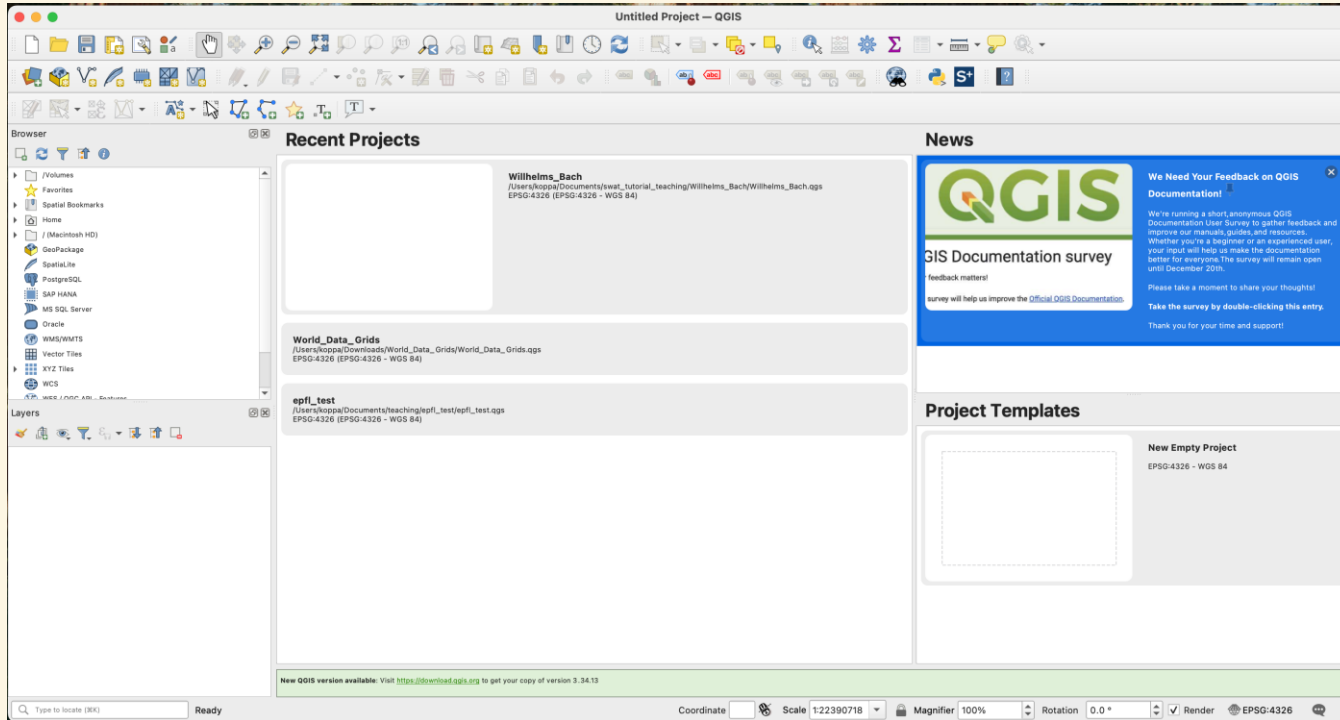


A panoramic view of a river valley. In the foreground, there are terraced vineyards on a hillside. A winding road runs through the vineyards. In the middle ground, a large blue reservoir or lake is visible, with a dam structure extending across it. A small town with white buildings and dark roofs is situated on the left bank of the reservoir. The background shows rolling green hills under a clear blue sky.

