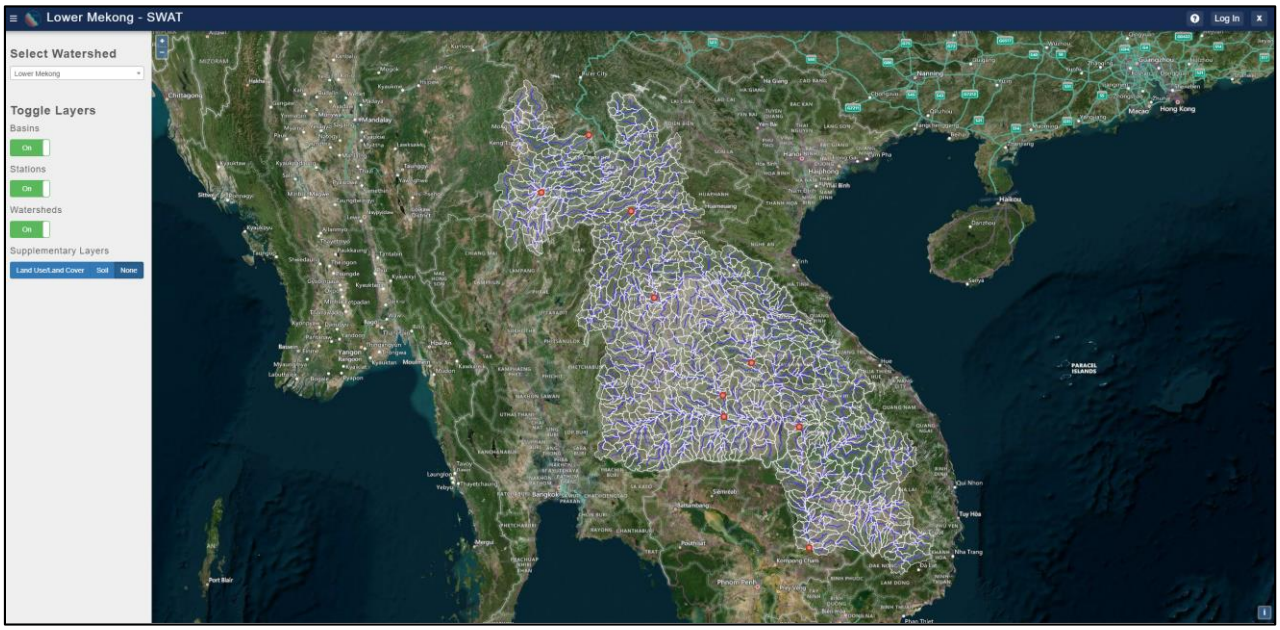
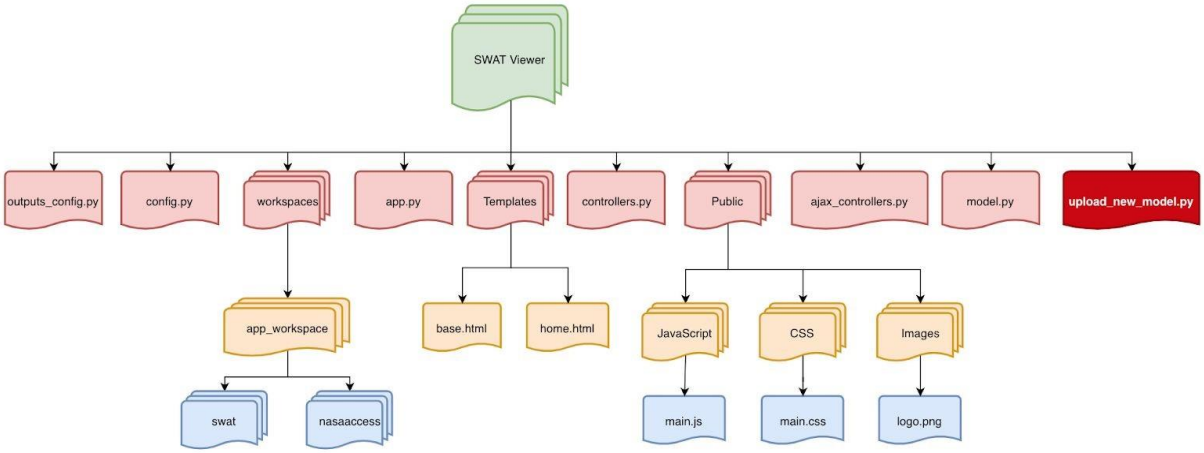
# SWAT Data Viewer - Upload New SWAT Model




## Overview

The SWAT Data Viewer was developed to act as a virtual and open access data store for stakeholders and decision-makers to view and download SWAT model inputs and outputs for their area of interest. The app features various spatial and temporal data visualization interfaces (mainly in the form of maps and time series plots). Unlike many of the SWAT related web applications, this application is completely modular meaning that it can be duplicated, customized and served from any server running the Tethys platform and can display the data from any valid SWAT model.

