

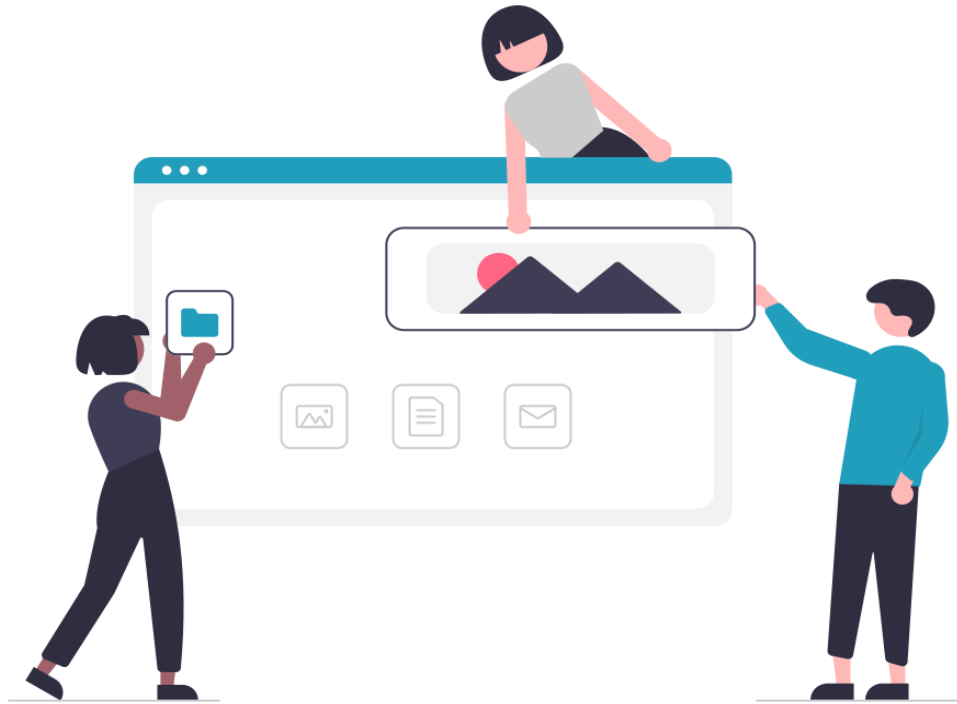
Efficient SWAT+ input maps generation with an open-source QGIS-Google Earth Engine plugin



Adrián López-Ballesteros, Raghavan Srinivasan, Javier Senent-Aparicio

2024 Strasbourg, France SWAT Conference

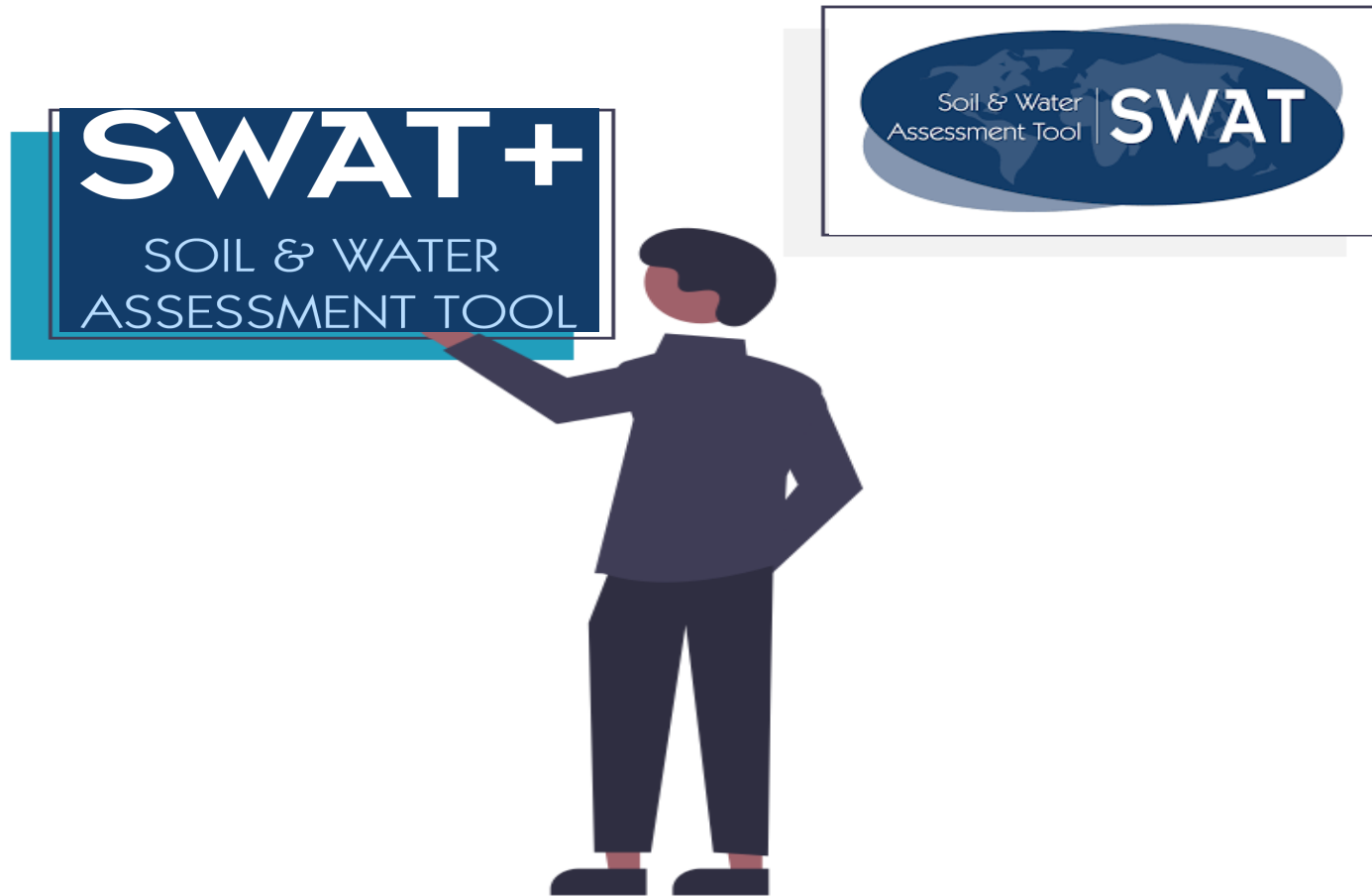
"We are all good individually, but together we are better."