SWAT+ Model Setup Hydrology for Engineers

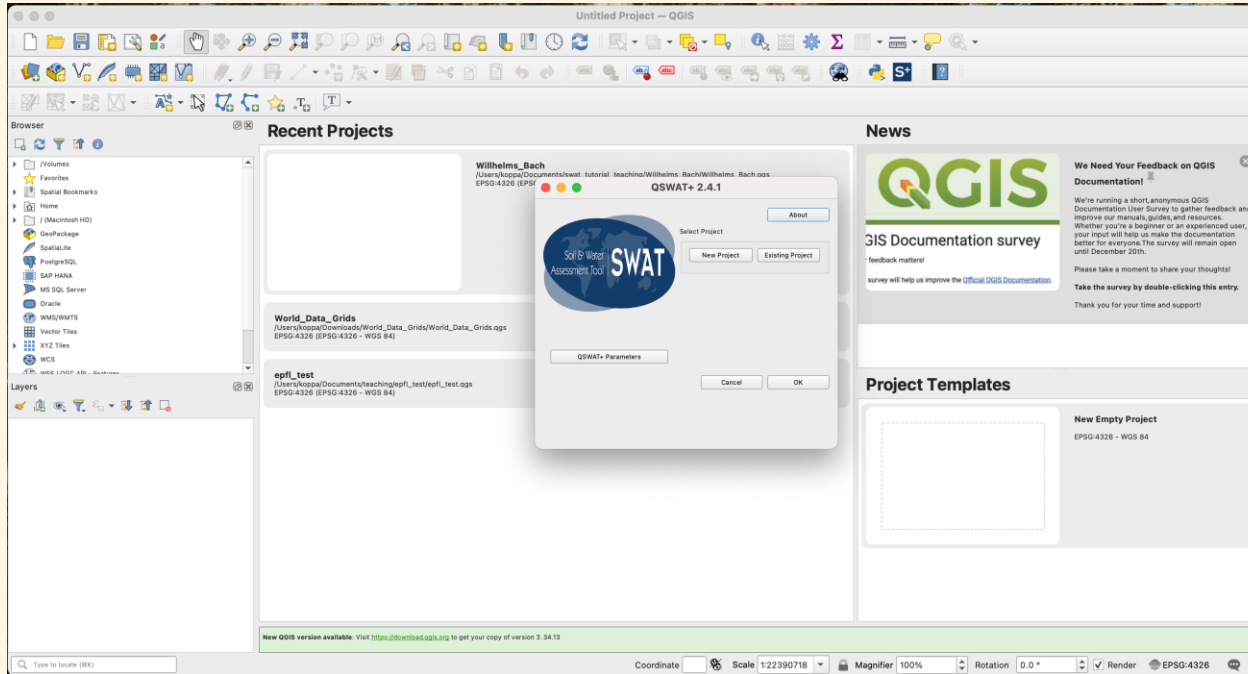
Prerequisites

Make sure QGIS is installed



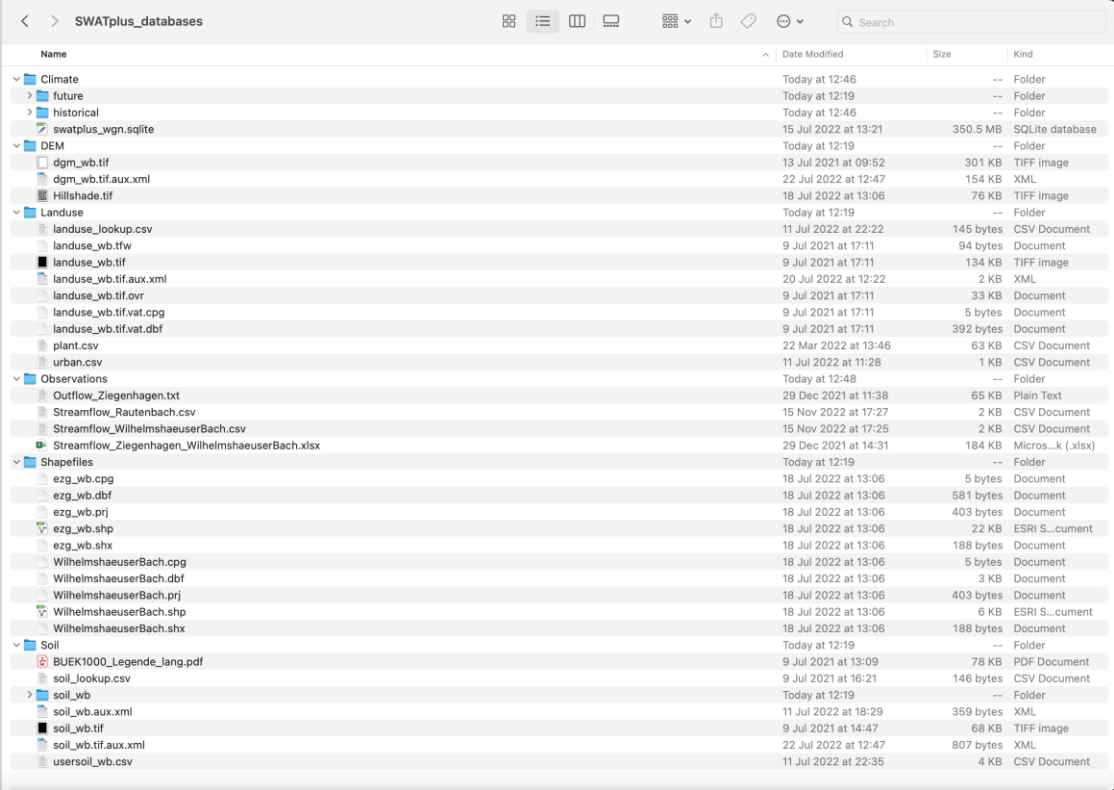
Prerequisites

Make sure QSWAT+ and SWAT+ editors are installed



Download the input datasets

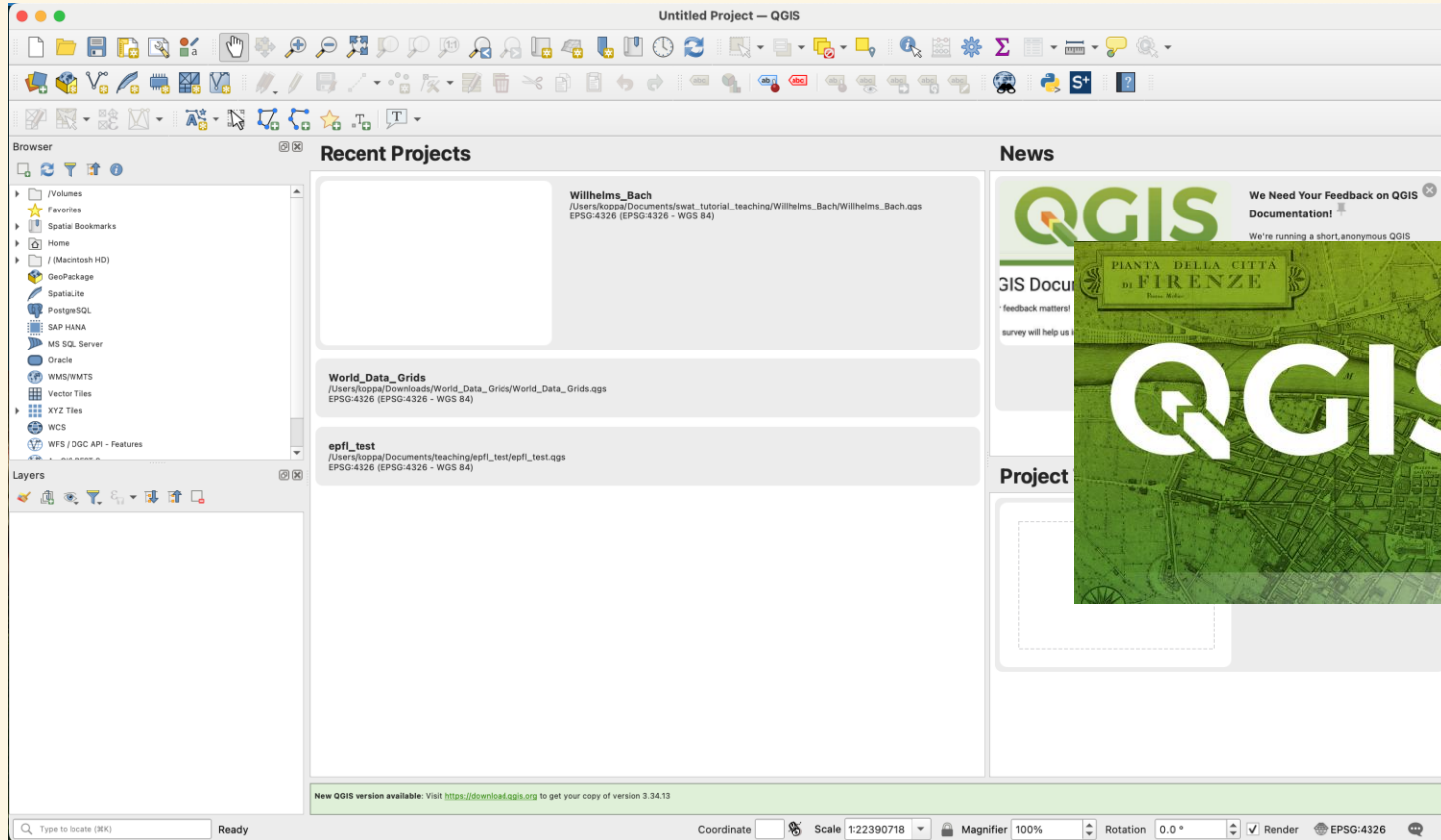
[Google drive download link](#)



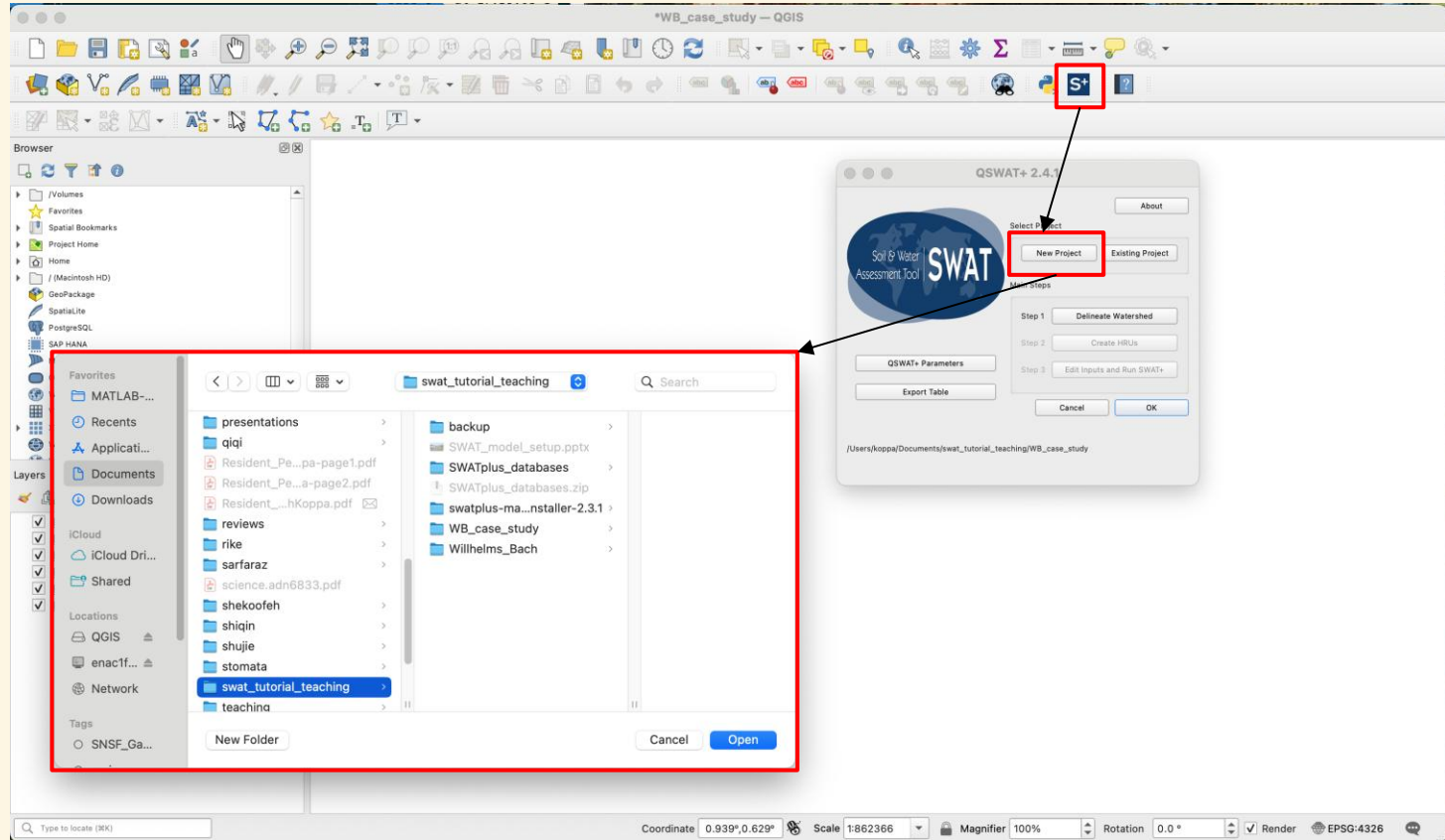
The screenshot shows a file explorer window titled 'SWATplus_databases'. The window displays a list of files and folders organized into several categories. The columns are 'Name', 'Date Modified', 'Size', and 'Kind'. The files are grouped into folders: Climate, DEM, Landuse, Observations, Shapefiles, and Soil. Each folder contains various data files such as CSV documents, XML files, TIFF images, and databases.

