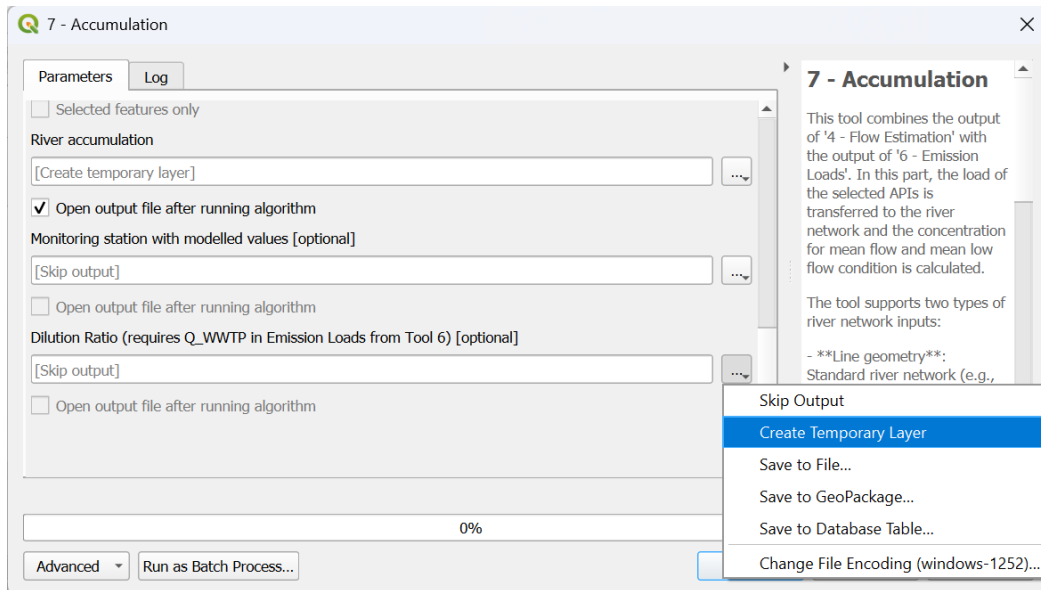


Figure 10. Configuration of the Accumulation tool (Part B)

## Output:

- River accumulation.shp
- Dilution Ratio.shp

If you open the attribute table of “River accumulation.shp”, you can notice that the output contains 4 new columns for each substance that was selected. In Fig. 11 there is an example of Diclofenac.

|    | Dicl[kg/a]       | acc_Dicl         | acc_unit | conc_Dicl        | conL_Dicl        | conc_unit |
|----|------------------|------------------|----------|------------------|------------------|-----------|
| 1  | 0.52408977       | 1.418975455      | kg/a     | 178.350663482... | 1136.48839093... | ng/L      |
| 2  | NULL             | 1.418975455      | kg/a     | 86.1814211548... | 684.030702852... | ng/L      |
| 3  | NULL             | 1.418975455      | kg/a     | 85.9376523913... | 680.113165855... | ng/L      |
| 4  | NULL             | 1.418975455      | kg/a     | 100.558663649... | 764.485658710... | ng/L      |
| 5  | NULL             | 0.894885685      | kg/a     | 118.574401904... | 759.987437044... | ng/L      |
| 6  | 0.830788375      | 0.830788375      | kg/a     | 699.157441669... | 5778.77948520... | ng/L      |
| 7  | NULL             | 0.830788375      | kg/a     | 179.378445191... | 1102.88583251... | ng/L      |
| 8  | 0.06409730999... | 0.06409730999... | kg/a     | 119.981745578... | 924.230547768... | ng/L      |
| 9  | NULL             | 0.06409730999... | kg/a     | 39.5524685711... | 321.689133354... | ng/L      |
| 10 | NULL             | 0.06409730999... | kg/a     | 74.7732945195... | 762.428490389... | ng/L      |

Figure 11. Attribute table of “River accumulation.shp”.

- The first column represent the API load transferred to the river section.
- The second column is the API load accumulated along the river network.

- The fourth column is the concentration calculated with annual mean flow values.
- The fifth column is the concentration calculated with annual mean low flow values.

In the attribute table of “Dilution Ratio”, we can instead find a column called “Dilu\_Ratio” containing the dilution ratio calculated via the following formula:

$$DR = \frac{Q_{WWTP,eff} + Q_{riv}}{Q_{WWTP,eff}}$$

## Exercise 4 – “Risk Assessment”

This tool calculates the final risk for each river section. In addition to individual PNEC calculations, a Component Cumulative Risk Index (CCRI) is calculated to provide an overall assessment when multiple APIs are selected. This single value summarizes the combined risk from all tested substances in each river section, giving the user a quick, comprehensive view of the situation.