QUICK TEST

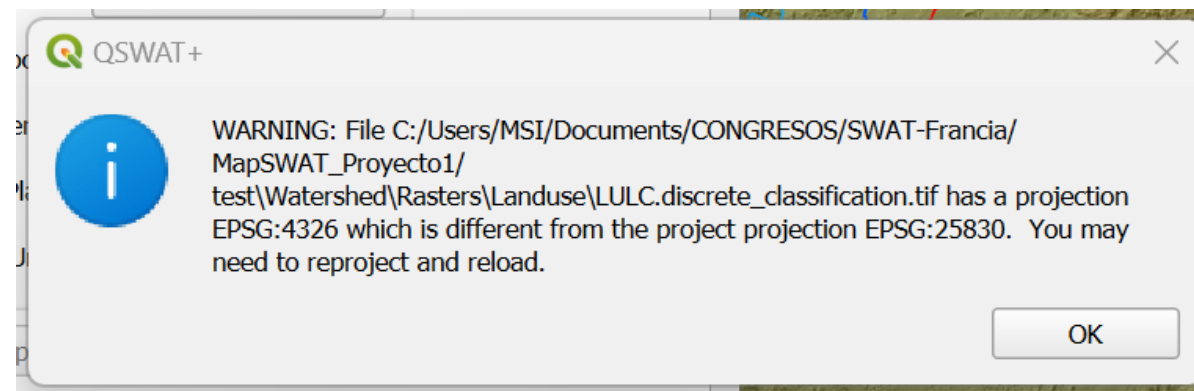
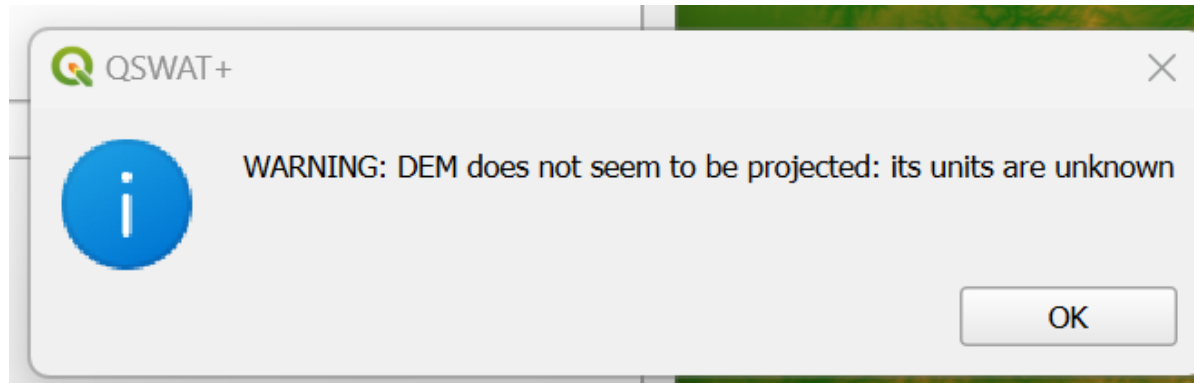
1. Who knows what the SWAT/SWAT+ model is?



2. When starting a SWAT+ model, who has spent a lot of time collecting and preparing the input maps?



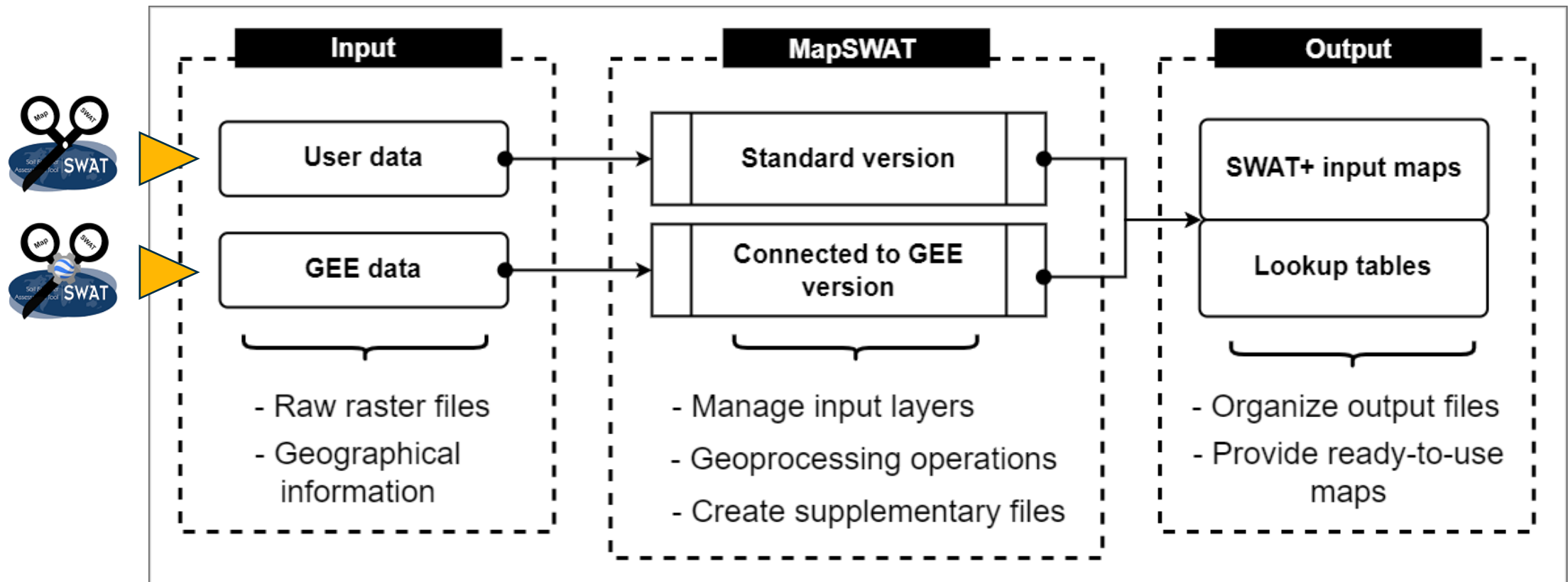
3. Who has ever had a formatting error?



MapSWAT



MapSWAT is a freely available QGIS plugin, developed in Python, that streamlines the preparation of the SWAT+ input maps.