Name	Date Modified	Size	Kind
Climate	Today at 12:46	--	Folder
future	Today at 12:19	--	Folder
historical	Today at 12:46	--	Folder
swatplus_wgn.sqlite	15 Jul 2022 at 13:21	350.5 MB	SQLite database
DEM	Today at 12:19	--	Folder
dgm_wb.tif	13 Jul 2021 at 09:52	301 KB	TIFF image
dgm_wb.tif.aux.xml	22 Jul 2022 at 12:47	154 KB	XML
Hillshade.tif	18 Jul 2022 at 13:06	76 KB	TIFF image
Landuse	Today at 12:19	--	Folder
landuse_lookup.csv	11 Jul 2022 at 22:22	145 bytes	CSV Document
landuse_wb.tfw	9 Jul 2021 at 17:11	94 bytes	Document
landuse_wb.tif	9 Jul 2021 at 17:11	134 KB	TIFF image
landuse_wb.tif.aux.xml	20 Jul 2022 at 12:22	2 KB	XML
landuse_wb.tif.ovr	9 Jul 2021 at 17:11	33 KB	Document
landuse_wb.tif.vat.cpg	9 Jul 2021 at 17:11	5 bytes	Document
landuse_wb.tif.vat.dbf	9 Jul 2021 at 17:11	392 bytes	Document
plant.csv	22 Mar 2022 at 13:46	63 KB	CSV Document
urban.csv	11 Jul 2022 at 11:28	1 KB	CSV Document
Observations	Today at 12:48	--	Folder
Outflow_Ziegenhagen.txt	29 Dec 2021 at 11:38	65 KB	Plain Text
Streamflow_Rautenbach.csv	15 Nov 2022 at 17:27	2 KB	CSV Document
Streamflow_WilhelmshaeuserBach.csv	15 Nov 2022 at 17:25	2 KB	CSV Document
Streamflow_Ziegenhagen_WilhelmshaeuserBach.xlsx	29 Dec 2021 at 14:31	184 KB	Micros...k (.xlsx)
Shapefiles	Today at 12:19	--	Folder
ezg_wb.cpg	18 Jul 2022 at 13:06	5 bytes	Document
ezg_wb.dbf	18 Jul 2022 at 13:06	581 bytes	Document
ezg_wb.prj	18 Jul 2022 at 13:06	403 bytes	Document
ezg_wb.shp	18 Jul 2022 at 13:06	22 KB	ESRI S...cument
ezg_wb.shx	18 Jul 2022 at 13:06	188 bytes	Document
WilhelmshaeuserBach.cpg	18 Jul 2022 at 13:06	5 bytes	Document
WilhelmshaeuserBach.dbf	18 Jul 2022 at 13:06	3 KB	Document
WilhelmshaeuserBach.prj	18 Jul 2022 at 13:06	403 bytes	Document
WilhelmshaeuserBach.shp	18 Jul 2022 at 13:06	6 KB	ESRI S...cument
WilhelmshaeuserBach.shx	18 Jul 2022 at 13:06	188 bytes	Document
Soil	Today at 12:19	--	Folder
BUEK1000_Legende_lang.pdf	9 Jul 2021 at 13:09	78 KB	PDF Document
soil_lookup.csv	9 Jul 2021 at 16:21	146 bytes	CSV Document
soil_wb	Today at 12:19	--	Folder
soil_wb.aux.xml	11 Jul 2022 at 18:29	359 bytes	XML
soil_wb.tif	9 Jul 2021 at 14:47	68 KB	TIFF image
soil_wb.tif.aux.xml	22 Jul 2022 at 12:47	807 bytes	XML
usersoil_wb.csv	11 Jul 2022 at 22:35	4 KB	CSV Document