The tool can be found under “Processing Toolbox” → “APRIORA” → “API emission” → “8 – Risk Assessment”.

### Input data:

- River accumulation.shp (from Exercise 3)
- PNEC.csv (from Exercise 1)

### Workflow:

1. Go in the Processing Toolbox and look for the APRIORA plugin. Click on API emission and open “8 – Risk Assessment”
2. Choose *River accumulation.shp* as input for “River accumulation”
3. Select the fields containing the concentration of APIs for the risk assessment. This selection should include only columns containing concentrations in ng/L (Fig. 12)

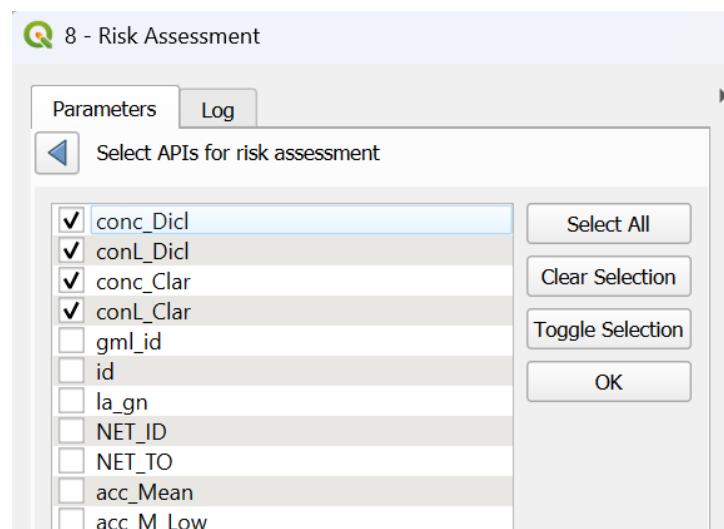


Figure 12. Configuration of Select APIs for risk assessment.

4. Select NET\_ID as “ID Field”
5. Choose PNEC.csv as input for “PNEC Table”
6. Select ERA and AMR-RA as risk assessment types
7. Click on Run (Fig. 13)

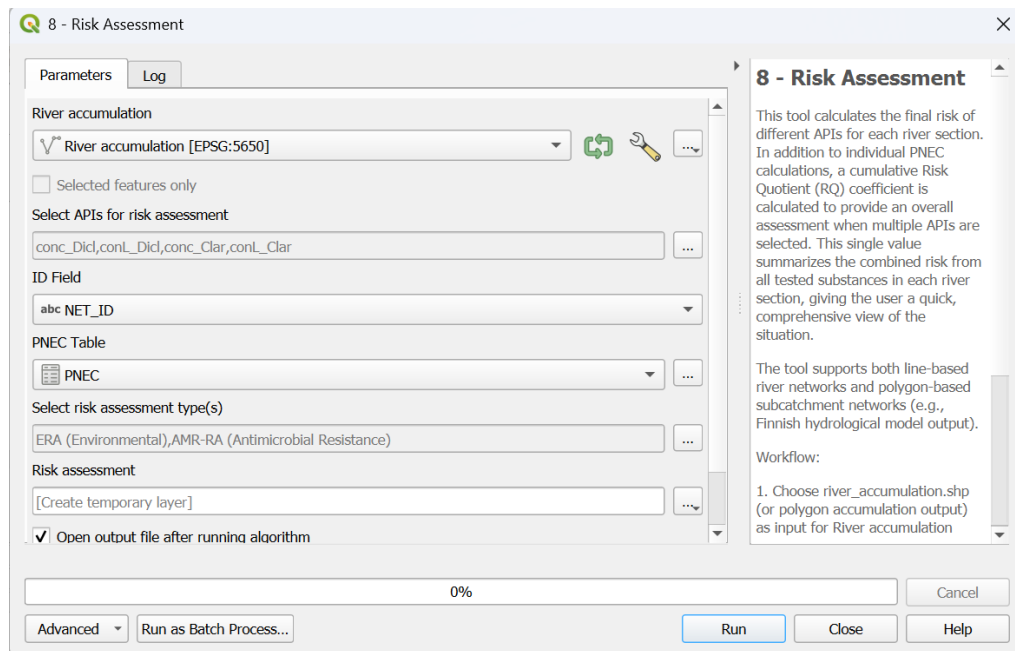


Figure 13. Configuration of Risk Assessment tool.