The modular capabilities of this application are facilitated through the use of web database (PostgreSQL) and map (Geoserver) services. Before the app can visualize and share the data from a SWAT model, the raw temporal (time-series) and spatial (watershed features and land information layers) need to be uploaded to the PostgreSQL database and Geoserver, respectively. Thus, as part of the app code package (shown below), a python script for uploading the data is provided.




This tutorial will explain the process of preparing and uploading a new SWAT model to the app for data visualization.

# Instructions

## 1. Check whether SWAT Data Viewer app is installed properly

a. If you have not already done it, install the SWAT Data Viewer app by following the instructions found in the “SWAT Data Viewer - Installation Guide”

## 2. Check PostgreSQL database and table structure

Before the app is installed, be sure there is a PostgreSQL database(can install from https://www.postgresql.org/download/).

The following sections will outline the various tables in the PostgreSQL database that needs to be created during the SWAT Data Viewer installation process and then used by the app to visualize and process data.

watershed

| Field | Description |
|---|---|
| id | ID number that will be used throughout the other tables to ensure the app knows what data belongs to which watershed |
| name | Name of the watershed/SWAT model<br>This will be the same name used for all files related to the given watershed/model |

output_rch

| Field | Description |
|---|---|
| watershed_id | ID number corresponding the the id field in the “watershed” table |
| year_month_day | The date that the value in the ‘val’ field represents |
| reach_id | ID of the stream reach within the watershed<br>Should match the ‘subbasin’ field in the stream shapefile |
| var_name | Variable name that the value in the ‘val’ field represents |
| val | Data value for a given reach_id, date, and variable combination |

output_sub

| Field | Description |
|---|---|
| watershed_id | ID number corresponding the the id field in the “watershed” table |
| year_month_day | The date that the value in the ‘val’ field represents |
| sub_id | ID of the subbasin within the watershed<br>Should match the ‘subbasin’ field in the Subbasin shapefile |
| var_name | Variable name that the value in the ‘val’ field represents |
| val | Data value for a given subbasin_id, date, and variable combination |

watershed_info

| Field | Description |
|---|---|
| watershed_id | ID number corresponding the the id field in the “watershed” table |
| rch_start | First date that rch data is available for a given watershed (obtained from output_rch table) |
| rch_end | Last date that rch data is available for a given watershed (obtained from output_rch table) |
| rch_vars | Available rch variables for a given watershed (obtained from output_rch table) |

| | |
|---|---|
| sub_start | First date that sub data is available for a given watershed (obtained from output_sub table) |
| sub_end | Last date that sub data is available for a given watershed (obtained from output_sub table) |
| sub_vars | Available sub variables for a given watershed (obtained from output_sub table) |
| lulc | Was there a lulc map provided for the given watershed? ('Yes'/'No') |
| soil | Was there a soil map provided for the given watershed? ('Yes'/'No') |
| stations | Was there a gauge stations shapefile provided for the given watershed? ('Yes'/'No') |
| rch | Was there an output.rch file provided for the given watershed? ('Yes'/'No') |
| sub | Was there an output.sub file provided for the given watershed? ('Yes'/'No') |
| nasaaccess | Was there a DEM file provided for the given watershed to use for nasaaccess processing? ('Yes'/'No') |

lulc

| **Field** | **Description** |
|---|---|
| watershed_id | ID number corresponding the the id field in the "watershed" table |
| value | Unique value in the lulc TIFF file that corresponds to a land use/land cover type |
| lulc | Four character classification of the lulc type (i.e. RICE, WATR) |
| lulc_class | lulc class name (i.e. forest) |
| lulc_subclass | Lulc subclass name (i.e. 'evergreen' and 'deciduous' would be subclasses of the 'forest' class) |
| class_color | Color that the app will use to display a given lulc class' coverage percentage in a pie chart |

| | |
|---|---|
| subclass_color | Color that the app will use to display a given lulc subclass' coverage percentage in a pie chart and that will correspond to the display of the lulc map (This color on the pie chart should match the color on the map) |

soil

| Field | Description |
|---|---|
| watershed_id | ID number corresponding the the id field in the "watershed" table |
| value | Unique value in the soil TIFF file that corresponds to a land use/land cover type |
| soil_class | Soil class name |
| class_color | Color that the app will use to display a given lulc class' coverage percentage in a pie chart and that will correspond to the display of the soil map (This color on the pie chart should match the color on the map) |

stream_connect

| Field | Description |
|---|---|
| watershed_id | ID number corresponding the the id field in the "watershed" table |
| stream_id | ID of a stream in the stream shapefile |
| to_node | ID of the stream downstream of the given stream_id |

# 3. Prepare SWAT inputs/outputs for upload

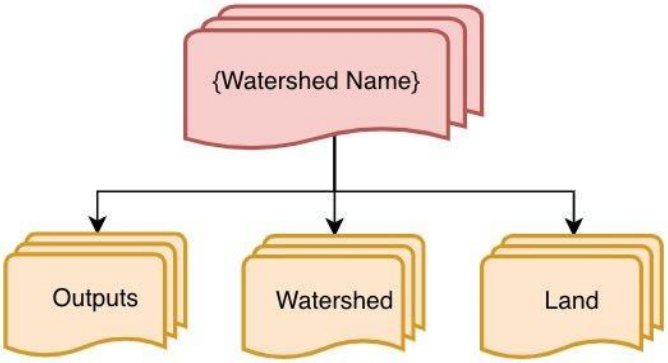
For the SWAT Data Viewer application to function fully, there needs to be at least one SWAT model available for the app to view. All of the data/files that the app uses will be located in one of four locations: (1) File on the server, (2) PostgreSQL database, (3) Geoserver, and (4) the app's workspace (app_workspace folder in the app package). The sections below describes the various files/data that the app is able to process, where they needs to be located, and whether the file is required for the app to run.

## Data file structure

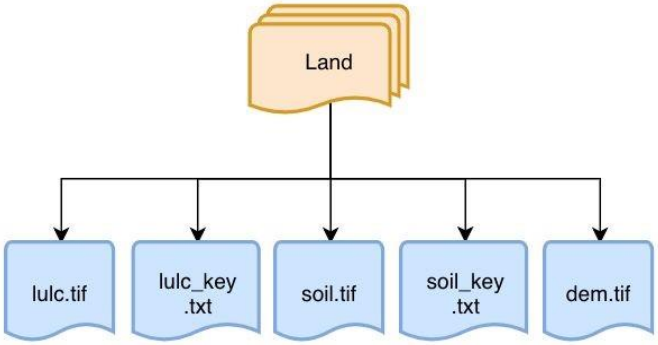
The data will need to be organized in the following file structure for the upload_new_model.py functions to work properly.

## Top Level

a. Create a new folder that will contain all of the data and name it the same name that you want to show in the app
b. Create 3 subfolders in the <watershed_name> folder and name them “Land”, “Outputs”, and “Watershed”




## Land folder




| Data/File | Description | Locations | Req’d? |
|---|---|---|---|
| Land use/Land cover (lulc) map with lookup table | TIFF file containing lulc information over the watershed<br><br>Comma delimited .txt file containing lulc classes (i.e agriculture), subclasses (i.e. rice crops), and hexidecimal color codes for each value in the lulc TIFF file | Geoserver<br><br>PostgreSQL<br><br>File on server | No |
| Soil map with lookup table | TIFF file containing soil information over the watershed<br><br>Comma delimited .txt file contatining soil type names and a hexidecimal color code for each value in the soil TIFF file | Geoserver<br><br>PostgreSQL<br><br>File on server | No |

| | | | |
|---|---|---|---|
| DEM | TIFF file containing elevation data over the watershed to be used when users want to run nasaaccess functions from the SWAT data viewer | File on server<br><br>PostgreSQL | No |

*lulc_key.txt* lulc_key.txt is a comma-delimited lookup table that the app will use to compute and display coverage statistics for the SWAT model's land use/land cover map. The information in this file will be uploaded to the PostgreSQL database.

| Value | Landuse | lulc_class | lulc_subclass | class_color | subclass_color |
|---|---|---|---|---|---|
| Integer code used in lulc.tif pixels | 4-char class code used by SWAT | lulc class name (i.e. forest) | lulc subclass name (i.e. deciduous forest) | Hex color code for lulc_class | Hex color code for lulc_subclass |

```
Value,Landuse,lulc_class,lulc_subclass,class_color,subclass_color
10,WATR,water,water,#0055ff,#0055ff
15,SWRN,barren,barren - rock outcrops,#91522f,#91522f
16,URBN,urban,urban,#ff0000,#ff0000
21,RICE,agriculture,rice - 1 crop/year,#ff7070,#ffadad
22,RISU,agriculture,rice - 2 crops/year,#ff7070,#ff54f0
23,SUGC,agriculture,mixed annual crops - other than rice,#ff7070,#ffe100
24,RNGE,agriculture,shifting cultivation - cleared before 2010-herbaceous cover,#ff7070,#ffae00
25,HAY,agriculture,shifting cultivation - cleared in 2010,#ff7070,#912f08
26,HAY,agriculture,shifting cultivation - partially cleared in 2010,#ff7070,#593200
31,RNGB,forest,deciduous shrubland broadleaved,#1a8e16,#ed6600
32,FRSD,forest,deciduous broadleaved,#1a8e16,#a0d89e
33,FRST,forest,deciduous/evergreen,#1a8e16,#269924
34,FRSE,forest,evergreen broadleaved,#1a8e16,#013d00
35,FRST,forest,evergreen/deciduous broadleaved,#1a8e16,#026801
36,RNGB,forest,bamboo scrub/forest mostly evergreen,#1a8e16,#99ff00
41,RNGE,grassland,grassland - sparse vegetation,#969696,#969696
42,FRST,forest,industrial forest plantation,#1a8e16,#8300db
43,WETF,wetland,shrubland/herbaceous riparian areas,#0092ed,#0092ed
127,NONE,NoData,NoData,#000000,#000000
```

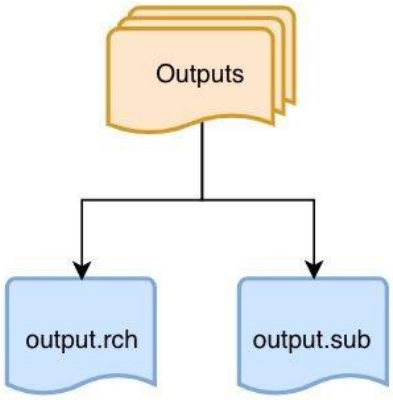
Note: Be sure to include any NoData values in the list.

*soil_key.txt* soil_key.txt is a comma-delimited lookup table that the app will use to compute and display coverage statistics for the SWAT model's soil map. The information in this file will be uploaded to the PostgreSQL database.

| Value | Name | Color |
|---|---|---|
| Integer code used in soil.tif pixels | Soil type name | Hex color code for the given soil type |

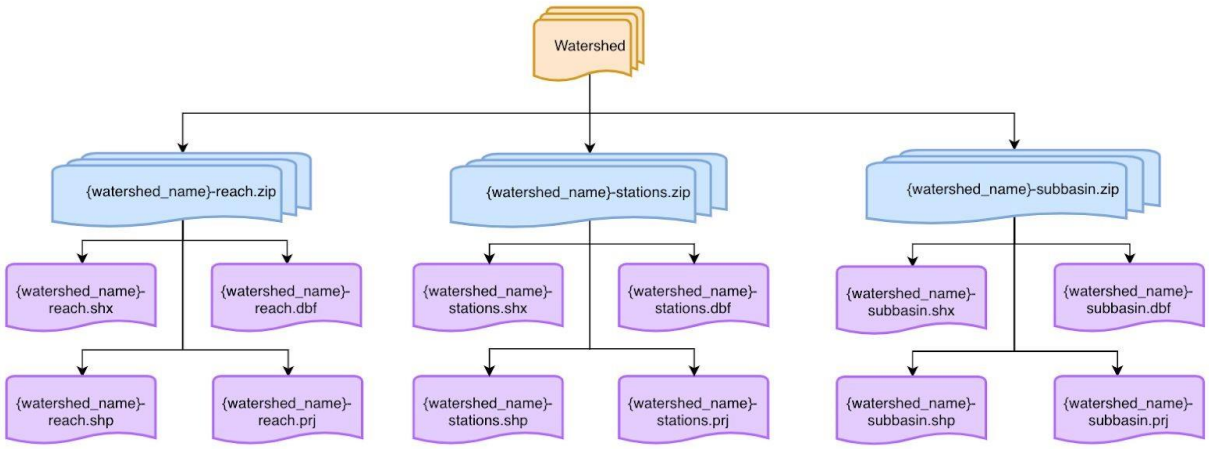
```
Value,Name,color
4260,AfAfBfAoQlA,#fff500
4261,AfAfApGdAg,#ff3d0c
4264,AgLgAoSgGdAp,#5788f2
4265,AgAgLgBfAfWdGd,#ff7200
4267,AoNdAflBf,#671dbc
4284,AoAolBdAh,#23a274
4325,GeGmJeGh,#ff8e8e
4383,ILcBk,#c5ff7a
4393,JeGeGm,#f4d03f
4408,LgLoGeJeAg,#79dbff
4414,NhNhAoGAp,#eb984e
4452,AfAfAoAg,#0c65ff
4464,AoNdAfVcAg,#b23399
4486,FalFAf,#af9a2f
4491,FoFhGAf,#aa2e4b
4494,FrFoVNdl,#6f48a5
4499,GdJeGmGh,#4fb7cc
4502,GeJeGm,#cc894b
4544,NdBdVclE,#772d3b
4587,VpVclGF87,#e2b7bf
4588,VpVclGF88,#d5d800
11375,CMd,#424c68
```

## Outputs folder



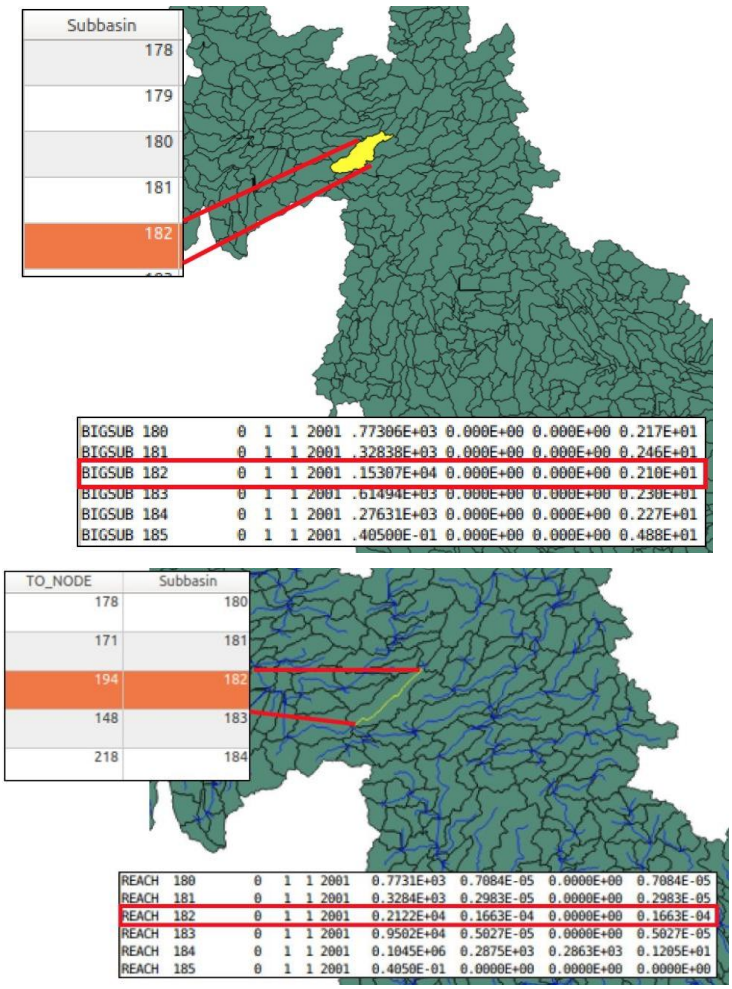

| Data/File | Description | Locations | Req'd? |
|---|---|---|---|
| output.rch and output.sub | Daily SWAT model output files with IDs that correspond to the "subbasin" fields in the stream and subbasin shapefiles | PostgreSQL | At least one of them |

## Watershed folder




| Data/File | Description | Locations | Req'd? |
|---|---|---|---|
| Stream Shapefile (.zip file containing .shp, .shx, .dbf, and .prj files) | Polyline shapefile containing stream reach information.<br><br>Required attribute fields: "subbasin", "TO_NODE" | Geoserver<br><br>PostgreSQL | Yes |
| Subbasin Shapefile (.zip file containing .shp, .shx, .dbf, and .prj files) | Polygon shapefile containing subbasin information<br><br>Required attribute fields: "subbasin" | Geoserver | Yes |
| Gauge stations Shapefile (.zip file containing .shp, .shx, .dbf, and .prj files) | Point shapefile containing gauge station information | Geoserver<br><br>PostgreSQL | No |

i. The attribute table for the both the subbasin and reach shapefiles need to have a field called "subbasin" that has a value that correspond with each other. ii. The attribute table for the reach shapefile needs to have a field called "TO_NODE" that identifies the subbasin id of the next downstream reach




## 4. Copy data over to the app's hosting server/computer

If you prepared the data elsewhere, copy the entire data folder to the app's hosting server/computer.

Some of the data (the Land folder) will need to remain saved on that machine even after being uploaded to the geoserver/database and will need to be located in the "swat_data" folder. It's recommended to put the data directly in that folder from the beginning to avoid confusion.

## 5. Update input arguments in upload_new_model.py

The upload_new_model.py file contains 9 separate functions that are called based on data availability. The first function called (check_available_files()) opens the data folder, makes sure all required data is present and then lists all of the available data in the folder. The other functions will only be called if the data file it corresponds to is in the data folder.

This logic is executed through the following python code.

```
if new_watershed(db, watershed_name) == 0:
    available_files = check_available_files(watershed_name, data_path)
    if available_files != 1:
        upload_swat_outputs(db, os.path.join(data_path, 'Outputs'), watershed_name, sub_vars, rch_vars)
        upload_shapefiles(geoserver, os.path.join(data_path, 'Watershed'))
        upload_stream_connect(db, os.path.join(data_path, 'Watershed'), watershed_name)
        upload_tiffiles(geoserver, os.path.join(data_path, 'Land'), watershed_name)
        if 'lulc_key.txt' in available_files['Land']:
            upload_lulc_key(db, os.path.join(data_path, 'Land'), watershed_name)
        if 'soil_key.txt' in available_files['Land']:
            upload_soil_key(db, os.path.join(data_path, 'Land'), watershed_name)
        watershed_info(watershed_name, available_files, sub_vars, rch_vars)
    print('SUCCESS: Upload Complete!')
```

Before executing the upload_new_model.py script, there are a number of input parameters that need to be changed in the file.

a. Change watershed_name to the match the name of the data folder (the name you want the app to display for the watershed model)
    i. **This name should have no spaces and should be all lowercase**. Use '_' instead of spaces. The app will convert this to Title case with spaces when displaying it.
b. Specify the file path to the data folder (to the top level folder)
    i. If the folder is structured correctly according to step 4, the functions will know how to access all the necessary files
c. Specify the output.sub variables that you want to upload to the database
    i. The sub_column_list contains all of the variable codes in the output.sub file
    ii. Be sure that the variables you list here match the codes in sub_column_list
    iii. If you're not uploading any output.sub data, you can leave this blank (i.e. sub_vars = '')
d. Specify the output.rch variables that you want to upload to the database
    i. The rch_column_list contains all of the variable codes in the output.rch file
    ii. Be sure that the variables you list here match the codes in rch_column_list
    iii. If you're not uploading any output.rch data, you can leave this blank (i.e. rch_vars = '')
e. Make sure the db object contains the correct information for connecting to the app's PostgreSQL database
f. Make sure the geoserver object contains the correct information for connecting to the app's geoserver

## 6. Run upload_new_model.py

a. Open the terminal for the server/computer containing the SWAT Data Viewer app package and data folder
b. Navigate to the app package folder containing the upload_new_model.py script
c. Activate the 'tethys' conda environment
d. Run the script

```
python upload_new_model.py
```

## 7. Delete data files from server

If space is limited on your server/computer, you can delete most of the data files after the script has completed.

a. The only files that need to remain on the server are:
    i. lulc.tif
    ii. soil.tif
    iii. dem.tif
b. If you haven't done so already, move the data folder to the swat_data folder so that the app can find the TIFF files for further processing