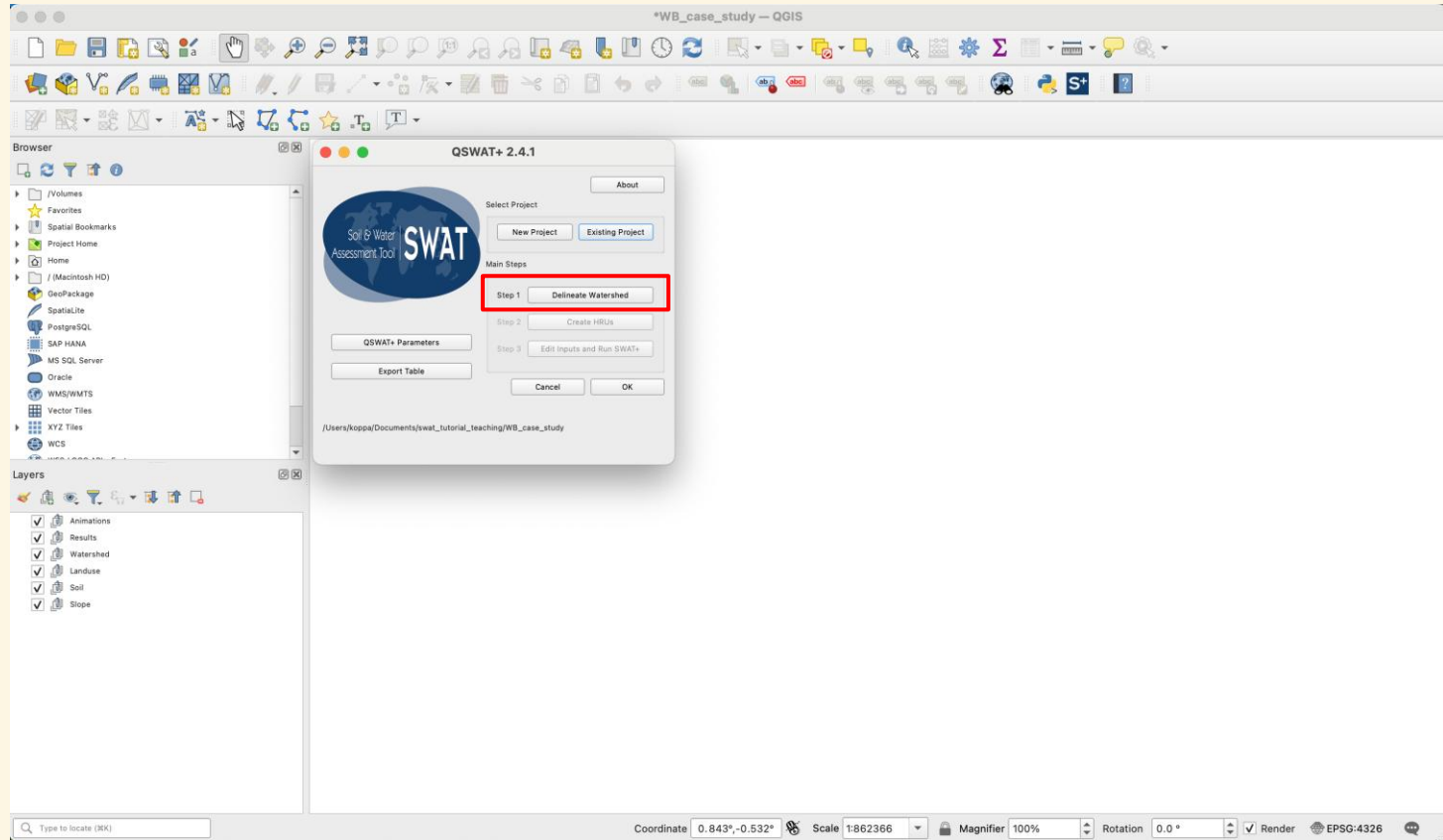
Start QGIS



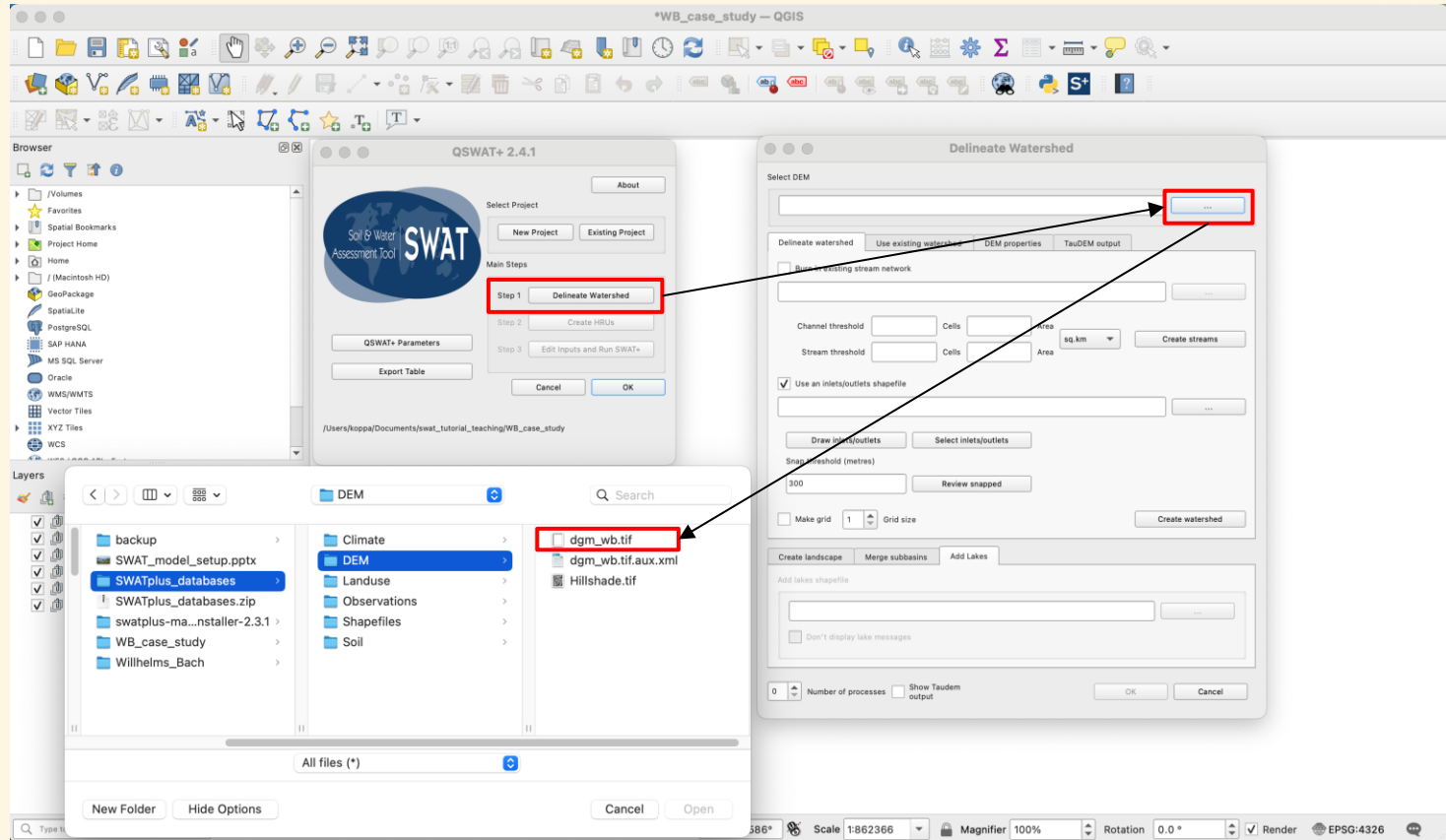
Start QGIS



Delineate Watershed



Load digital elevation model (DEM)



Create streams

What happens when these parameters are changed?

The image shows a QGIS desktop environment with the SWAT+ 2.4.1 application open. The main window displays a topographic map with a stream network overlaid in blue. The 'Delineate Watershed' dialog box is open on the right, and a red rectangular box highlights the 'Channel threshold' and 'Stream threshold' settings. An arrow points from the text 'What happens when these parameters are changed?' to the 'Channel threshold' field.