MapSWAT application area



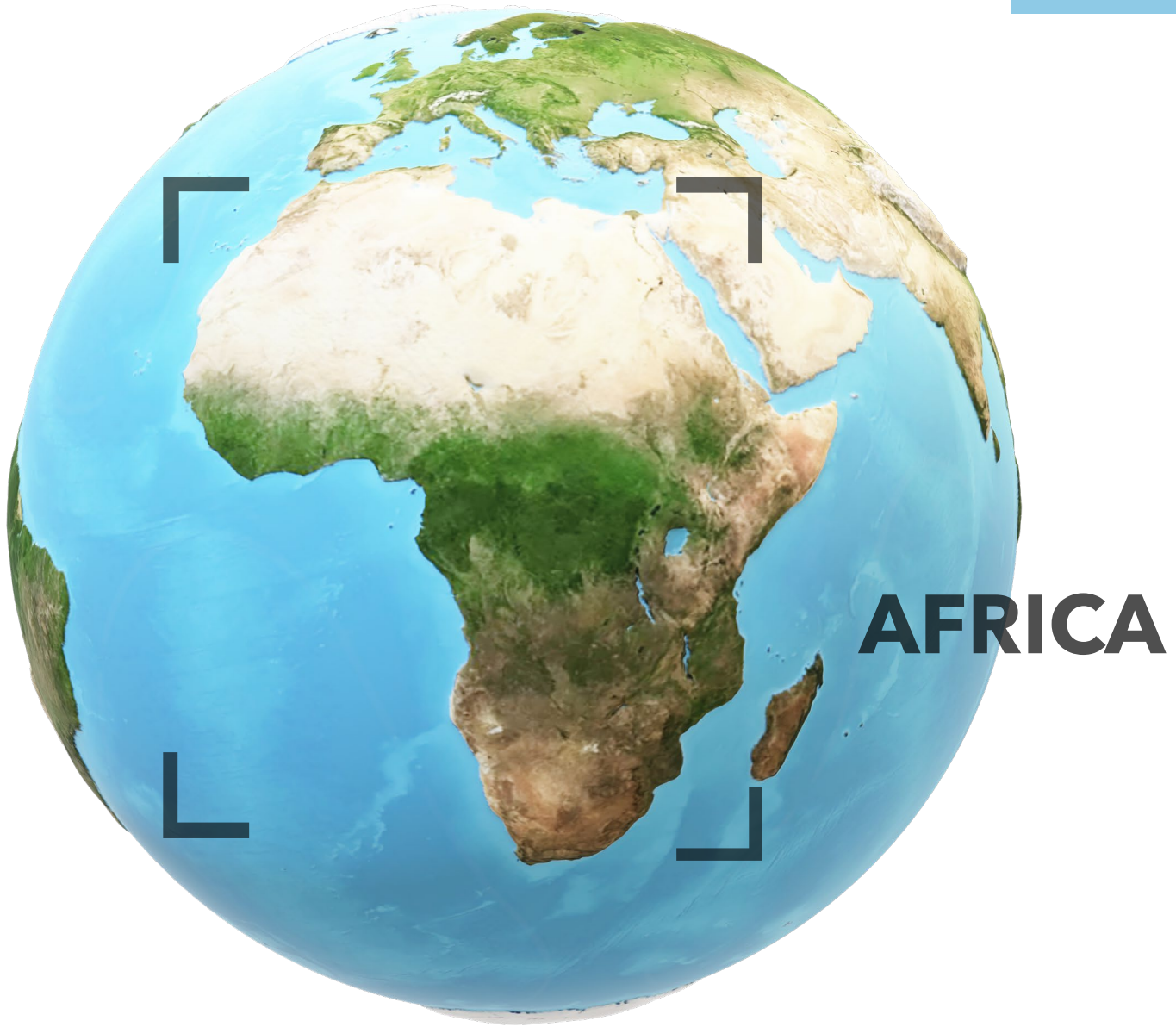


**SOUTH
AMERICA**

MapSWAT application area



MapSWAT application area



OCEANIA







The MOON



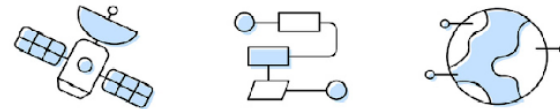
Standard version



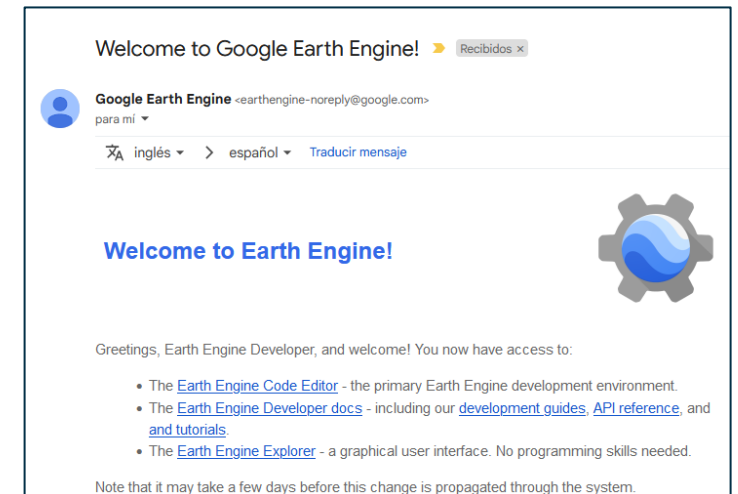
Google Earth Engine



Connected to GEE version



GEE is a cloud-based platform that hosts a multi-petabyte collection of satellite imagery and geospatial data.



MapSWAT workflow



Step 3

MapSWAT v3.0

OUTLET Coordinates: X Y Select (X, Y) CRS

DEM: ...

MERGE DEMs

LANDUSE: ...

SOIL: ...

ADD LAYERS

Step 4

CLIPPING OPTIONS: ...

MANUAL CLIP SHAPEFILE CLIP BUFFER CLIP

FROM OUTLET: Buffer (Km) 10

Step 5

SWAT INPUT MAPS CRS: Select target CRS for SWAT input maps

CREATE SWAT INPUT MAPS

MapSWAT GEE

OUTLET Coordinates: X Y Select (X, Y) CRS

ADD OUTLET ADD BASEMAP

DEM: SRTM Digital Elevation Data 90m

LANDUSE: Copernicus Global Land Cover 2019

SOIL: DSOLMap: Digital Soil Open Land Map

GET MAPS

Step 4

CLIPPING OPTIONS: ...