**Output:**

- Risk assessment.shp

The output is a line shapefile containing the same geometry of “River accumulation.shp” (Fig. 14). The attribute table instead, has the same API concentration columns plus ERA and HHRA fields for both conditions (mean flow and mean low flow) for each API selected. Finally, the last four columns represent CCRI for ERA and HHRA for the same two conditions.

|    | era_Dicl         | era_L_Dicl       | era_Clar         | amr_Clar         | era_L_Clar       | amr_L_Clar       | CCRI_era        |
|----|------------------|------------------|------------------|------------------|------------------|------------------|-----------------|
| 1  | 17.4789360417... | 144.469487130... | 2.27946175074... | 1.18532011038... | 18.8405443716... | 9.79708307324... | 6.0659017553... |
| 2  | 4.48446112979... | 27.5721458128... | 0.58482722253... | 0.30411015571... | 3.59573669795... | 1.86978308293... | 3.3984486565... |
| 3  | 4.45876658707... | 28.4122097732... | 0.45859786974... | 0.23847089226... | 2.92228324183... | 1.51958728575... | 3.3899745713... |
| 4  | 2.99954363946... | 23.1057636942... | 0.19175307329... | 0.09971159811... | 1.47709176182... | 0.76808771614... | 2.7799161116... |
| 5  | 2.96436004762... | 18.9996859261... | 0.37247151836... | 0.19368518955... | 2.38730847526... | 1.24140040714... | 2.7705191166... |
| 6  | 2.51396659123... | 19.1121414677... | 0.25856920312... | 0.13445598562... | 1.96574258646... | 1.02218614496... | 2.5316678728... |
| 7  | 2.15453552887... | 17.1007675713... | 0.22160061185... | 0.11523231816... | 1.75886658922... | 0.91461062639... | 2.3199902830... |
| 8  | 2.14844130978... | 17.0028291463... | 0.22097380266... | 0.11490637738... | 1.74879332071... | 0.90937252677... | 2.3161906672... |
| 9  | 1.86933236298... | 19.0607122597... | 0.11950158713... | 0.06214082531... | 1.21850207705... | 0.63362108006... | 2.1239792155... |
| 10 | 0.98881171427... | 8.04222833386... | 0.06321217755... | 0.03287033232... | 0.51411887422... | 0.26734181459... | 0.7188265704... |

Figure 14. Attribute table of “Risk assessment.shp”

In this example, the style of “Risk assessment.shp” is based on the value of CCRI\_amr.

If we would like to display the ERA of Diclofenac, we can change the style by doing so:

1. Right click on “Risk Assessment” → “Properties” → “Symbology”
2. Click on “Style” situated at the bottom of the window and then select “Load Style”
3. Click on the three dots and look for the “15\_06\_26\_Workshop” folder
4. Click on the folder “styles” and select “risk\_assessment\_ERA\_line”
5. Click on “Load Style”
6. In the “Value” field, select “era\_Dicl” and then click on OK

## Bonus exercise – Mitigation options

A dedicated tool for applying different mitigation options has not been designed yet, nevertheless it is still possible to complete this task with some basic QGIS tool. We will explore three different options:

- Option I: Upgrade treatment type
- Option II: Relocate the WWTP
- Option III: Redirect treated effluent

### Option I: Upgrade treatment type

Upgrade the treatment type means for example that a WWTP is upgraded from a tertiary to a quaternary treatment. Here is how we can do it:

1. Go to the attribute table of WWTP.shp
2. Click on the “Toggle editing mode” (pencil icon in the top left corner)
3. Click on the “New field” icon (Fig. 15)
4. Add a new field called “TC\_upgr”, type “Integer (32 bit)” (Fig. 15)