Parameter	Value	Units
Channel threshold	75	Cells
Stream threshold	748	Cells

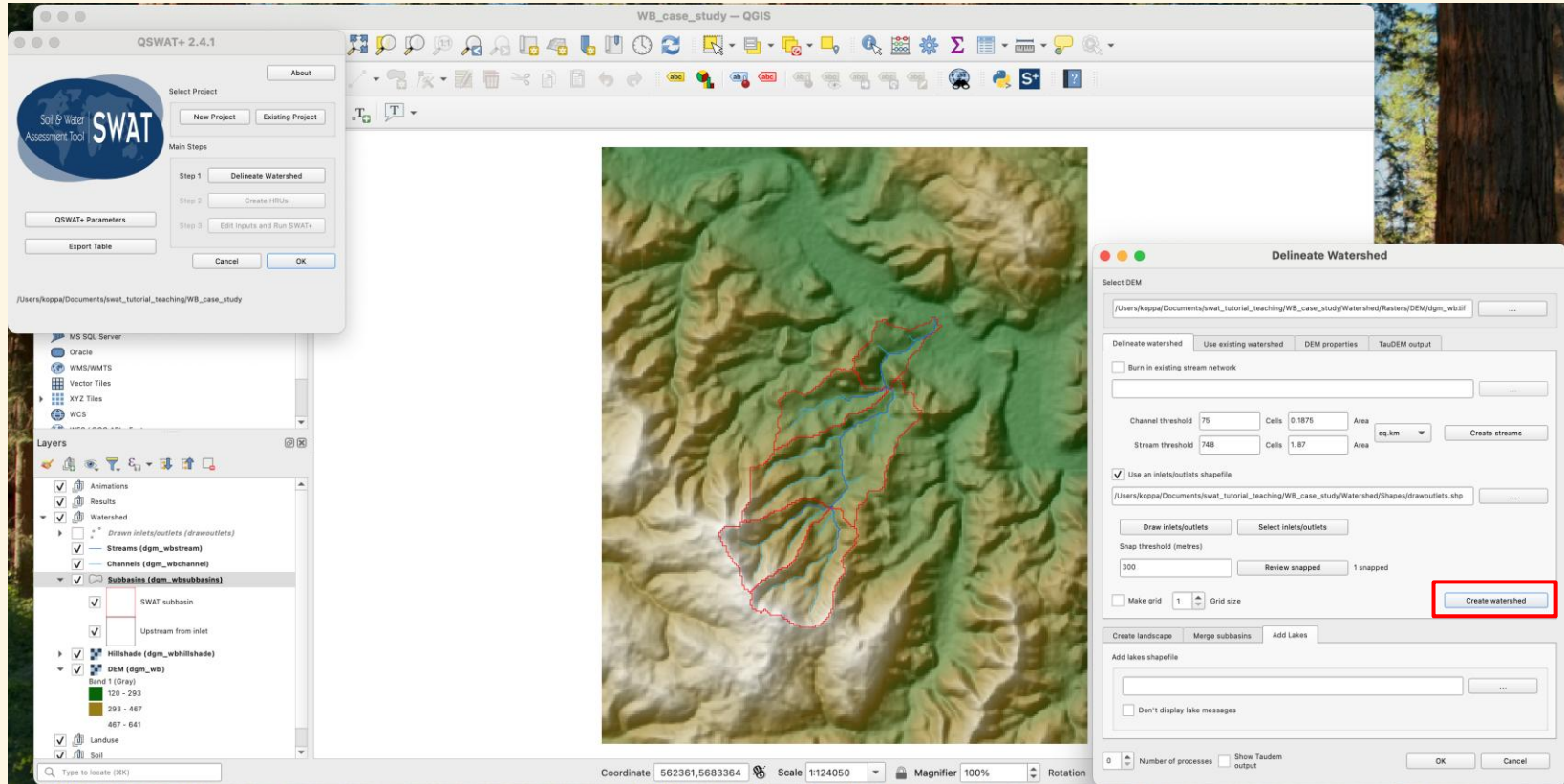
The 'Create streams' button is also visible in the dialog box.

Create outlet

What is an outlet and why is it needed?

The screenshot displays the QSWAT+ 2.4.1 software interface. The main window shows a topographic map with a watershed delineation. A red box highlights a blue triangle symbol on the map, which is used to define an outlet point. The 'Delineate Watershed' dialog box is open on the right, with the 'Draw inlets/outlets' button highlighted in red. An arrow points from this button to the 'Inlets/outlets' dialog box on the left, which is also highlighted in red. The 'Inlets/outlets' dialog box shows the 'Outlet' option selected under the 'Select type of point to add' section. The 'Delineate Watershed' dialog box includes various settings such as 'Channel threshold', 'Stream threshold', and 'Use an inlets/outlets shapefile'.

Create watershed



Create HRUs – Landuse and soil maps

The screenshot displays the QGIS interface with the SWAT+ 2.4.1 application window open. The main map area shows a topographic map of a watershed with a red outline and a network of blue lines representing streams. The 'Create HRUs' dialog box is open on the right side, and its content is highlighted with a red border. The dialog has two tabs: 'Landuse and soil' and 'HRUs'. The 'Landuse and soil' tab is active, showing fields for 'Select landuse map', 'Select soil map', and 'Select landuse and soil database'. Below these are 'Soil data' and 'Tables' sections. The 'Soil data' section has radio buttons for 'user soil', 'STATSGO', and 'SSURGO/STATSGO2'. The 'Tables' section has dropdown menus for 'Landuse lookup', 'Soil lookup', 'Usersoil', 'Plant', and 'Urban'. There are also sections for 'Set slope bands (%)', 'Slope bands', 'Reservoir threshold', 'Short channel merge', and 'Read choice'. At the bottom right of the dialog, the 'Read' button is highlighted with a red box. The status bar at the bottom of the QGIS window shows 'Coordinate: 553784,5693386', 'Scale: 1:124050', 'Magnifier: 100%', 'Rotation: 0.0°', 'Render', and 'EPSG:25832'.

Create HRUs

The screenshot shows the QGIS interface with the SWAT+ tool. The central map displays a watershed with a grid of Hydrologic Response Units (HRUs). Three dialog boxes are open:

- QSWAT+ 2.4.1** (Left): Shows the main steps: Step 1: Delineate Watershed, Step 2: Create HRUs, Step 3: Edit Inputs and Run SWAT+.
- Split Landuses** (Bottom Left): A dialog for splitting landuses. It has a table with columns: Landuse, Sub-landuse, and Percent. The table contains two rows: AGRL, CDORN, 50 and WWHT, 50. Buttons include "Add sub-landuse", "Delete sub-landuse", "Delete split landuse", "Cancel edits", "Save edits", "Save splits", and "Cancel".
- Create HRUs** (Right): A dialog for creating HRUs. It has tabs for "Landuse and soil" and "HRUs". Under "Optional", there are radio buttons for "Single/Multiple HRUs", "Dominant landuse, soil, slope", "Dominant HRU", "Filter by landuse, soil, slope", "Filter by area", and "Target number of HRUs". There is a "Target" field with a value of 449. Under "Threshold method", there are radio buttons for "Percent of landscape unit" (selected) and "Area (ha)".

The "Split Landuses" dialog is highlighted with a red box, and the "Split landuses" button in the "Create HRUs" dialog is also highlighted with a red box. A black arrow points from the "Split Landuses" dialog to the "Split landuses" button.

Create HRUs

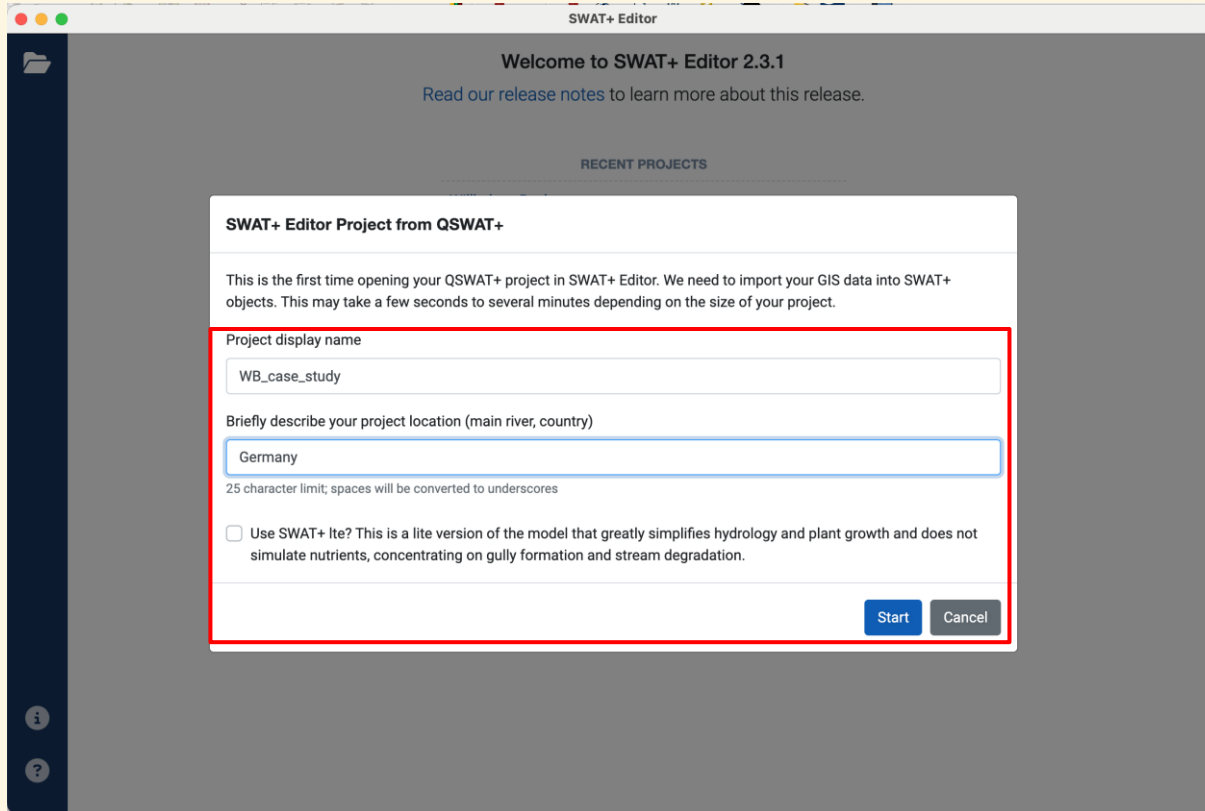
The screenshot displays the QGIS interface with the SWAT+ 2.4.1 application window. The main map shows a watershed delineation with a grid of Hydrologic Response Units (HRUs) overlaid on a topographic map. The 'Create HRUs' dialog box is open, showing the following settings:

- Landuse and soil:** HRUs
- Optional:** Split landuses, Exempt landuses
- Single/Multiple HRUs:**
 - Dominant landuse, soil, slope
 - Dominant HRU
 - Filter by landuse, soil, slope
 - Filter by area
 - Target number of HRUs
- Target:** 5 Number of HRUs, 449
- Threshold method:**
 - Percent of landscape unit
 - Area (Ha)

The 'Actual HRUs (hrus2)' layer is visible in the layer browser on the left. The status bar at the bottom shows the coordinate (544747,5693342), scale (1:124050), magnifier (100%), and rotation (0.0°).

Open SWAT+ editor

Enter relevant details and start the editor



Open SWAT+ editor

Explore the different watershed characteristics

The screenshot displays the SWAT+ Editor 2.3.1 interface. On the left is a dark blue sidebar with navigation icons and a 'RECENT PROJECTS' section containing 'WB_case_study'. The main area shows 'Current project: WB_case_study' for 'Germany' at the path '/Users/koppa/Documents/swat_tutorial_teaching/WB_case_study'. Below this is a table of 'SWAT+ Project information' and a list of 'Object totals'. A 'Land use distribution' pie chart is shown on the right, with a legend below it. The legend includes categories like corn, past, fodb, shrb, fomi, uidu, frse, urbn, orcd, and wwht. At the bottom, there are buttons for 'Get started', 'Change Name/Description', and 'Re-import from GIS'.

SWAT+ Editor 2.3.1 / WB_case_study

SWAT+ Editor 2.3.1
[Read our release notes](#) to learn more about this release.

Open another project

Create a new project

RECENT PROJECTS

WB_case_study

Current project: WB_case_study
Germany

/Users/koppa/Documents/swat_tutorial_teaching/WB_case_study

SWAT+ Project information

Total area	1,987.75 ha	Software	SWAT+ Editor 2.3.1, QSWAT+ 2.4.1
Simulation period	1980 - 1985	Last saved	Sun, Dec 8, 2024 6:30 PM

Object totals

- 5 Subbasins
- 536 HRUs
- 45 Channels
- 6 Aquifers
- 0 Reservoirs
- 45 Routing Units
- 45 Landscape Units
- 45 Recall (point source/inlet data)
- 0 Export Coefficients
- 0 Delivery Ratio

Land use distribution

corn fodb fomi frse orcd
past shrb uidu urbn wwht

Highcharts.com

Get started Change Name/Description Re-import from GIS

Load weather generator data

The screenshot displays the SWAT+ Editor 2.3.1 interface. The main window is titled "Weather Generator" and contains a message: "You don't have any weather generators. Use the buttons below to import data or create a new record manually." A sidebar on the left lists various model components, with "Weather Generator" highlighted under the "CLIMATE" section. A red box highlights the pencil icon in the sidebar. An "Import Weather Generator Data" dialog box is open in the center, with a red box around its content. The dialog box includes a "Select your data format" dropdown menu set to "Database", a "Database file" field with the path "/Users/koppa/Documents/swat_tutorial_teaching/SWATplus_databases/Climate/swatplus_wgn.sqlite" and a "Browse" button, a "Table name in database" field with the value "wgn_cfsr_world", and a checked checkbox labeled "Check if you are using observed weather data". At the bottom of the dialog are "Start" and "Cancel" buttons. In the main window, at the bottom, there are three buttons: "Create Record", "Import Data" (highlighted with a red box), and "Delete All".

Load observed data

The screenshot displays the SWAT+ Editor software interface. On the left, a vertical sidebar contains a list of model components: CLIMATE, CONNECTIONS, BASIN, REGIONS, LAND USE MANAGEMENT, DECISION TABLES, CHANGE, INITIALIZATION DATA, HYDROLOGY, SOILS, DATABASES, STRUCTURAL, and WATER RIGHTS. The 'Weather Stations' component is selected and highlighted with a red box. A red box also highlights the pencil icon in the sidebar. The main window shows the 'Weather Stations' configuration page with a message: 'Need weather data? See options on the SWAT website.' A dialog box titled 'Import Observed Weather Data' is open in the center, also outlined with a red box. It contains the following fields and instructions:

- Select your data format:** A dropdown menu is set to 'SWAT2012 / Global Data Websites'.
- Instructions:** A blue text box states: 'This is not your pcp.pcp (etc); instead you will have a text file for each measurement listing each station and its coordinated, and a text file for each station for each measurement. These files should be named: pcp.txt, rh.txt, solar.txt, tmp.txt, and wind.txt.'
- SWAT2012 weather files directory:** A text field contains '/Users/koppa/Documents/swat_tutorial_teaching/SWATplus_databases/Climate/historical/CFSR' with a 'Browse' button to its right.
- Directory to save your SWAT+ weather files:** A text field contains '/Users/koppa/Documents/swat_tutorial_teaching/WB_case_study/Scenarios/Default/TxtInOut' with a 'Browse' button to its right.
- Buttons:** 'Start' and 'Cancel' buttons are located at the bottom right of the dialog.

At the bottom of the main window, the 'Import Data' button is highlighted with a red box. Other buttons visible include 'Create Record' and 'Delete All'.

Load observed data

The screenshot displays the SWAT+ Editor software interface. The main window is titled "Weather Stations" and shows a list of weather stations. A red box highlights the "Weather Stations" dropdown menu in the left sidebar. A dialog box titled "Import Observed Weather Data" is open in the center, with a red box around its content. The dialog box contains the following text:

Select your data format

SWAT2012 / Global Data Websites

This is not your `pcp.pcp` (etc); instead you will have a text file for each measurement listing each station and its coordinated, and a text file for each station for each measurement. These files should be named: `pcp.txt`, `rh.txt`, `solar.txt`, `tmp.txt`, and `wind.txt`.

SWAT2012 weather files directory

`/Users/koppa/Documents/swat_tutorial_teaching/SWATplus_databases/Climate/historical/CFSR` Browse

Directory to save your SWAT+ weather files

`/Users/koppa/Documents/swat_tutorial_teaching/WB_case_study/Scenarios/Default/TxtInOut` Browse

Start Cancel

At the bottom of the main window, the "Import Data" button is highlighted with a red box.