MANUAL CLIP SHAPEFILE CLIP

FROM OUTLET: 10 (Km) BUFFER CLIP

HydroSHEDS Basins L-7 AUTOBASIN CLIP

Step 5

SWAT INPUT MAPS CRS: Select target CRS for SWAT input maps

CREATE SWAT INPUT MAPS

Step 1



MapSWAT version



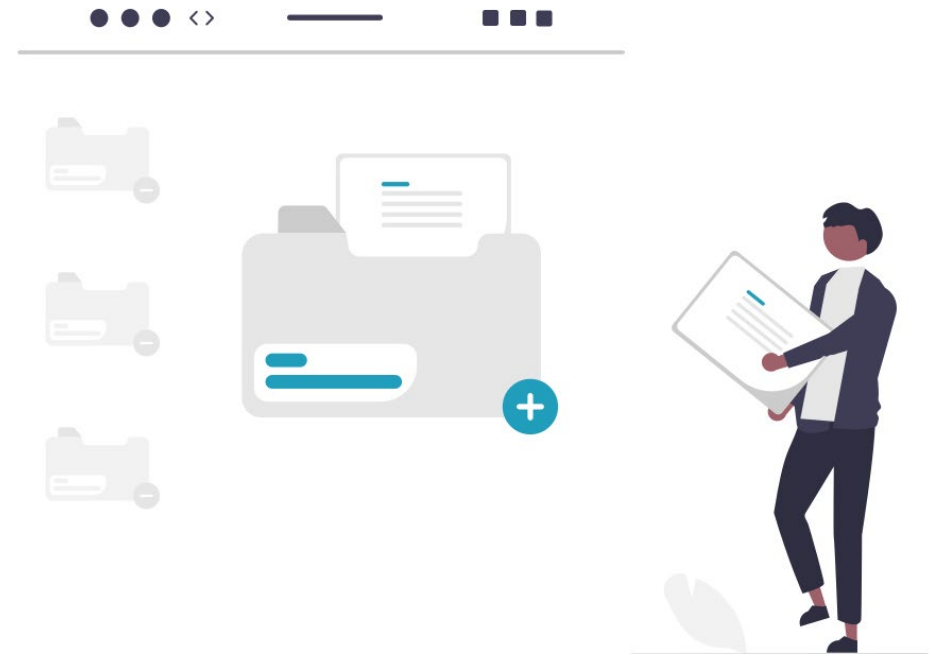
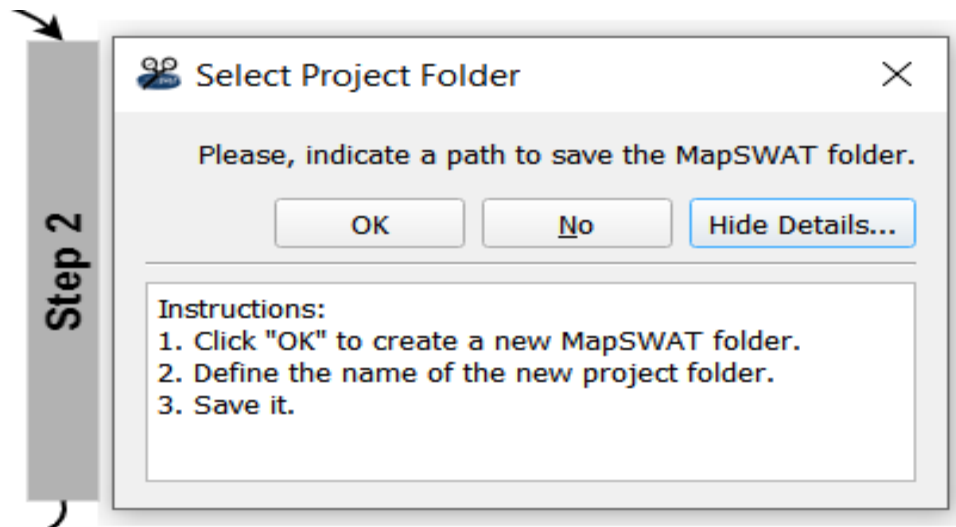
Please, select the version of MapSWAT you want to use.

MapSWAT v3.0

MapSWAT GEE

Show Details...





MapSWAT workflow

Step 3

MapSWAT v3.0

OUTLET Coordinates: X Y Select (X, Y) CRS

DEM: ...

LANDUSE: ...

SOIL: ...

MERGE DEMs

ADD LAYERS

CLIPPING OPTIONS:

FROM OUTLET: Buffer (Km)

MANUAL CLIP

SHAPEFILE CLIP

BUFFER CLIP

SWAT INPUT MAPS CRS: Select target CRS for SWAT input maps

CREATE SWAT INPUT MAPS

MapSWAT GEE

OUTLET Coordinates: X Y Select (X, Y) CRS

ADD OUTLET ↔ ADD BASEMAP

DEM: SRTM Digital Elevation Data 90m

LANDUSE: Copernicus Global Land Cover 2019

SOIL: DSOLMap: Digital Soil Open Land Map

GET MAPS

CLIPPING OPTIONS:

FROM OUTLET: (Km) BUFFER CLIP

MANUAL CLIP

SHAPEFILE CLIP

HydroSHEDS Basins L-7

AUTOBASIN CLIP


SWAT INPUT MAPS CRS: Select target CRS for SWAT input maps

CREATE SWAT INPUT MAPS

MapSWAT workflow

Step 3


MapSWAT v3.0


OUTLET Coordinates: X Y Select (X, Y) CRS 

DEM: ...


LANDUSE: ...


SOIL: ...


MERGE DEMs 


ADD LAYERS 


MapSWAT GEE


OUTLET Coordinates: X Y Select (X, Y) CRS 

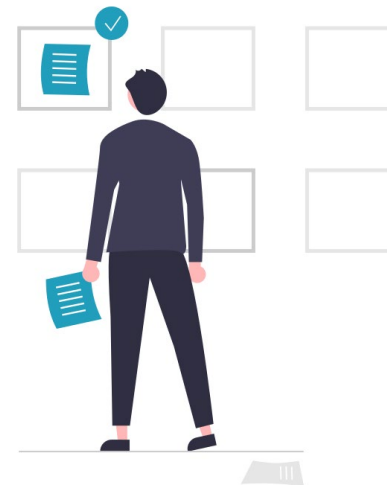
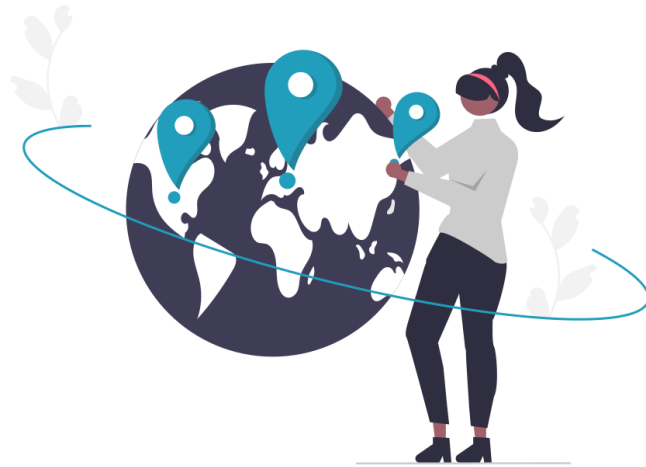
ADD OUTLET  ADD BASEMAP

DEM: SRTM Digital Elevation Data 90m 

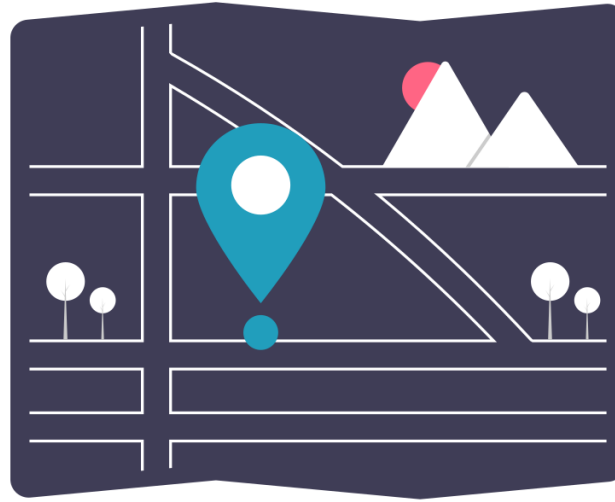
LANDUSE: Copernicus Global Land Cover 2019 

SOIL: DSOLMap: Digital Soil Open Land Map 

GET MAPS 



MapSWAT workflow



Step 4

CLIPPING OPTIONS:



MANUAL
CLIP

SHAPEFILE
CLIP

FROM OUTLET:

Buffer (Km)

10

BUFFER
CLIP

CLIPPING OPTIONS:



MANUAL
CLIP

SHAPEFILE
CLIP

FROM OUTLET:

10

(Km)

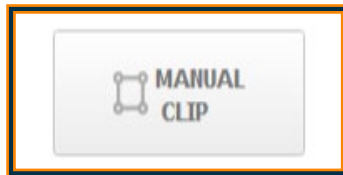
BUFFER
CLIP

HydroSHEDS Basins L-7



AUTOBASIN CLIP

Manual Clip



MapSWAT GEE

OUTLET Coordinates: X Y EPSG:25830 - ETRS

↔

DEM:

LANDUSE:

SOIL:

CLIPPING OPTIONS: ...

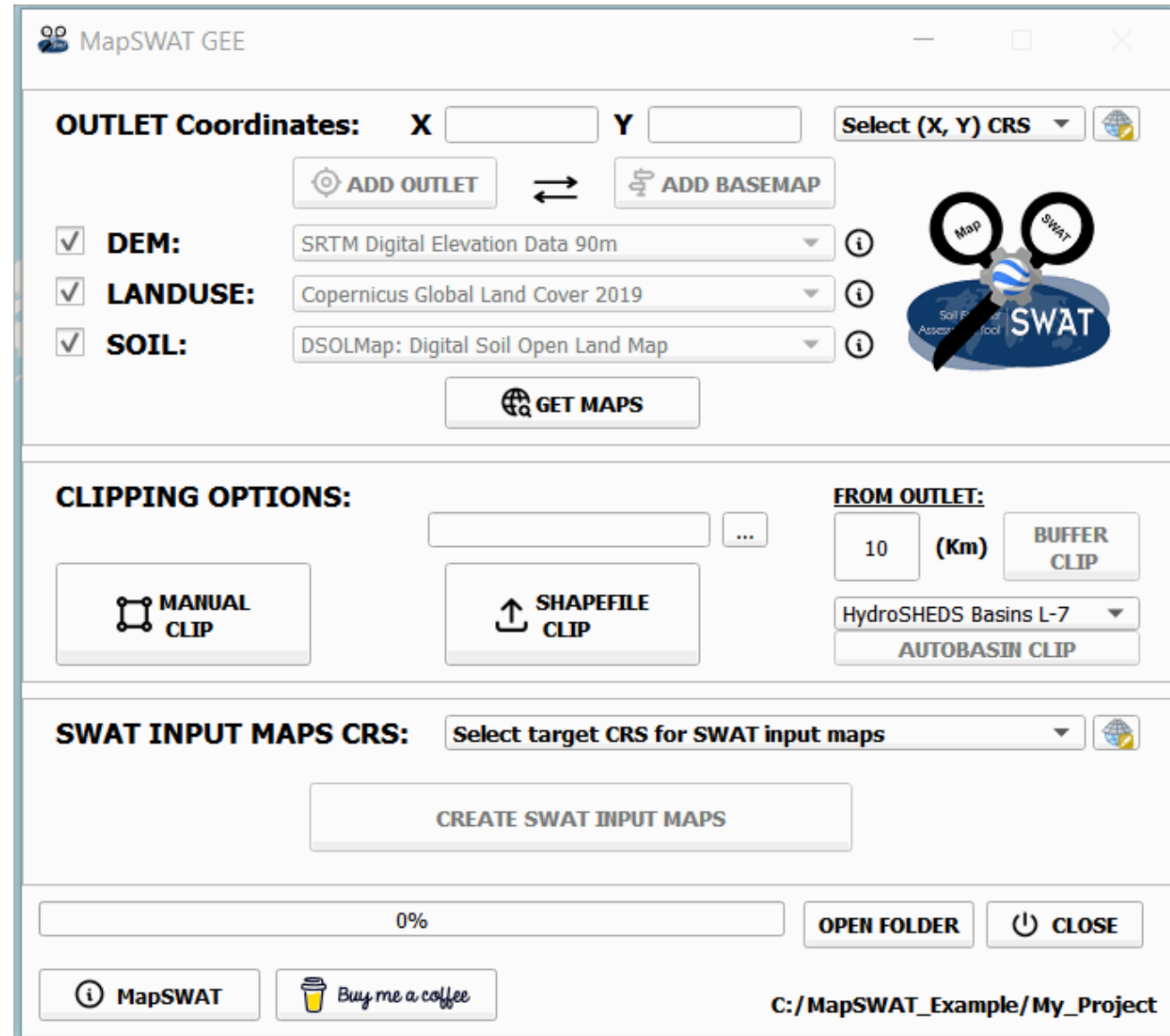
FROM OUTLET: (Km)

SWAT INPUT MAPS CRS:

MapSWAT Buy me a coffee

C:/MapSWAT_Example/My_Project

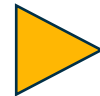
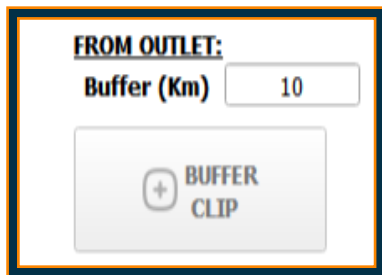
Shapefile Clip



The screenshot displays the MapSWAT GEE web interface, which is organized into several sections:

- OUTLET Coordinates:** Includes input fields for X and Y coordinates, a 'Select (X, Y) CRS' dropdown menu, and a globe icon.
- Map Selection:** Features 'ADD OUTLET' and 'ADD BASEMAP' buttons, a double-headed arrow, and a 'GET MAPS' button with a globe icon.
- Map Selection List:** A list of maps with checkboxes and dropdown menus:
 - DEM:** SRTM Digital Elevation Data 90m
 - LANDUSE:** Copernicus Global Land Cover 2019
 - SOIL:** DSOLMap: Digital Soil Open Land MapInformation icons (i) are present next to each map name.
- MapSWAT Logo:** A logo featuring a pair of scissors cutting a globe, with the text 'Map', 'SWAT', and 'Soil Assessment Tool'.
- CLIPPING OPTIONS:** Includes a text input field with a three-dot menu, a 'MANUAL CLIP' button with a polygon icon, and a 'SHAPEFILE CLIP' button with an upload icon.
- FROM OUTLET:** Includes a '10 (Km) BUFFER CLIP' button, a 'HydroSHEDS Basins L-7' dropdown menu, and an 'AUTOBASIN CLIP' button.
- SWAT INPUT MAPS CRS:** A dropdown menu labeled 'Select target CRS for SWAT input maps' with a globe icon, and a 'CREATE SWAT INPUT MAPS' button.
- Progress and Actions:** A progress bar showing '0%', an 'OPEN FOLDER' button, and a 'CLOSE' button with a power icon.
- Footer:** Includes 'MapSWAT' and 'Buy me a coffee' buttons, and the project path 'C:/MapSWAT_Example/My_Project'.

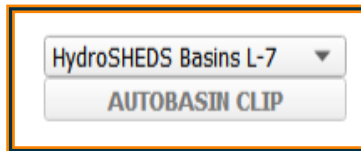
Buffer Clip




The MapSWAT GEE interface is shown with the following sections:

- OUTLET Coordinates:** X: 118722, Y: 4788209, EPSG:25830 - ETRS. Includes "ADD OUTLET" and "ADD BASEMAP" buttons.
- Map Selection:** Checkboxes for DEM, LANDUSE, and SOIL. Dropdown menus for "SRTM Digital Elevation Data 90m", "Copernicus Global Land Cover 2019", and "DSOLMap: Digital Soil Open Land Map". Includes "GET MAPS" button and a "Map SWAT" logo.
- CLIPPING OPTIONS:** Includes "MANUAL CLIP" and "SHAPEFILE CLIP" buttons. A "FROM OUTLET:" section with "10 (Km)" and "BUFFER CLIP" button. A dropdown for "HydroSHEDS Basins L-7" and an "AUTOBASIN CLIP" button.
- SWAT INPUT MAPS CRS:** A dropdown menu set to "Select target CRS for SWAT input maps" and a "CREATE SWAT INPUT MAPS" button.
- Progress and Actions:** A progress bar at 0%, "OPEN FOLDER", and "CLOSE" buttons.
- Footer:** "MapSWAT" logo, "Buy me a coffee" button, and the path "C:/MapSWAT_Example/My_Project".


Autobasin Clip





MapSWAT GEE


OUTLET Coordinates: X Y EPSG:25830 - ETRS 

↔

DEM: 


LANDUSE: 


SOIL: 





CLIPPING OPTIONS: ...

FROM OUTLET: (Km)



SWAT INPUT MAPS CRS: 

 MapSWAT  Buy me a coffee

C:/MapSWAT_Example/My_Project

MapSWAT workflow



Step 5

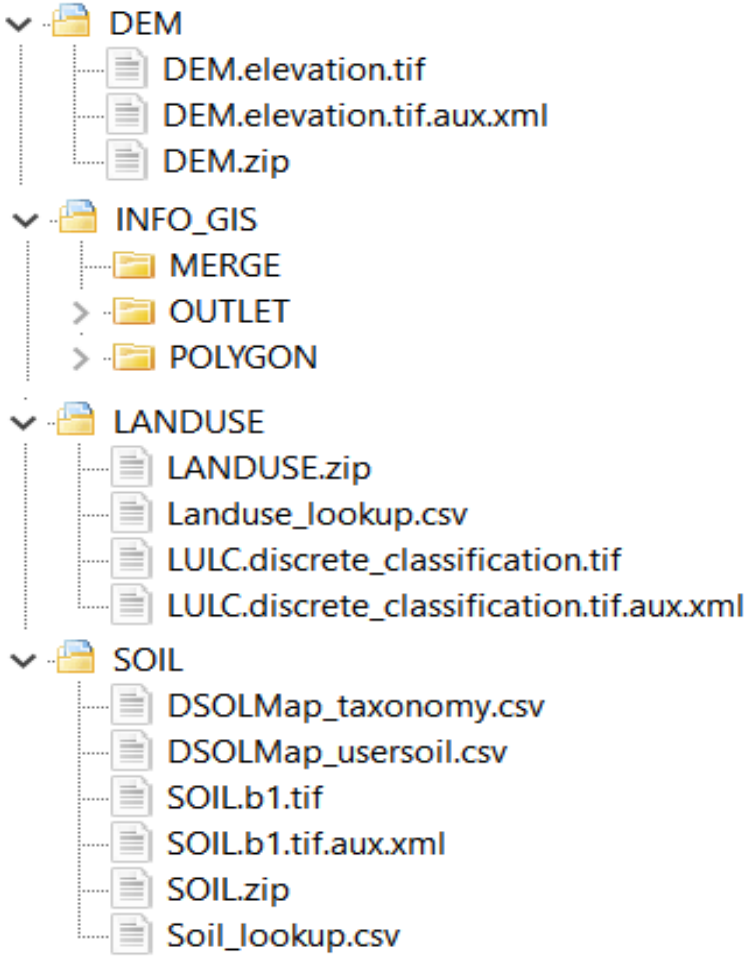
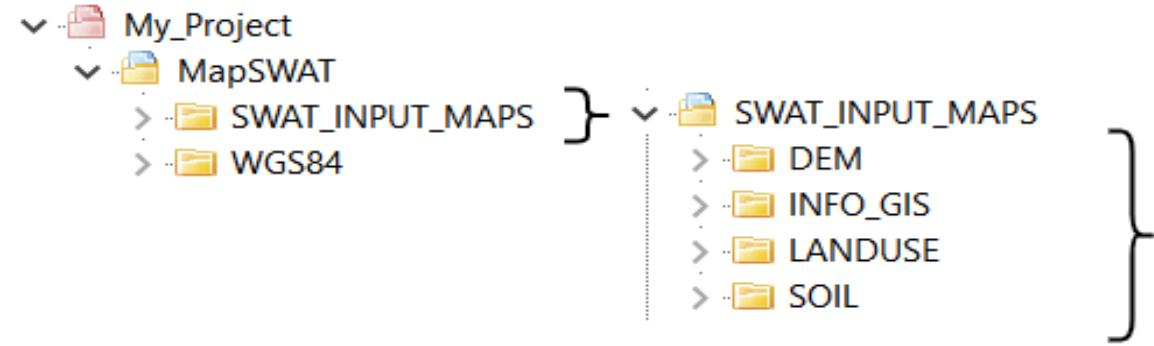
SWAT INPUT MAPS CRS: 

CREATE SWAT INPUT MAPS

SWAT INPUT MAPS CRS: 

CREATE SWAT INPUT MAPS

MapSWAT outputs

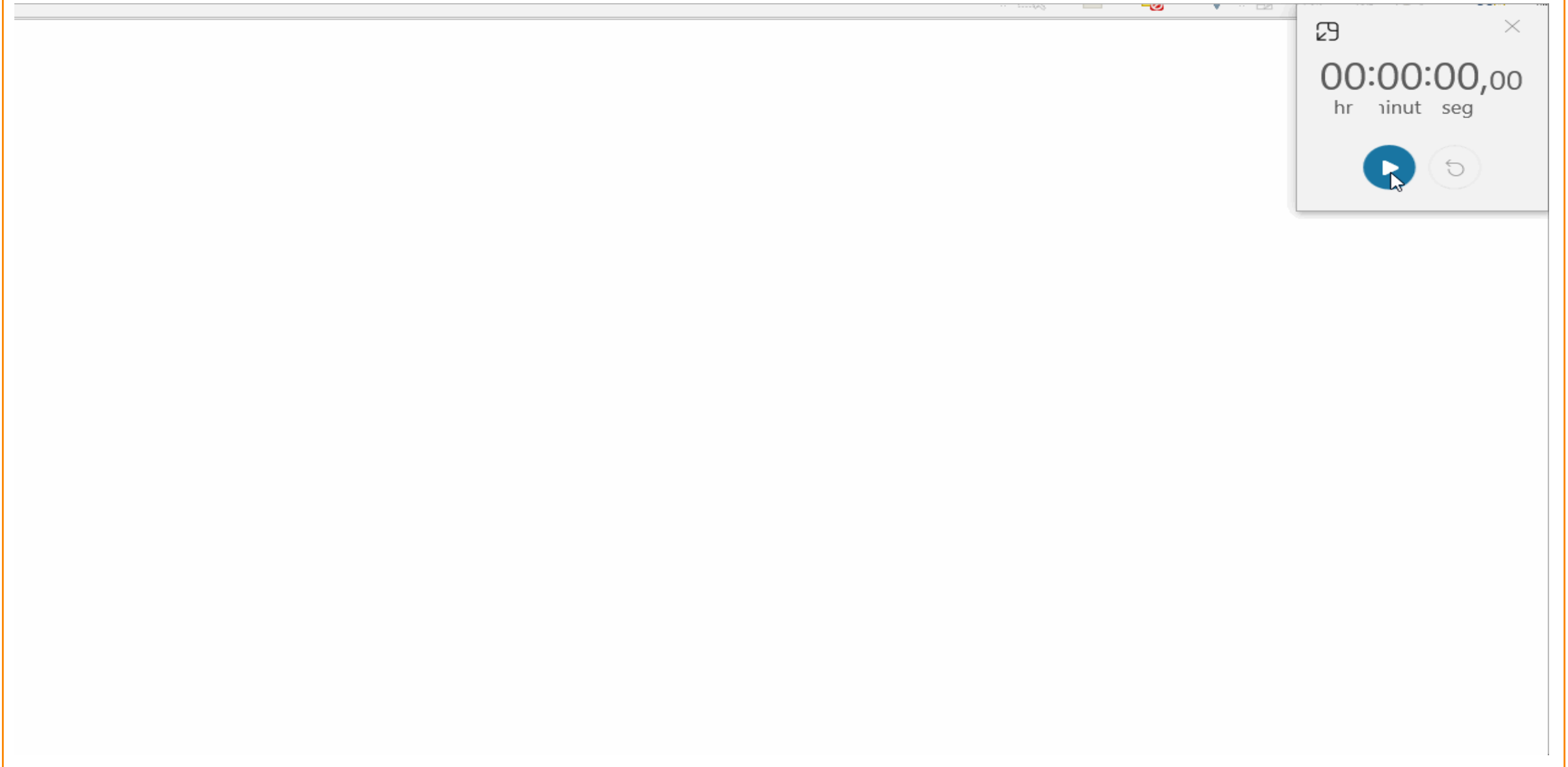


MapSWAT output files

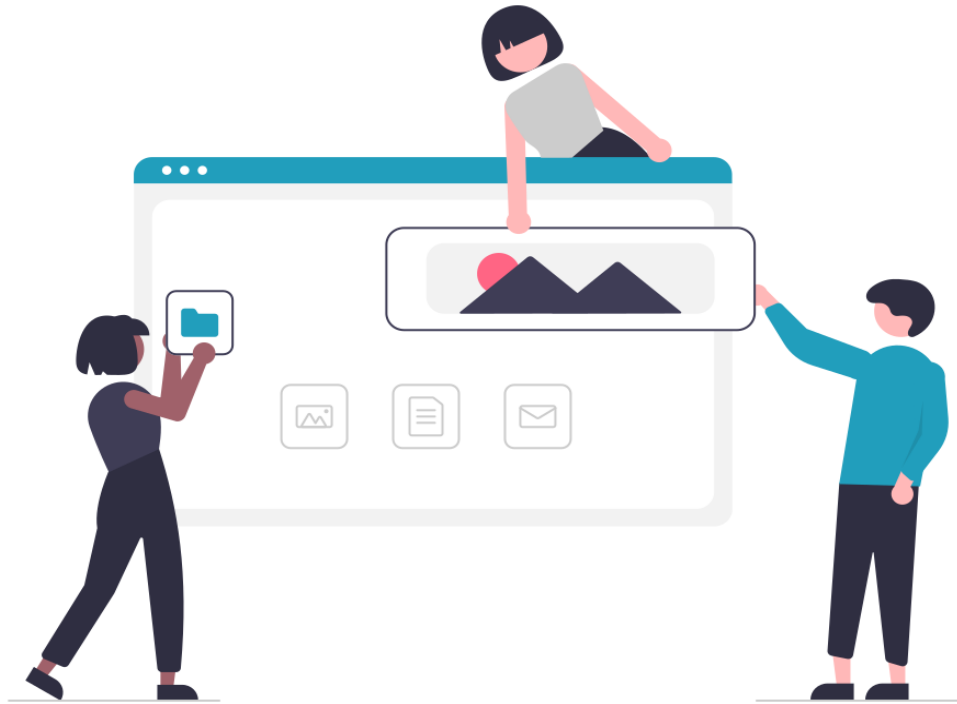
A	B
1	LANDUSE_ID SWAT_CODE
2	20 SHR
3	30 PAST
4	40 AGRL
5	50 URHD
6	80 WATR
7	90 WETL
8	111 FRSE
9	114 FRSD
10	115 FRST
11	116 FRST
12	121 RRGB
13	124 RRGB
14	126 FRST
15	
16	

A	B
1	SOIL_ID SNAM
2	942 DSOLMap_942
3	1374 DSOLMap_1374
4	1410 DSOLMap_1410
5	1413 DSOLMap_1413
6	1449 DSOLMap_1449
7	1845 DSOLMap_1845
8	1874 DSOLMap_1874
9	1877 DSOLMap_1877
10	1881 DSOLMap_1881
11	1884 DSOLMap_1884
12	
13	
14	
15	
16	

MapSWAT application example



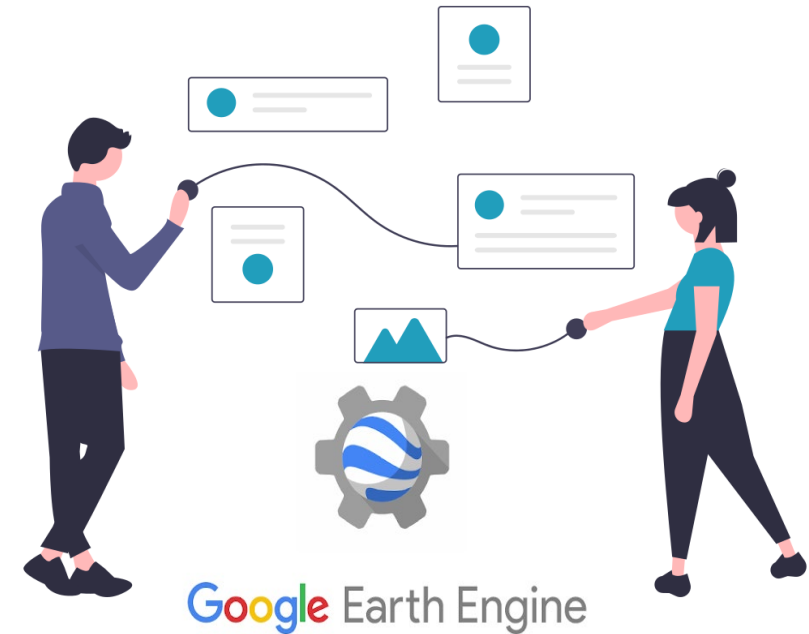
**"We are all good individually , but
together we are better."**



Looking for collaboration

Table 1. Databases included in the Connected to GEE version of MapSWAT.

Data	Name	Spatial resolution	Reference
DEM			
	SRTM Digital Elevation Data 90m	90 m x 90 m	Jarvis et al. (2008)
	NASADEM Digital Elevation 30m	30 m x 30 m	NASA (2020)
	Copernicus DEM GLO-30m	30 m x 30 m	ESA (2022)
LULC			
	Copernicus Global Land Cover 2019	100 m x 100 m	Buchhorn et al. (2020)
	GlobCover: Global Land Cover Map 2009	300 m x 300 m	Bontemps et al. (2013)
	Copernicus CORINE Land Cover 1990, 2000, 2006, 2012 and 2018	100 m x 100 m	EEA (2020)
Soil			
	DSOLMap: Digital Soil Open Land Map	250 m x 250 m	López-Ballesteros et al. (2023b)



Your suggestions and contributions are greatly appreciated.



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alopez6@ucam.edu

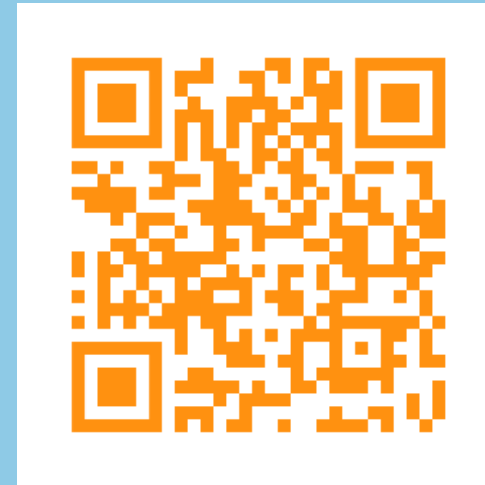


<https://github.com/AdrLBallesteros>



[@AdrLBallesteros](https://twitter.com/AdrLBallesteros)

<https://doi.org/10.1016/j.envsoft.2024.106108>



(Free access until August 01, 2024)

López-Ballesteros, A., Srinivasan, R., & Senent-Aparicio, J. (2024). **Introducing MapSWAT: An open source QGIS plugin integrated with Google Earth Engine for efficiently generating ready-to-use SWAT+ input maps.** *Environmental Modelling & Software*, 106108.



<https://adrlballesteros.github.io/MapSWAT/>

SWAT Community Tools

[MapSWAT](#)

MapSWAT is an open-source QGIS plugin integrated with Google Earth Engine (GEE) that obtains and prepares SWAT+ input maps. It aims to help new or advanced users streamline the setup of their SWAT+ models. MapSWAT makes the preparation of SWAT+ input maps less error-prone, time-consuming and resource-intensive and facilitates model application in any study area worldwide. Additional information and the MapSWAT user manual and executable are available [online](#). View [reference paper](#).

[SWAT-C](#)

SWAT-Carbon is a watershed scale model that converges terrestrial and aquatic carbon cycles at the watershed scale. It is based on the SWAT2012 and has unique functions to assess impacts that agricultural management and climate change have on a wide range of processes and indicators, such as soil organic carbon storage, nitrous oxides emissions, freeze-thaw cycles/water temperature, and riverine carbon fluxes.

[R-SWAT](#)

Free, open source, graphical user interface for SWAT/SWAT+ calibration, parameter sensitivity/uncertainty analysis. For help see the [user group](#) and [tutorial videos](#).

[SWAT+ Toolbox](#)

SWAT+ Toolbox is a user-friendly tool for SWAT+ model adaptations. Get the most recent version from the Additional Tools section of the SWAT+ page.

Weather Tools

[CMhyd](#)

Climate model data for hydrologic modeling

[WGN Parameters Estimation Tool](#)

Microsoft Access tool to store and process daily weather data

[WGN Excel macro](#)

Calculate statistics needed to create weather station files

[SWAT Precipitation Input Preprocessors \(pcpSTAT\)](#)

Calculate statistical parameters of daily precipitation data used by WGN

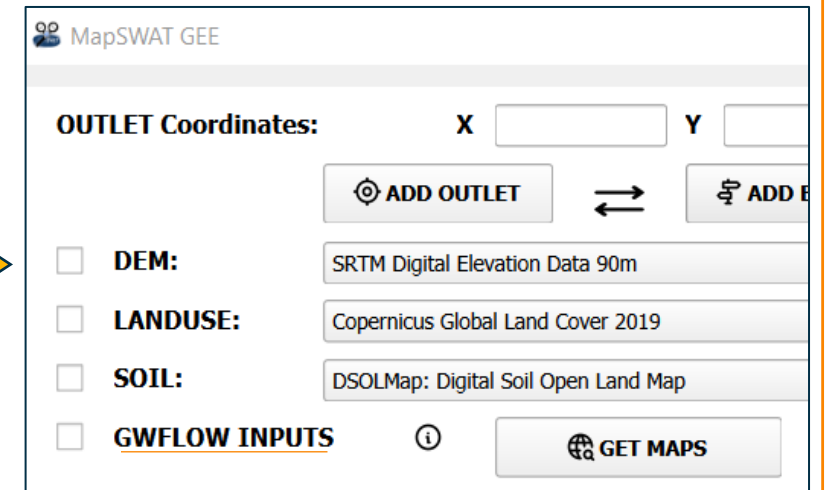
[Dewpoint Estimation](#)

Calculate average daily dewpoint temperature per month

Global Data

Get weather, grid, landuse and soil map data for your SWAT models from our [global data page](#).

- ❑ More DEM, LULC, and SOIL databases.
- ❑ Include global input maps require by GWFLOW.
- ❑ Add a Climate Data Extraction Tool.
- ❑ Upload to the QGIS plugin repository.





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