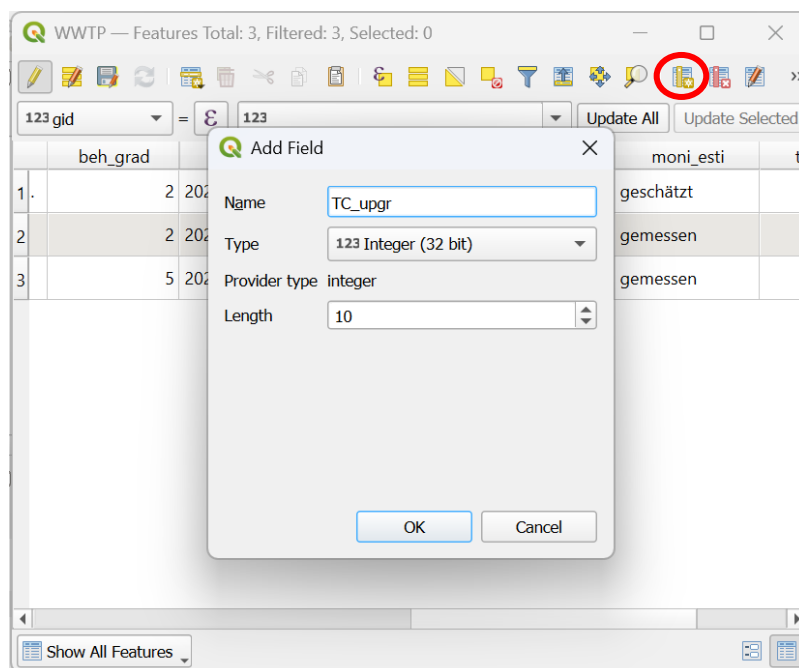


Figure 15. Add a new field in the WWTP layer

- In the drop-down menu, select “TC\_upgr” between all the available fields
- In the equation box, write “tech\_class” and click on “Update All” (Fig.16)

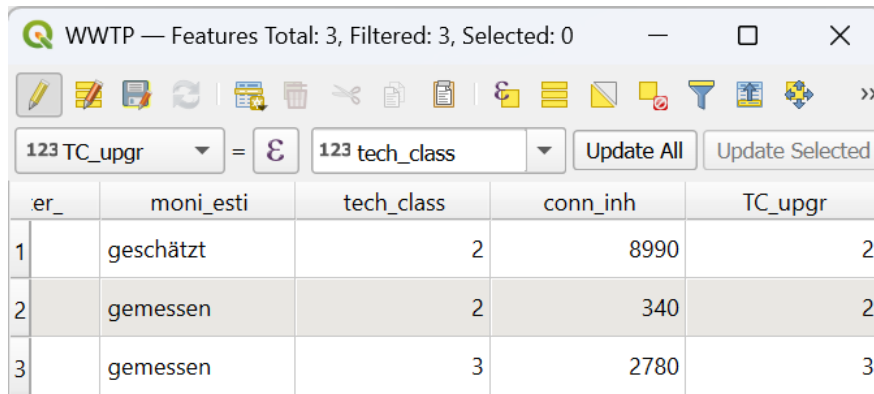


Figure 16. Populating the "TC\_upgr" field

- Change the value of “TC\_upgr” from one of the WWTPs to “4”
- Save the edit
- Re-do the exercise 1-4 to see the updated concentration values and the new risk maps

## Option II: Relocate the WWTP

Another mitigation option could be to relocate the WWTP to other larger facilities with higher removal rates. It is possible to do it accordingly:

- Go to the attribute table of WWTP.shp
- Click on the “Toggle editing mode” (pencil icon in the top left corner)
- Click on the “New field” icon
- Add a new field called “conn\_upgr”, type “Integer (32 bit)”

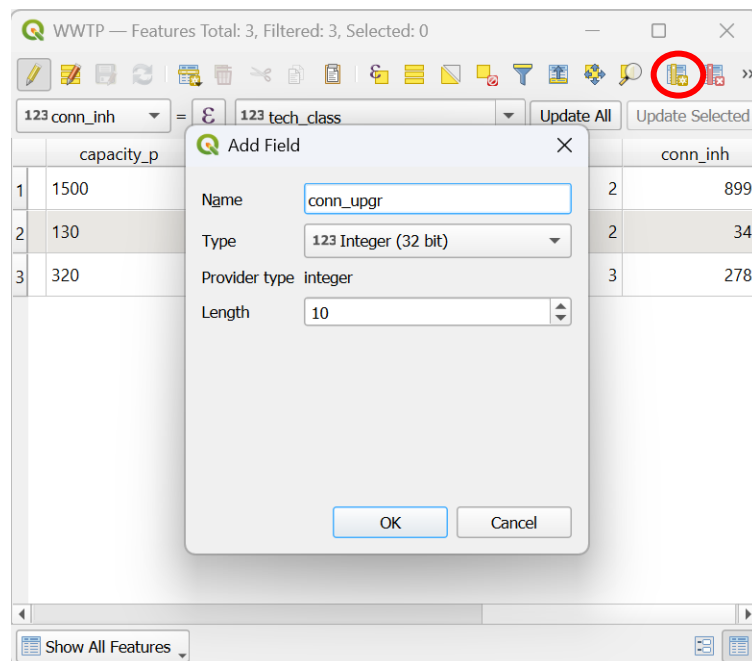


Figure 17. Add a new field in the WWTP layer

5. In the drop-down menu, select “conn\_upgr” between all the available fields
6. In the equation box, write “conn\_inh” and click on “Update All” (Fig. 18)

|   | Wastwater_ | moni_esti | tech_class | conn_inh | conn_upgr |
|---|------------|-----------|------------|----------|-----------|
| 1 | 335121     | geschätzt | 2          | 8990     | 8990      |
| 2 | 28072      | gemessen  | 2          | 340      | 340       |
| 3 | 175343     | gemessen  | 3          | 2780     | 2780      |