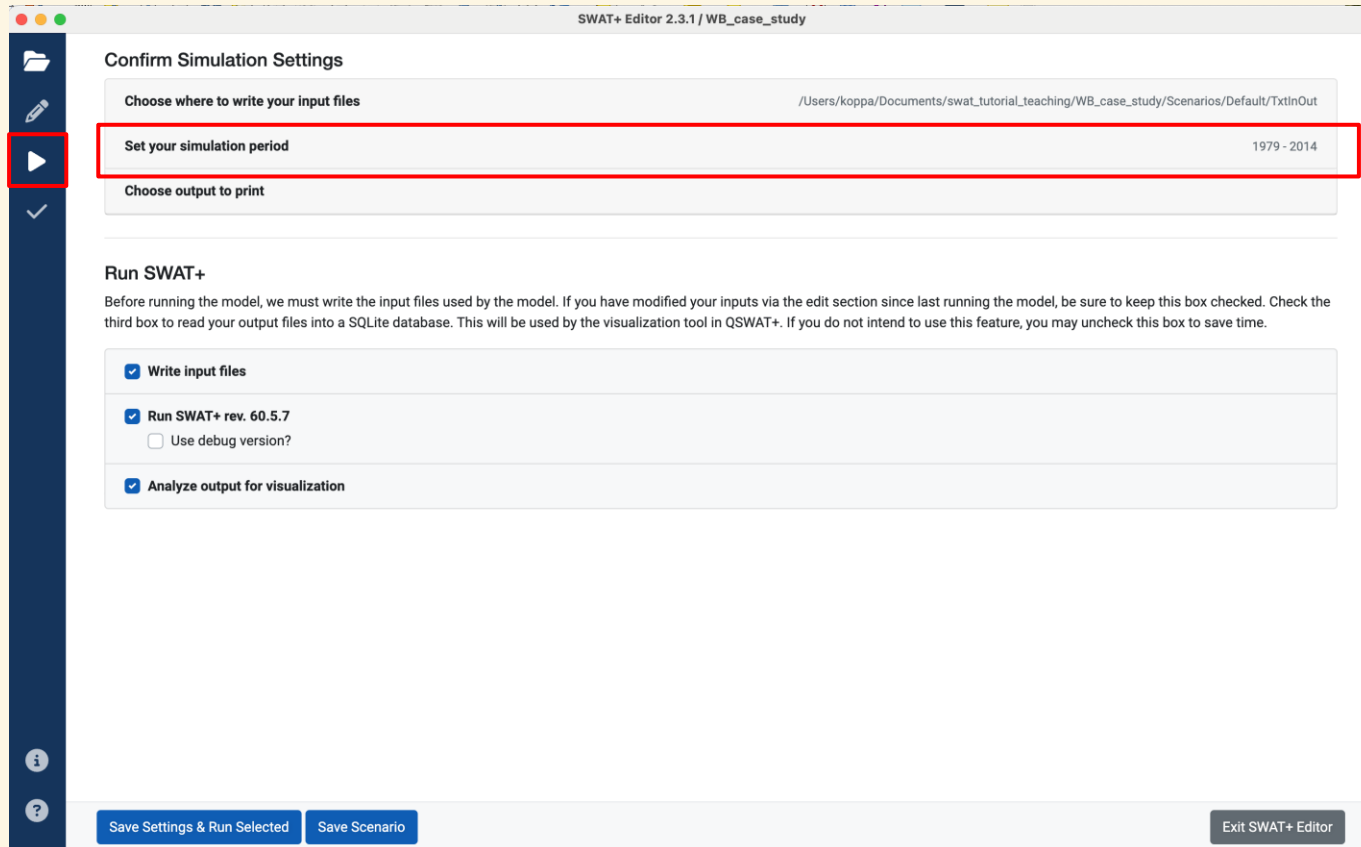
Run SWAT+

The screenshot displays the SWAT+ Editor software interface. On the left, a vertical sidebar contains various model components, with 'Weather Stations' highlighted in red. The main window shows the 'Weather Stations' configuration page, also with a red box around the title. A modal dialog box titled 'Import Observed Weather Data' is open in the center, containing the following fields and instructions:

- Select your data format:** A dropdown menu set to 'SWAT2012 / Global Data Websites'.
- Instructions:** A blue text box stating: "This is not your pcp.pcp (etc); instead you will have a text file for each measurement listing each station and its coordinated, and a text file for each station for each measurement. These files should be named: pcp.txt, rh.txt, solar.txt, tmp.txt, and wind.txt."
- SWAT2012 weather files directory:** A text field containing '/Users/koppa/Documents/swat_tutorial_teaching/SWATplus_databases/Climate/historical/CFSR' with a 'Browse' button.
- Directory to save your SWAT+ weather files:** A text field containing '/Users/koppa/Documents/swat_tutorial_teaching/WB_case_study/Scenarios/Default/TxtInOut' with a 'Browse' button.
- Buttons:** 'Start' and 'Cancel' buttons at the bottom of the dialog.

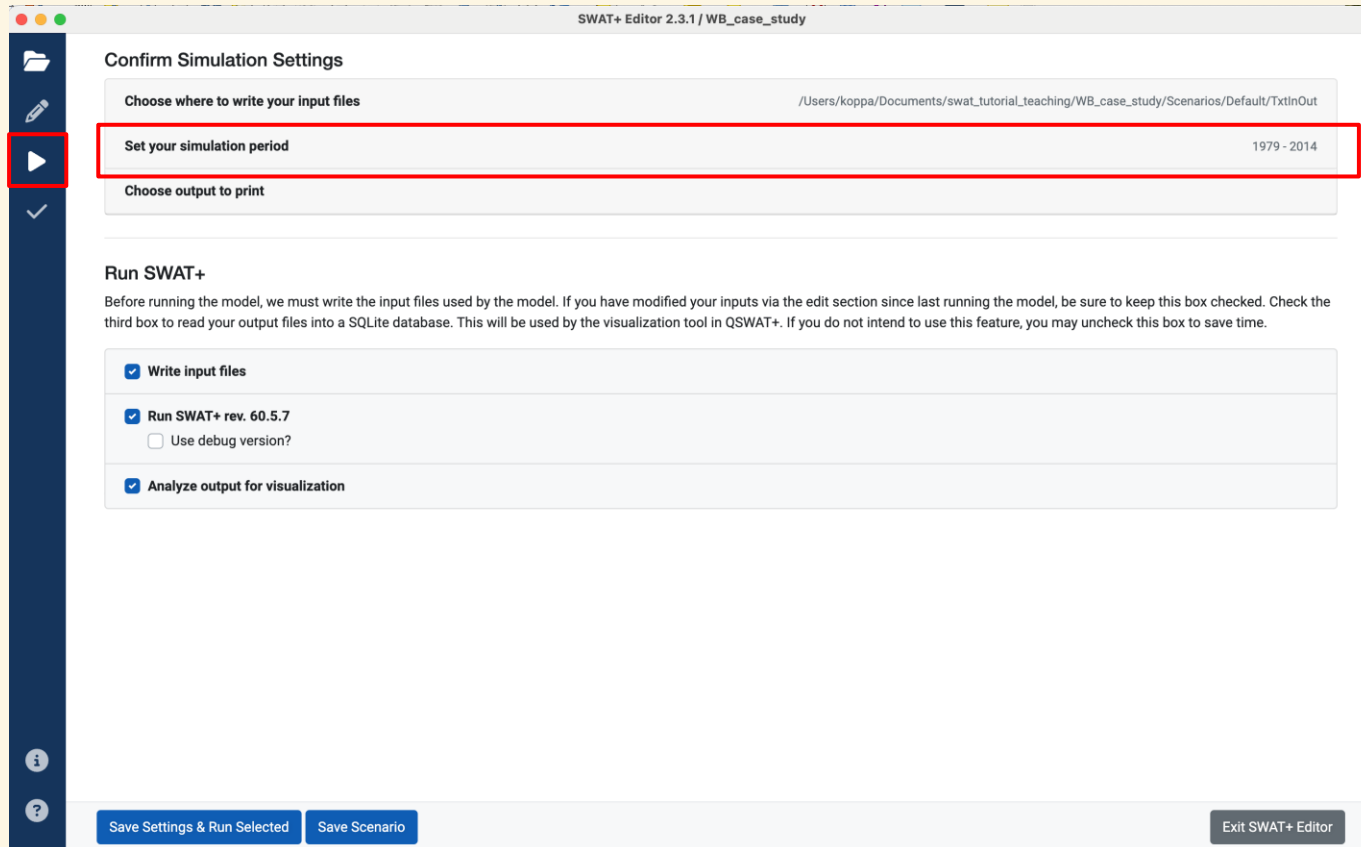
At the bottom of the main window, the 'Import Data' button is highlighted with a red box.

Run SWAT+: set simulation period



Run SWAT+: choose output to write out

Figure out how to set model time step to daily



Run SWAT+: choose output to write out

Number of years to skip printing output

	Daily	Monthly	Yearly	Average	Outputs
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Model Components					
Channel	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	channel_sd channel_sdmorph
Aquifer	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	aquifer
Reservoir	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	reservoir
Point Source (Recall)	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	recall
Routing Unit	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	ru
Hydrology	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	hyd
Water Allocation	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	water_allo
Basin Model Components					
Channel	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	basin_sd_cha basin_sd_chamorph
Aquifer	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	basin_aqu
Reservoir	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	basin_res
Point Source (Recall)	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	basin_psc
Nutrient Balance					
Basin	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	basin_nb
Landscape Unit	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	lsunit_nb
HRU	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	hru_nb
Water Balance					
Basin	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	basin_wb
Landscape Unit	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	lsunit_wb
HRU	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	hru_wb
Plant Weather					
Basin	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	basin_pw

Run SWAT+: choose output to write out and run the model

Run SWAT+

Before running the model, we must write the input files used by the model. If you have modified your inputs via the edit section since last running the model, be sure to keep this box checked. Check the third box to read your output files into a SQLite database. This will be used by the visualization tool in QSWAT+. If you do not intend to use this feature, you may uncheck this box to save time.

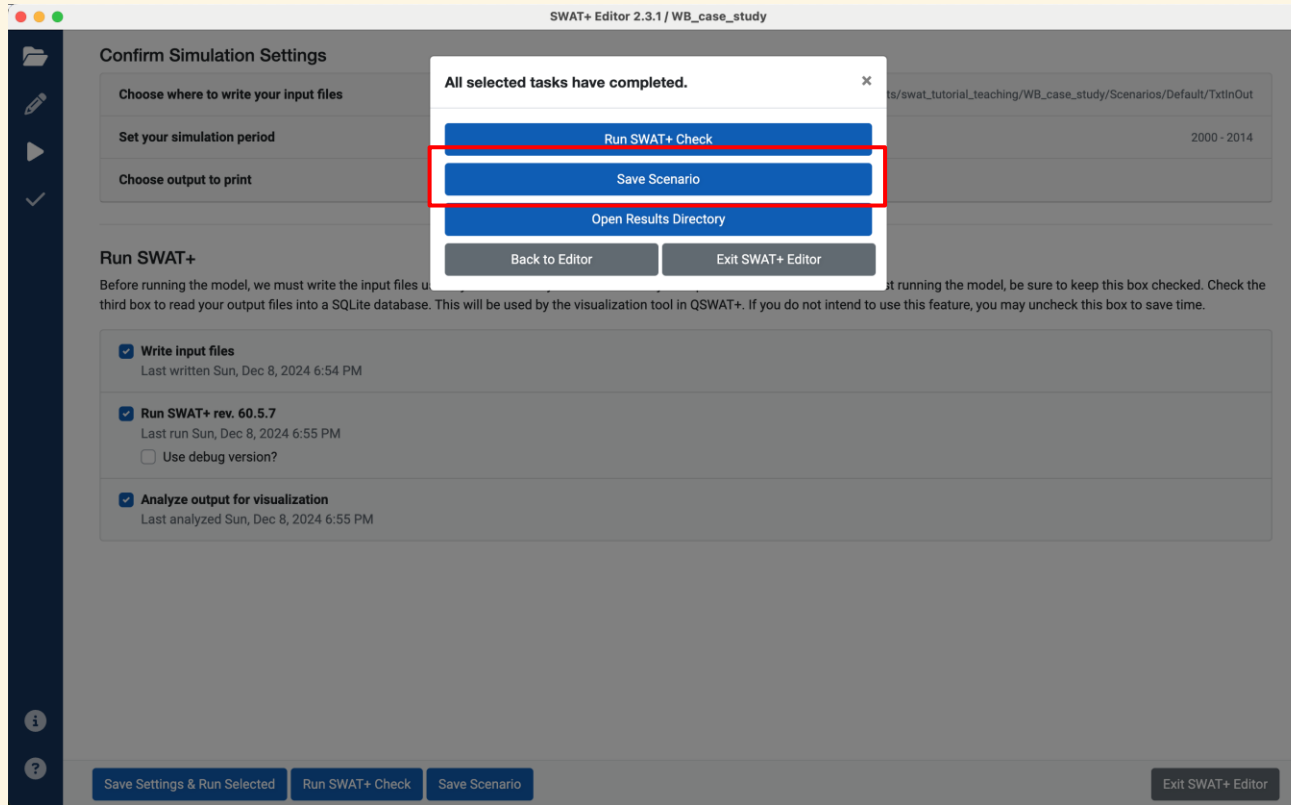
- Write input files
- Run SWAT+ rev. 60.5.7
 - Use debug version?
- Analyze output for visualization

Save Settings & Run Selected

Save Scenario

Exit SWAT+ Editor

Save the model run as a scenario



Check output with SWAT+ check

SWAT+ Editor 2.3.1 / WB_case_study

SWAT+ Check / Hydrology

Realistic hydrology is the foundation of any model. Pay particular attention to evapotranspiration, baseflow and surface runoff ratios. Baseflow/streamflow ratios for the US are provided by the USGS, these data are accessible via the button below. The ranges specified here are general guidelines only, and may not apply to your simulation area.

Messages and Warnings

- Surface runoff ratio may be low (< 0.2)
- Groundwater ratio may be high
- Surface runoff may be too low

Diagram illustrating hydrology components and water flow:

- PET: 664.27
- Plant ET: 171.59
- Soil ET: 178.69
- Evaporation and Transpiration: 399.22
- Precipitation: 752.20
- Average Curve Number: 44.77
- Irrigation: 0.00
- Tile: 0.00
- Surface Runoff: 16.74
- Lateral Flow: 18.36
- Return Flow: 235.79
- Recharge to deep aquifer: 13.20
- Percolation to shallow aquifer: 264.07
- Revap from shallow aquifer: 15.21

All Units mm

Exit SWAT+ Editor

Visual results with QSWAT+

The screenshot displays the QGIS interface with the QSWAT+ 2.4.1 plugin window open. The QSWAT+ window shows the 'Main Steps' section with 'Visualise' selected in Step 4. The 'Visualise Results' dialog is also open, showing the 'Choose scenario' dropdown set to 'historical2' and the 'Choose period' section with 'Start date' set to 1 January 2001 and 'Finish date' set to 31 July 2014. The 'Choose variables' section has 'precip' selected. The 'Choose summary' section has 'Totals' selected. The 'Print' section has 'Landscape' selected and 'Number of maps' set to 1. The main QGIS window shows a map of a watershed with a red outline and a blue stream network. The status bar at the bottom indicates the coordinate system as EPSG:25832, scale as 1:131082, and magnification as 100%.

SWAT model exercise

For the **Wilhelmshaeuser Bach** watershed

1. Test the three components of SWAT+ (QGIS, QSWAT+, SWAT+ Editor) are working.
2. Setup the model as detailed in the presentation (make sure to save monthly outputs).
3. Create different different scenarios with
 - 3a. Systematically change **curve number** (cn2) and compare the discharge values
 - 3b. Compare discharge and evapotranspiration output for two different potential evapotranspiration methods– **Penman-Monteith and Hargreaves** method
 - 3c. Compare evapotranspiration output for two scenarios – **All stresses applied** and **All stresses turned off**.