Figure 18. Populating the “conn\_upgr” field

7. Remove the value of “conn\_upgr” from one WWTP and add it to another WWTP. For example, let’s transfer all the connected inhabitants from Gubkow to Petschow (Fig. 19)

|   | Wastwater_ | moni_esti | tech_class | conn_inh | conn_upgr |
|---|------------|-----------|------------|----------|-----------|
| 1 | 335121     | geschätzt | 2          | 8990     | 8990      |
| 2 | 28072      | gemessen  | 2          | 340      | 0         |
| 3 | 175343     | gemessen  | 3          | 2780     | 3120      |

Figure 19. Transferring the connected inhabitants from one WWTP to another

8. Save the edit
9. Re-do the exercise 1-4 to see the updated concentration values.  
**IMPORTANT:** in exercise 2, you need to select “conn\_upgr” for the connected inhabitant field. If you select “conn\_inh”, you won’t see any difference.

### Option III: Redirect treated effluent

Finally, a last mitigation option is to redirect the discharge point of a WWTP to a larger or less-sensitive receiving water body. The steps to do this are:

1. Left click on emission\_load.shp in order to have it as your active layer
2. Click on the “Toggle editing mode” (Fig.20)
3. Click on “Vertex Tool” (Fig. 20)

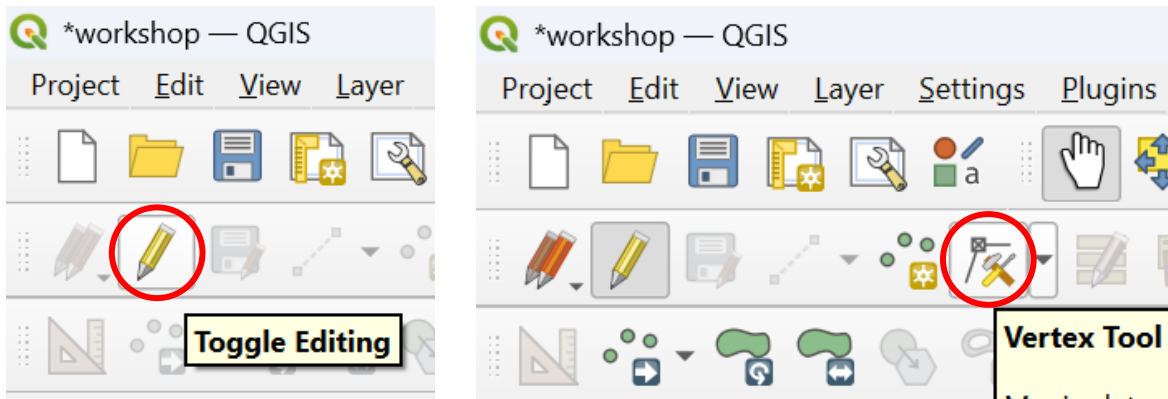


Figure 20. On the left, location of "Toggle Editing" button. On the right, location of the "Vertex Tool" button.

4. Click on the emission point that you want to redirect and move it to a different river section (e.g., let's move the emission point of Groß Lüsewitz (Fig.21))



Figure 21. On the left, original location of Groß Lüsewitz emission point. On the right, new emission location point.

5. Save the edit
6. Re-do the exercise 3 and 4 to see the updated concentration values and risk maps.

## Double bonus exercise – Hydro-Module group of tools

We started our workshop with tool 5, but what are the other four tools before that? Well, the other tools are grouped in a group called Hydro-Module, which provides an estimation of yearly mean flow and yearly mean low flow for each subcatchment or river section within a specified catchment area. This estimation is made by Random Forest, which uses the catchment's geographical characteristics as predictors and water flow data collected from gauging stations to calibrate and validate the approach.

Feel free to try out these tools and try to estimate flow in the whole Warnow catchment. You find the workflow in the manual under "Hydro-Module" and the necessities data in the "Dummy data" section.

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QR code for the APRIORA plugin manual:

