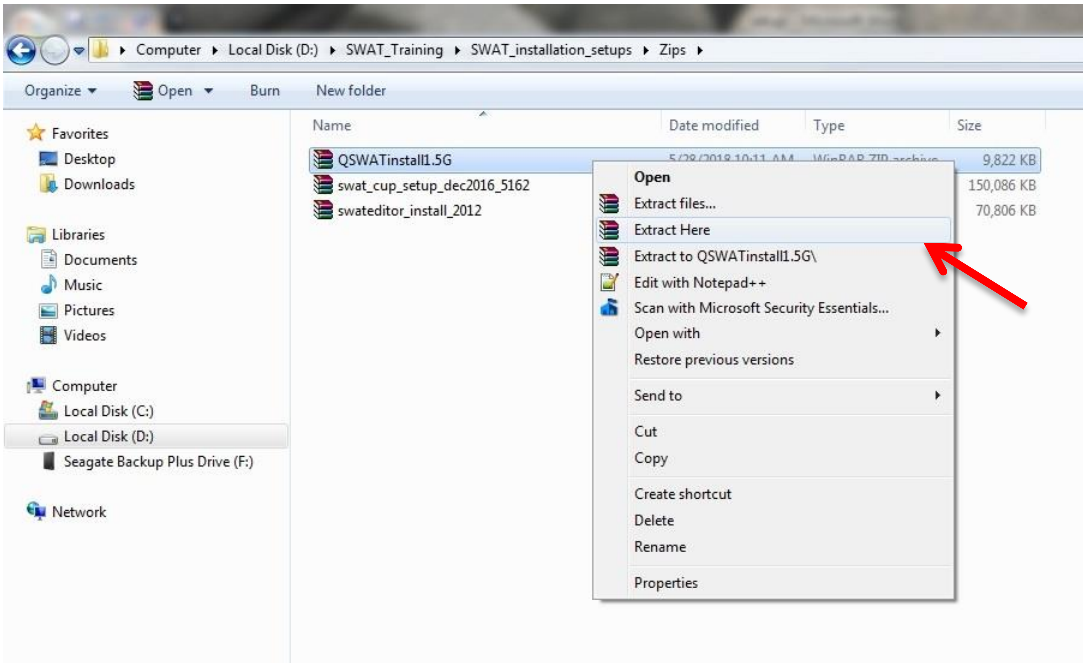
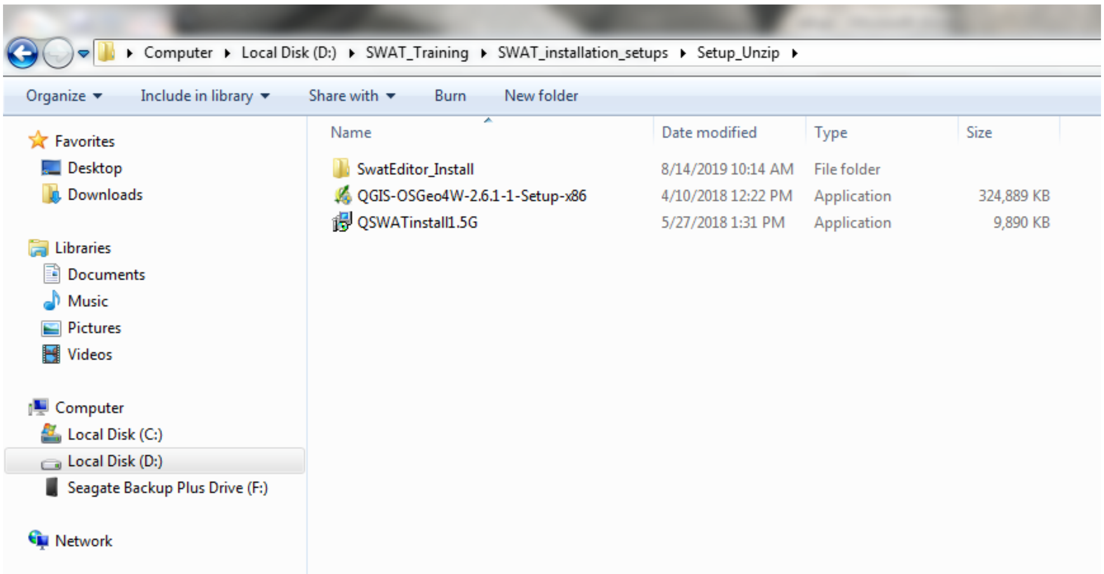
# SURFACE RUNOFF MODELING USING "QSWAT"

## INSTALLATION OF SOFTWARES

1. Unzip the files ***QSWATInstall1.5G, swateditor_install_2012***.

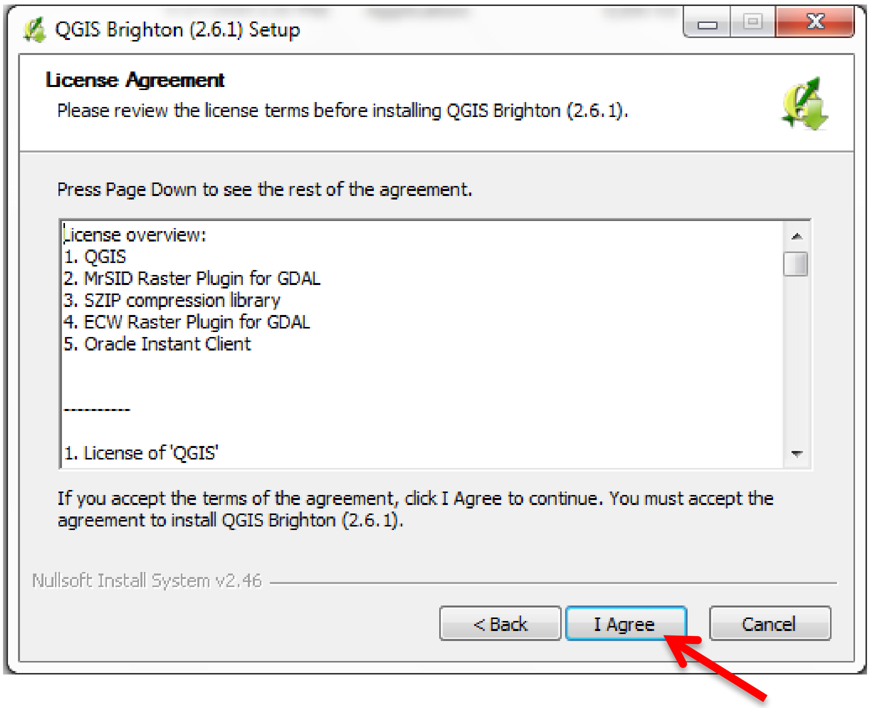


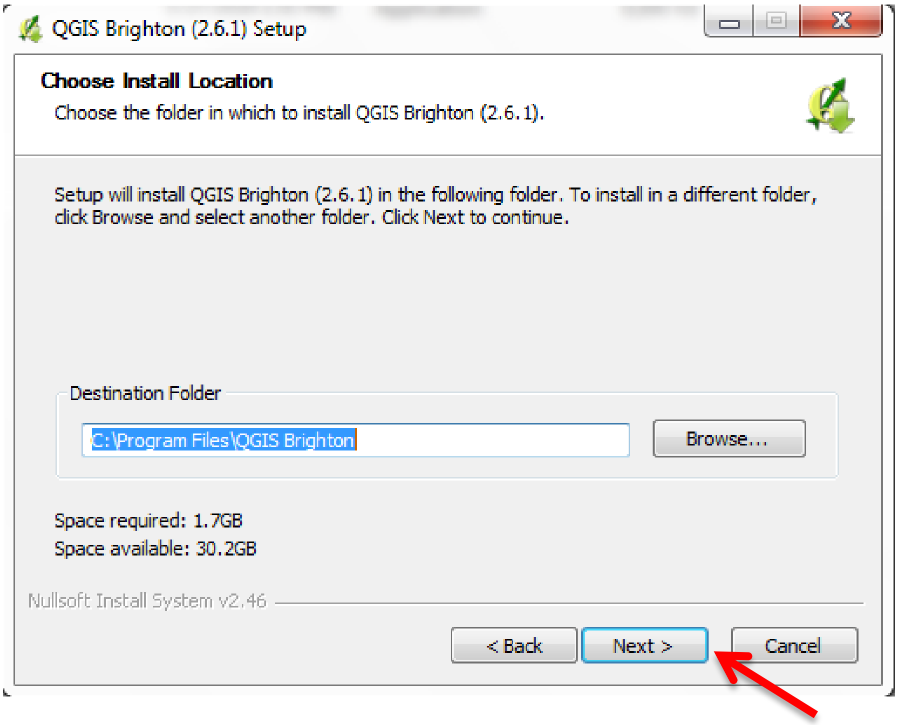

2. Move the unzipped files to ***Setup_Unzip*** folder.



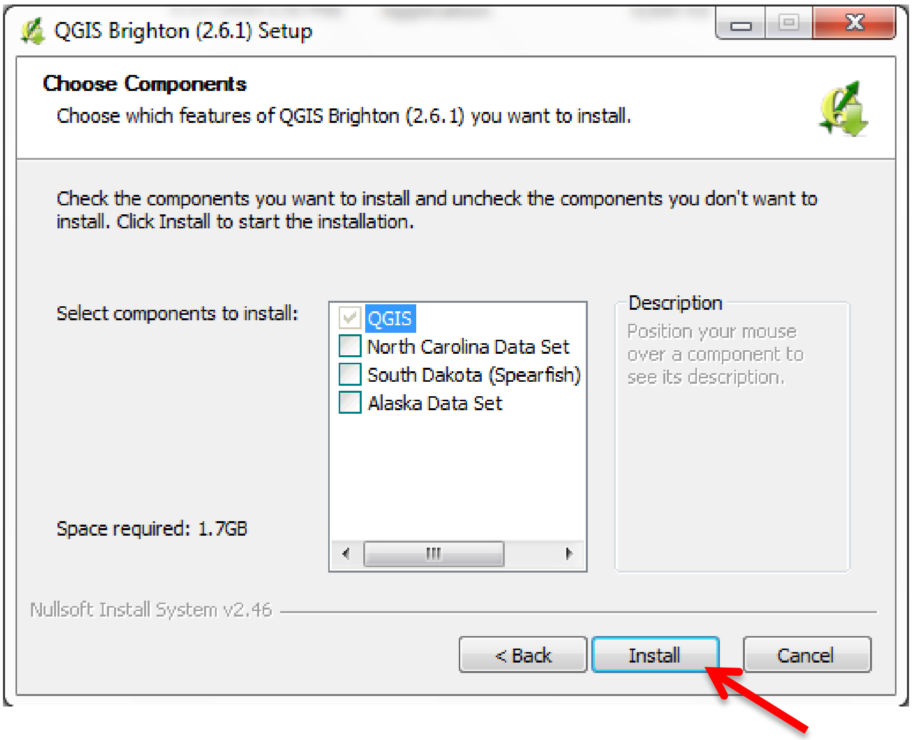
3. Run ***QGIS-OSGeo4W-2.6.1-1-Setup-x86.exe*** from ***Setup_Unzip*** folder and click ***Yes*** on the popup dialog box. Setup dialog box appears. Click ***Next***.


4. Click ***I Agree*** button.



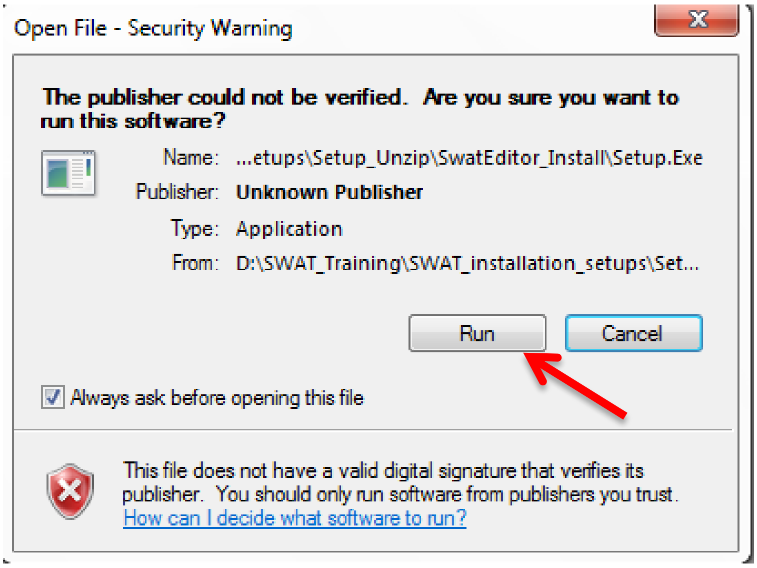



5. Click ***Install.***

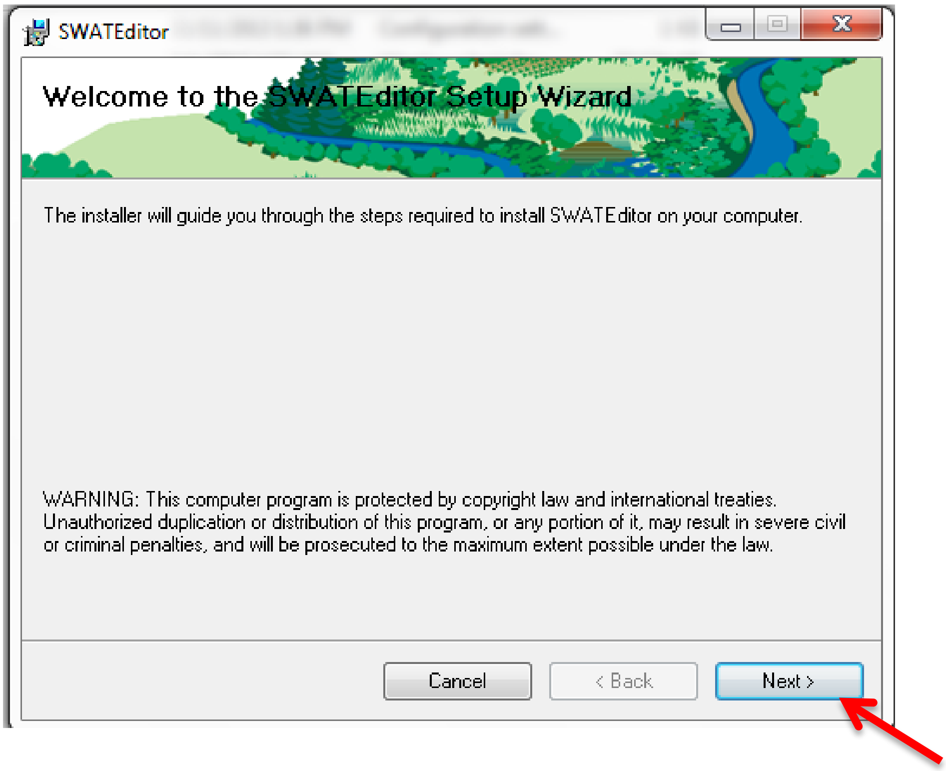


6. Installation of QGIS starts and once completed Click ***Finish.*** This reboots the system.

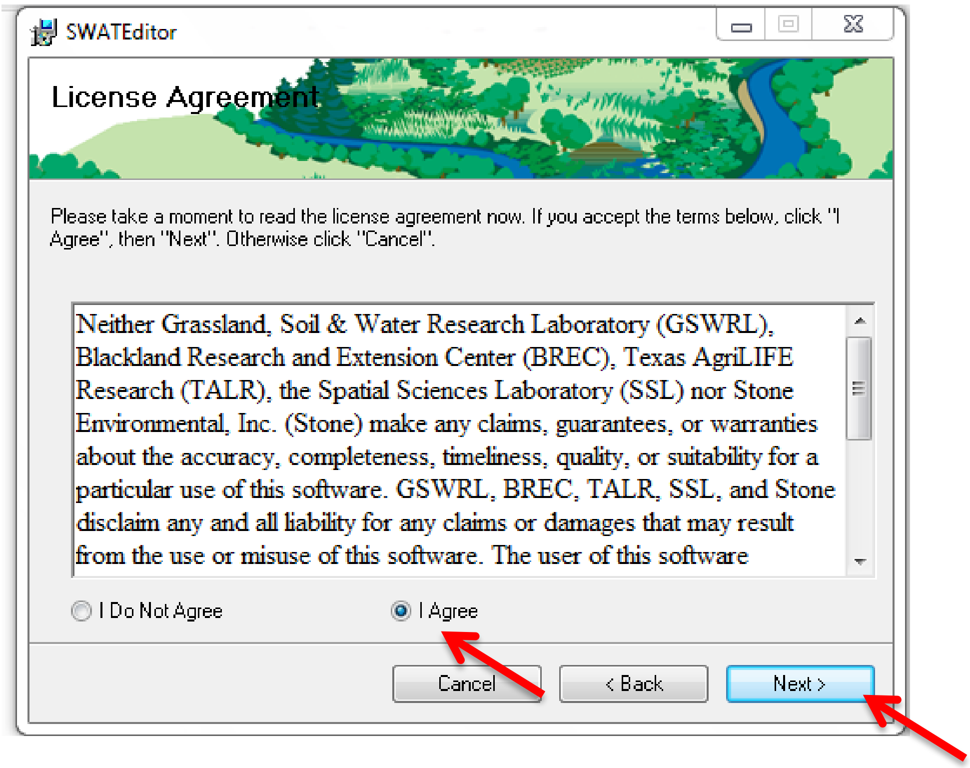

7. Run ***Setup.Exe*** in the ***SwatEditor_Install*** Folder. Click ***Run***.



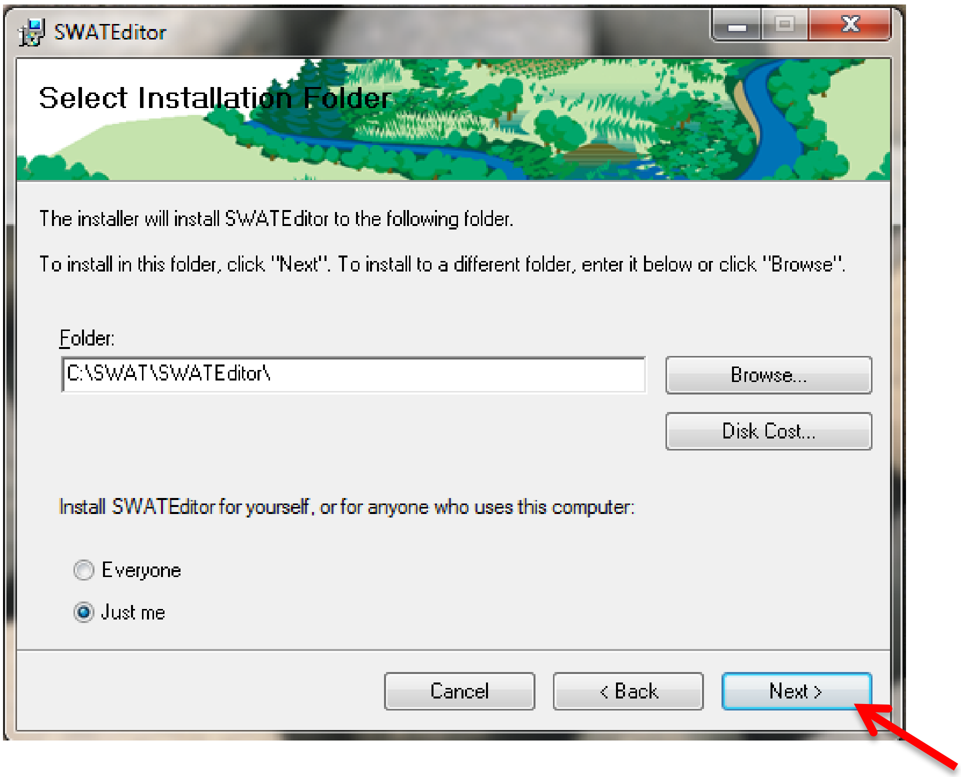
8. Click ***Next***.

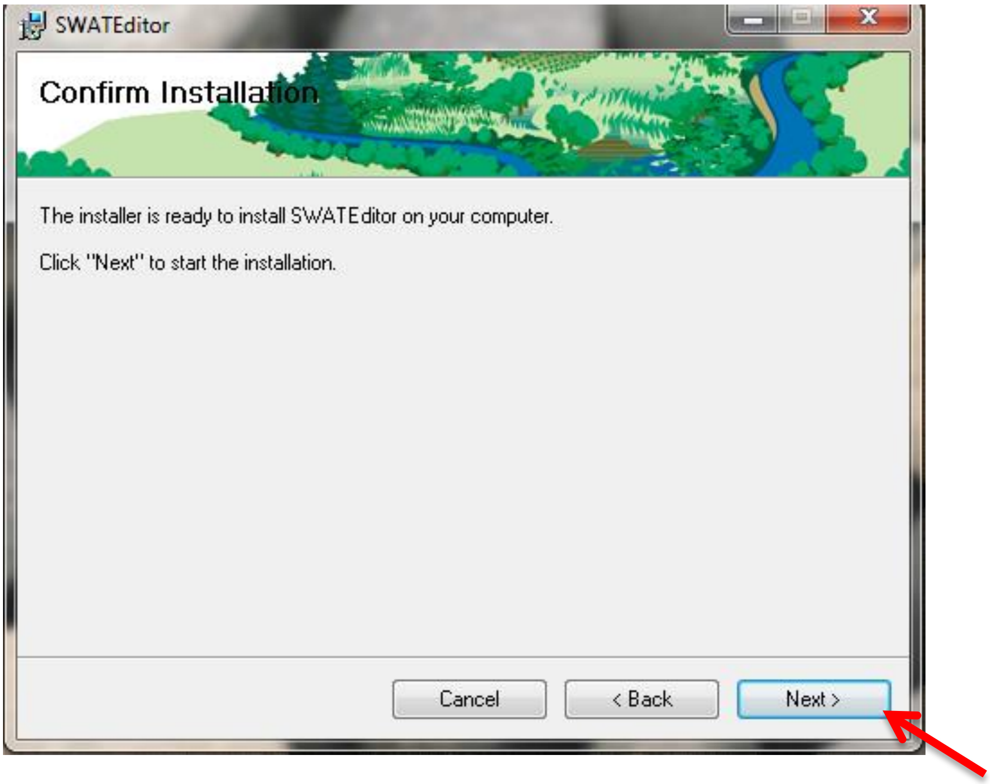



9. Click on ***I Agree*** radio button and click ***Next***.

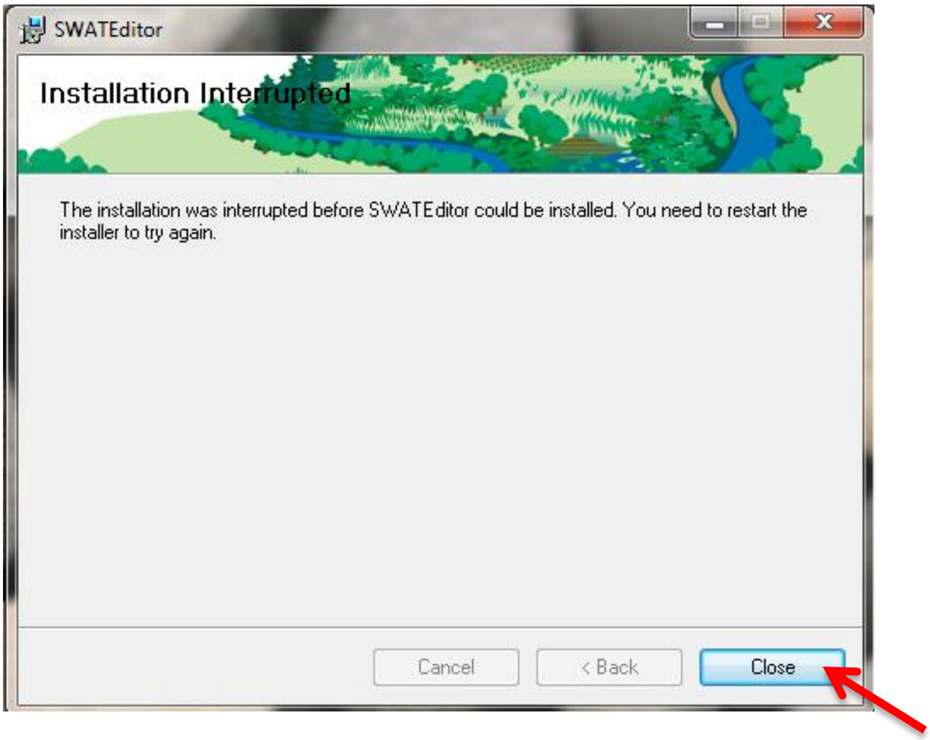


10. Click ***Next***.

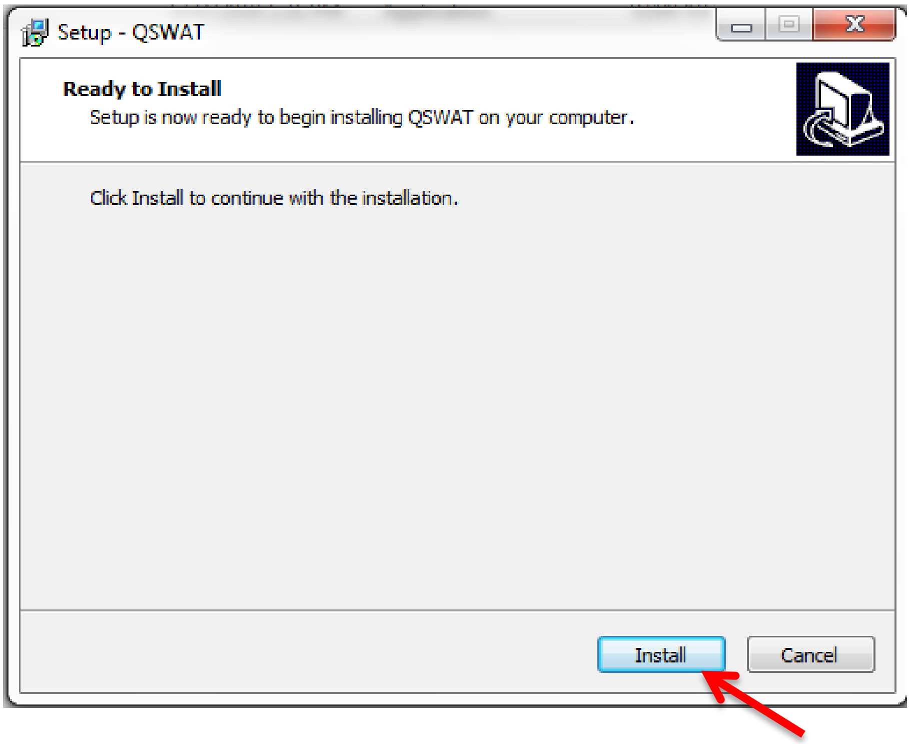


11. Click ***Close***.




12. Run ***QSWATinstall1.5G.exe*** in the ***Setup_Unzip*** Folder. Click ***Install***.



13. Click ***Finish***.

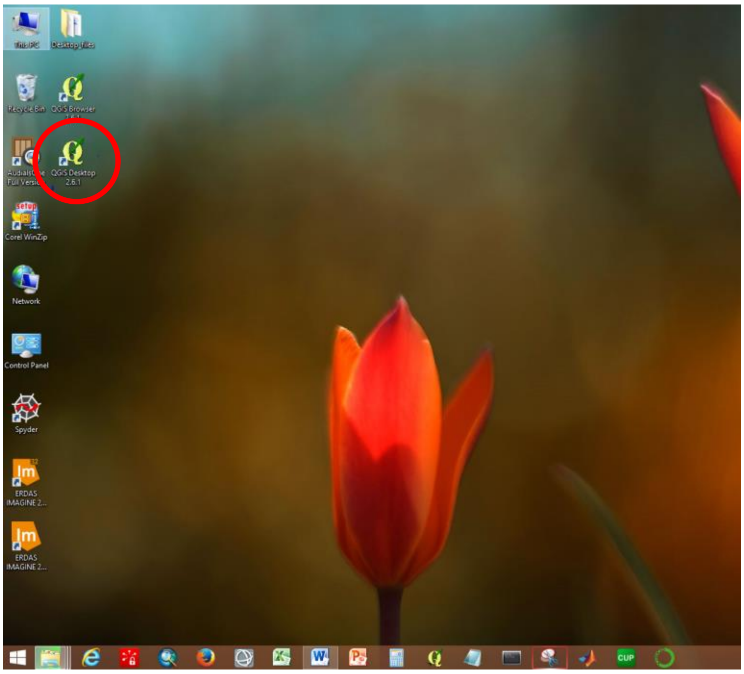
# OVERVIEW OF SOIL AND WATER ASSESSMENT TOOL (SWAT):

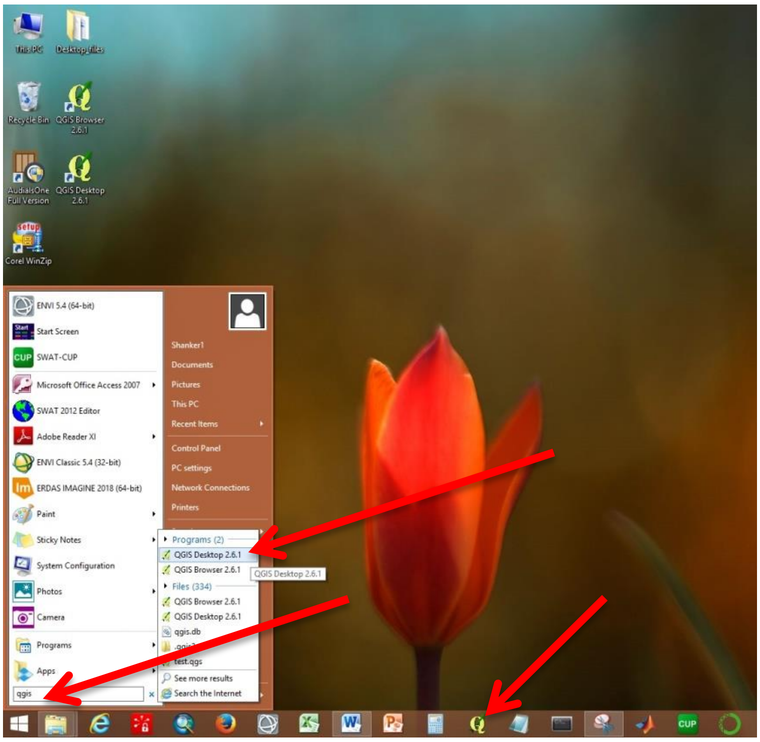
The Soil and Water Assessment Tool (SWAT) is a physically- based continuous-event model developed to predict the impact of land management practices on water, sediment, and agricultural chemical yields in large, complex watersheds with varying soil, land use and management conditions over long periods of time. For simulations, a watershed is subdivided into a number of homogenous sub basins (hydrologic response units or HRUs) having unique soil and use properties. The input information for each subbasin is grouped into categories of weather; unique areas of land cover, soil, and management within the subbasin; ponds/reservoirs; groundwater; and the main channel or reach, draining the subbasin. The loading and movement of runoff, sediment, nutrient and pesticide loadings to the main channel in each subbasin is simulated considering the effect of several physical processes that influence the hydrology. For a detailed description of the capabilities of the SWAT, refer to Soil and Water Assessment Tool User's Manual, Version 2000 (Neitsch et al.., 2002), published by the Agricultural Research Service and the Texas Agriculturall Experiment Station, Temple , Texas. The manual can also be downloaded from the SWAT Web site (www.brc,tamus.edu/swat/swatdoc.htm#new)

The Following are the key procedures necessary for modeling using SWAT.

- Create SWAT project
    - Delineate the designated watershed for modeling
    - Define landuse, soil, slope data grids
    - Determine the distribution of HRUs based on the landuse and soil data
    - Define rainfall, temperature and other weather data.
    - Write the SWAT input files – requires access to data on soil, weather, land cover, plant growth, fertilizer and pesticide use, tillage and urban activities.
    - Edit the input files – if necessary
- Setup and run SWAT
- View SWAT Output

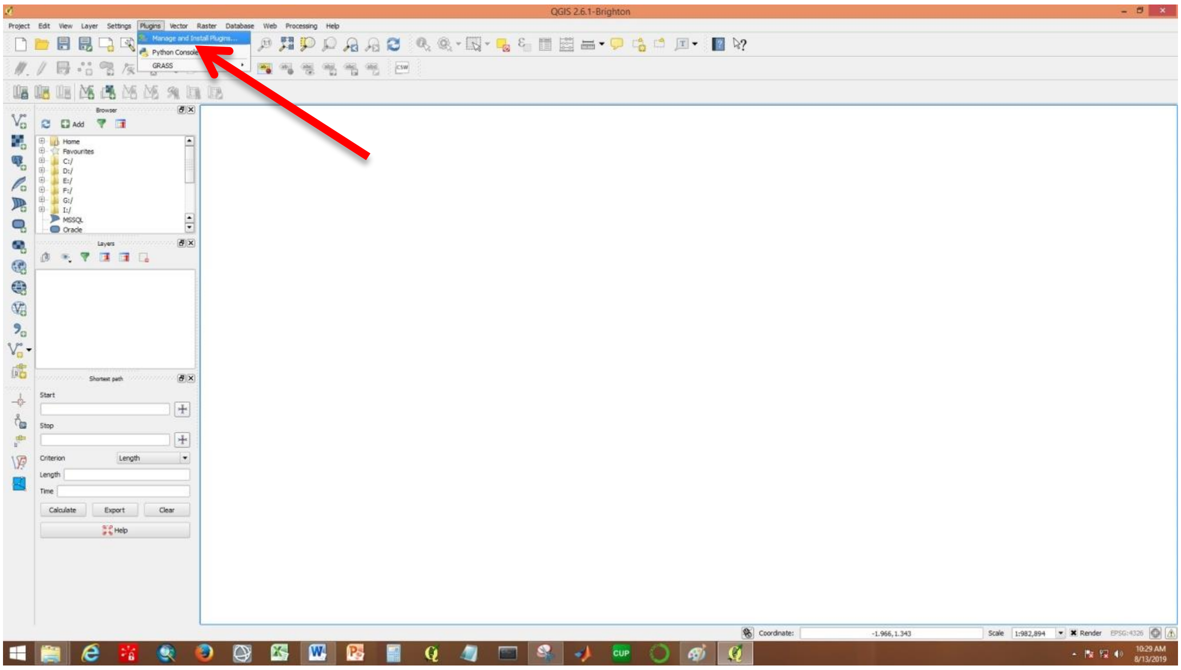
1. Open ***QGIS Desktop 2.6.1*** from the PC's desktop **or** Go to start and search "QGIS" and click on ***QGIS Desktop 2.6.1*** **or** Click on the QGIS icon from the taskbar.





2. ***QGIS Desktop 2.6.1*** opens.

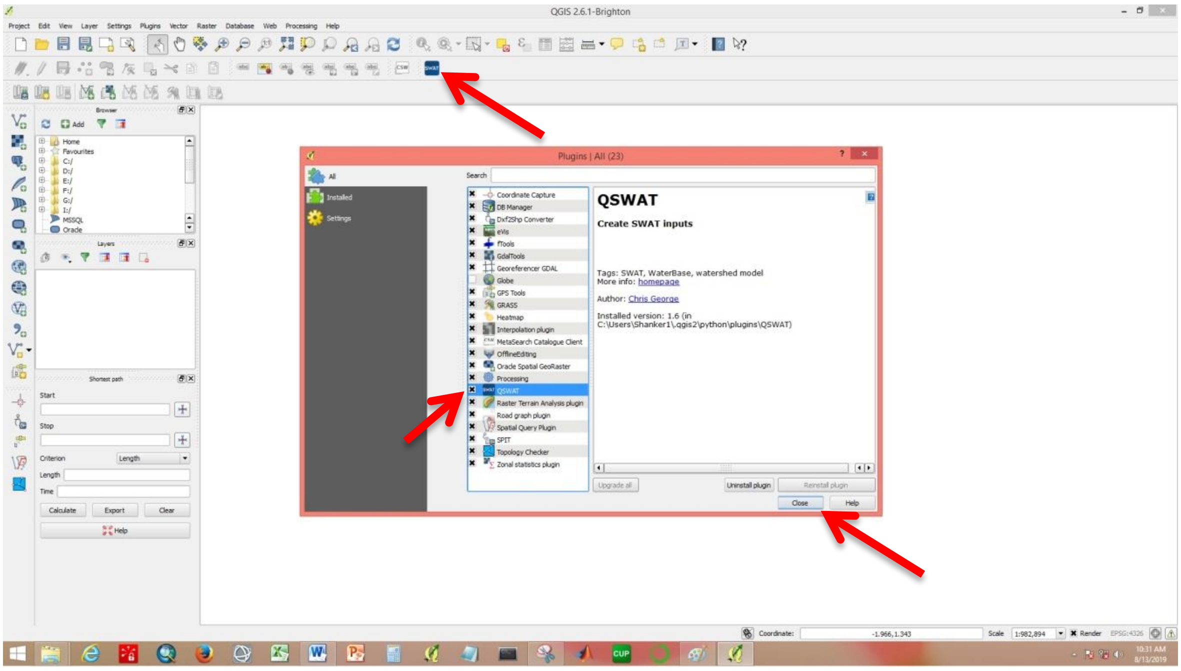
3. Click on ***plugin*** in the QGIS taskbar and then click on ***manage and install plugins***




4. ***Plugins*** dialog box appears.

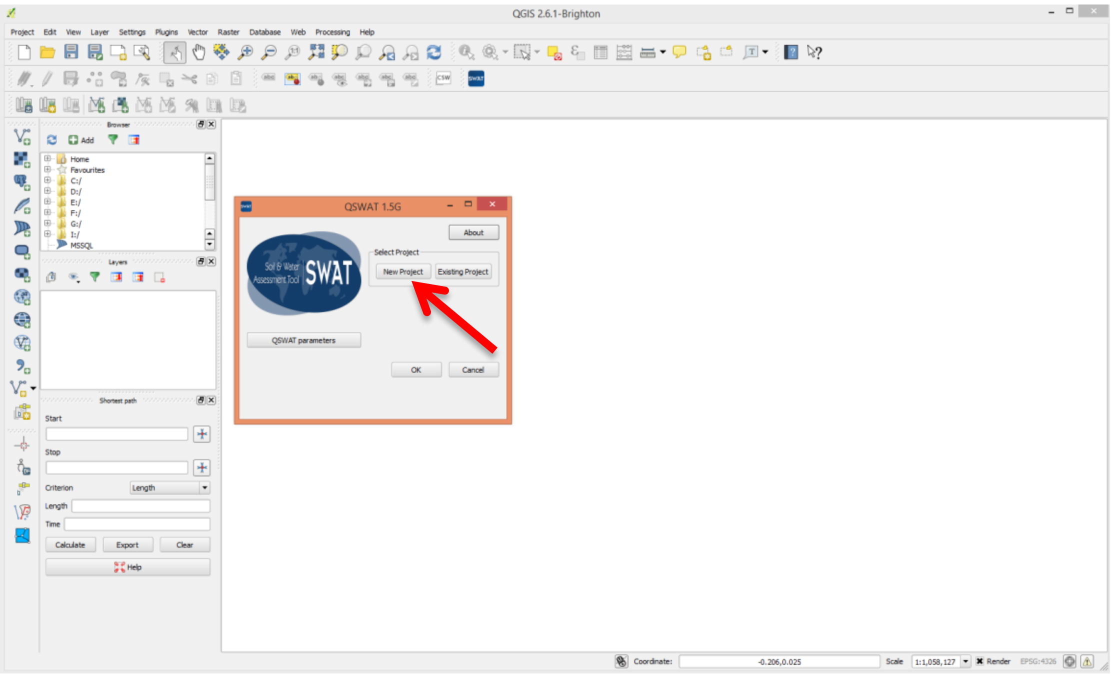
5. Check the ***QSWAT icon*** and ***close*** the dialog box.

6. ***QSWAT tool*** icon appears on the toolbar.

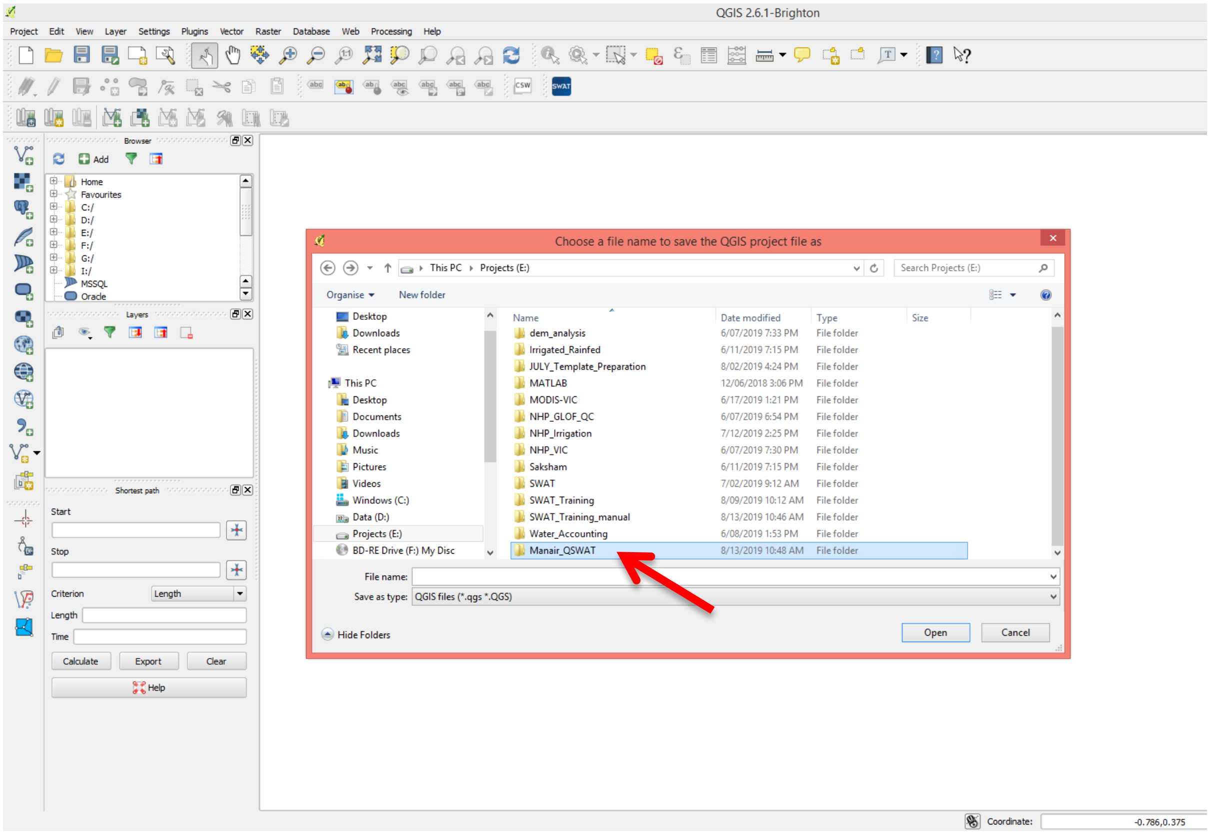


7. Click on the **QSWAT tool** in the tool bar to open QSWAT and ***QSWAT 1.5G*** dialog box appears.

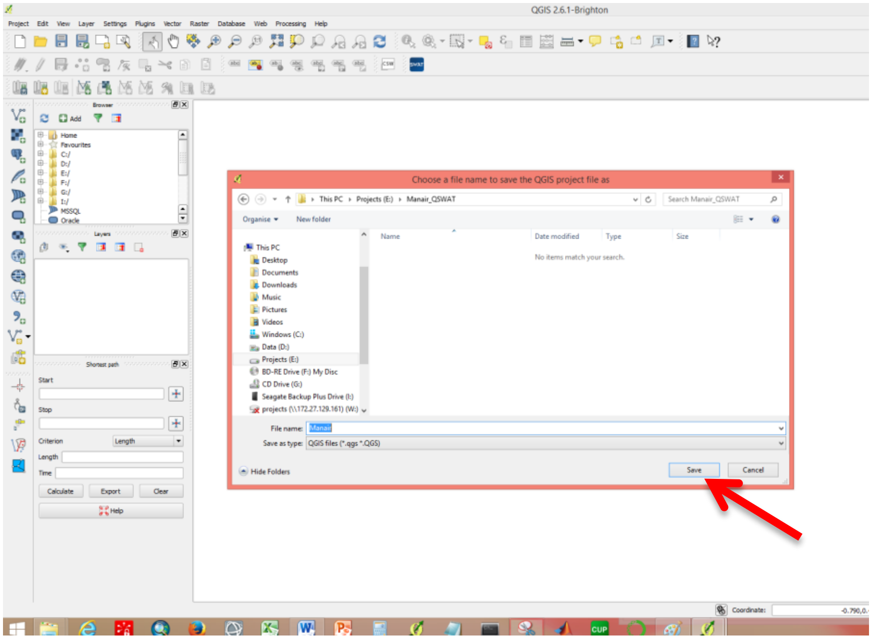
8. Click on the **New Project** button to create a Project.



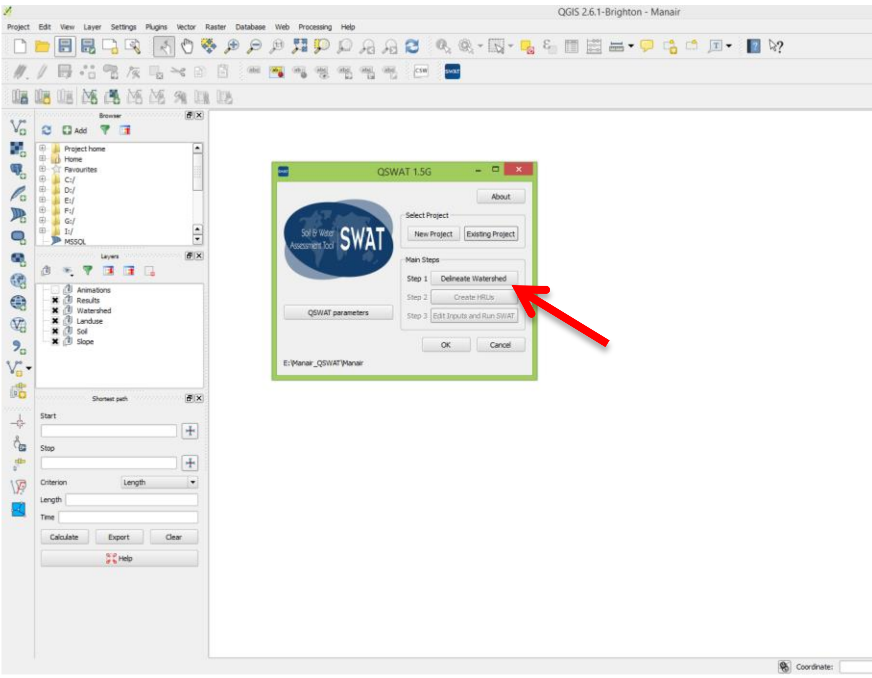
9. Create a folder named “Manair_QSWAT”



10. Save the file name as ***Manair.*** QSWAT 1.5G dialog box appears again. This creates a new project.

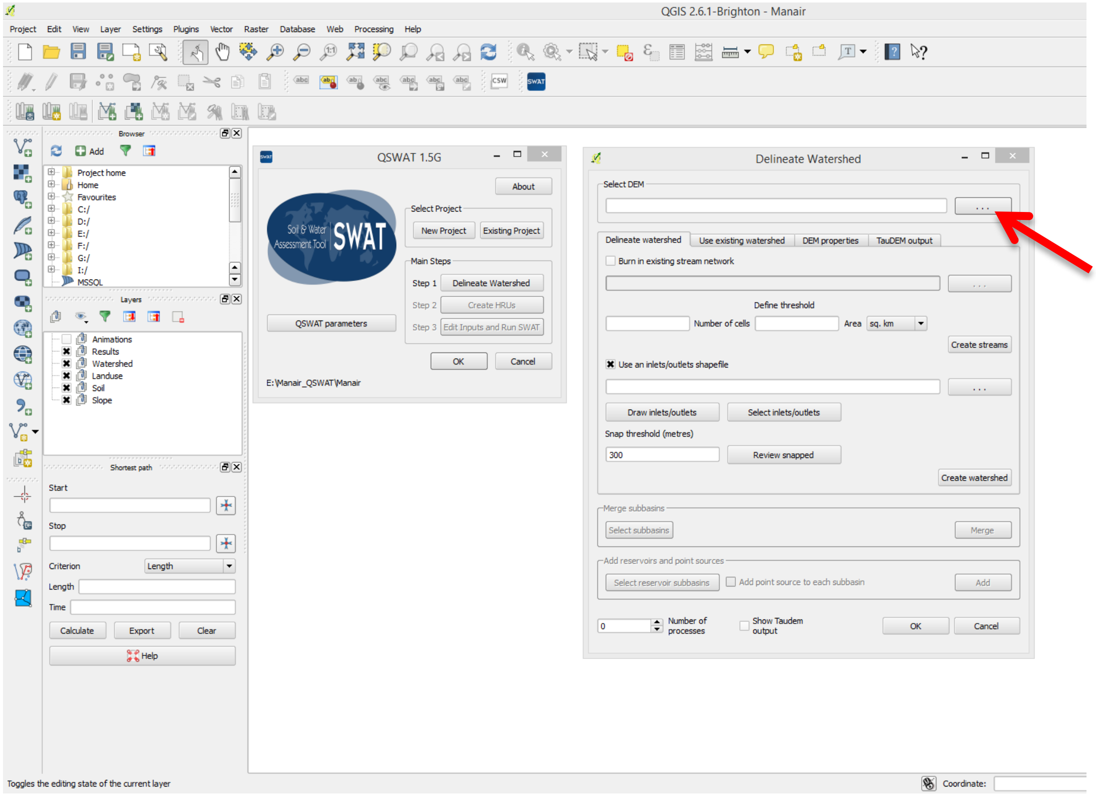



11. The First step is the delineation of watershed. The watershed delineation tool's functions are divided into sections, namely; Select DEM, Stream Threshold Definition for creating streams, Outlet/Inlet Selection/Definition, Watershed Outlet(s) Selection/Definition. Click on delineate watershed button in the QSWAT 1.5G dialog box.

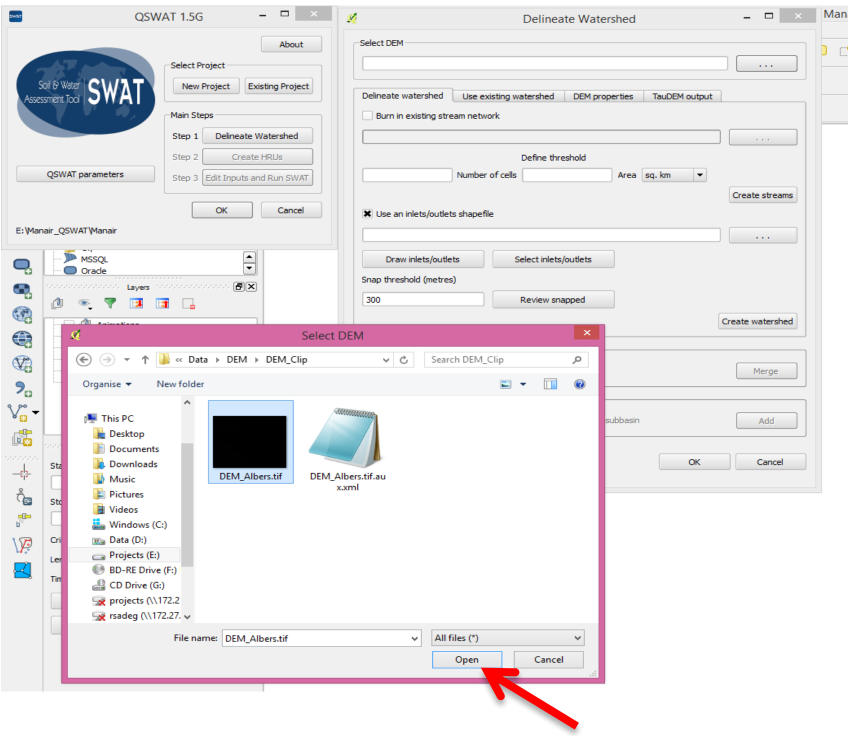



Note: Before proceeding to this step, ensure that all your three principal datasets (DEM, landuse, Soil ) are in projected (Cartesian) coordinate system, preferably in an EQUAL AREA PROJECTION for better accuracy in the extraction of watershed parameters. IMPORTANT: The data should not be in Geographic Coordinates System (Decimal Degrees).

12. Delineate watershed dialog box appears. Click on the ***icon*** in Select DEM.

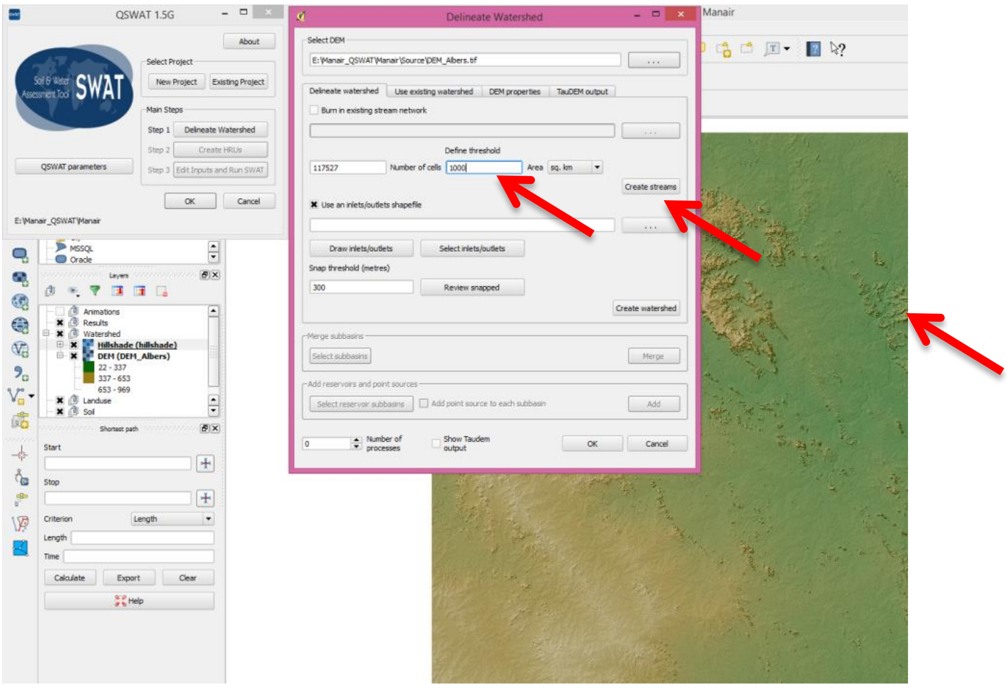



13. Open ***DEM_Albers.tif*** from the following path, SWAT_Training > Data > DEM > DEM_Clip

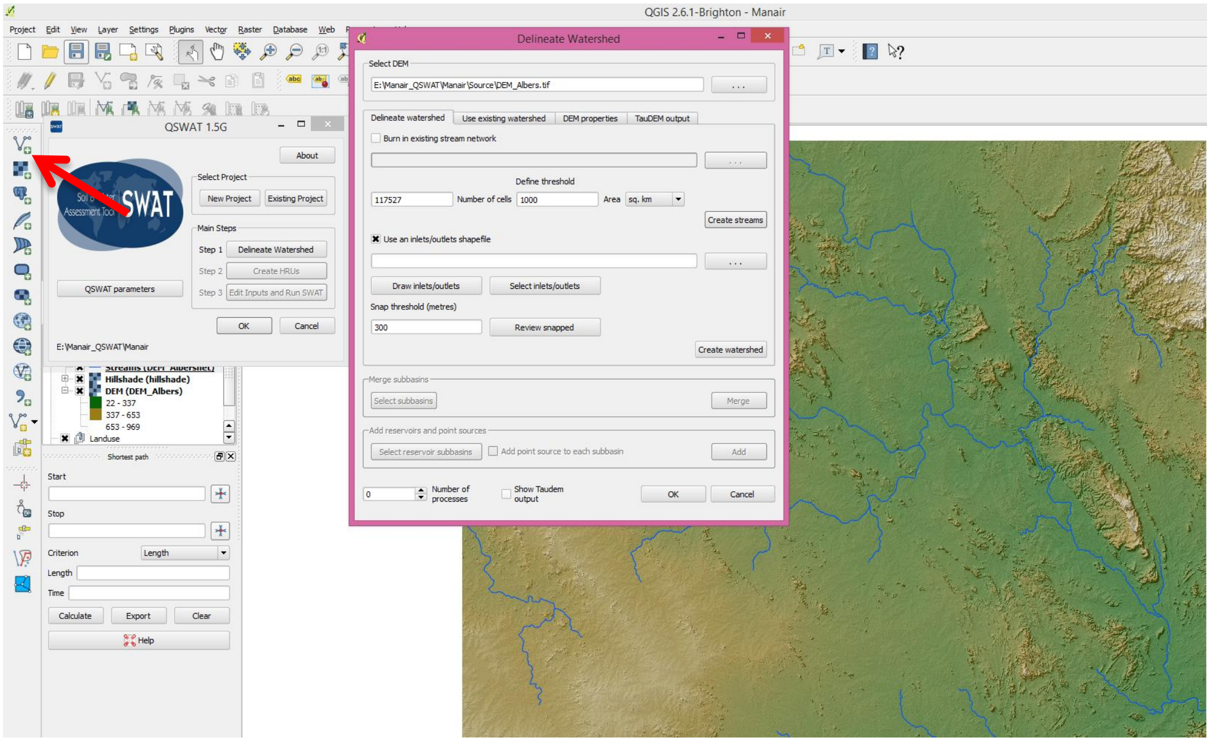


14. DEM loads at the background.

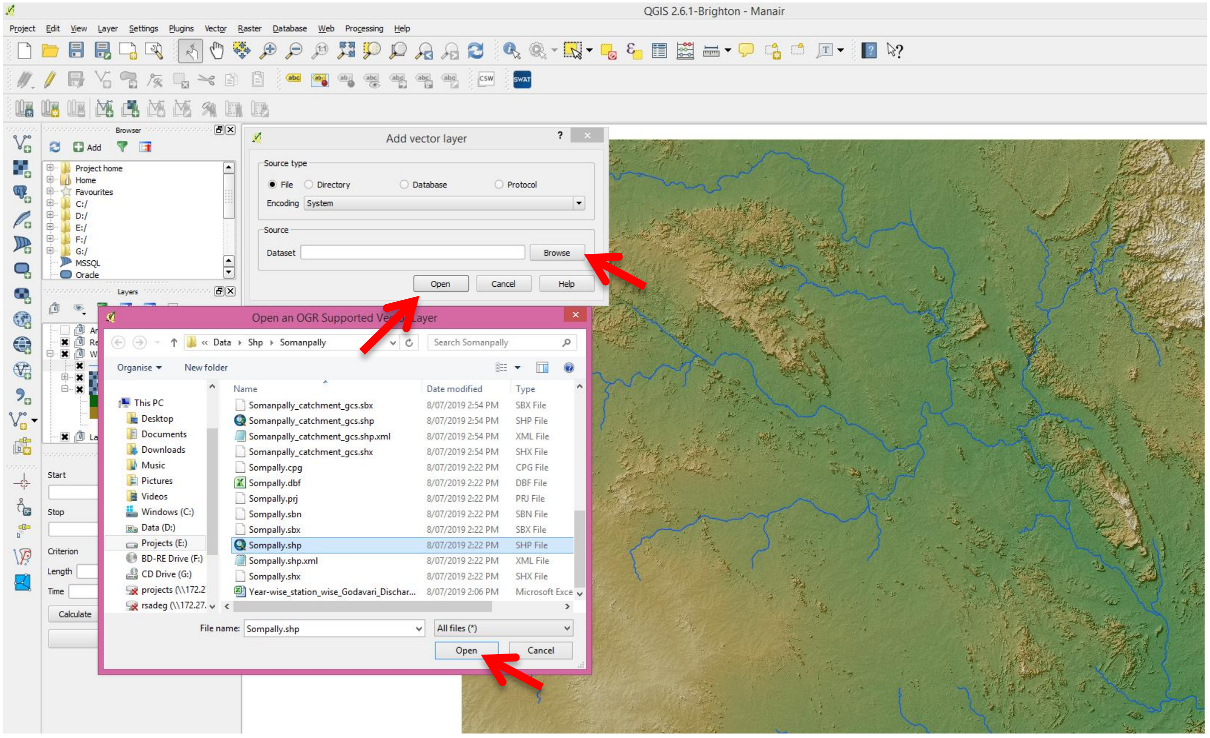
15. Change the ***Area*** in Define threshold to ***1000 sq.km*** and click on ***Create streams*** button. This creates the stream based on the threshold value provided. Click **OK** on ***MPI error dialog box***.




16. The Streams are created and click on the “V” icon from the toolbox to load a vector data.

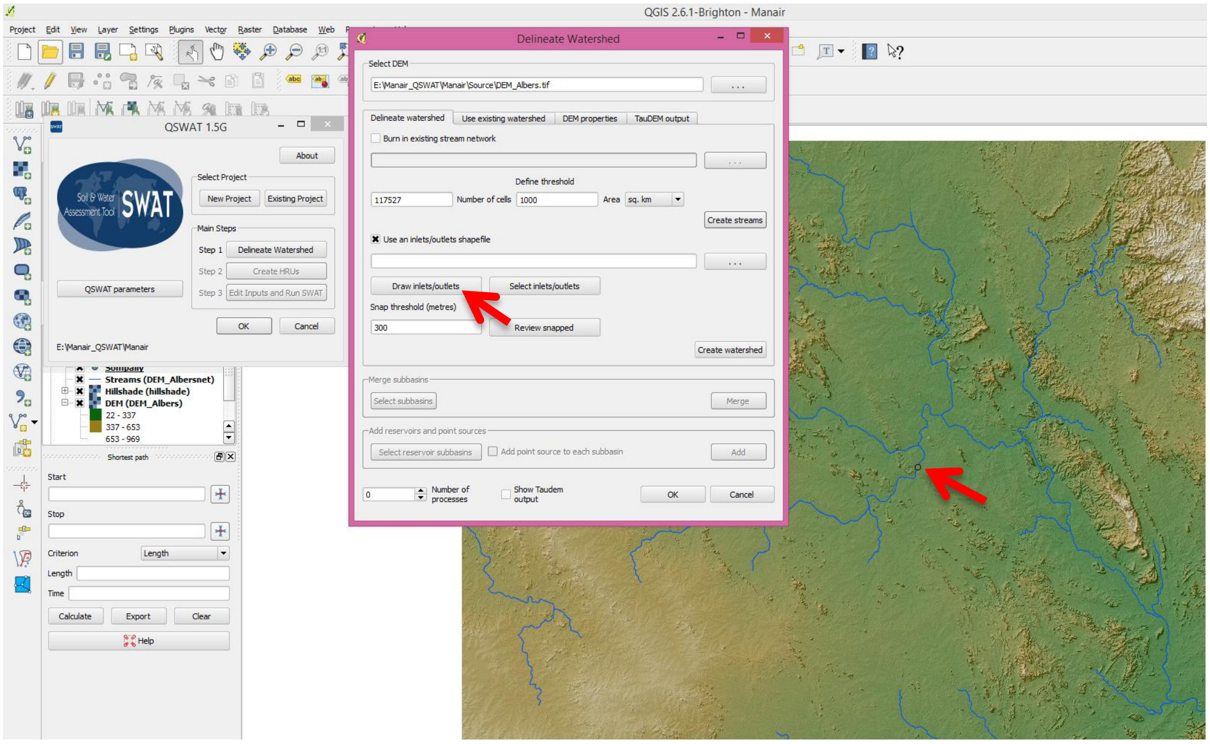


17. Open ***Somanpally.shp*** from the following path SWAT_Training > Data > Shp > Somanpally

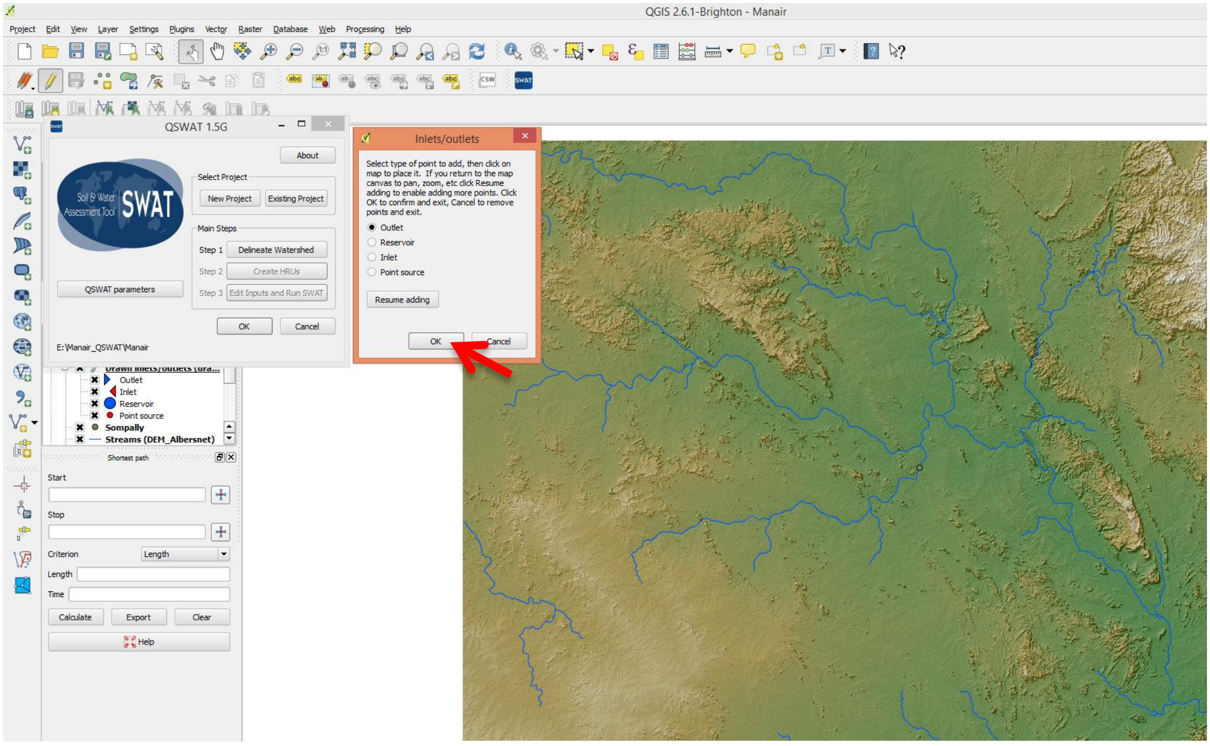


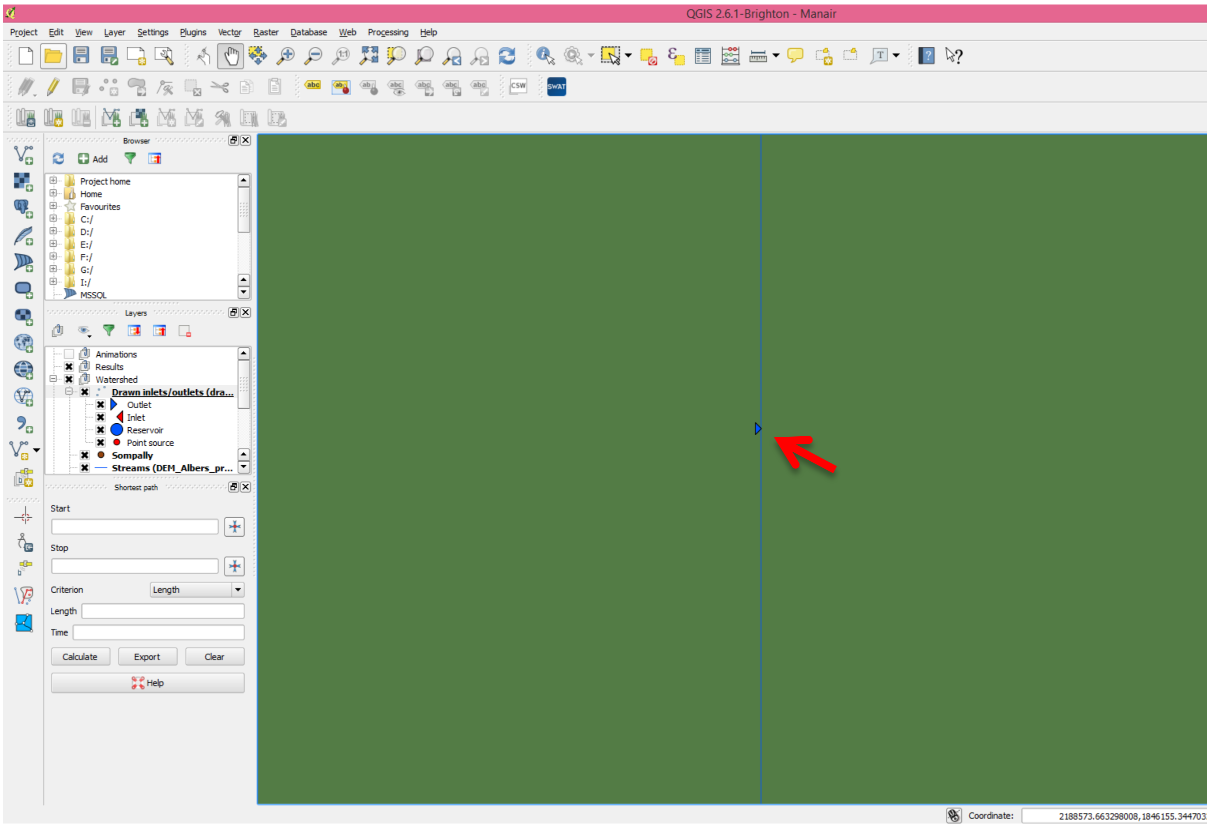
18. ***Somanpally.shp*** is added to the project.

19. Click on ***Draw Inlets/outlets button*** to add the outlet to our basin of interest.

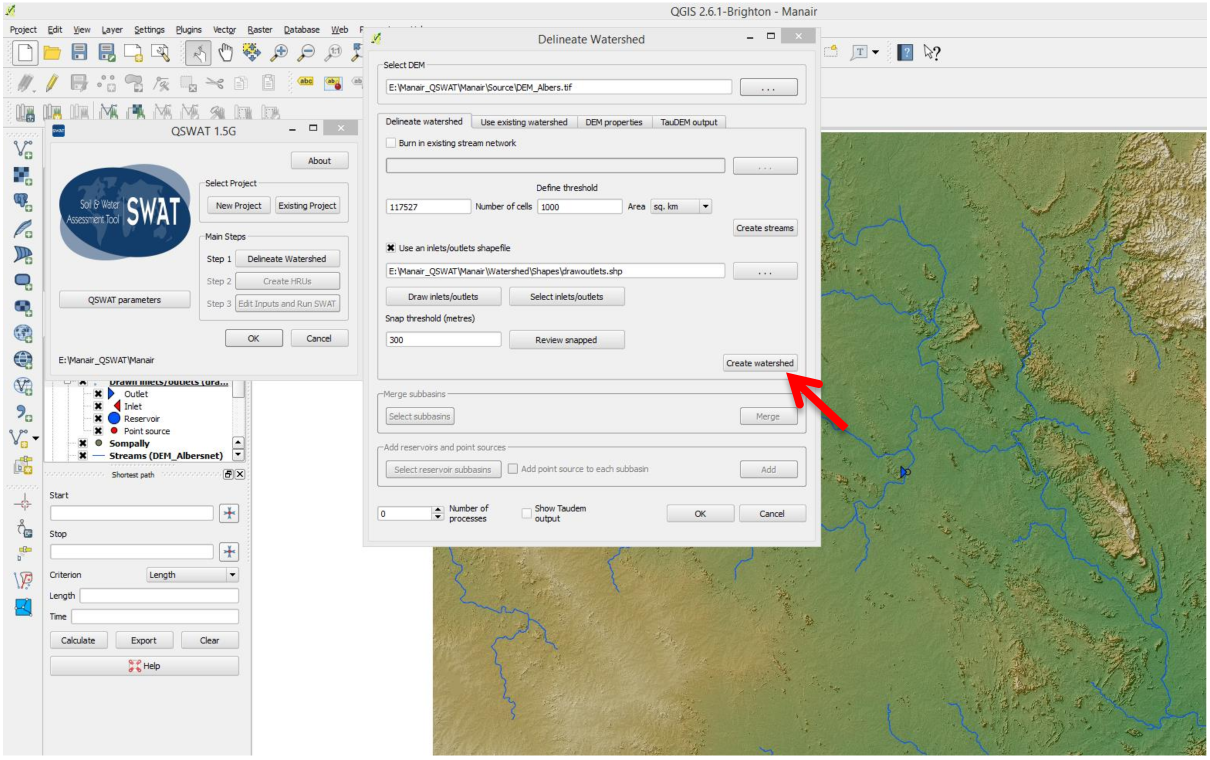


20. Inlets/outlets dialog box appears. Further zoom to the ***Somanpally.shp*** which was added already and click on the stream closer to ***Somanpally.shp*** at maximum zoom level and Click Ok. This adds an outlet point.

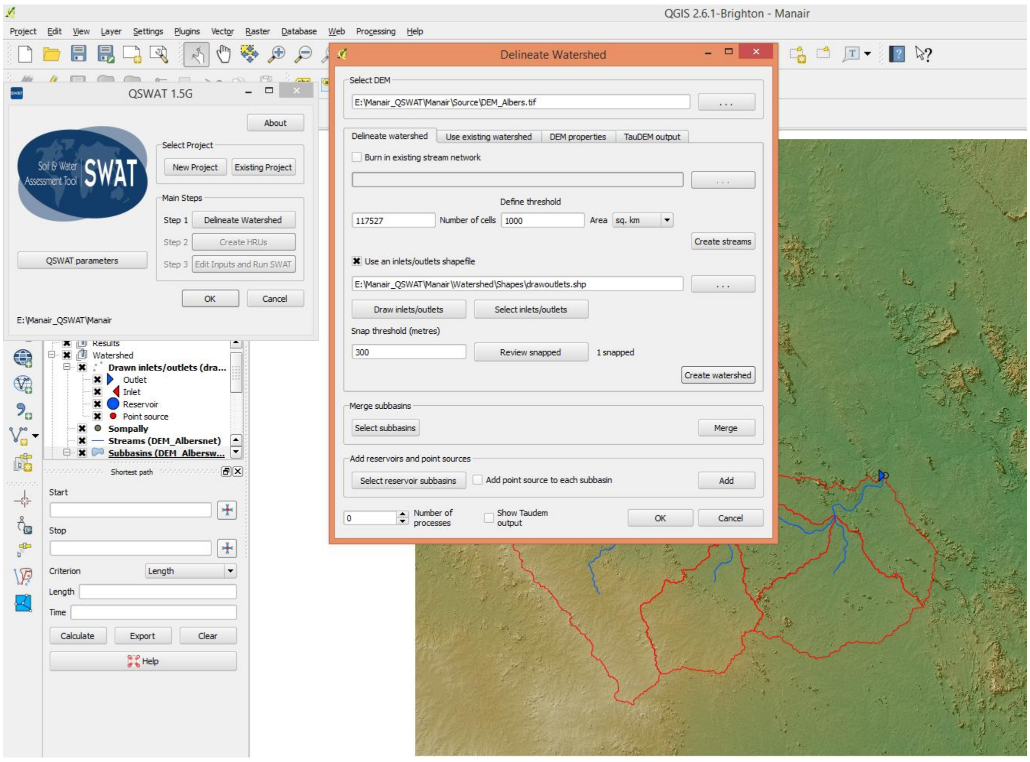


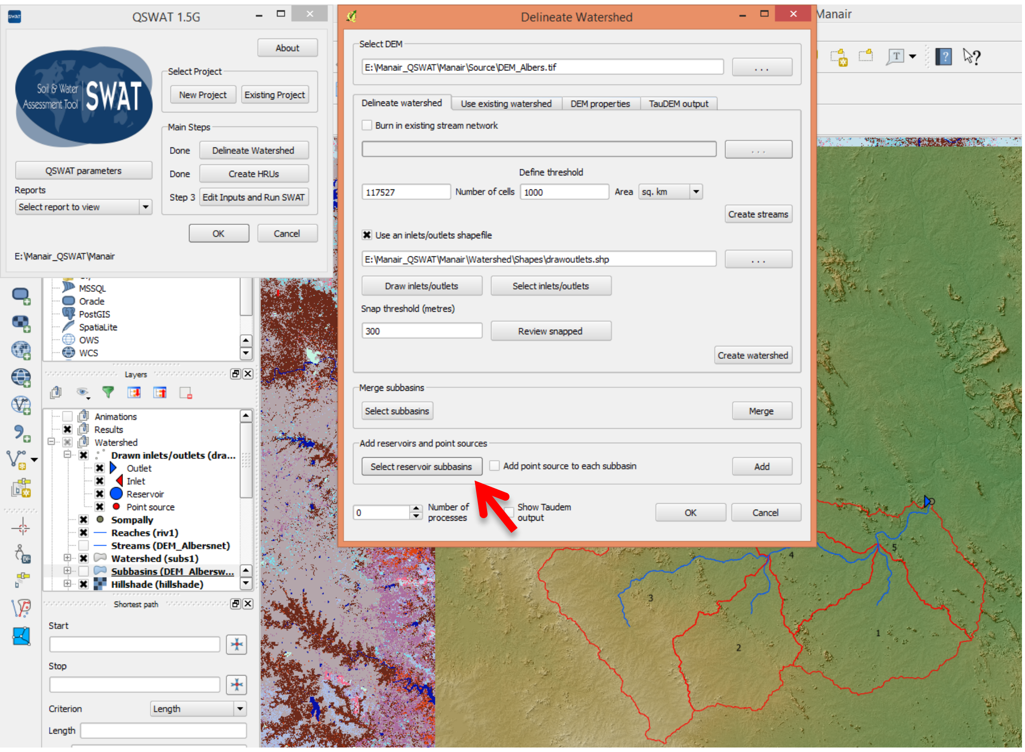
21. Click on the ***Create Watershed*** button to delineate the watershed.



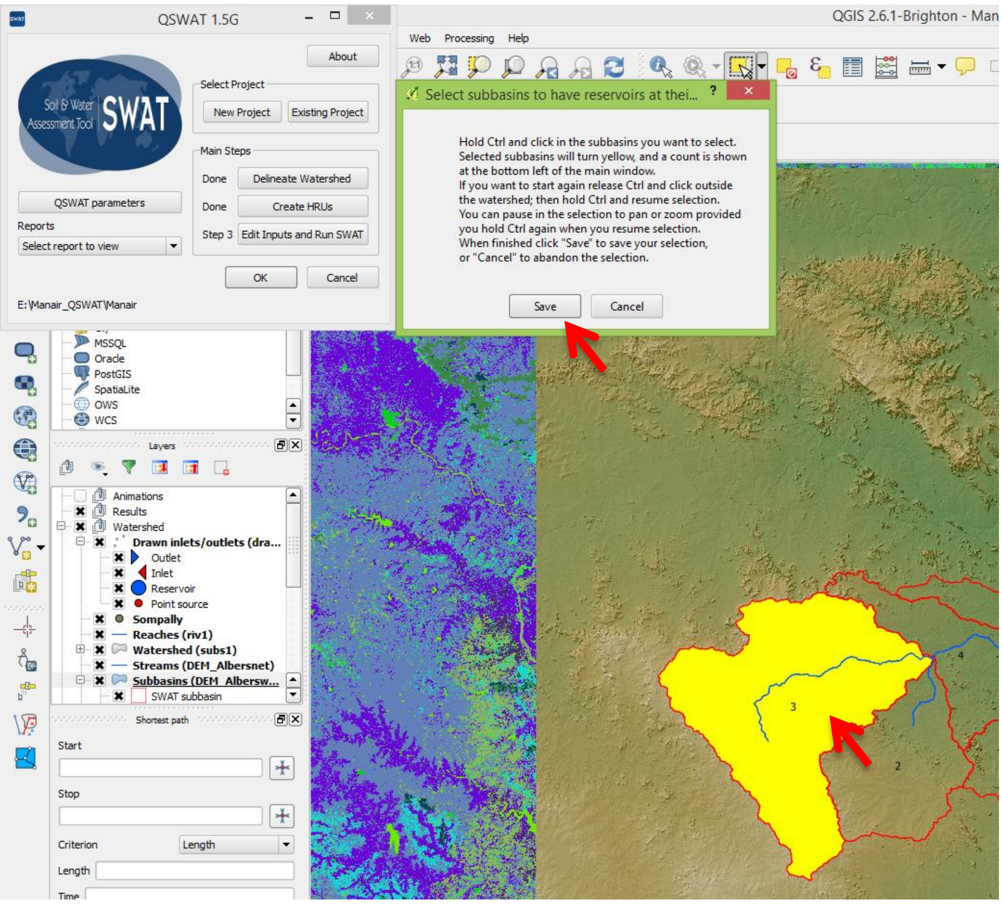

22. The Watershed is delineated with its Subbasins. Click ***OK***. **Proceed to step 28 if reservoir is not to be provided.**



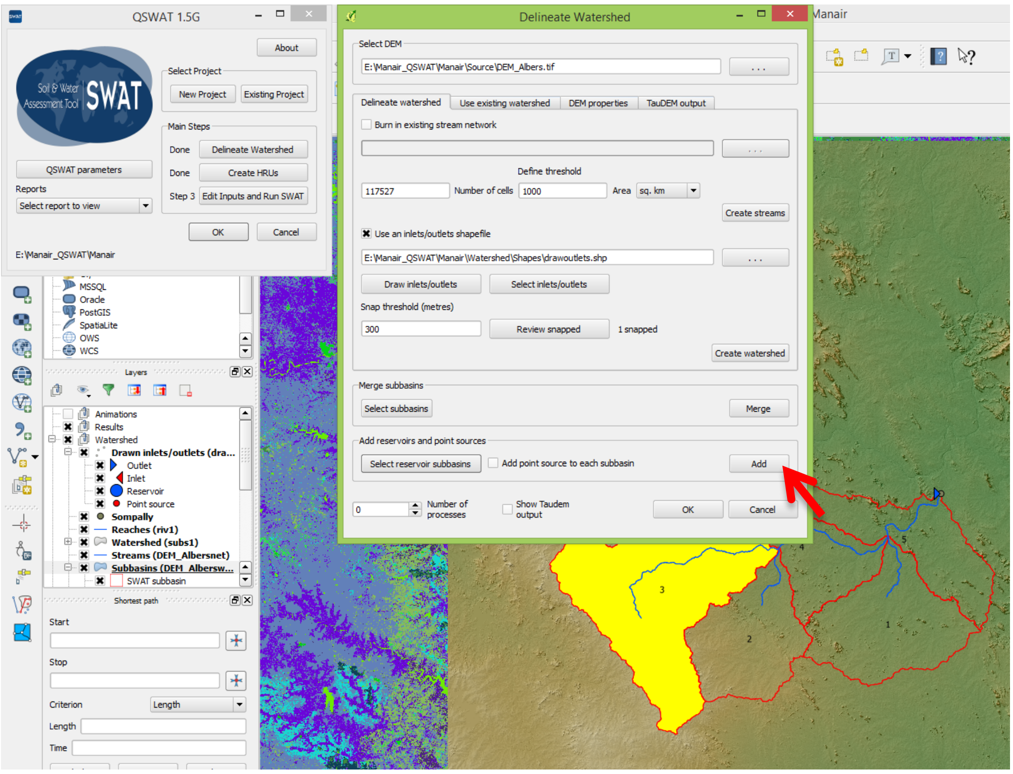
23. Click on ***Select reservoir Subbains*** to add reservoir.



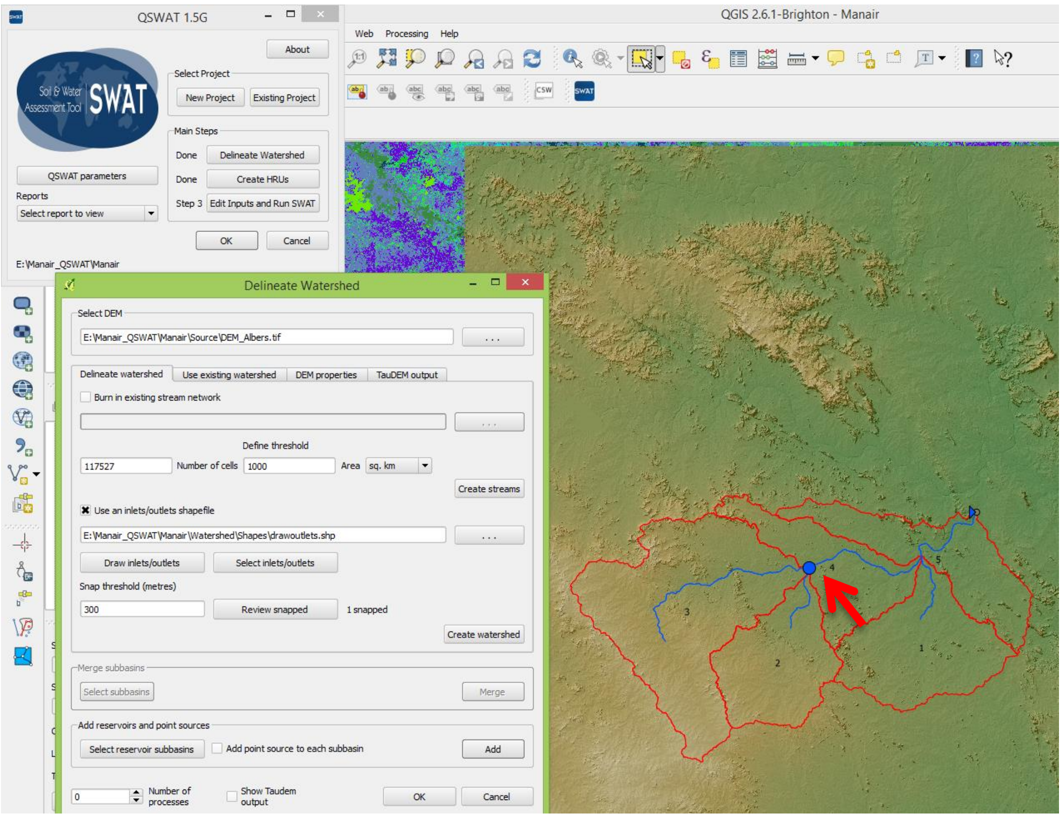

24. Hold Ctrl and Click on subbasin “3” and click Save.



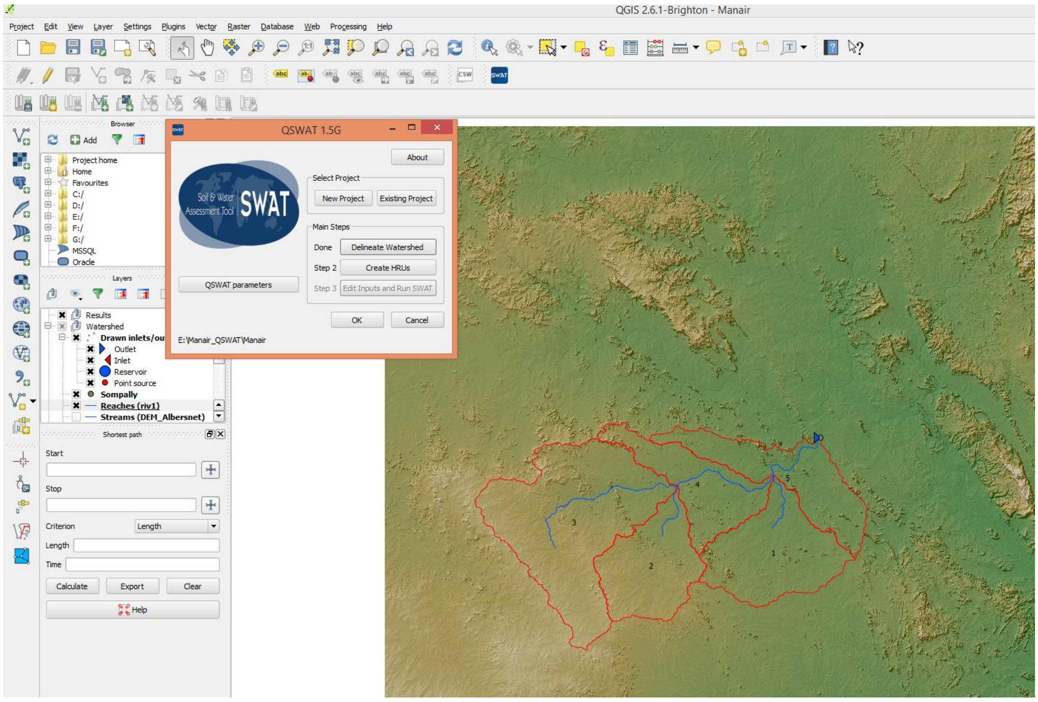
25. Click Add button.



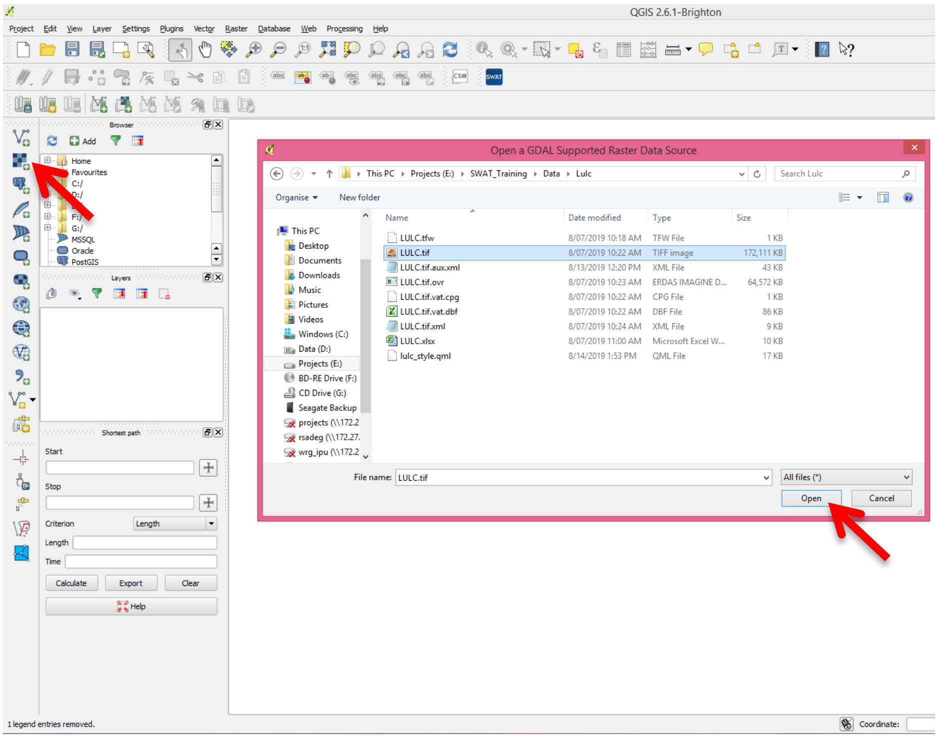

26. This adds reservoir to the project. Click OK.



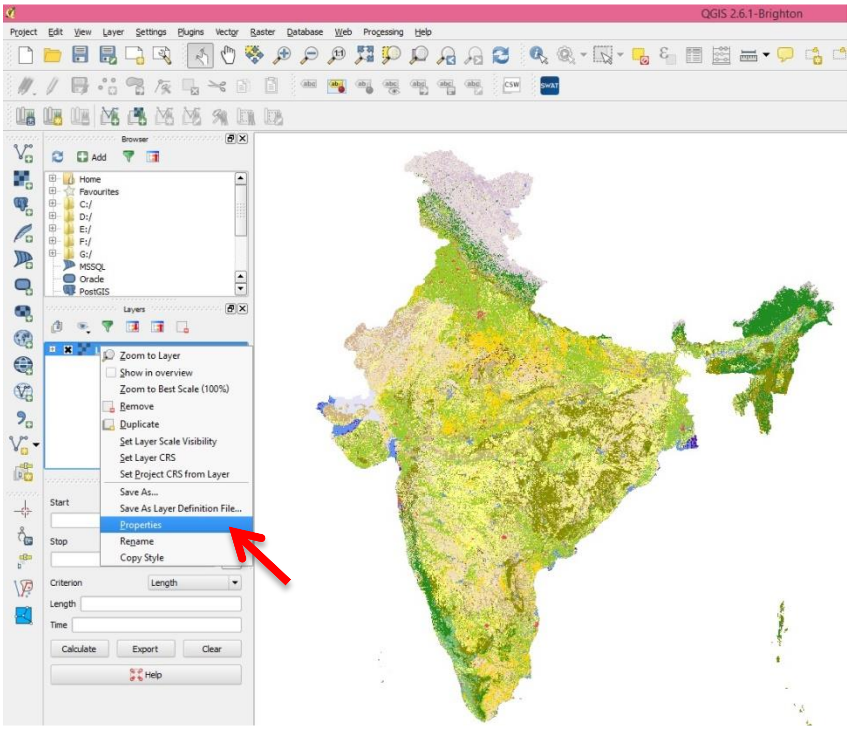
27. The corresponding Subbasins are visible.



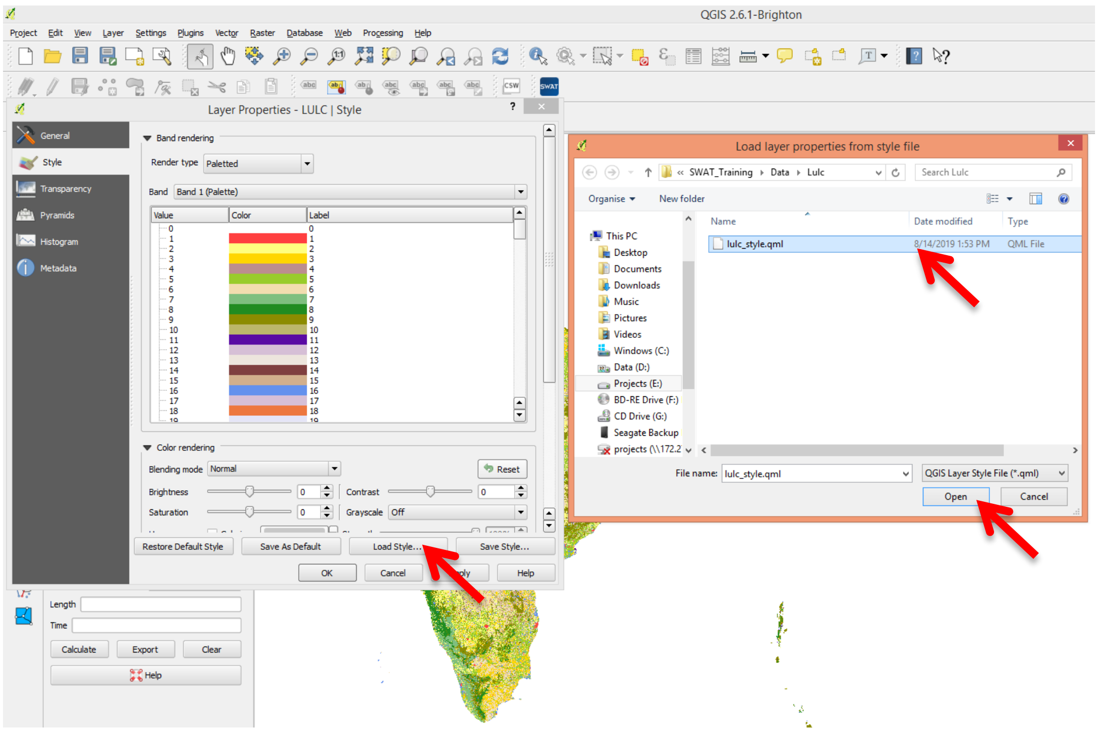

28. Open QGIS. Add the ***LULC.tif*** (landuse map) from the following path: ***SWAT_Training > Data > Lulc***



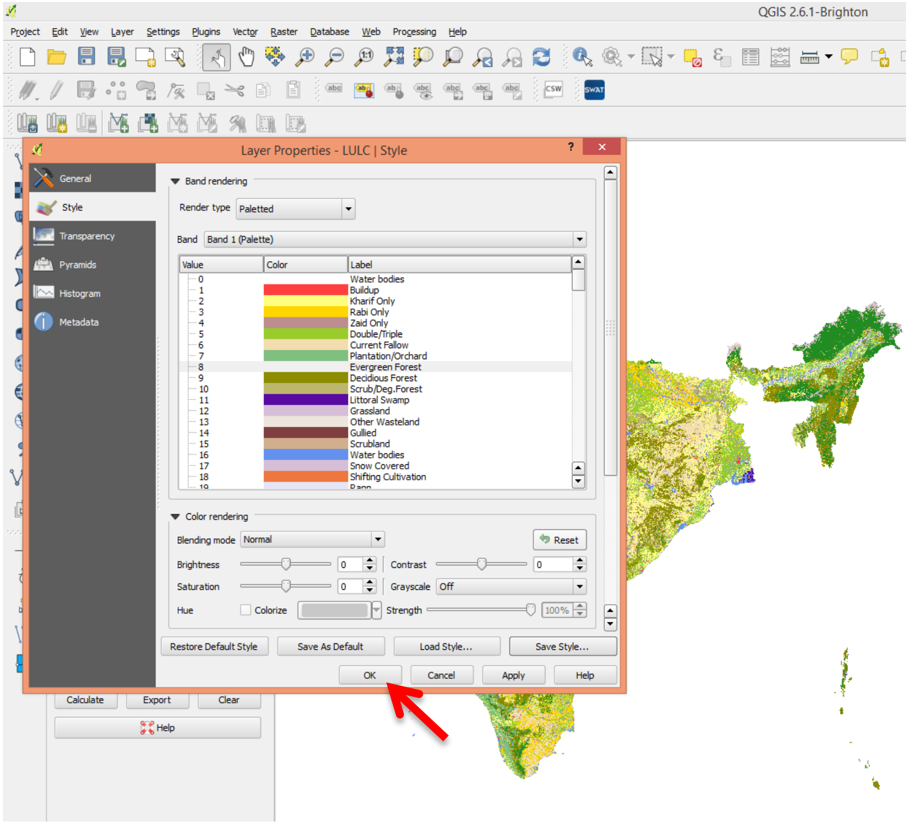
29. Right Click on ***LULC.tif*** and click on properties.



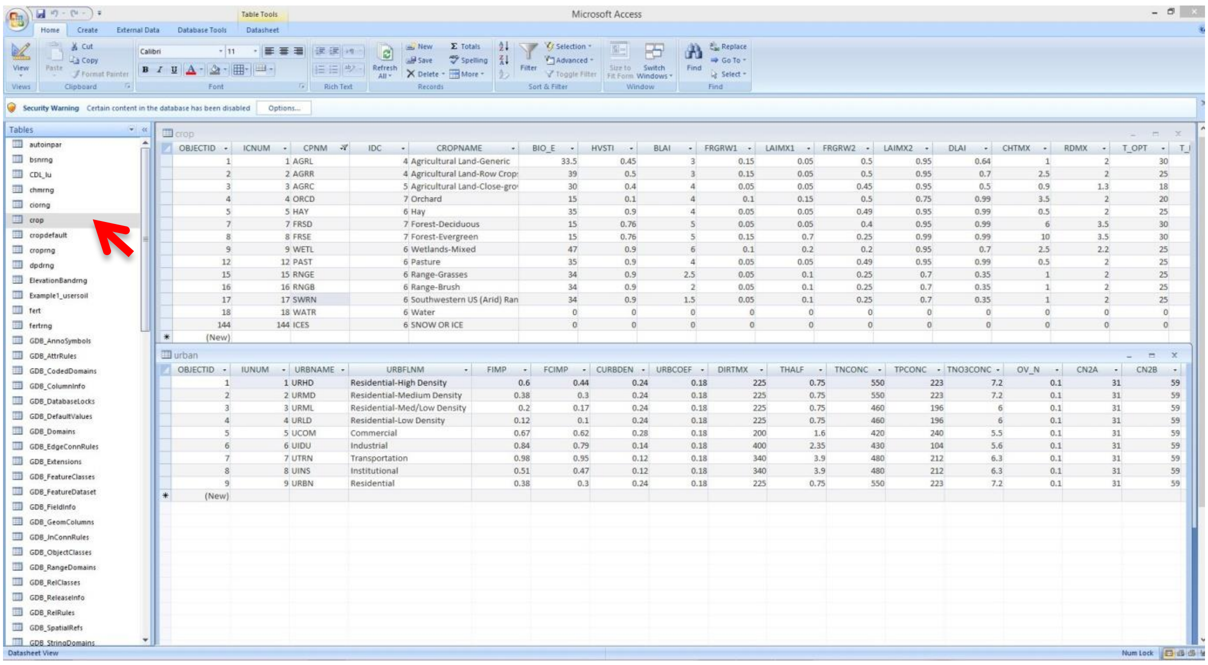
30. In the Layer Properties dialog box, click on ***load style*** button. Select ***lulc_style.qml*** from the following path: ***SWAT_Training > Data > Lulc***



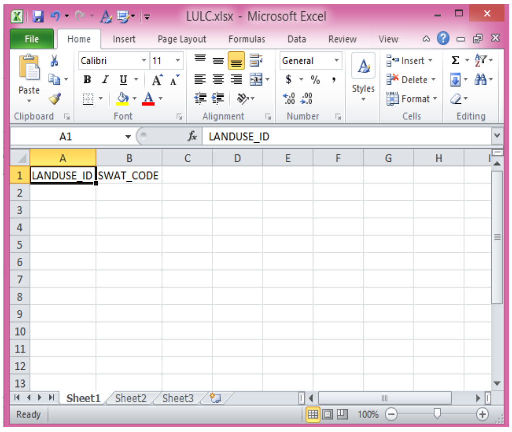
31. This displays the Value and its corresponding LULC class names. Click OK

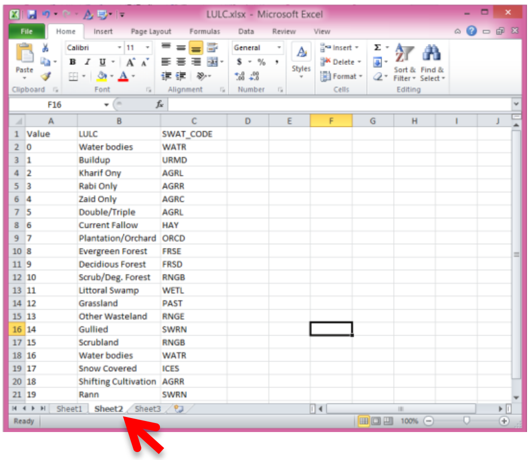



32. Now Open the ***QSWATRef2012.mdb*** from the following path: Manair_QSWAT > Manair and open the table ***crop*** and ***urban***. ***QSWATRef2012.mdb*** contains the LULC codes defined by SWAT. In order to link LULC data to SWAT database we need to create a lookup table. So, we need to define the SWAT code for the LULC classes in LULC.tif file.

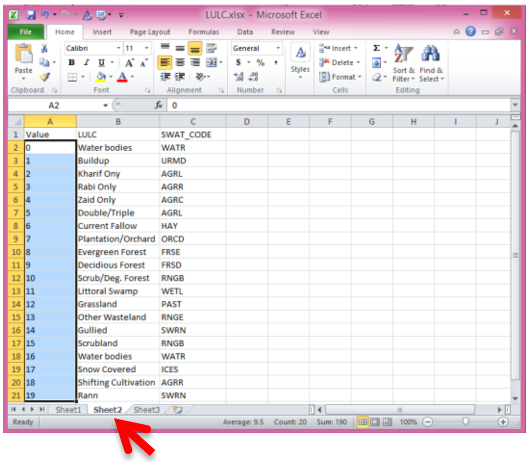


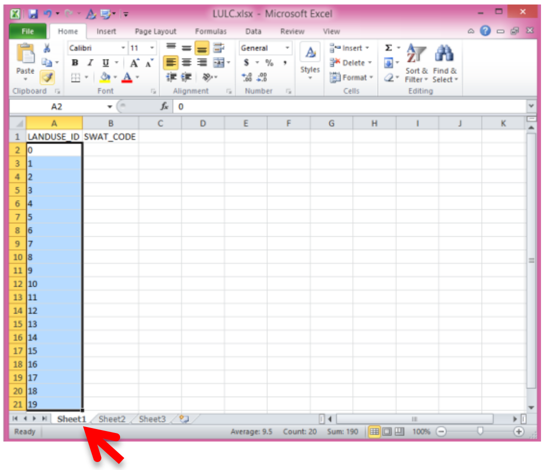
33. Open ***LULC.xlsx*** from the following path: SWAT_Training > Data > Lulc. Click on ***sheet2***. The LULC classes of ***LULC.tif*** is listed.



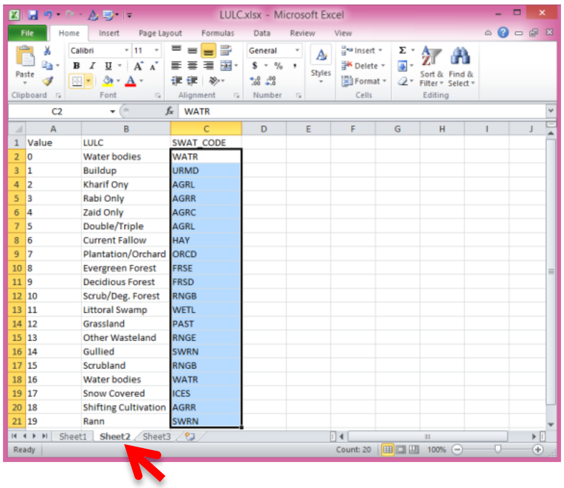



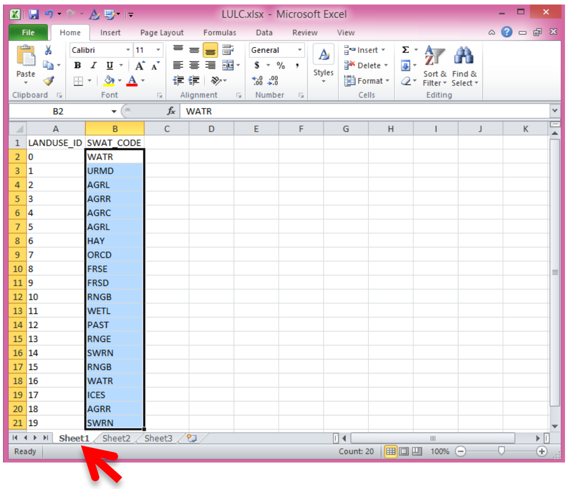

34. Copy the ***Value*** column from ***sheet2*** to ***sheet1.***



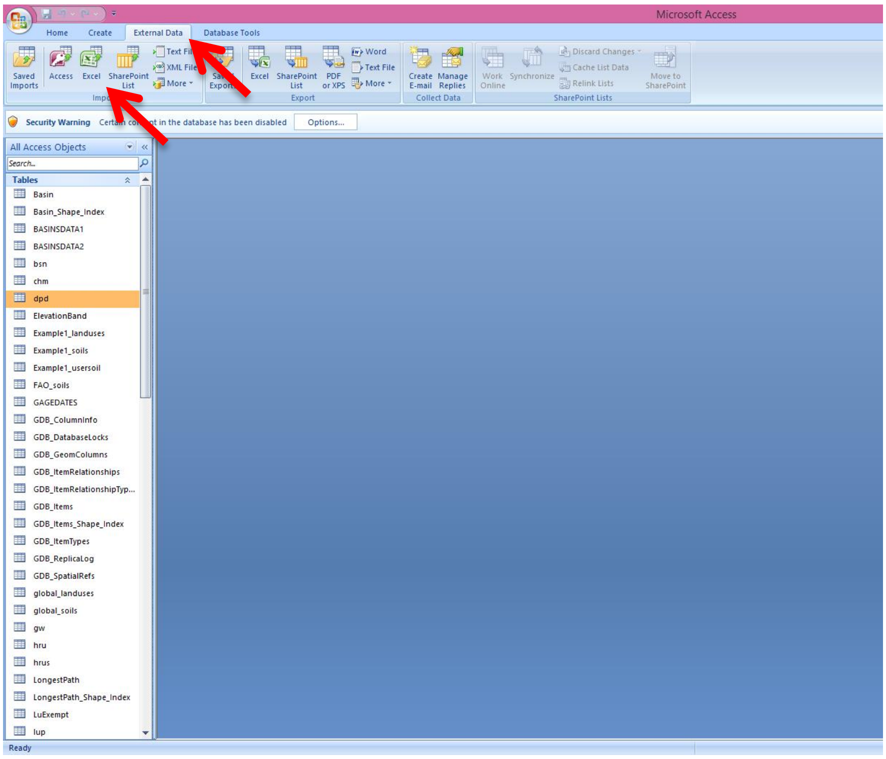

35. Copy the ***SWAT_CODE*** column from ***sheet2*** to ***sheet1.*** Now the lookup table is completed.



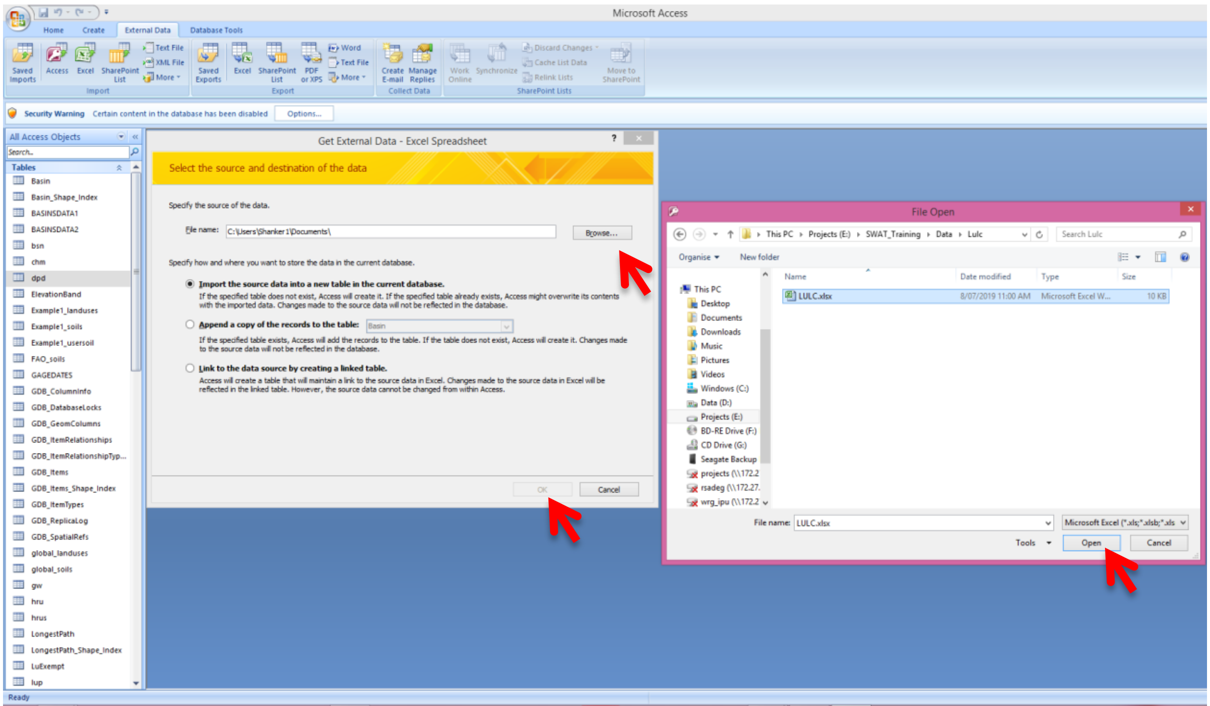



36. Open ***Manair.mdb*** from the following path: Manair_QSWAT >Manair.

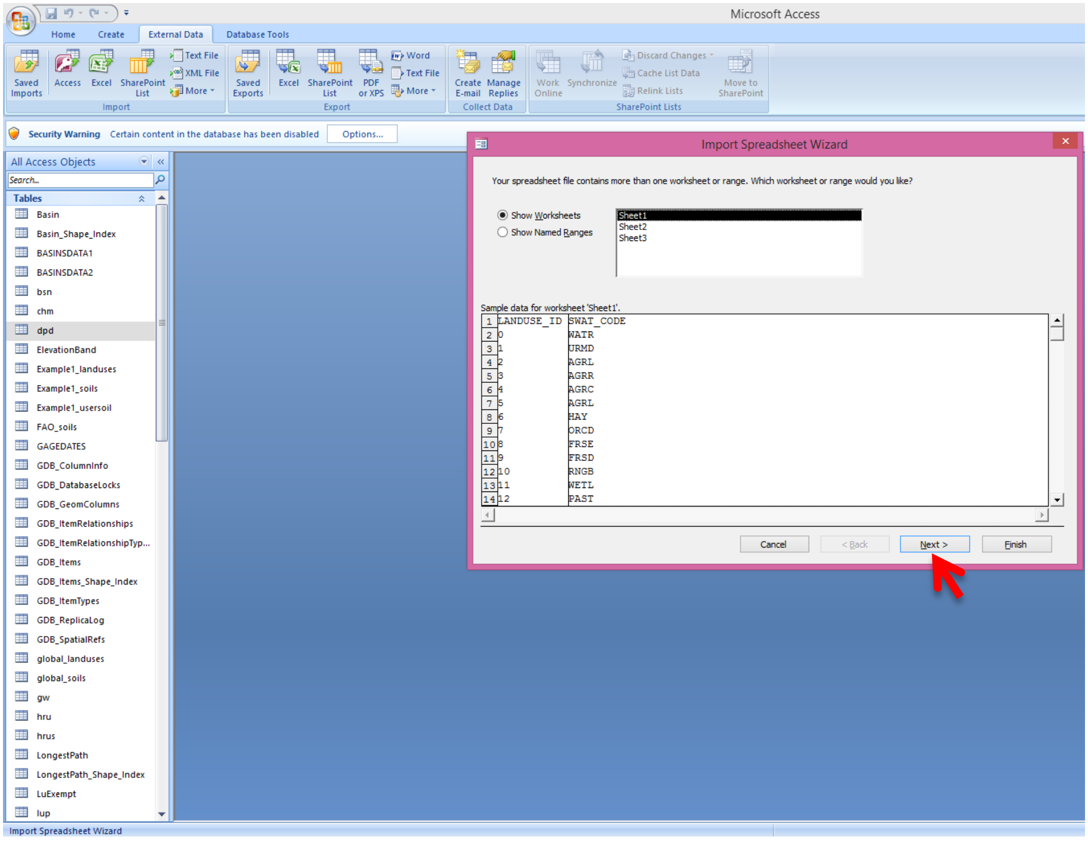
Click External Data, then click Excel.

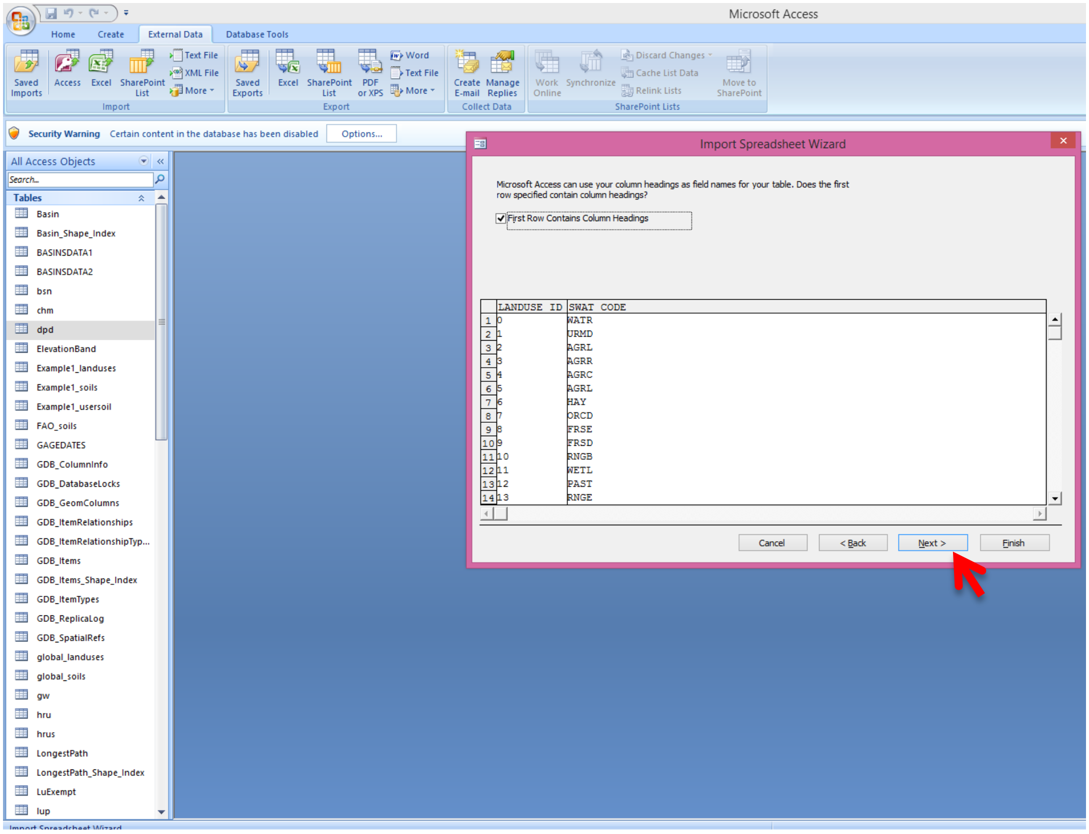


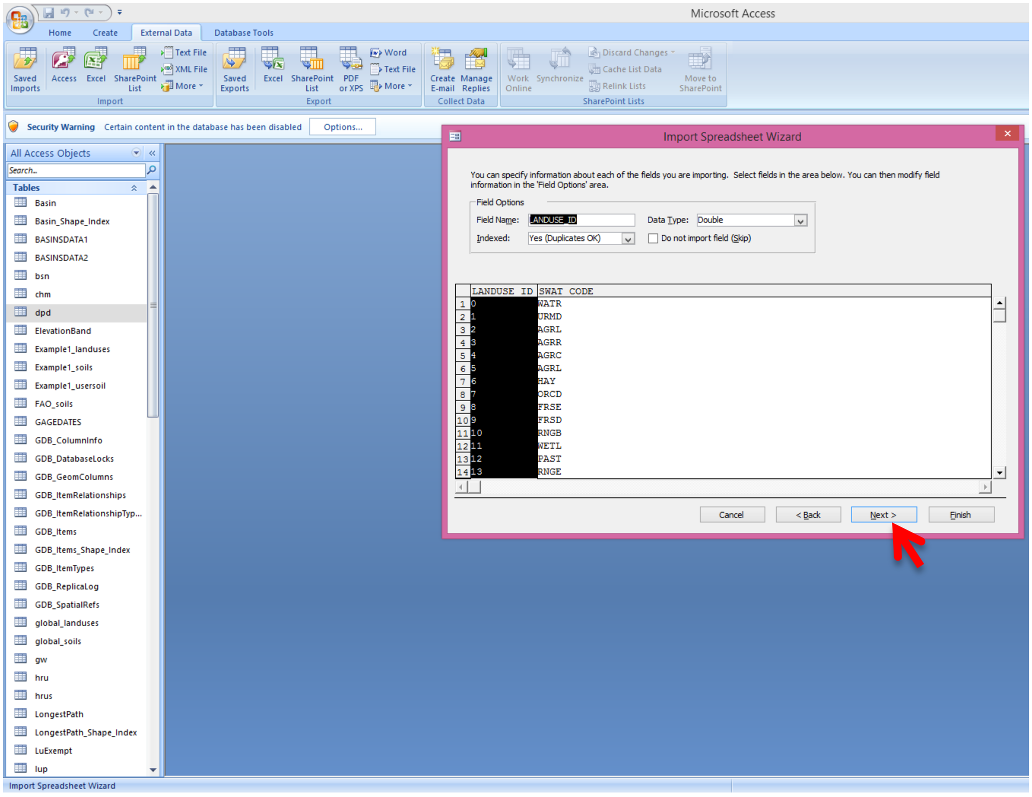

37. Import the file ***LULC.xlsx*** from the following path: SWAT_Training  > Data > Lulc and Click Ok.



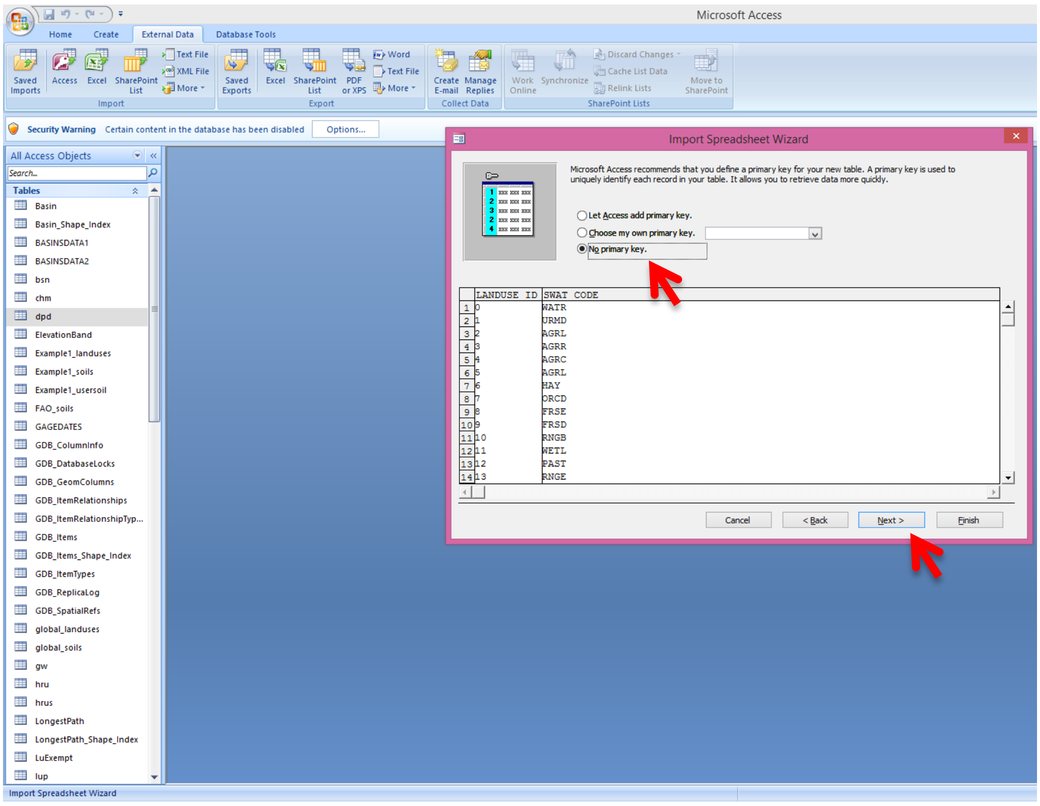
38. Click Next.



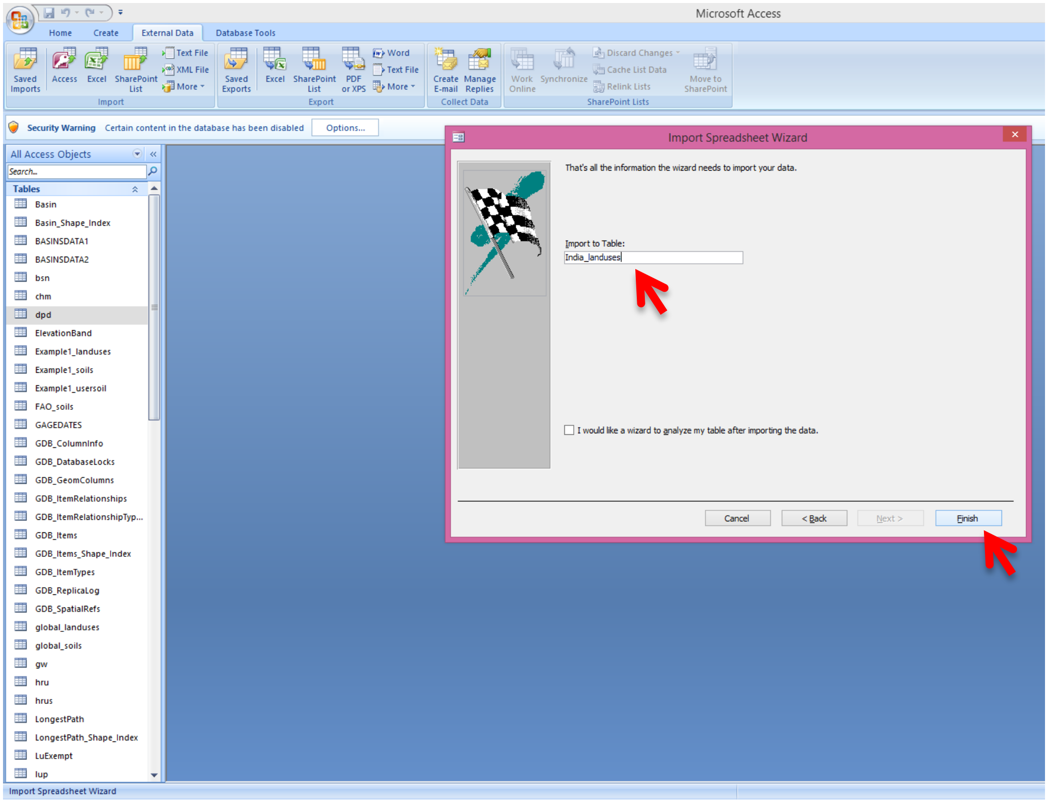




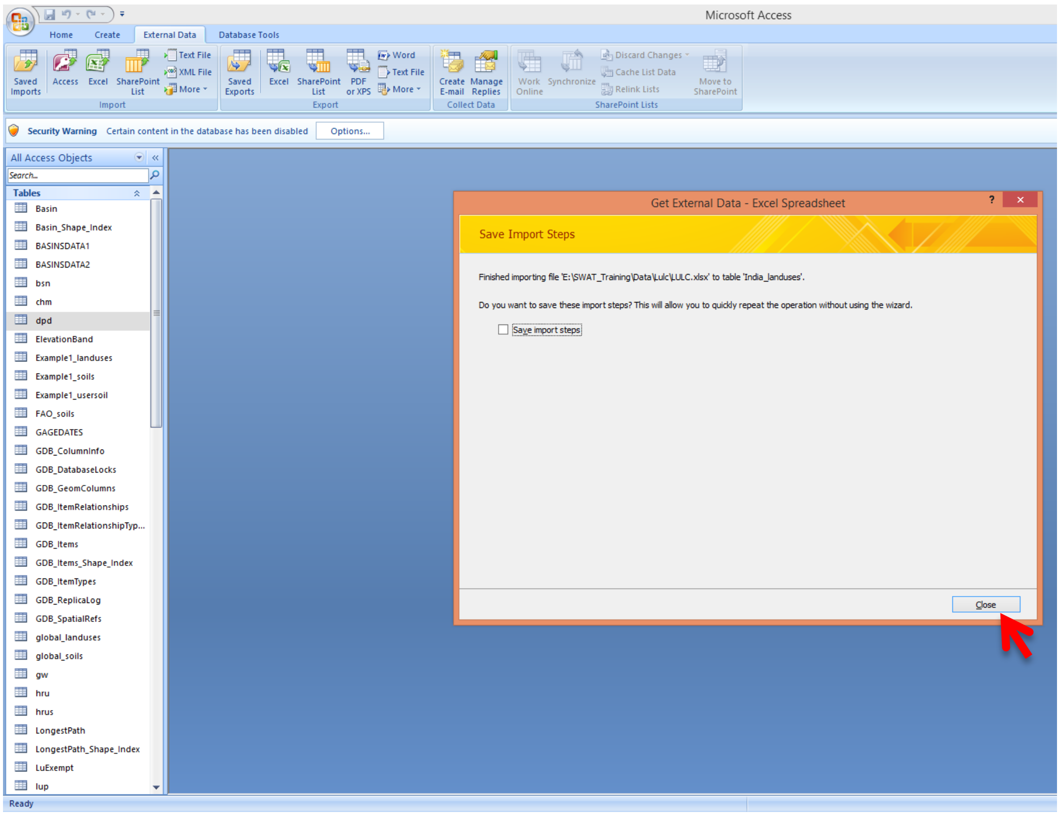

39. Select ***No primary key*** radio button.



40. Rename the table as ***India_landuses*** and click ***Finish***. (Note: Name should end with _landuses)

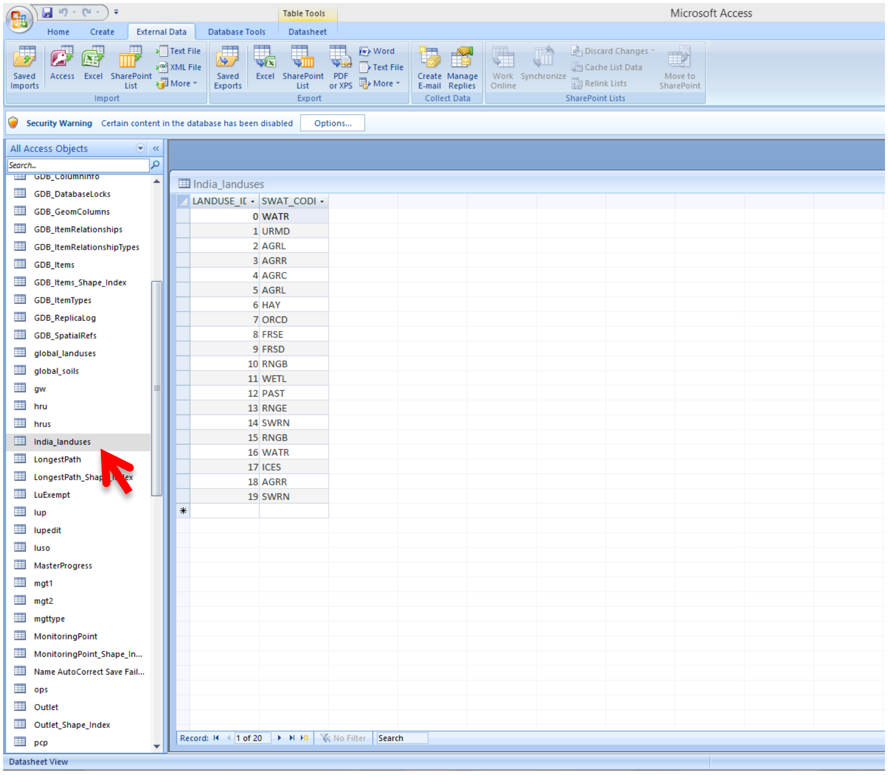


41. Close the dialog box.

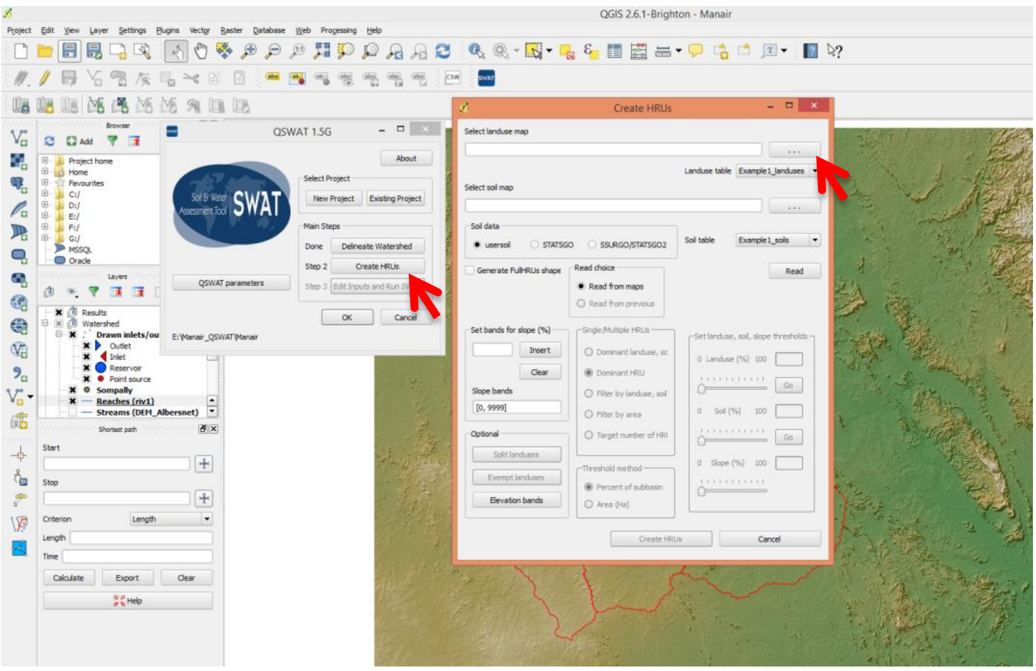


42. India_landuses Look up table is imported to the database ***Manair.mdb.***

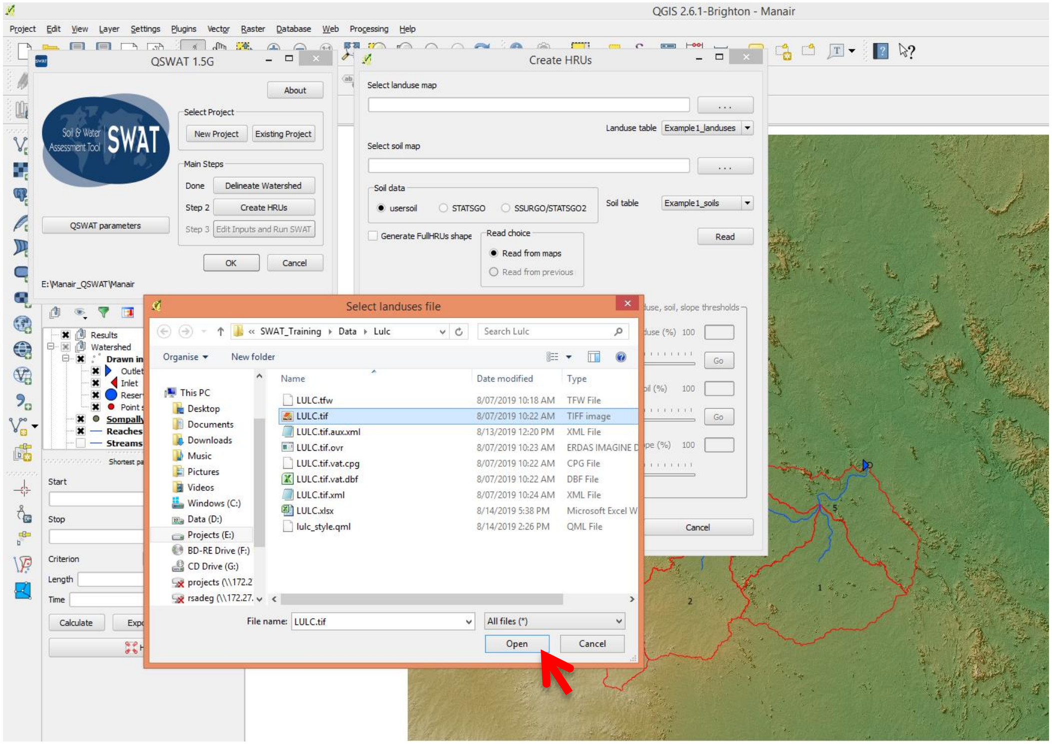
43. Close the database ***Manair.mdb.***



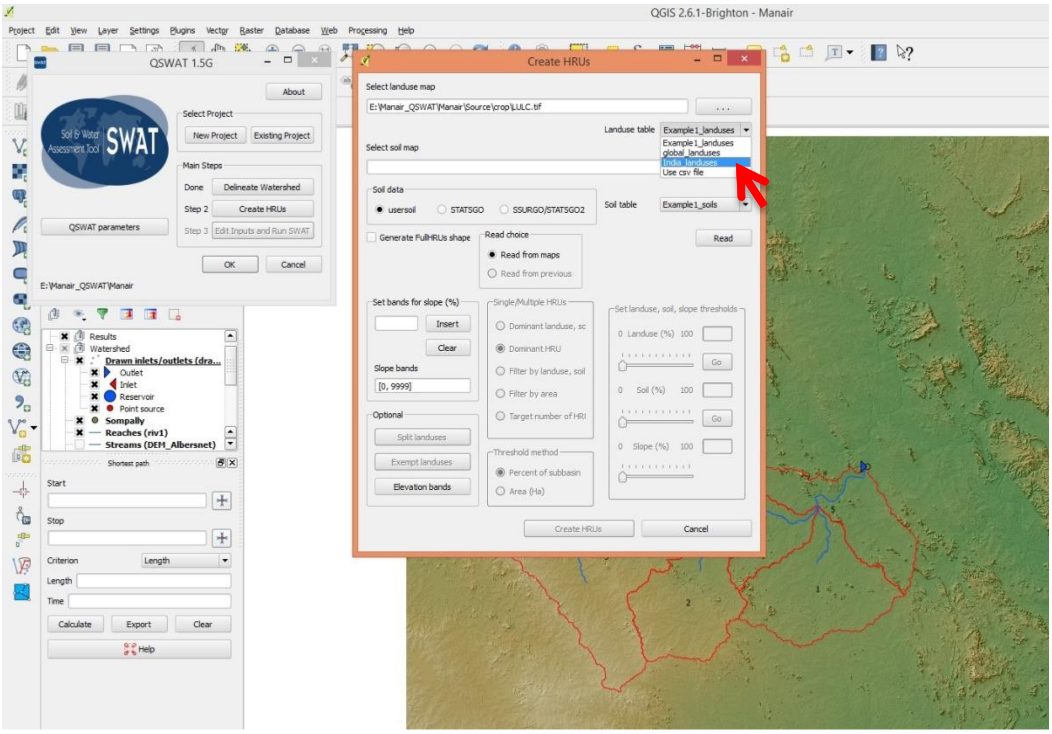

44. Click on ***Create HRUs*** button. The Land Use, Soil and slope Definition option in the HRU Analysis menu allows the user to specify the land use, soil and slope themes that will be used for modeling using SWAT. These themes are then used to determine the hydrologic response unit (HRU) distribution in each sub- watershed.



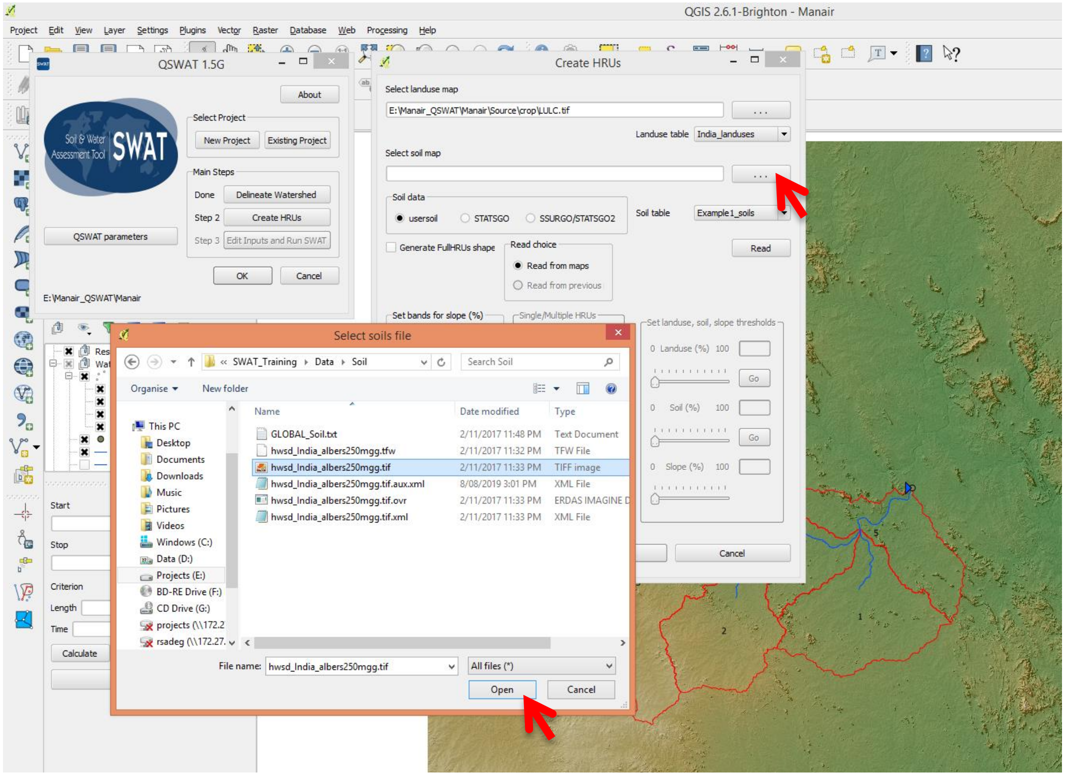
45. Select and open ***LULC.tif*** (landuse map) from the following path: SWAT_Training > Data > Lulc



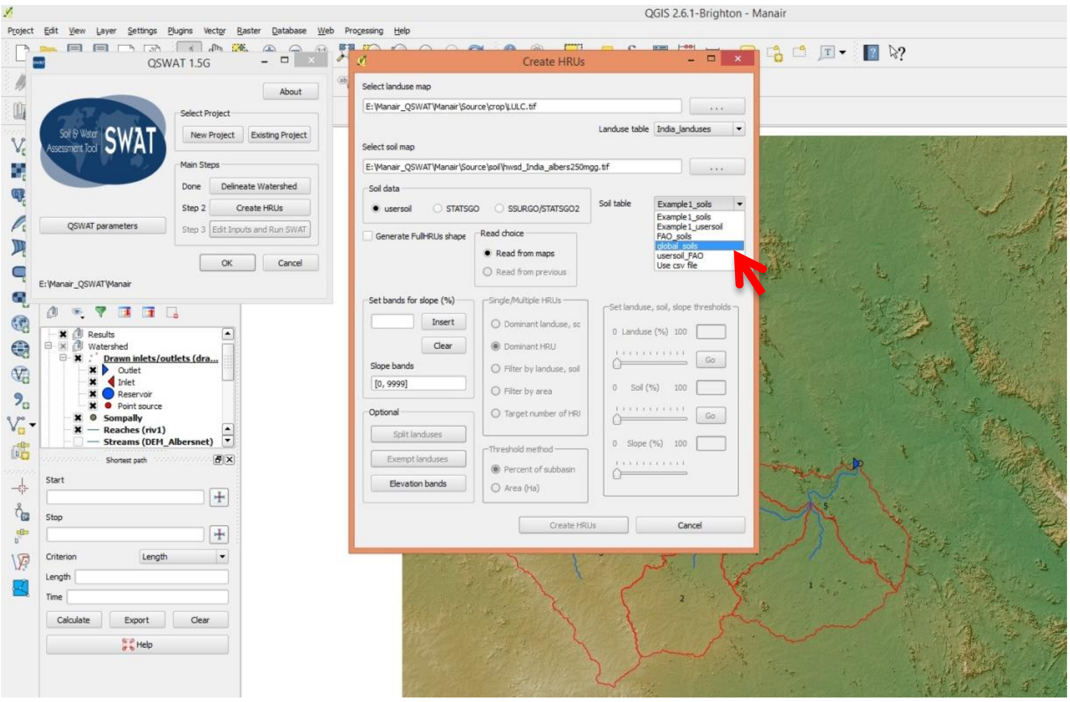

46. From the ***landuse*** table dropdown, select ***India_landuses***.



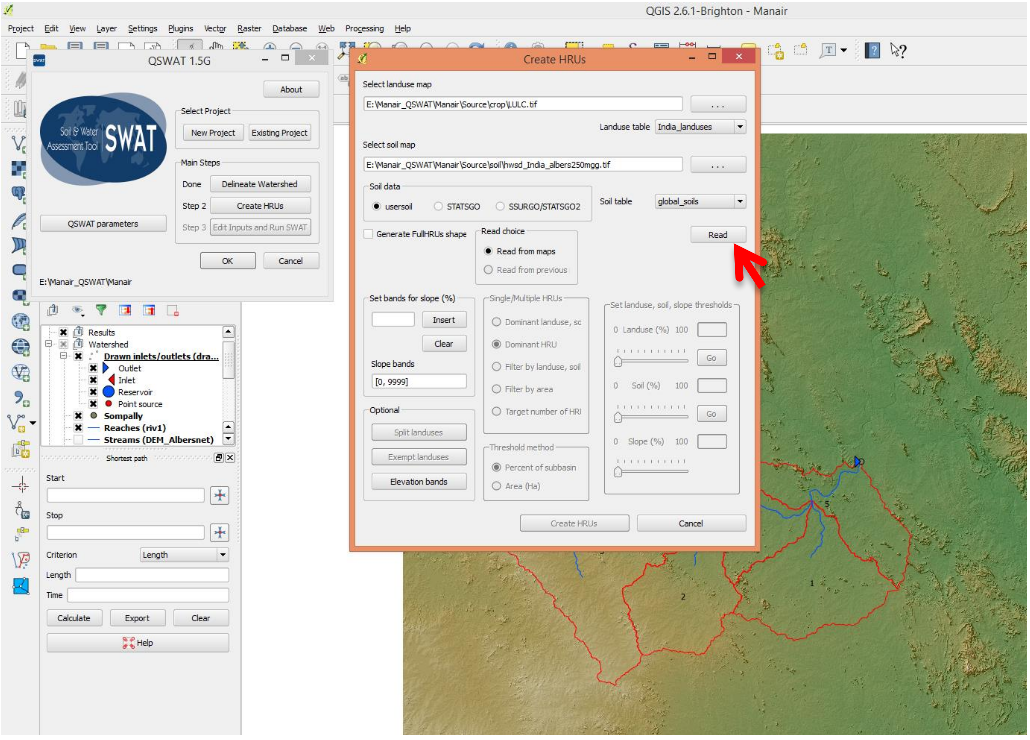
47. For Soil data, select and open ***hwsd_India_albers250mgg.tif*** from the following path: SWAT_Training > Data > Soil. (Data Source : FAO)



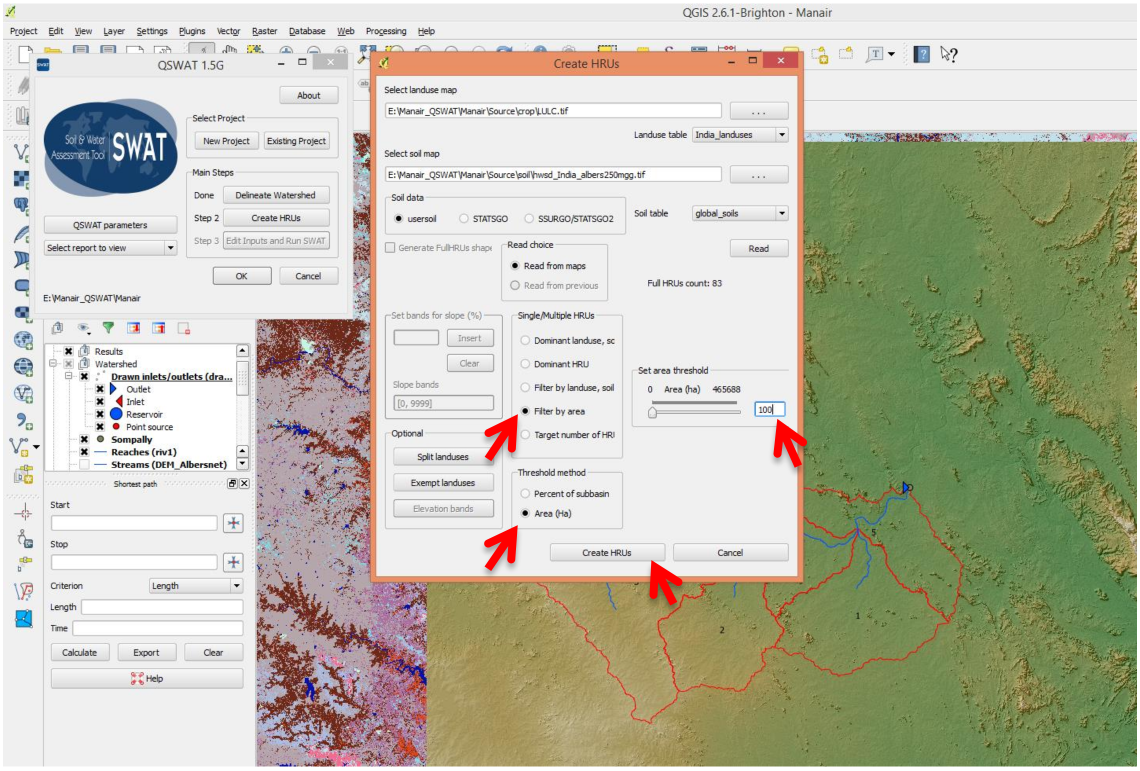

48. From the ***soil table*** dropdown, select ***global_soils. (Note:*** *global_soils is the lookup table for soil data****)***



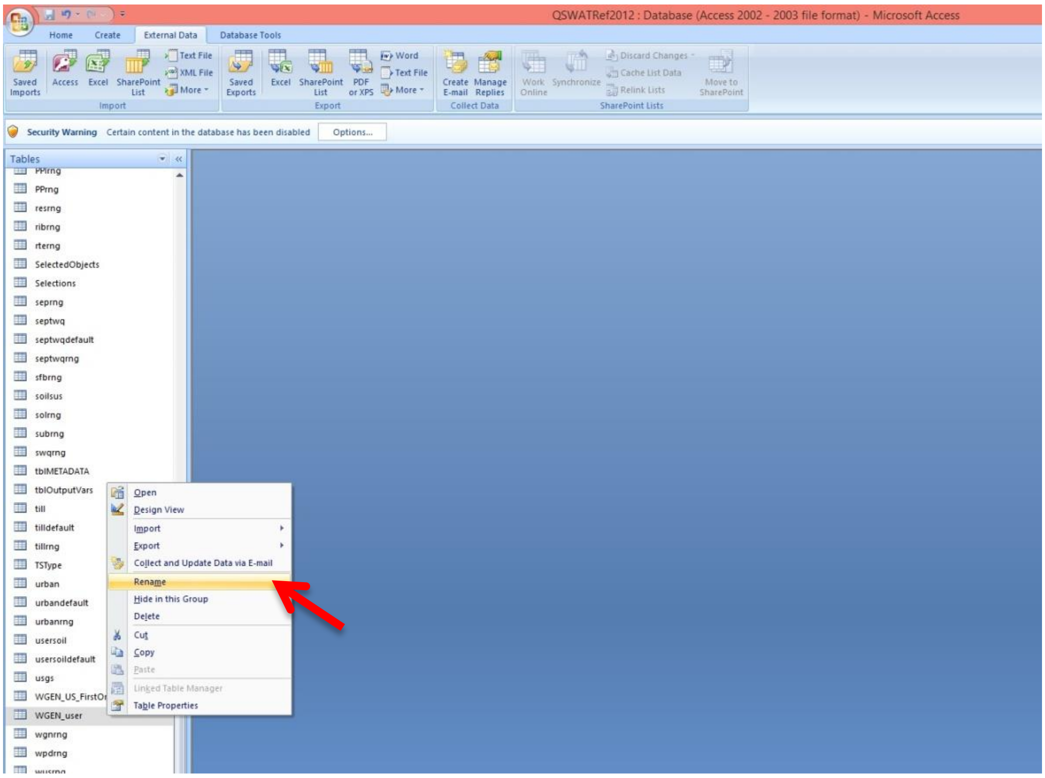
49. Click on ***Read*** button and this reads the landuse and soil data provided.

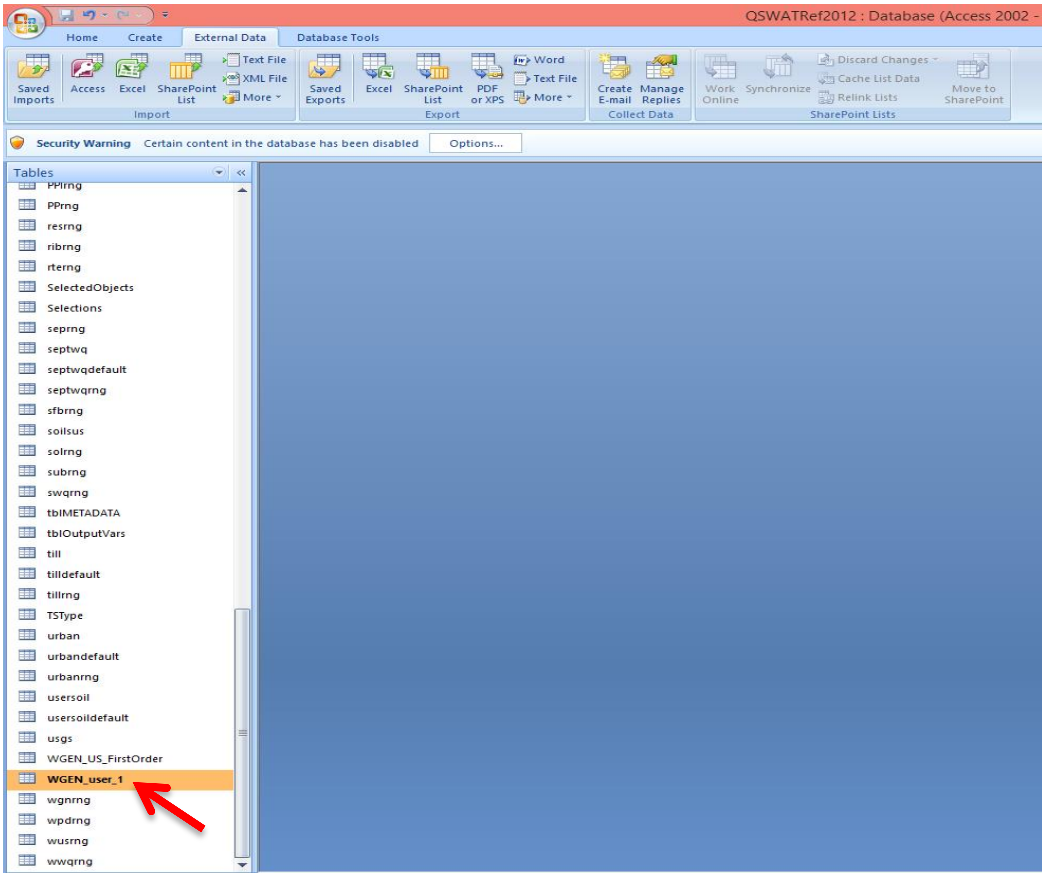


50. Select ***Filter by area*** radio button, then select ***Area (Ha)*** radio button. Set the ***area threshold*** as ***100 ha***. Click ***Create HRUs.*** This creates HRUs based on the threshold value provided.

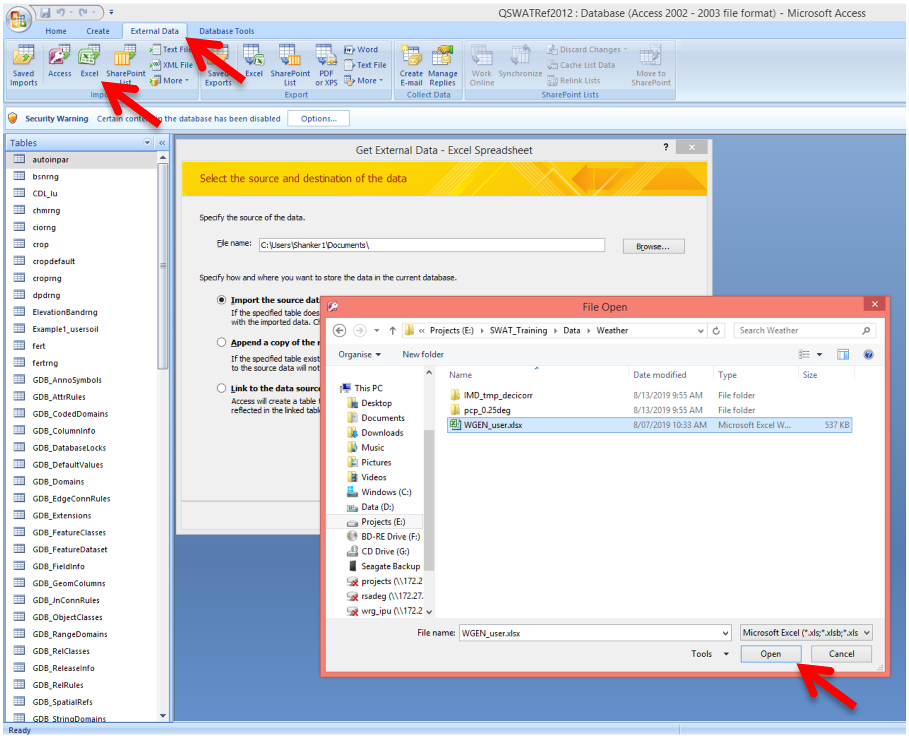


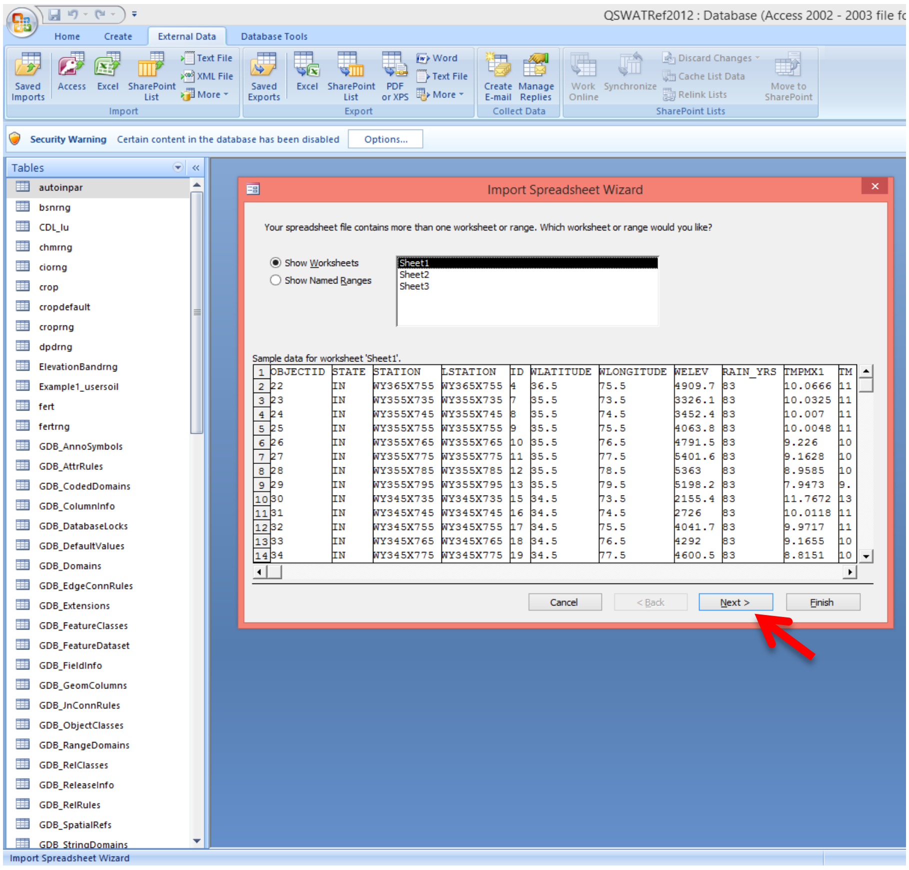
51. Open ***QSWATRef2012.mdb*** from the following path: Manair_QSWAT > Manair. Rename the ***WGEN_user*** table to ***WGEN_user_1.***



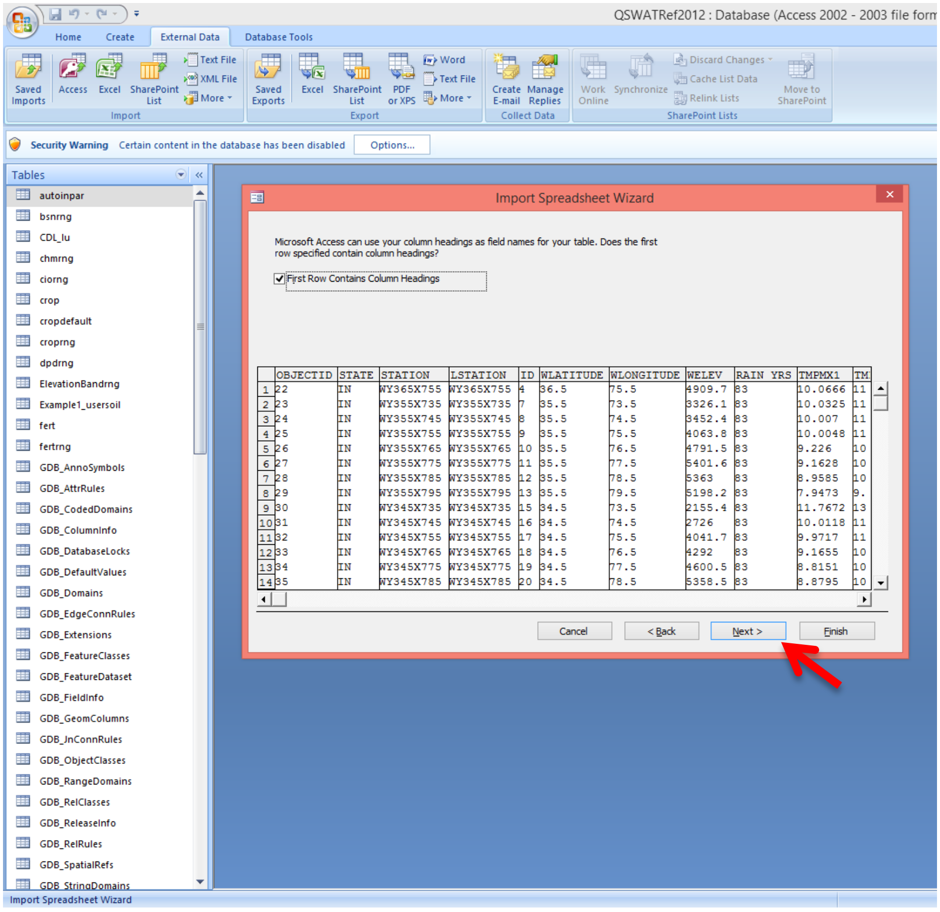



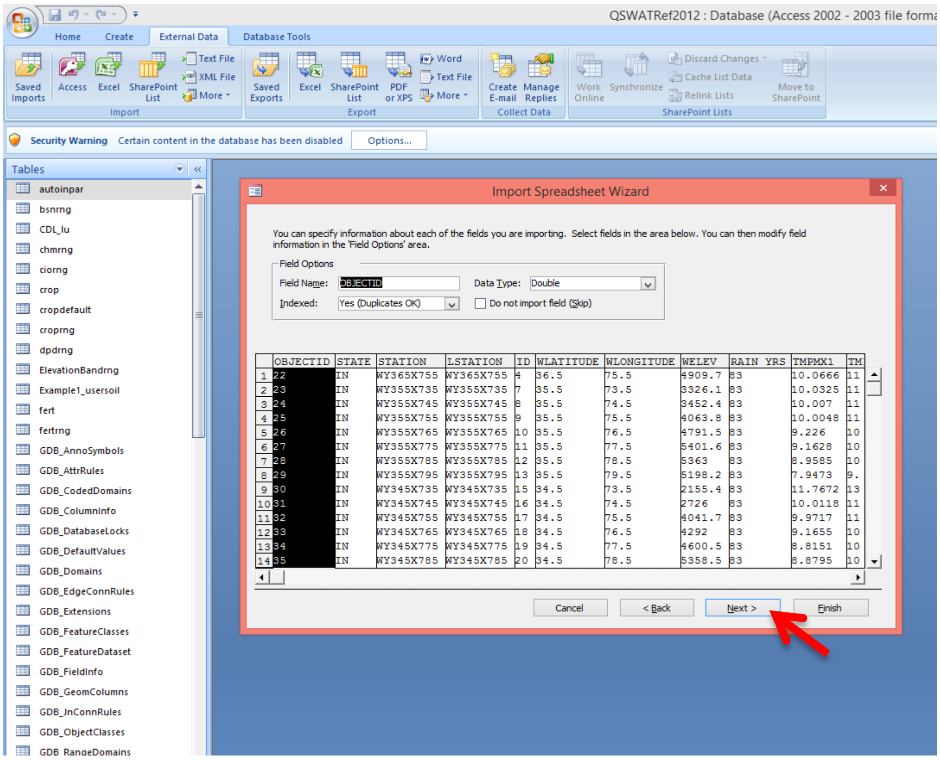
52. Click External Data, then click Excel. Import the file ***WGEN_user.xlsx*** from the following path: SWAT_Training > Data > Weather and Click open and then Ok.



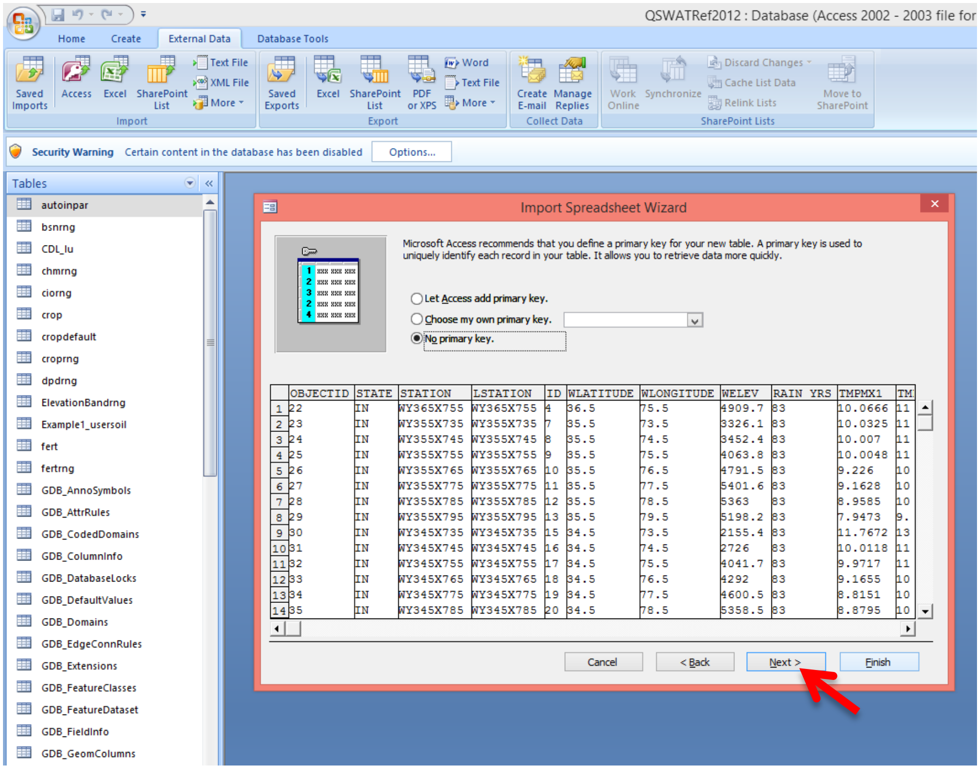


53. Click ***Next***.

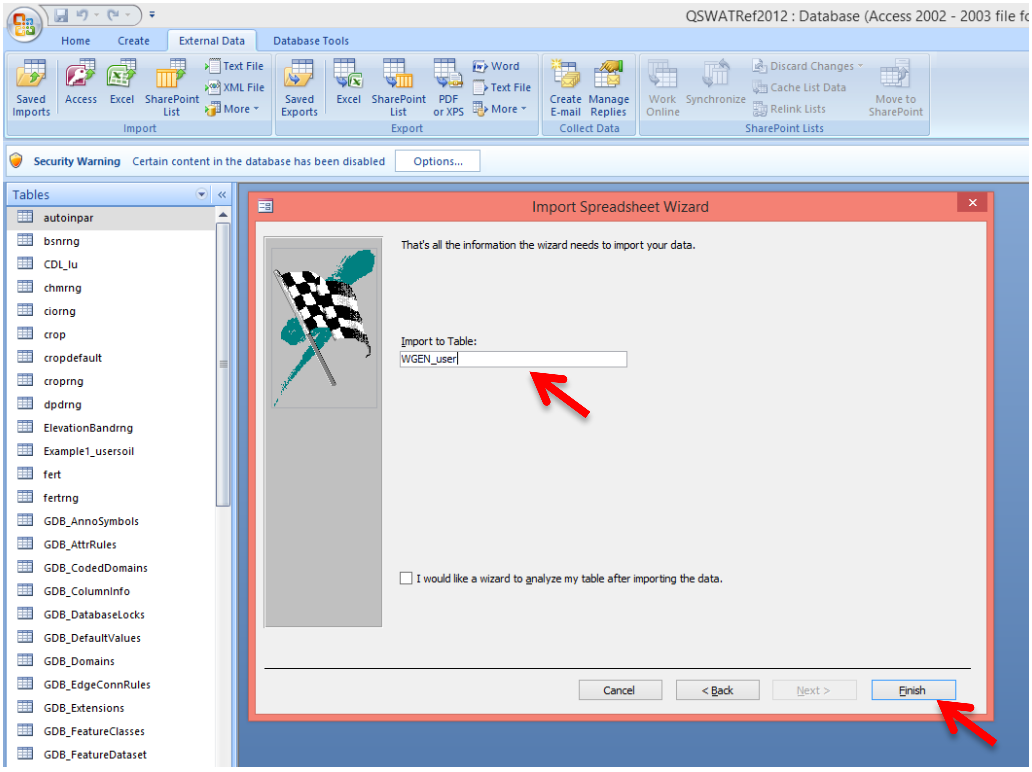




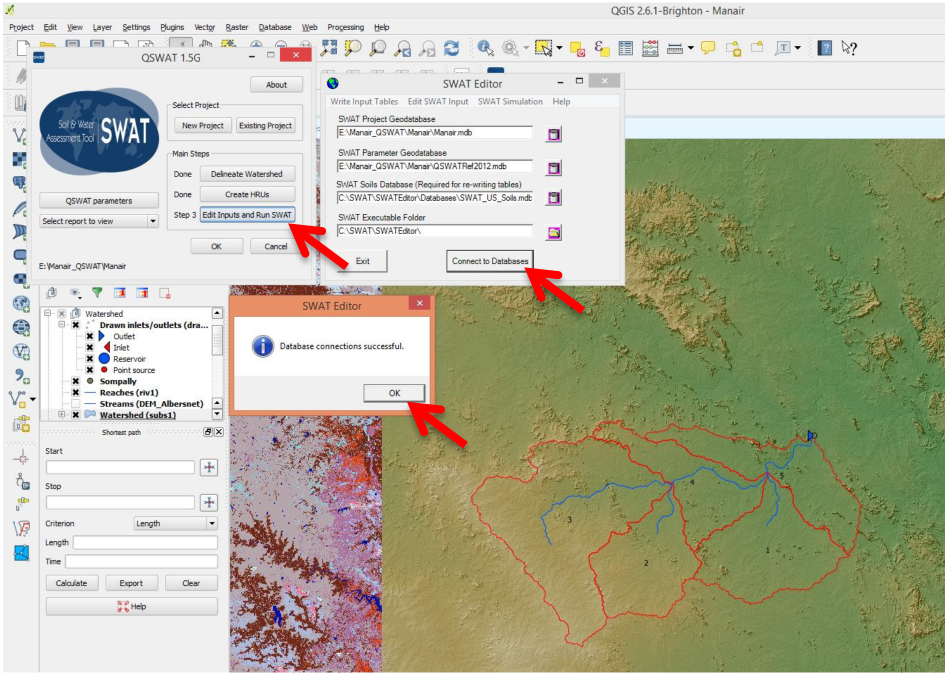
54. Select ***No primary key*** radio button and click next.



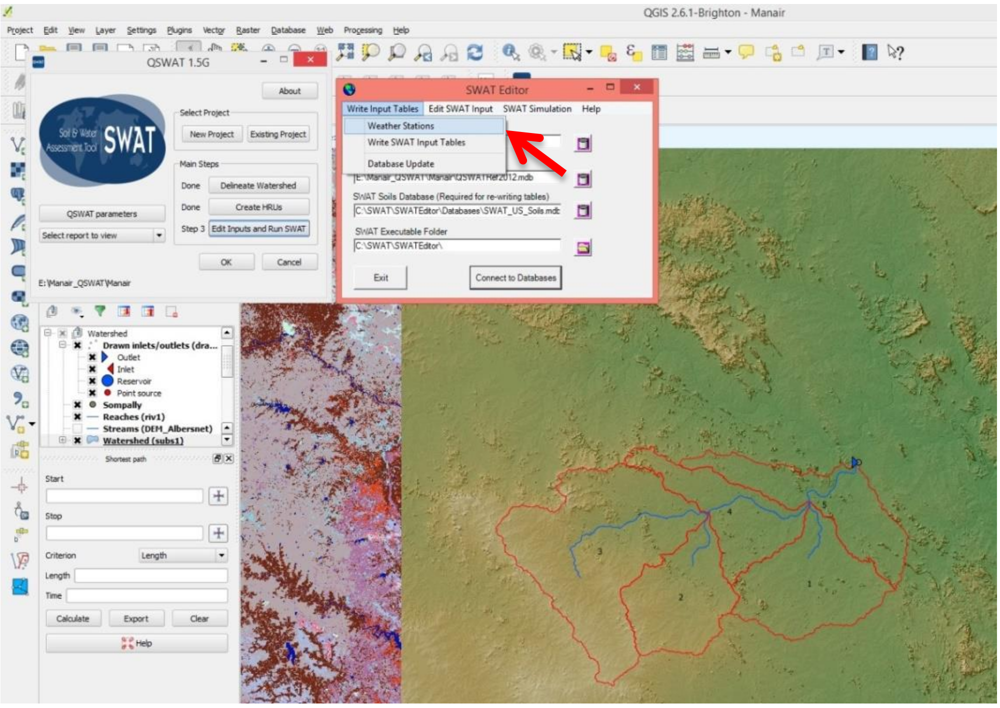
55. Rename the table name as ***WGEN_user*** and click Finish and close the dialog box.



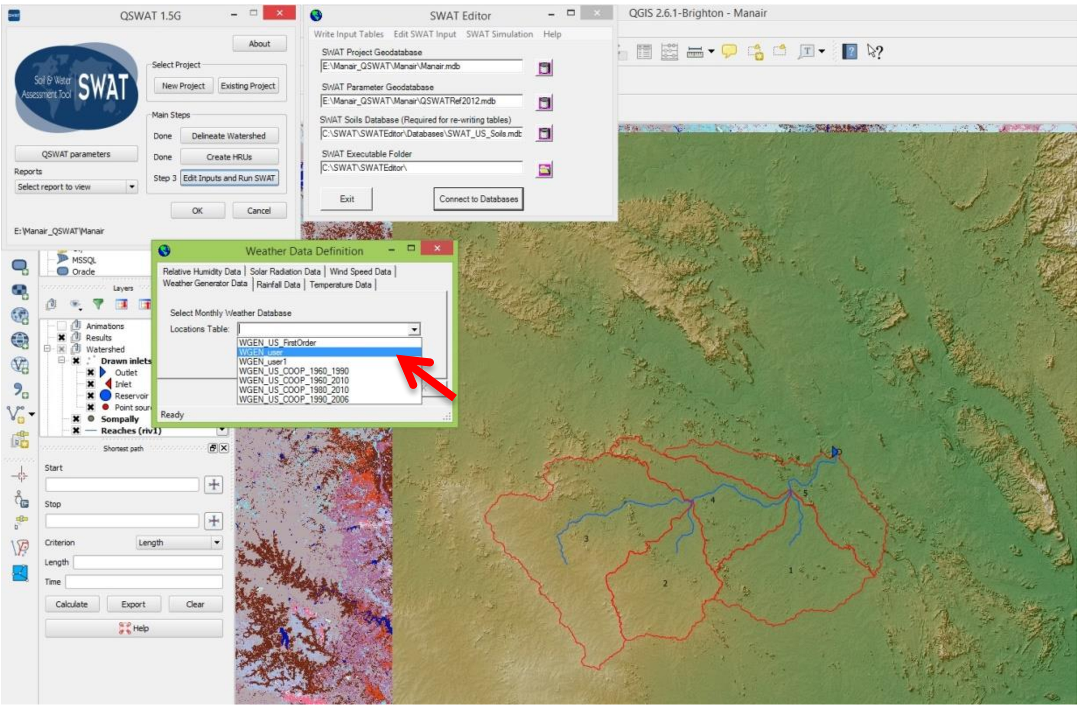
56. Go to QSWAT 1.5G dialog box and click ***Edit Inputs and Run SWAT button***. ***SWAT Editor*** Dialog box opens. Click ***Connect to Database*** button. ***Database connection successful*** message appears. Click OK.




57. Click ***Write Input Tables*** from toolbar and from the drop down, click ***Weather Stations***. This menu contains functions to build database files that include information needed to generate default input for the SWAT model. The commands on the menu need to be implemented only once for a project. However, if the user modifies the HRU distribution after building the input database files, these commands must be reprocessed again.

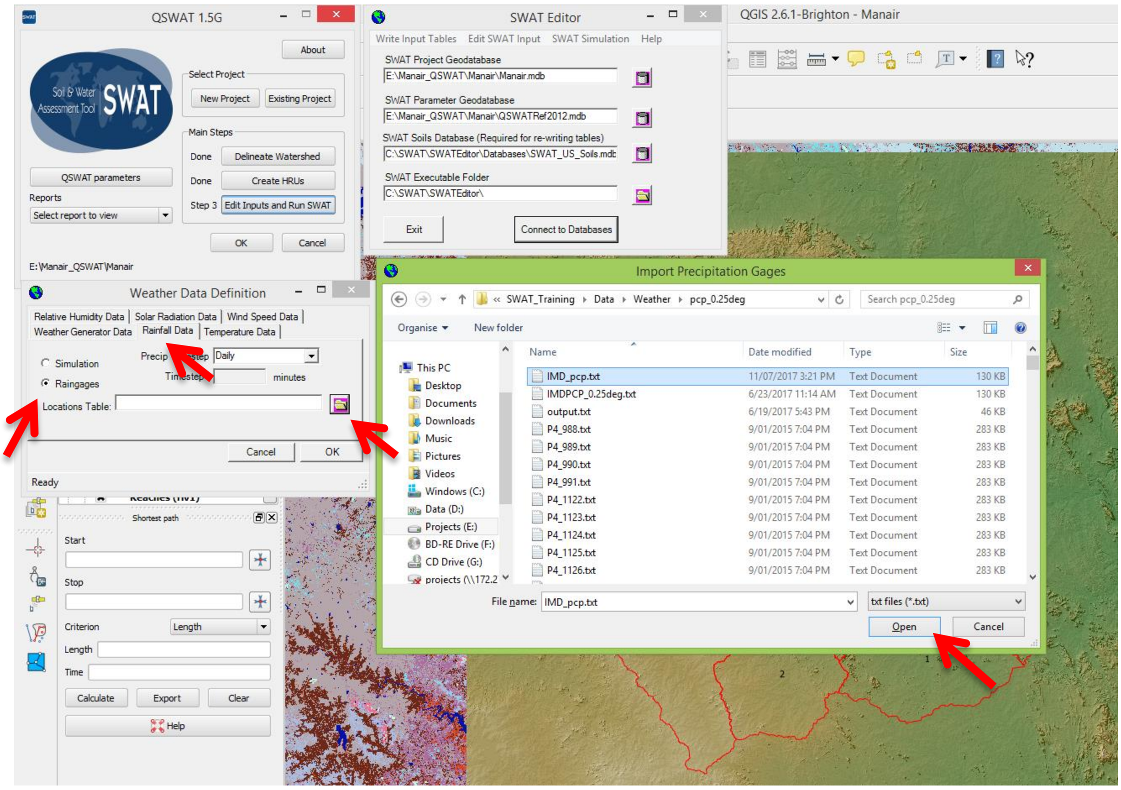


58. The ***Weather Data Definition*** dialog box opens. From the Locations Table dropdown, select ***WGEN_user***. (Note: Don't click OK)



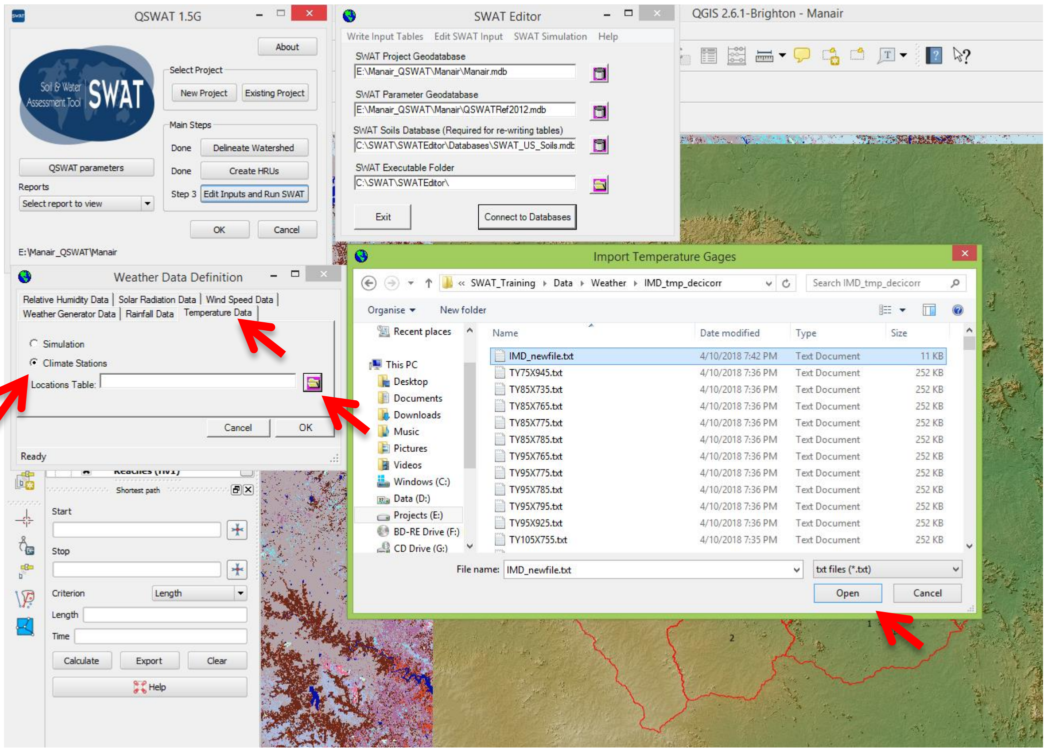

59. Click on Rainfall Data tab and select Raingages radio button.

60. Import the precipitation gauges file ***IMD_pcp.txt*** from the following path: SWAT_Training > Data > Weather > pcp_0.25deg

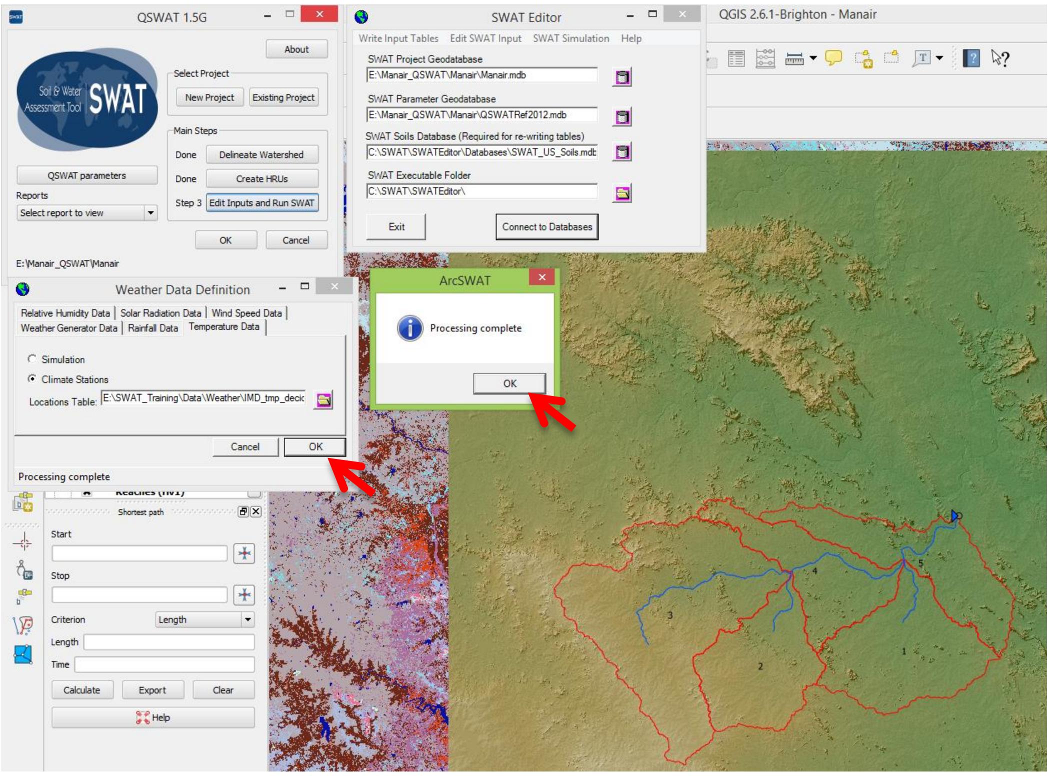


61. Click on Temperature Data tab and select Climate Stations radio button.

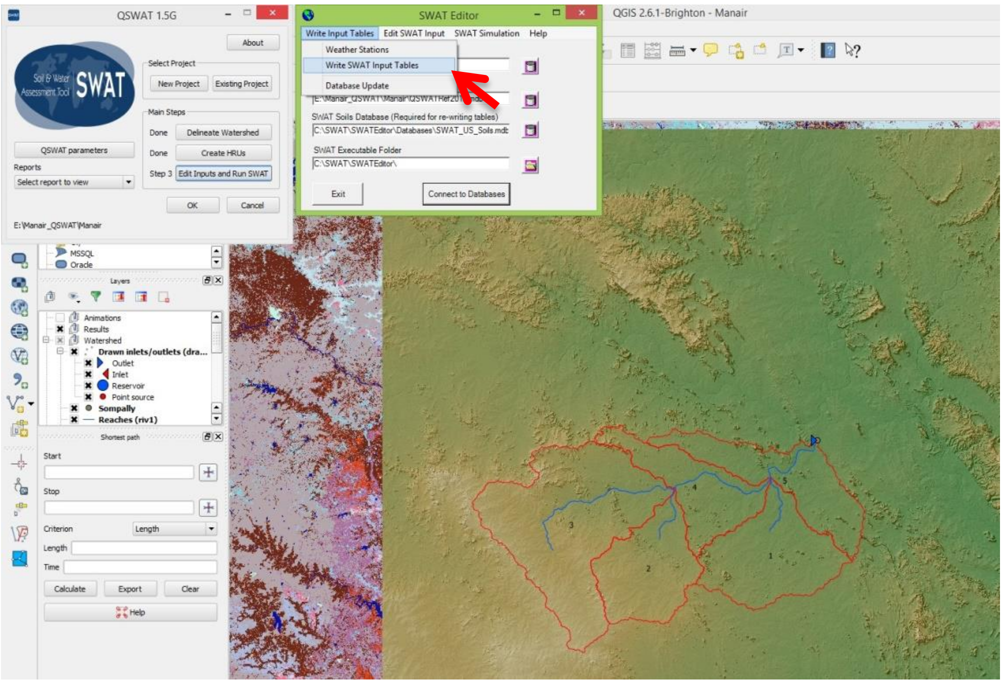
62. Import the Temperature gauges file ***IMD_newfile.txt*** from the following path: SWAT_Training > Data > Weather > IMD_tmp_decicorr



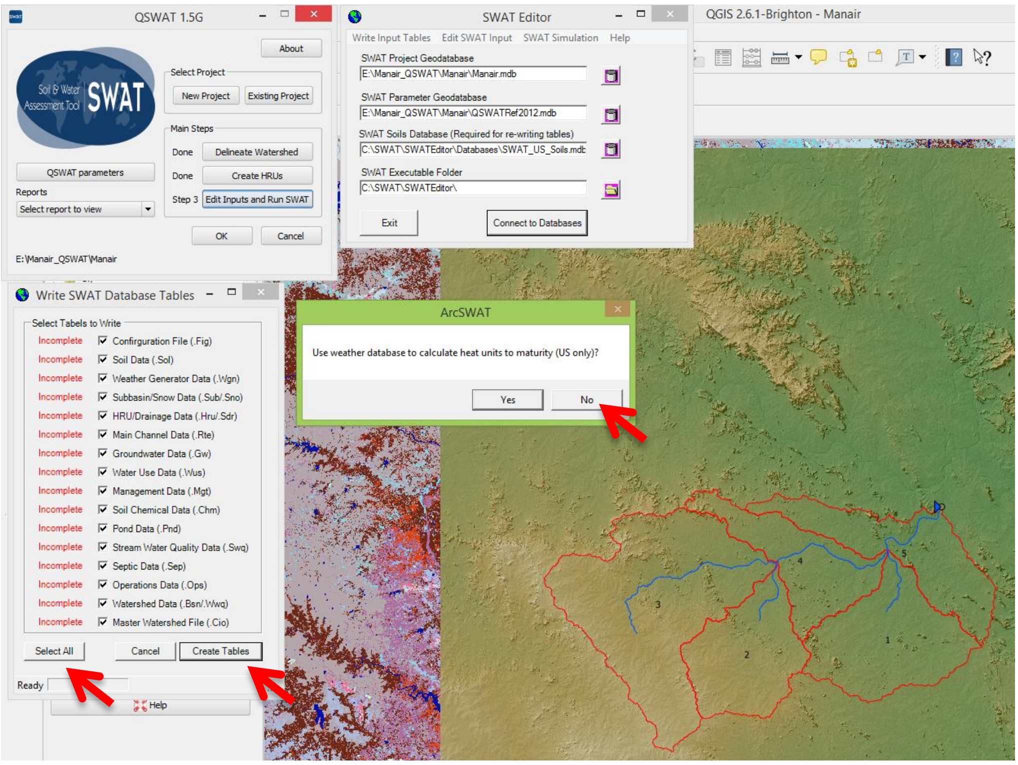

63. Click OK and close the weather data definition dialog box. The Weather files are read successfully.

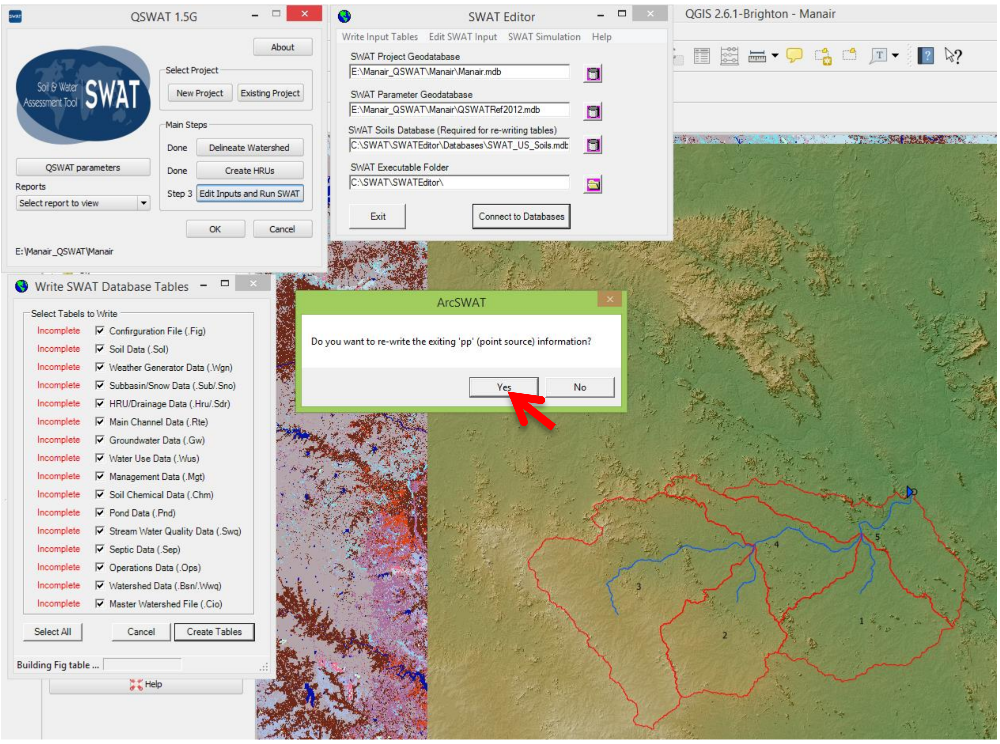


64. Click ***Write Input Tables*** from toolbar and from the drop down, click ***Write SWAT Input Tables***.

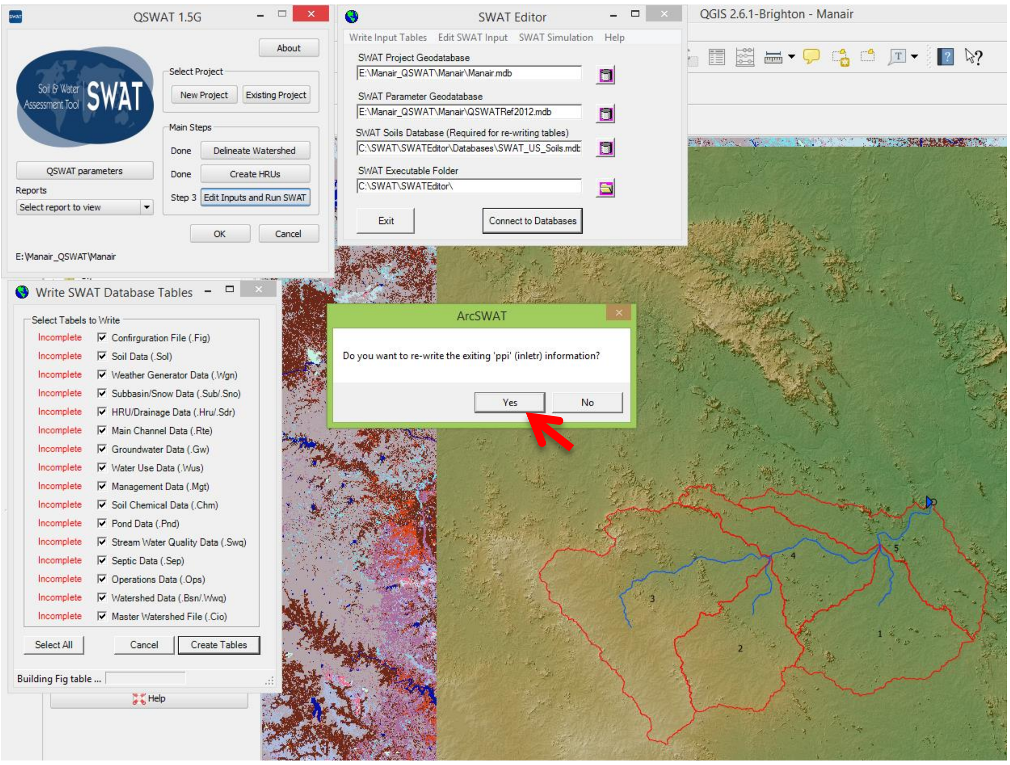


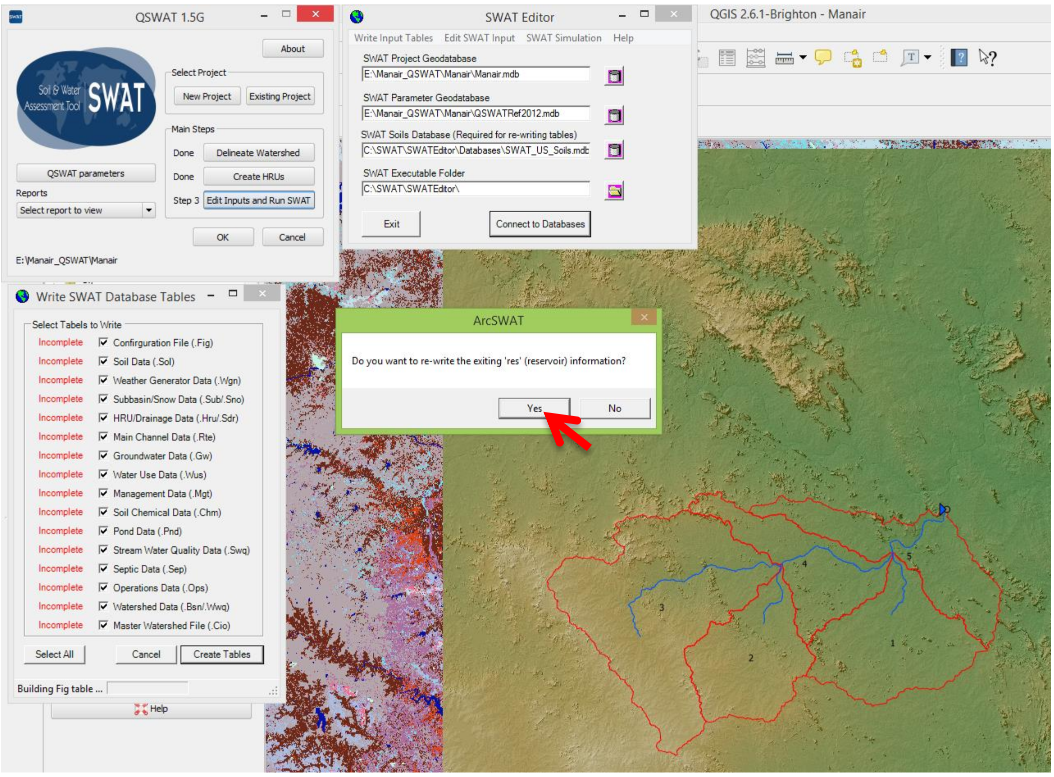

65***. Write SWAT Database Tables*** dialog appears. Click ***Select All*** button and then click ***Create Tables*** button. Then Click ***No.***



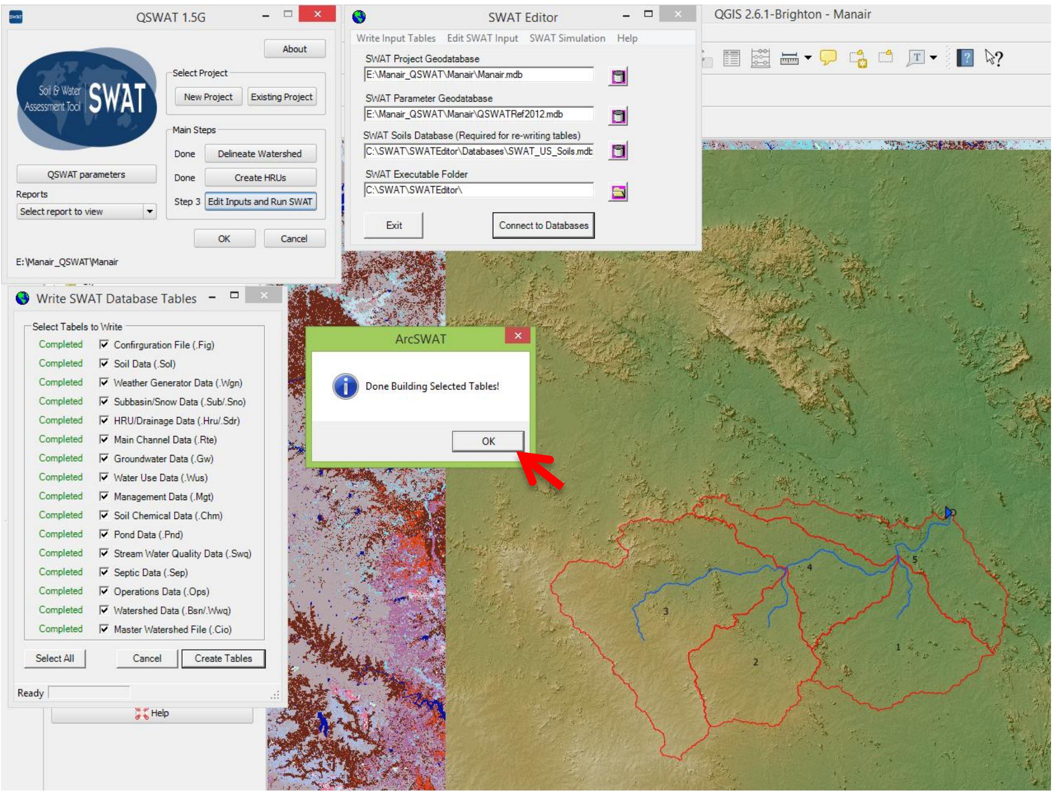

QSWAT 1.5G
About
Select Project
New Project
Existing Project
Main Steps
Done Delineate Watershed
Done Create HRUs
Step 3 Edit Inputs and Run SWAT
QSWAT parameters
Reports
Select report to view
OK
Cancel
E:\Manair_QSWAT\Manair
SWAT Editor
Write Input Tables Edit SWAT Input SWAT Simulation Help
SWAT Project Geodatabase
E:\Manair_QSWAT\Manair\Manair.mdb
SWAT Parameter Geodatabase
E:\Manair_QSWAT\Manair\QSWATRef2012.mdb
SWAT Soils Database (Required for re-writing tables)
C:\SWAT\SWATEditor\Databases\SWAT_US_Soils.mdb
SWAT Executable Folder
C:\SWAT\SWATEditor\
Exit
Connect to Databases
QGIS 2.6.1-Brighton - Manair
Write SWAT Database Tables
Select Tabels to Write
Incomplete Confirguration File (.Fig)
Incomplete Soil Data (.Sol)
Incomplete Weather Generator Data (.Wgn)
Incomplete Subbasin/Snow Data (.Sub/.Sno)
Incomplete HRU/Drainage Data (.Hru/.Sdr)
Incomplete Main Channel Data (.Rte)
Incomplete Groundwater Data (.Gw)
Incomplete Water Use Data (.Wus)
Incomplete Management Data (.Mgt)
Incomplete Soil Chemical Data (.Chm)
Incomplete Pond Data (.Pnd)
Incomplete Stream Water Quality Data (.Swq)
Incomplete Septic Data (.Sep)
Incomplete Operations Data (.Ops)
Incomplete Watershed Data (.Bsn/.Wwq)
Incomplete Master Watershed File (.Cio)
Select All
Cancel
Create Tables
Building Fig table ...
Help
ArcSWAT
Do you want to re-write the exiting 'pp' (point source) information?
Yes
No

66. Click ***Yes***.

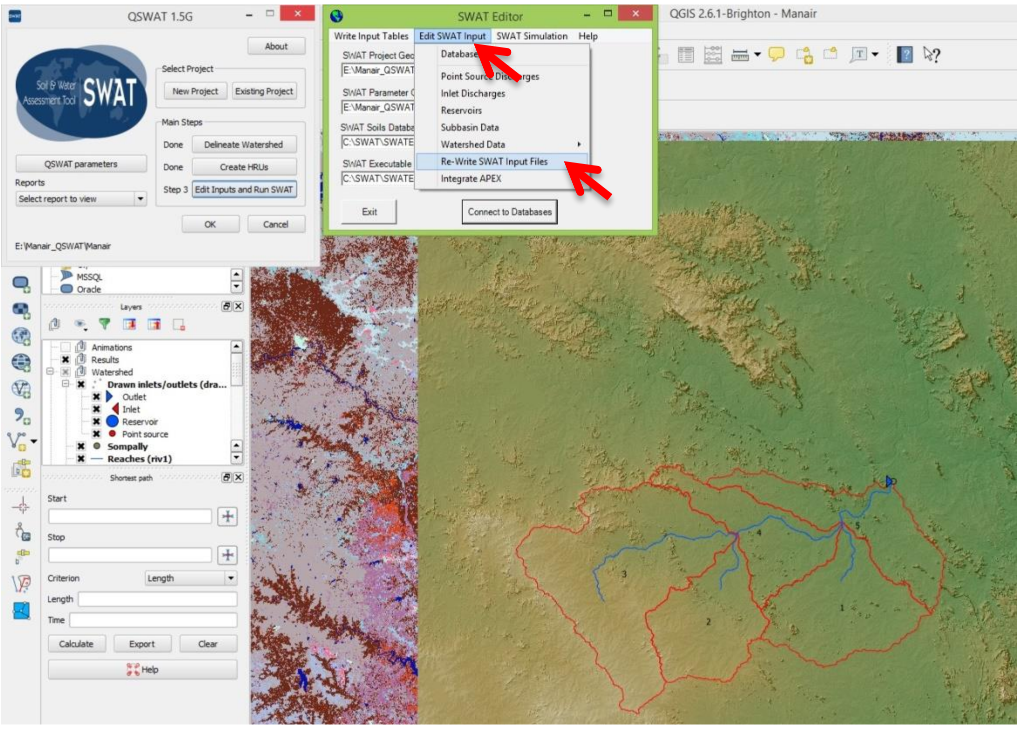

QSWAT 1.5G
About
Select Project
New Project
Existing Project
Main Steps
Done Delineate Watershed
Done Create HRUs
Step 3 Edit Inputs and Run SWAT
QSWAT parameters
Reports
Select report to view
OK
Cancel
E:\Manair_QSWAT\Manair
SWAT Editor
Write Input Tables Edit SWAT Input SWAT Simulation Help
SWAT Project Geodatabase
E:\Manair_QSWAT\Manair\Manair.mdb
SWAT Parameter Geodatabase
E:\Manair_QSWAT\Manair\QSWATRef2012.mdb
SWAT Soils Database (Required for re-writing tables)
C:\SWAT\SWATEditor\Databases\SWAT_US_Soils.mdb
SWAT Executable Folder
C:\SWAT\SWATEditor\
Exit
Connect to Databases
QGIS 2.6.1-Brighton - Manair
Write SWAT Database Tables
Select Tabels to Write
Incomplete Confirguration File (.Fig)
Incomplete Soil Data (.Sol)
Incomplete Weather Generator Data (.Wgn)
Incomplete Subbasin/Snow Data (.Sub/.Sno)
Incomplete HRU/Drainage Data (.Hru/.Sdr)
Incomplete Main Channel Data (.Rte)
Incomplete Groundwater Data (.Gw)
Incomplete Water Use Data (.Wus)
Incomplete Management Data (.Mgt)
Incomplete Soil Chemical Data (.Chm)
Incomplete Pond Data (.Pnd)
Incomplete Stream Water Quality Data (.Swq)
Incomplete Septic Data (.Sep)
Incomplete Operations Data (.Ops)
Incomplete Watershed Data (.Bsn/.Wwq)
Incomplete Master Watershed File (.Cio)
Select All
Cancel
Create Tables
Building Fig table ...
Help
ArcSWAT
Do you want to re-write the exiting 'ppi' (inletr) information?
Yes
No



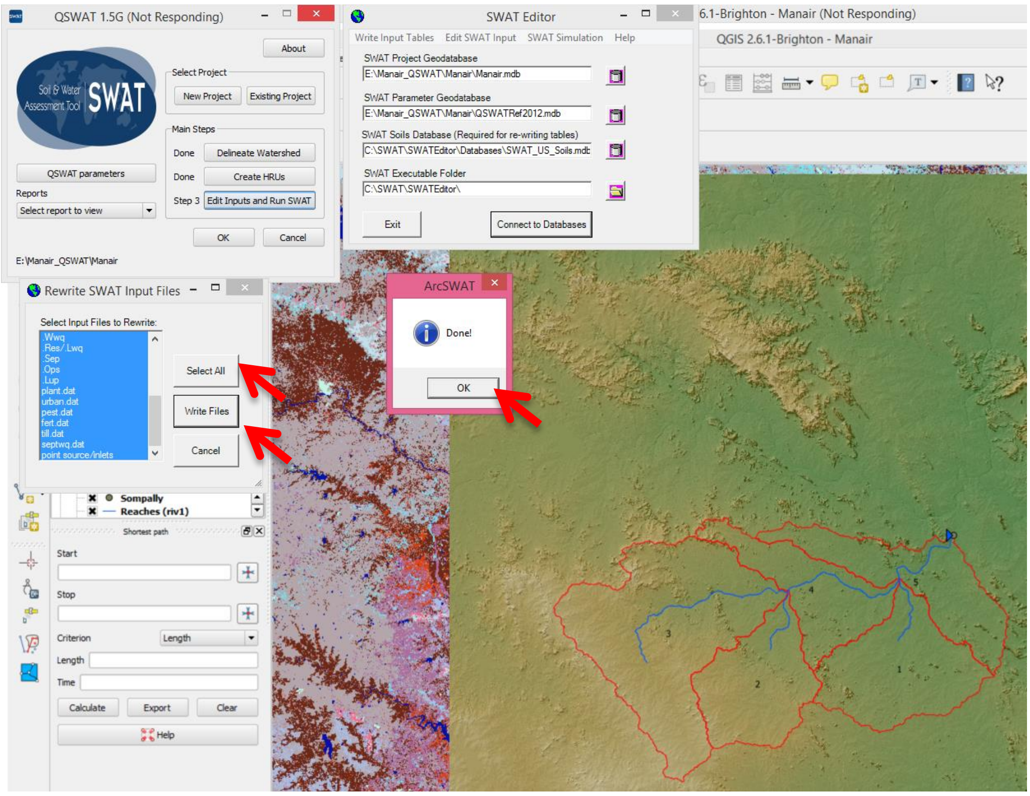

67. Click ***OK*** and close ***Write SWAT database Tables*** dialog box. This creates tables for all files to be written.



68. Click **Edit SWAT Input** from toolbar and from the drop down, click ***Re-Write SWAT Input Files***.

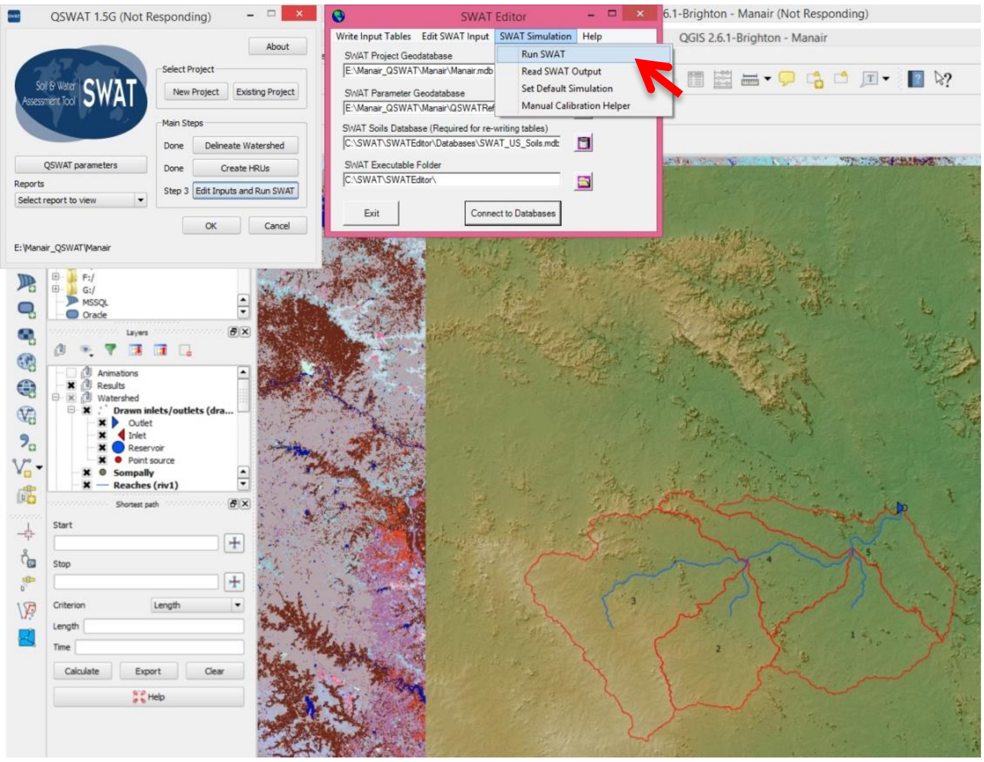



69. From the ***Rewrite SWAT Input Files*** dialog box, click ***Select All*** button and click ***Write Files*** button, then click ***OK.*** Rewriting of all tables is done successfully.

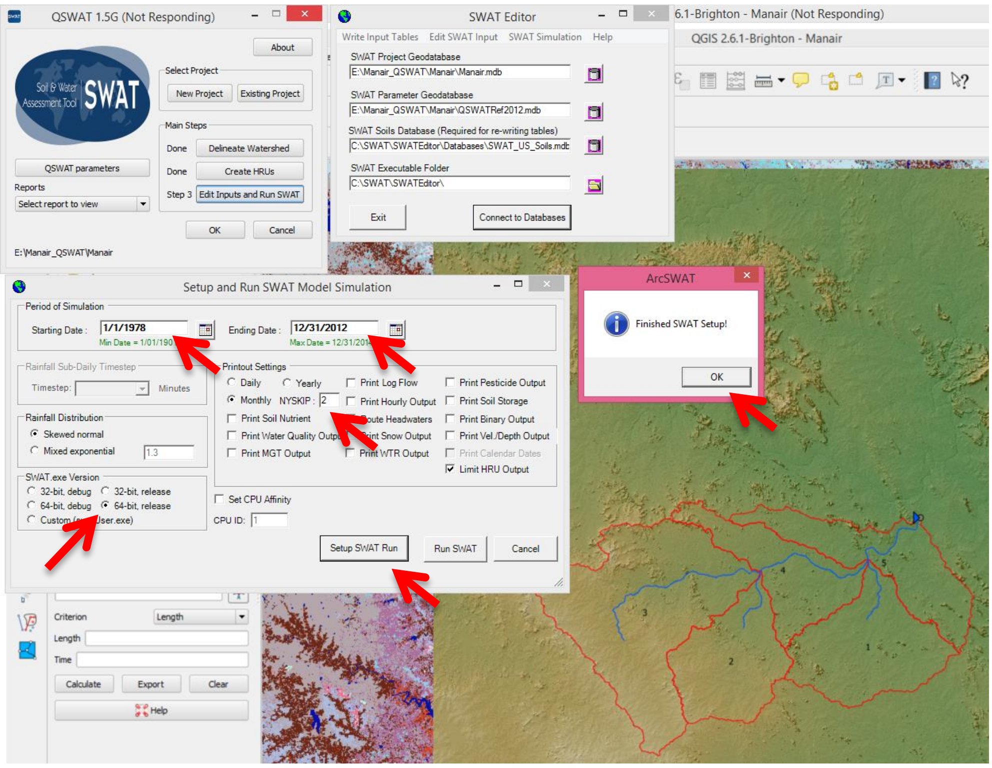


70. Then Close Rewrite SWAT Input Files dialog box.

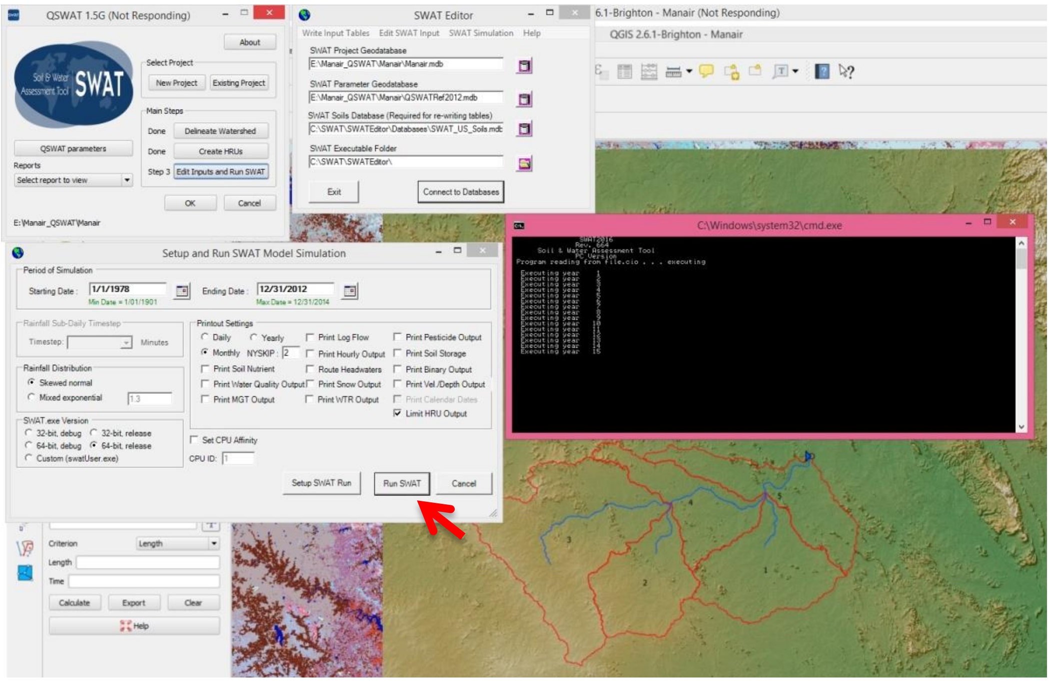
71. Click **SWAT Simulation** from toolbar and from the drop down, click ***Run SWAT***.



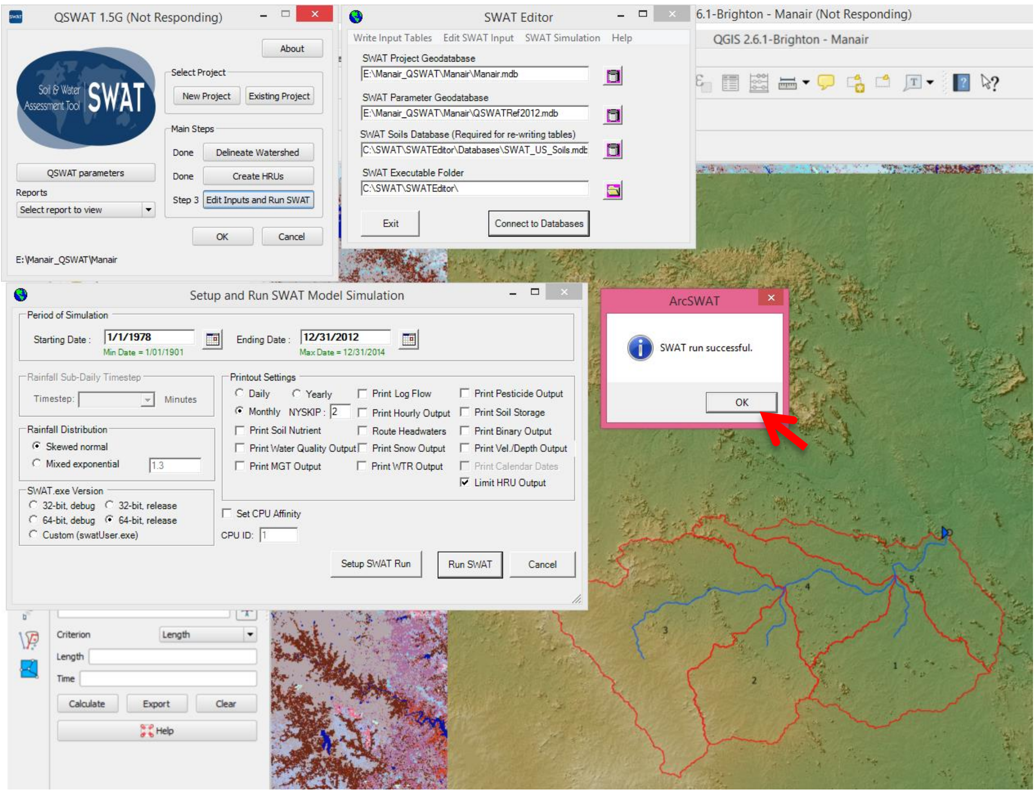

72. ***Setup and Run SWAT Model Simulation*** dialog box appears. In that dialog box, Change the ***starting and ending date*** to 1/1/1978 and 12/31/2012 respectively. Select ***64-bit release*** radio button, provide ***NYSKIP*** value of 2. Then click ***Setup SWAT Run*** button. Click ***OK***.



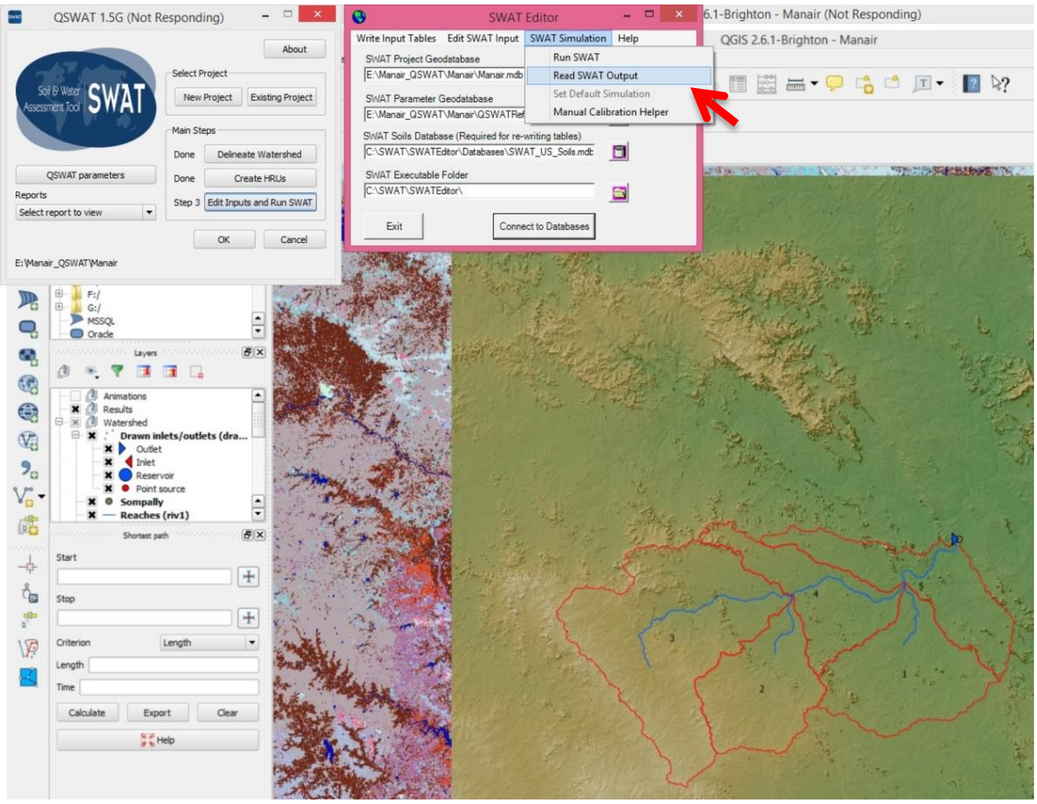
73. Click Run SWAT button. This runs the SWAT model.



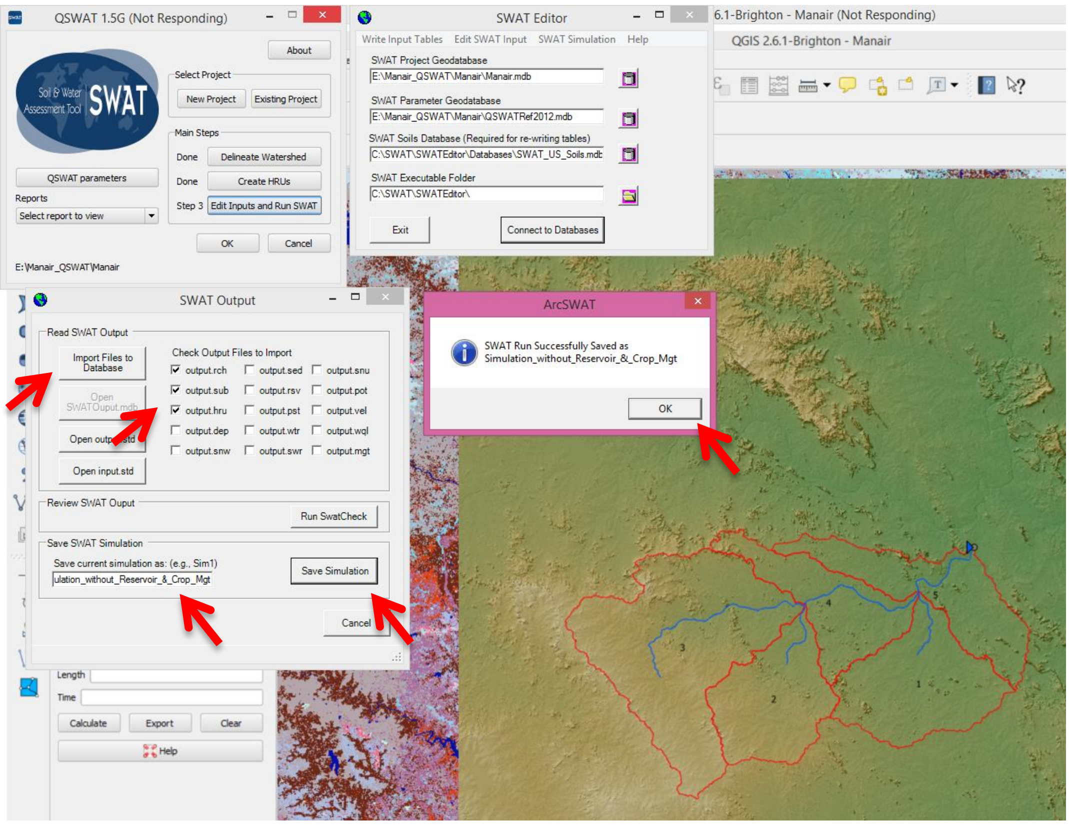

74. Click ***OK*** and close the ***Setup and Run SWAT Model Simulation*** dialog box.



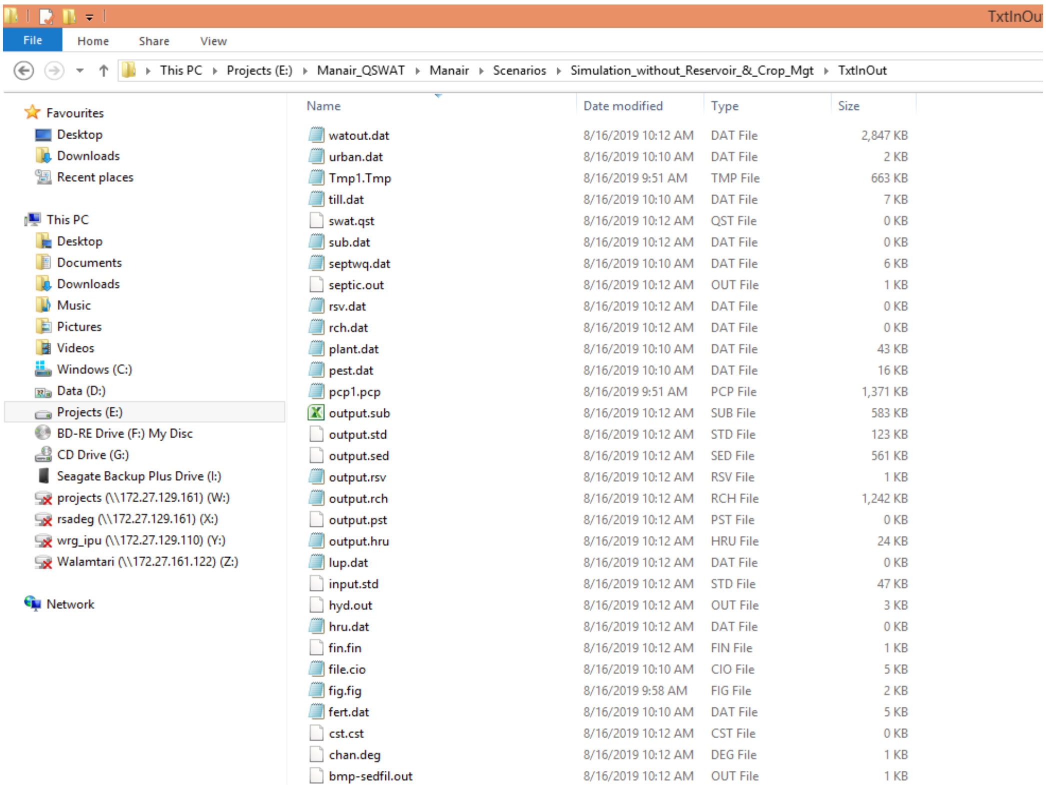
75. Click **SWAT Simulation** from toolbar and from the drop down, click ***Read SWAT Output.***




76. Check ***output.rch, output.sub, output.hru*** and click on ***Import Files to Databases*** button. Save current simulation name as "Simulation_without_Reservoir_&_Crop_Mgt" and Save the SWAT simulation by clicking on ***Save Simulation*** button.

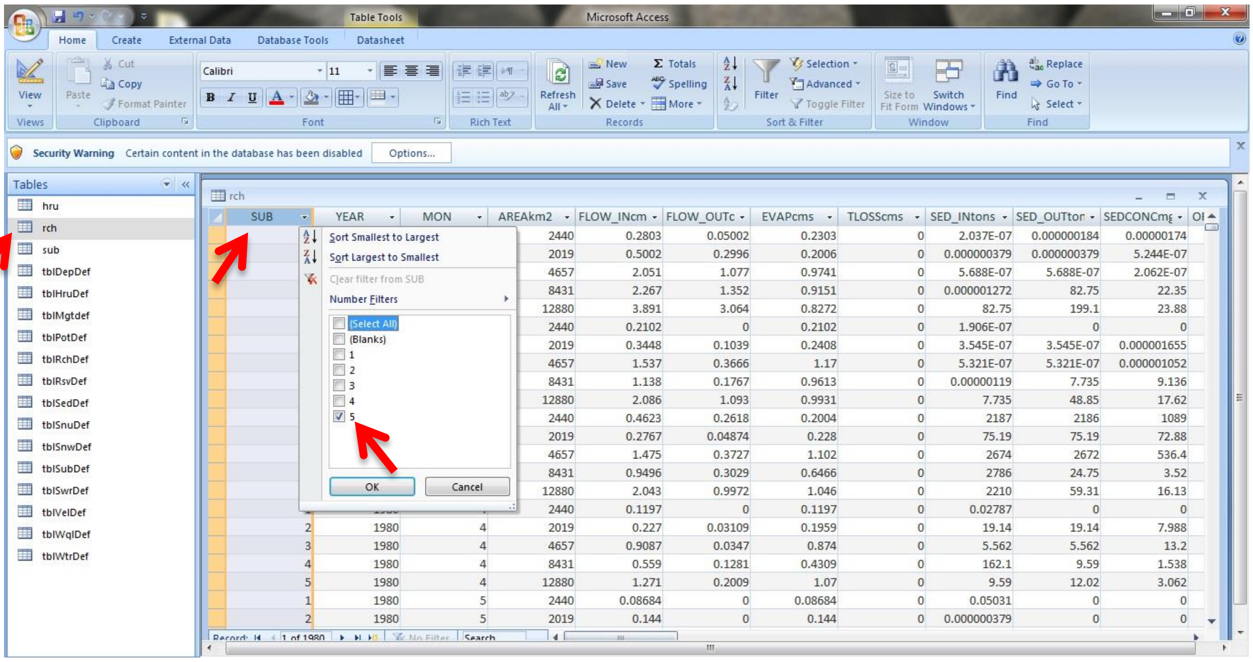


77. The simulation results are saved in the following path: Manair_QSWAT > Manair > Scenarios > Simulation_without_Reservoir_&_Crop_Mgt > TxtInOut

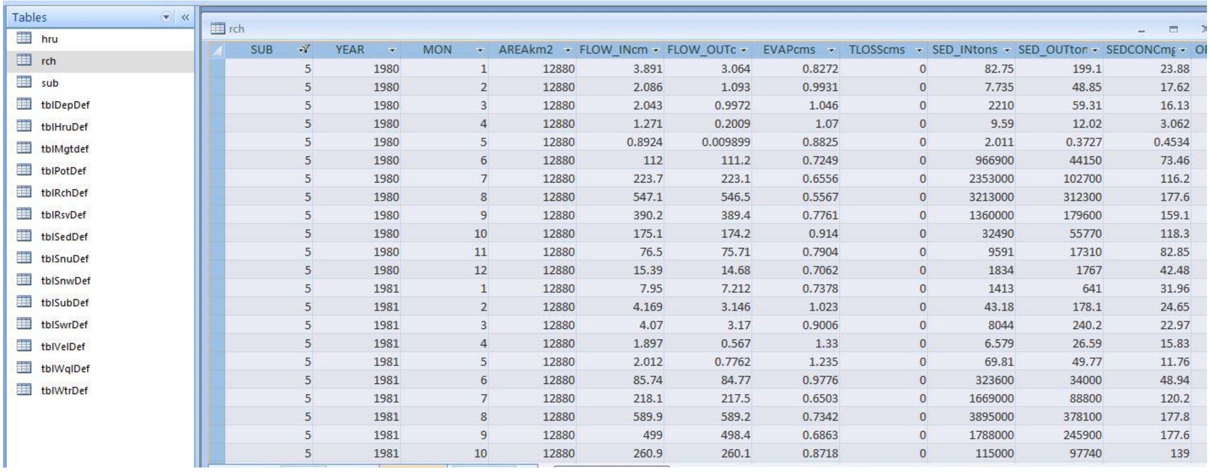



78. Open the ***SWATOutput.mdb*** file from the following path: Manair_QSWAT > Manair > Scenarios > Simulation_with_Reservoir_&_Crop_Mgt > TablesOut

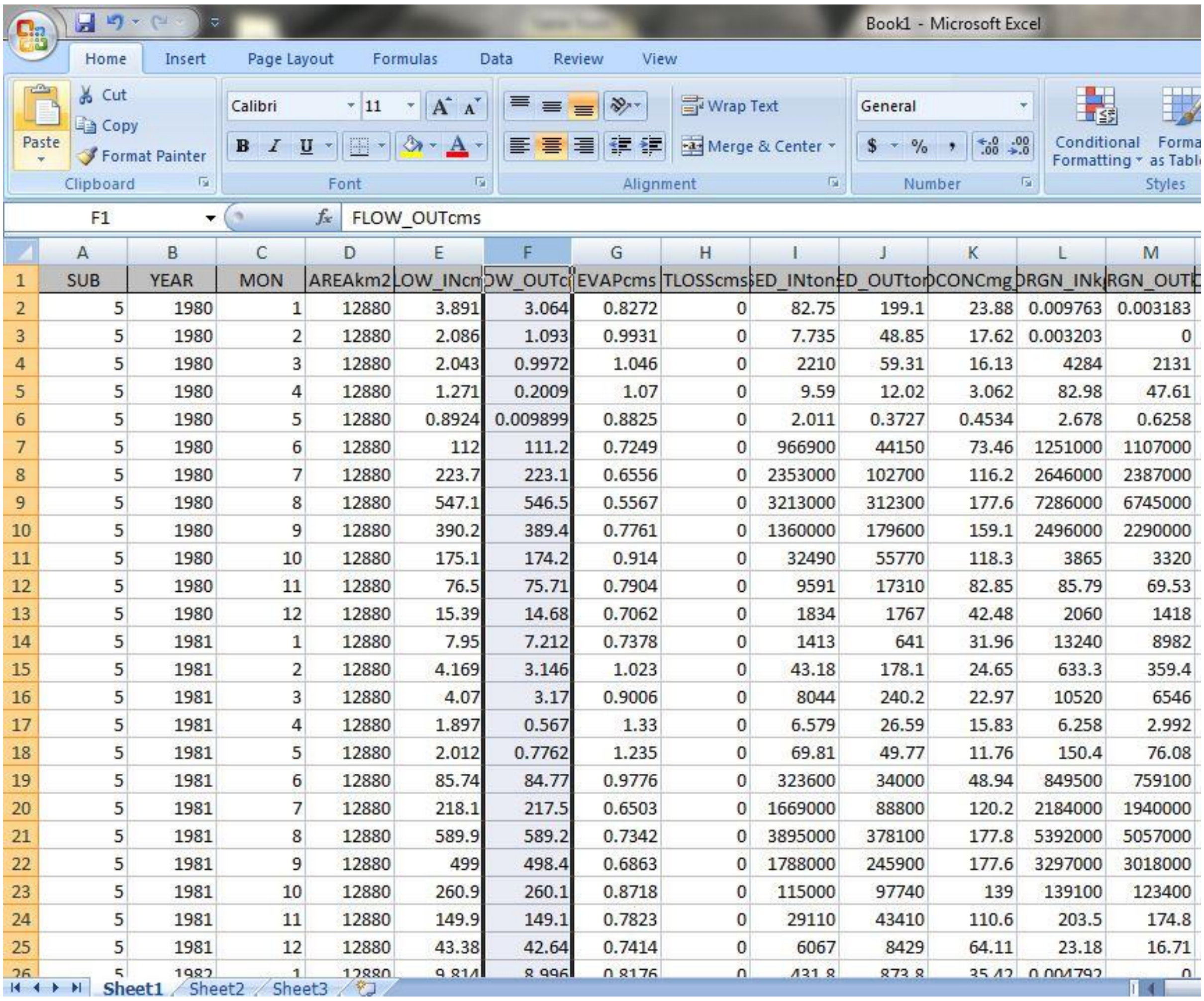
Open the ***rch*** table from it. Click on SUB and filter only SUB with value “5”.



79. Copy the sheet and paste it in a new excel sheet named “Results”




| SUB | YEAR | MON | AREAkm2 | FLOW_INcm | FLOW_OUTc | EVAPcms | TLOSScms | SED_INtons | SED_OUTton | SEDCONCmg |
|---|---|---|---|---|---|---|---|---|---|---|
| 5 | 1980 | 1 | 12880 | 3.891 | 3.064 | 0.8272 | 0 | 82.75 | 199.1 | 23.88 |
| 5 | 1980 | 2 | 12880 | 2.086 | 1.093 | 0.9931 | 0 | 7.735 | 48.85 | 17.62 |
| 5 | 1980 | 3 | 12880 | 2.043 | 0.9972 | 1.046 | 0 | 2210 | 59.31 | 16.13 |
| 5 | 1980 | 4 | 12880 | 1.271 | 0.2009 | 1.07 | 0 | 9.59 | 12.02 | 3.062 |
| 5 | 1980 | 5 | 12880 | 0.8924 | 0.009899 | 0.8825 | 0 | 2.011 | 0.3727 | 0.4534 |
| 5 | 1980 | 6 | 12880 | 112 | 111.2 | 0.7249 | 0 | 966900 | 44150 | 73.46 |
| 5 | 1980 | 7 | 12880 | 223.7 | 223.1 | 0.6556 | 0 | 2353000 | 102700 | 116.2 |
| 5 | 1980 | 8 | 12880 | 547.1 | 546.5 | 0.5567 | 0 | 3213000 | 312300 | 177.6 |
| 5 | 1980 | 9 | 12880 | 390.2 | 389.4 | 0.7761 | 0 | 1360000 | 179600 | 159.1 |
| 5 | 1980 | 10 | 12880 | 175.1 | 174.2 | 0.914 | 0 | 32490 | 55770 | 118.3 |
| 5 | 1980 | 11 | 12880 | 76.5 | 75.71 | 0.7904 | 0 | 9591 | 17310 | 82.85 |
| 5 | 1980 | 12 | 12880 | 15.39 | 14.68 | 0.7062 | 0 | 1834 | 1767 | 42.48 |
| 5 | 1981 | 1 | 12880 | 7.95 | 7.212 | 0.7378 | 0 | 1413 | 641 | 31.96 |
| 5 | 1981 | 2 | 12880 | 4.169 | 3.146 | 1.023 | 0 | 43.18 | 178.1 | 24.65 |
| 5 | 1981 | 3 | 12880 | 4.07 | 3.17 | 0.9006 | 0 | 8044 | 240.2 | 22.97 |
| 5 | 1981 | 4 | 12880 | 1.897 | 0.567 | 1.33 | 0 | 6.579 | 26.59 | 15.83 |
| 5 | 1981 | 5 | 12880 | 2.012 | 0.7762 | 1.235 | 0 | 69.81 | 49.77 | 11.76 |
| 5 | 1981 | 6 | 12880 | 85.74 | 84.77 | 0.9776 | 0 | 323600 | 34000 | 48.94 |
| 5 | 1981 | 7 | 12880 | 218.1 | 217.5 | 0.6503 | 0 | 1669000 | 88800 | 120.2 |
| 5 | 1981 | 8 | 12880 | 589.9 | 589.2 | 0.7342 | 0 | 3895000 | 378100 | 177.8 |
| 5 | 1981 | 9 | 12880 | 499 | 498.4 | 0.6863 | 0 | 1788000 | 245900 | 177.6 |
| 5 | 1981 | 10 | 12880 | 260.9 | 260.1 | 0.8718 | 0 | 115000 | 97740 | 139 |




| | A | B | C | D | E | F | G | H | I | J | K | L | M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | SUB | YEAR | MON | AREAkm2 | LOW_INcm | DW_OUTc | EVAPcms | TLOSScms | ED_INton | ED_OUTto | DCONCmg | DRGN_INk | RGN_OUT |
| 2 | 5 | 1980 | 1 | 12880 | 3.891 | 3.064 | 0.8272 | 0 | 82.75 | 199.1 | 23.88 | 0.009763 | 0.003183 |
| 3 | 5 | 1980 | 2 | 12880 | 2.086 | 1.093 | 0.9931 | 0 | 7.735 | 48.85 | 17.62 | 0.003203 | 0 |
| 4 | 5 | 1980 | 3 | 12880 | 2.043 | 0.9972 | 1.046 | 0 | 2210 | 59.31 | 16.13 | 4284 | 2131 |
| 5 | 5 | 1980 | 4 | 12880 | 1.271 | 0.2009 | 1.07 | 0 | 9.59 | 12.02 | 3.062 | 82.98 | 47.61 |
| 6 | 5 | 1980 | 5 | 12880 | 0.8924 | 0.009899 | 0.8825 | 0 | 2.011 | 0.3727 | 0.4534 | 2.678 | 0.6258 |
| 7 | 5 | 1980 | 6 | 12880 | 112 | 111.2 | 0.7249 | 0 | 966900 | 44150 | 73.46 | 1251000 | 1107000 |
| 8 | 5 | 1980 | 7 | 12880 | 223.7 | 223.1 | 0.6556 | 0 | 2353000 | 102700 | 116.2 | 2646000 | 2387000 |
| 9 | 5 | 1980 | 8 | 12880 | 547.1 | 546.5 | 0.5567 | 0 | 3213000 | 312300 | 177.6 | 7286000 | 6745000 |
| 10 | 5 | 1980 | 9 | 12880 | 390.2 | 389.4 | 0.7761 | 0 | 1360000 | 179600 | 159.1 | 2496000 | 2290000 |
| 11 | 5 | 1980 | 10 | 12880 | 175.1 | 174.2 | 0.914 | 0 | 32490 | 55770 | 118.3 | 3865 | 3320 |
| 12 | 5 | 1980 | 11 | 12880 | 76.5 | 75.71 | 0.7904 | 0 | 9591 | 17310 | 82.85 | 85.79 | 69.53 |
| 13 | 5 | 1980 | 12 | 12880 | 15.39 | 14.68 | 0.7062 | 0 | 1834 | 1767 | 42.48 | 2060 | 1418 |
| 14 | 5 | 1981 | 1 | 12880 | 7.95 | 7.212 | 0.7378 | 0 | 1413 | 641 | 31.96 | 13240 | 8982 |
| 15 | 5 | 1981 | 2 | 12880 | 4.169 | 3.146 | 1.023 | 0 | 43.18 | 178.1 | 24.65 | 633.3 | 359.4 |
| 16 | 5 | 1981 | 3 | 12880 | 4.07 | 3.17 | 0.9006 | 0 | 8044 | 240.2 | 22.97 | 10520 | 6546 |
| 17 | 5 | 1981 | 4 | 12880 | 1.897 | 0.567 | 1.33 | 0 | 6.579 | 26.59 | 15.83 | 6.258 | 2.992 |
| 18 | 5 | 1981 | 5 | 12880 | 2.012 | 0.7762 | 1.235 | 0 | 69.81 | 49.77 | 11.76 | 150.4 | 76.08 |
| 19 | 5 | 1981 | 6 | 12880 | 85.74 | 84.77 | 0.9776 | 0 | 323600 | 34000 | 48.94 | 849500 | 759100 |
| 20 | 5 | 1981 | 7 | 12880 | 218.1 | 217.5 | 0.6503 | 0 | 1669000 | 88800 | 120.2 | 2184000 | 1940000 |
| 21 | 5 | 1981 | 8 | 12880 | 589.9 | 589.2 | 0.7342 | 0 | 3895000 | 378100 | 177.8 | 5392000 | 5057000 |
| 22 | 5 | 1981 | 9 | 12880 | 499 | 498.4 | 0.6863 | 0 | 1788000 | 245900 | 177.6 | 3297000 | 3018000 |
| 23 | 5 | 1981 | 10 | 12880 | 260.9 | 260.1 | 0.8718 | 0 | 115000 | 97740 | 139 | 139100 | 123400 |
| 24 | 5 | 1981 | 11 | 12880 | 149.9 | 149.1 | 0.7823 | 0 | 29110 | 43410 | 110.6 | 203.5 | 174.8 |
| 25 | 5 | 1981 | 12 | 12880 | 43.38 | 42.64 | 0.7414 | 0 | 6067 | 8429 | 64.11 | 23.18 | 16.71 |
| 26 | 5 | 1982 | 1 | 12880 | 9.814 | 8.996 | 0.8176 | 0 | 431.8 | 873.8 | 35.42 | 0.004792 | 0 |

80. Copy only SUB, YEAR, MON and FLOW_OUTcms columns to sheet2. Also copy observed data from ***Observed_Somanpally.xlsx*** from the following path: ***SWAT_Training > Data > Observed***

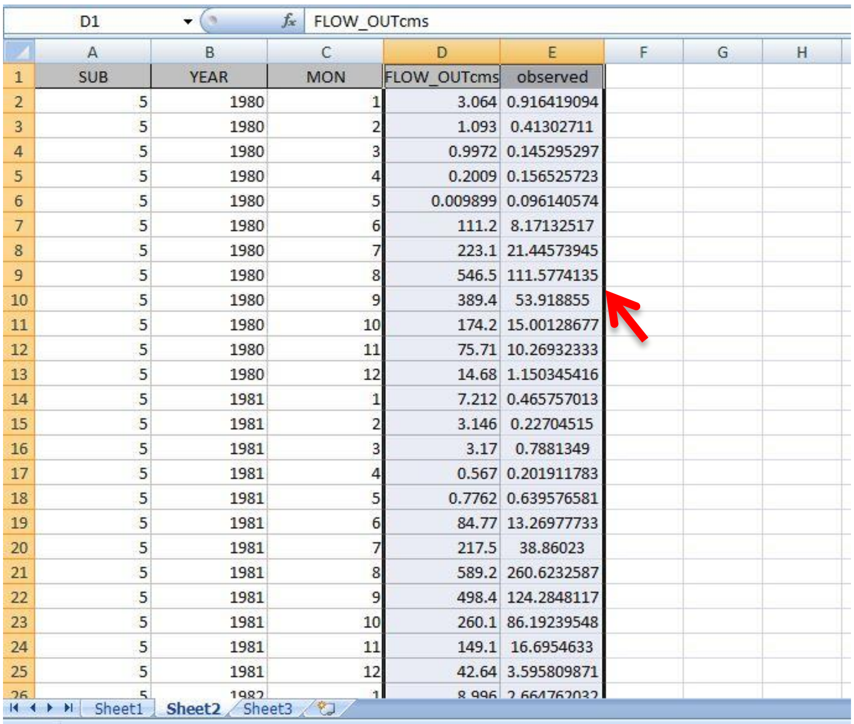
| | A | B | C | D | E |
|---|---|---|---|---|---|
| 1 | Year | Observed_Discharge_Monthly_Average | | | |
| 2 | 1980 | 0.916419094 | | | |
| 3 | 1980 | 0.41302711 | | | |
| 4 | 1980 | 0.145295297 | | | |
| 5 | 1980 | 0.156525723 | | | |
| 6 | 1980 | 0.096140574 | | | |
| 7 | 1980 | 8.17132517 | | | |
| 8 | 1980 | 21.44573945 | | | |
| 9 | 1980 | 111.5774135 | | | |
| 10 | 1980 | 53.918855 | | | |
| 11 | 1980 | 15.00128677 | | | |
| 12 | 1980 | 10.26932333 | | | |
| 13 | 1980 | 1.150345416 | | | |
| 14 | 1981 | 0.465757013 | | | |
| 15 | 1981 | 0.22704515 | | | |
| 16 | 1981 | 0.7881349 | | | |
| 17 | 1981 | 0.201911783 | | | |
| 18 | 1981 | 0.639576581 | | | |
| 19 | 1981 | 13.26977733 | | | |
| 20 | 1981 | 38.86023 | | | |
| 21 | 1981 | 260.6232587 | | | |
| 22 | 1981 | 124.2848117 | | | |
| 23 | 1981 | 86.19239548 | | | |
| 24 | 1981 | 16.6954633 | | | |
| 25 | 1981 | 3.595809871 | | | |
| 26 | 1982 | 2.664762032 | | | |

Observed_Daily_Raw | Observed_Discharge_Monthly_Avg | swatcup

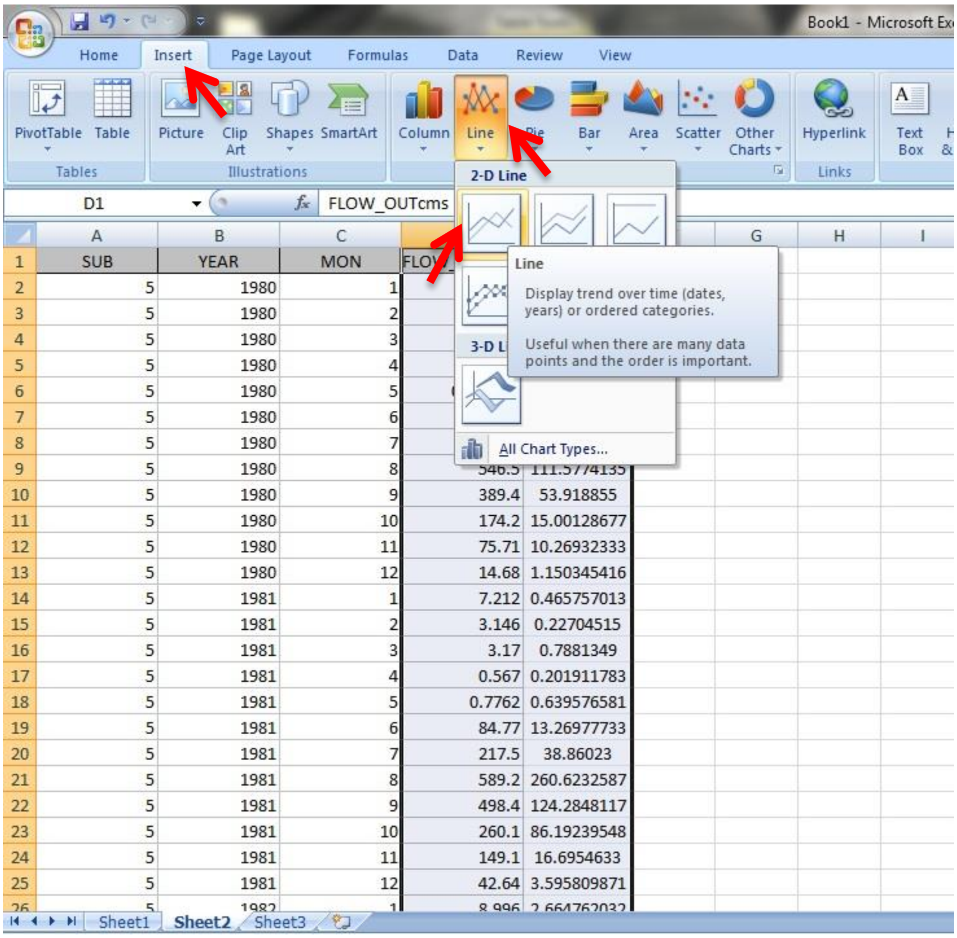
| | A | B | C | D | E | F | G |
|---|---|---|---|---|---|---|---|
| 1 | SUB | YEAR | MON | FLOW_OUTcms | observed | | |
| 2 | 5 | 1980 | 1 | 3.064 | 0.916419094 | | |
| 3 | 5 | 1980 | 2 | 1.093 | 0.41302711 | | |
| 4 | 5 | 1980 | 3 | 0.9972 | 0.145295297 | | |
| 5 | 5 | 1980 | 4 | 0.2009 | 0.156525723 | | |
| 6 | 5 | 1980 | 5 | 0.009899 | 0.096140574 | | |
| 7 | 5 | 1980 | 6 | 111.2 | 8.17132517 | | |
| 8 | 5 | 1980 | 7 | 223.1 | 21.44573945 | | |
| 9 | 5 | 1980 | 8 | 546.5 | 111.5774135 | | |
| 10 | 5 | 1980 | 9 | 389.4 | 53.918855 | | |
| 11 | 5 | 1980 | 10 | 174.2 | 15.00128677 | | |
| 12 | 5 | 1980 | 11 | 75.71 | 10.26932333 | | |
| 13 | 5 | 1980 | 12 | 14.68 | 1.150345416 | | |
| 14 | 5 | 1981 | 1 | 7.212 | 0.465757013 | | |
| 15 | 5 | 1981 | 2 | 3.146 | 0.22704515 | | |
| 16 | 5 | 1981 | 3 | 3.17 | 0.7881349 | | |
| 17 | 5 | 1981 | 4 | 0.567 | 0.201911783 | | |
| 18 | 5 | 1981 | 5 | 0.7762 | 0.639576581 | | |
| 19 | 5 | 1981 | 6 | 84.77 | 13.26977733 | | |
| 20 | 5 | 1981 | 7 | 217.5 | 38.86023 | | |
| 21 | 5 | 1981 | 8 | 589.2 | 260.6232587 | | |
| 22 | 5 | 1981 | 9 | 498.4 | 124.2848117 | | |
| 23 | 5 | 1981 | 10 | 260.1 | 86.19239548 | | |
| 24 | 5 | 1981 | 11 | 149.1 | 16.6954633 | | |
| 25 | 5 | 1981 | 12 | 42.64 | 3.595809871 | | |
| 26 | 5 | 1982 | 1 | 8.996 | 2.664762032 | | |

Sheet1 | Sheet2 | Sheet3

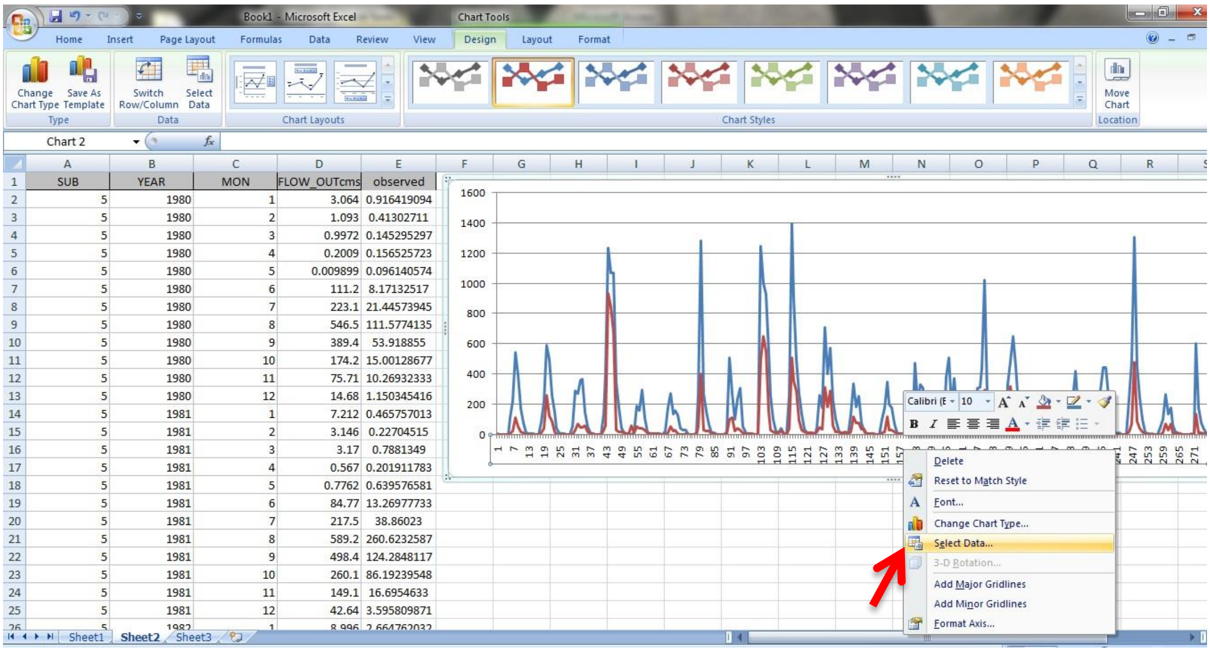
81. Rename the column FLOW_OUT to sim_normal and select that column and observed column. Plot a 2D line graph.



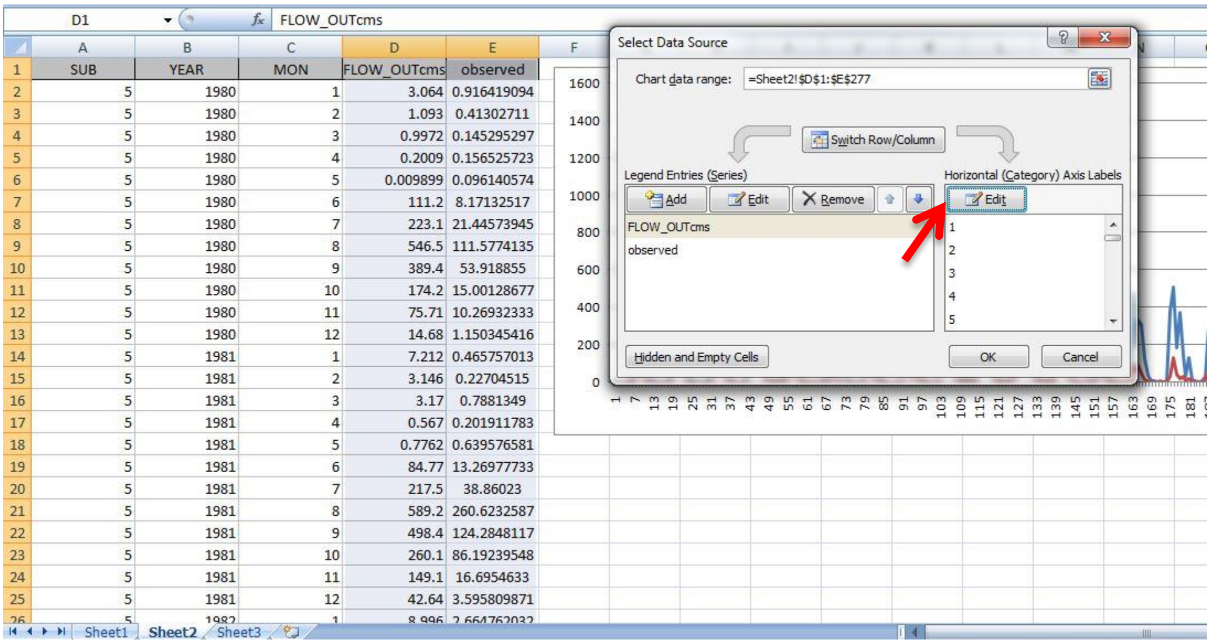

82. To plot the data, click on ***Line*** in ***insert*** toolbar and click ***Line*** option.



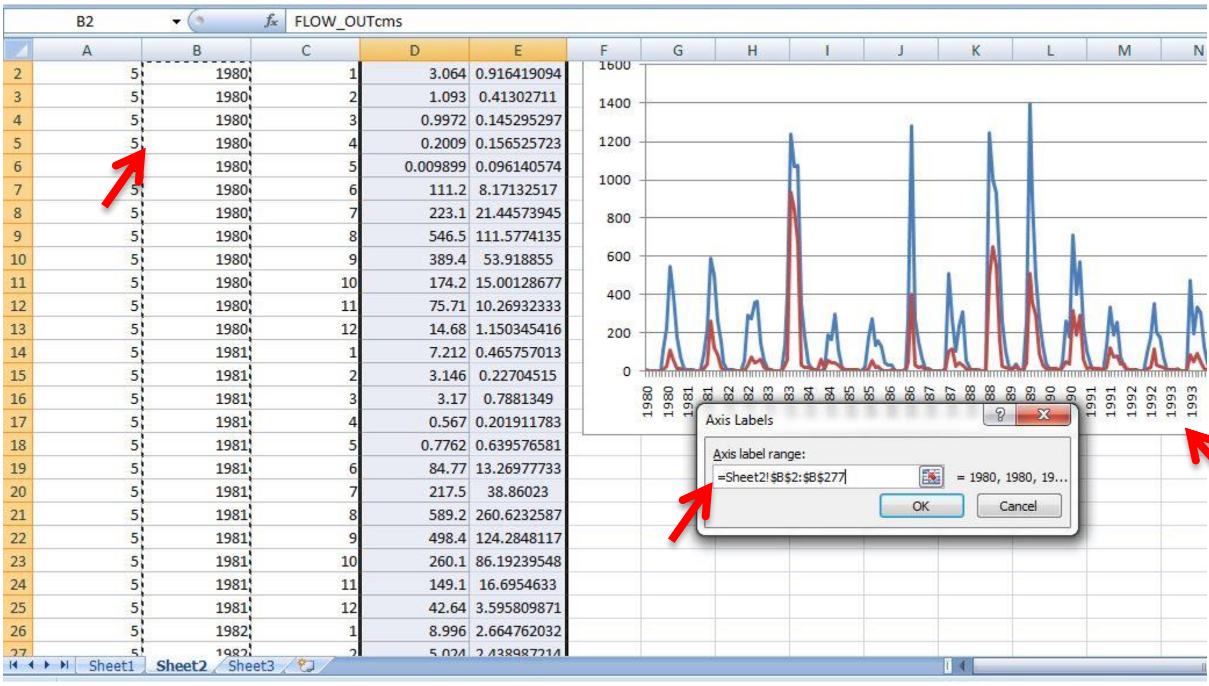
83. Right click on the x-axis and click on ***Select Data.***



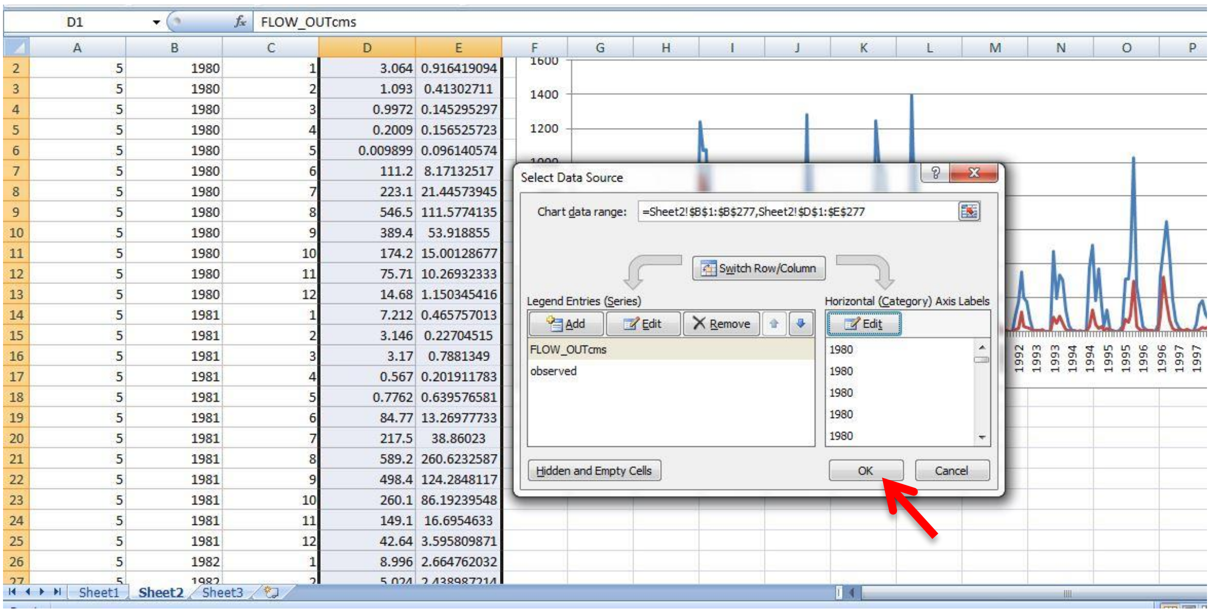
84. Click on Edit button.



85. Select the column in Axis label range.



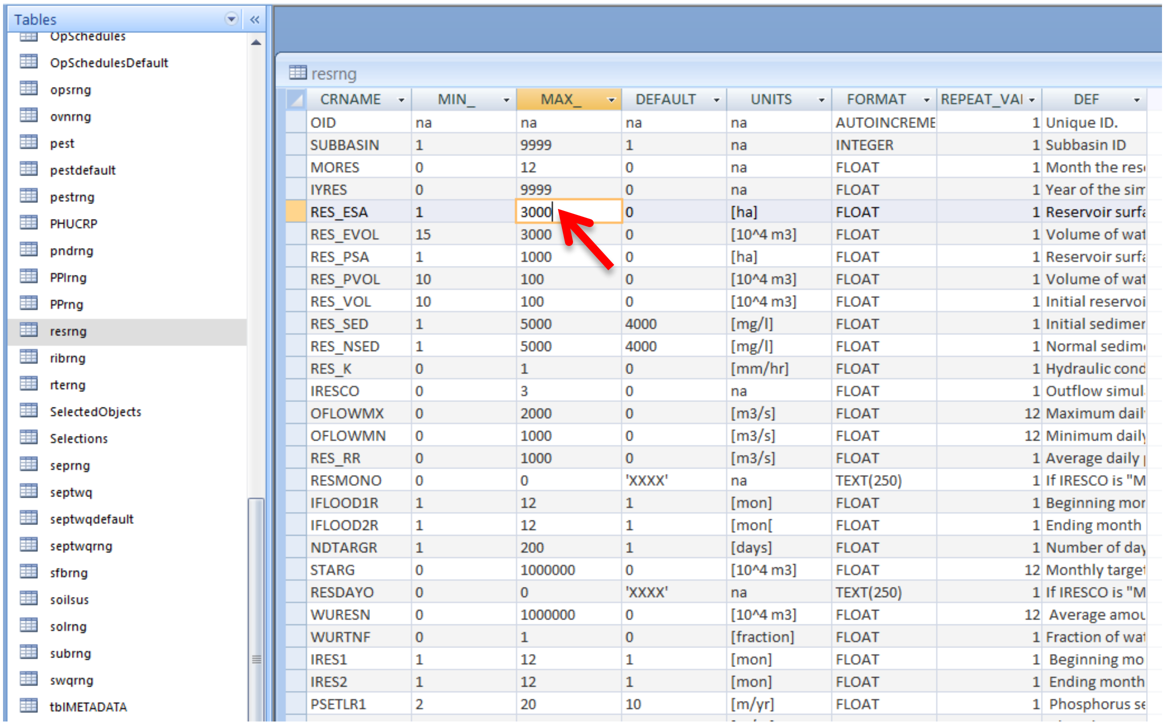

86. Click OK.




This displays the comparison between observed and simulated discharge.

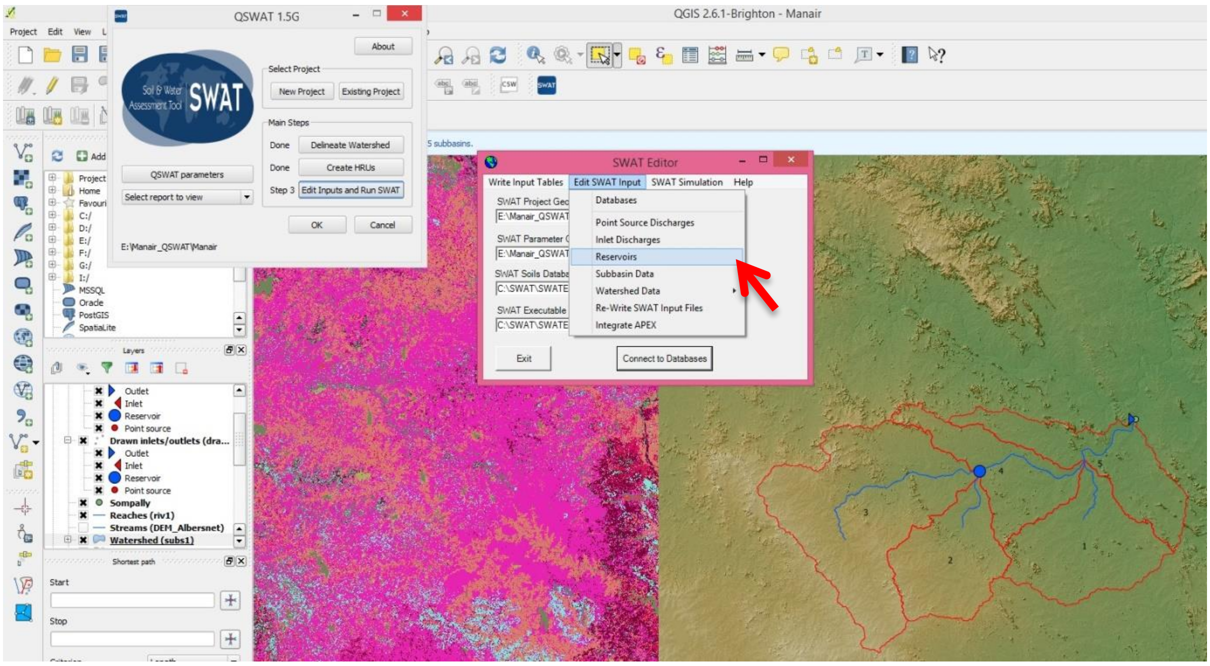
# INCORPORATION OF RESERVOIR

87. Open ***QSWATRef2012.mdb*** file from the project and open resrng table. Change the maximum values of RES_ESA, RES_EVOL, RES_PSA, RES_PVOL and RES_VOL to ***999999*** and save the file.

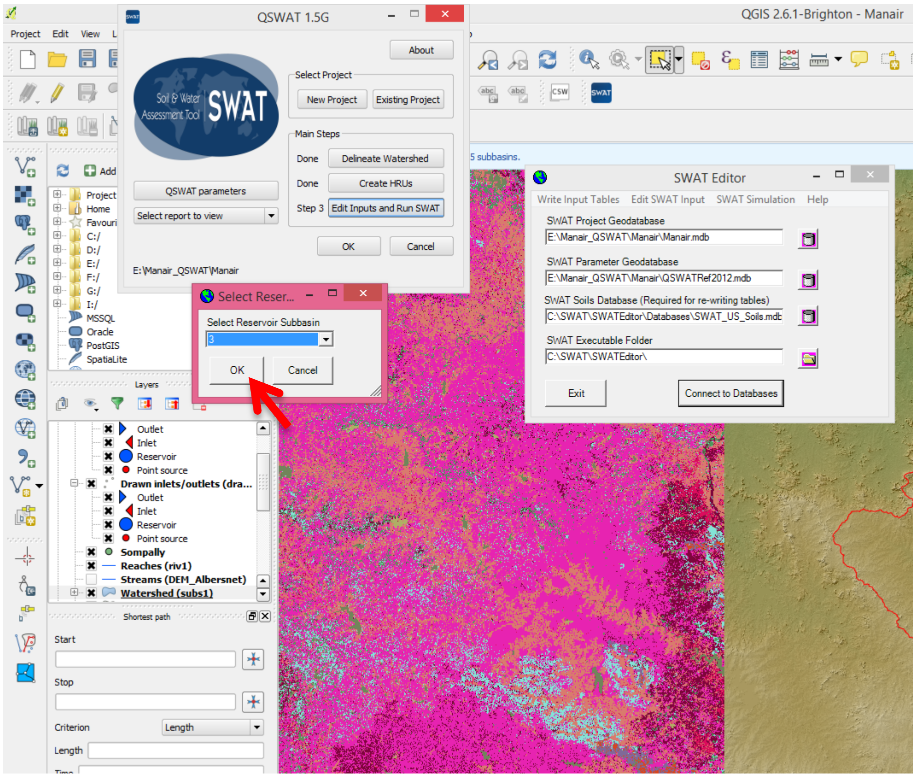



| CRNAME | MIN_ | MAX_ | DEFAULT | UNITS | FORMAT | REPEAT_VAL | DEF |
|---|---|---|---|---|---|---|---|
| OID | na | na | na | na | AUTOINCREME | 1 | Unique ID. |
| SUBBASIN | 1 | 9999 | 1 | na | INTEGER | 1 | Subbasin ID |
| MORES | 0 | 12 | 0 | na | FLOAT | 1 | Month the res |
| IYRES | 0 | 9999 | 0 | na | FLOAT | 1 | Year of the sim |
| RES_ESA | 1 | 3000 | 0 | [ha] | FLOAT | 1 | Reservoir surfa |
| RES_EVOL | 15 | 3000 | 0 | [10^4 m3] | FLOAT | 1 | Volume of wat |
| RES_PSA | 1 | 1000 | 0 | [ha] | FLOAT | 1 | Reservoir surfa |
| RES_PVOL | 10 | 100 | 0 | [10^4 m3] | FLOAT | 1 | Volume of wat |
| RES_VOL | 10 | 100 | 0 | [10^4 m3] | FLOAT | 1 | Initial reservoi |
| RES_SED | 1 | 5000 | 4000 | [mg/l] | FLOAT | 1 | Initial sedimer |
| RES_NSED | 1 | 5000 | 4000 | [mg/l] | FLOAT | 1 | Normal sedim |
| RES_K | 0 | 1 | 0 | [mm/hr] | FLOAT | 1 | Hydraulic cond |
| IRESCO | 0 | 3 | 0 | na | FLOAT | 1 | Outflow simul |
| OFLOWMX | 0 | 2000 | 0 | [m3/s] | FLOAT | 12 | Maximum dail |
| OFLOWMN | 0 | 1000 | 0 | [m3/s] | FLOAT | 12 | Minimum daily |
| RES_RR | 0 | 1000 | 0 | [m3/s] | FLOAT | 1 | Average daily |
| RESMONO | 0 | 0 | 'XXXX' | na | TEXT(250) | 1 | If IRESCO is "M |
| IFLOOD1R | 1 | 12 | 1 | [mon] | FLOAT | 1 | Beginning mor |
| IFLOOD2R | 1 | 12 | 1 | [mon[ | FLOAT | 1 | Ending month |
| NDTARGR | 1 | 200 | 1 | [days] | FLOAT | 1 | Number of day |
| STARG | 0 | 1000000 | 0 | [10^4 m3] | FLOAT | 12 | Monthly targe |
| RESDAYO | 0 | 0 | 'XXXX' | na | TEXT(250) | 1 | If IRESCO is "M |
| WURESN | 0 | 1000000 | 0 | [10^4 m3] | FLOAT | 12 | Average amou |
| WURTNF | 0 | 1 | 0 | [fraction] | FLOAT | 1 | Fraction of wat |
| IRES1 | 1 | 12 | 1 | [mon] | FLOAT | 1 | Beginning mo |
| IRES2 | 1 | 12 | 1 | [mon] | FLOAT | 1 | Ending month |
| PSETLR1 | 2 | 20 | 10 | [m/yr] | FLOAT | 1 | Phosphorus se |

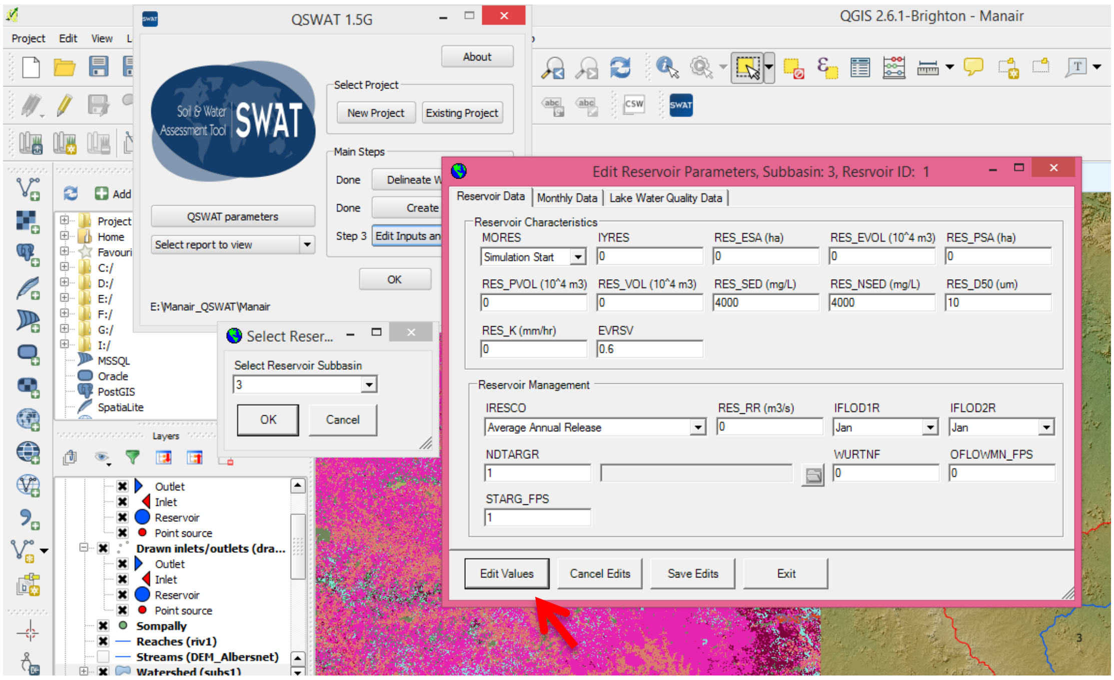
88. Go to QSWAT 1.5G dialog box and click ***Edit Inputs and Run SWAT button***. ***SWAT Editor*** Dialog box opens. Click ***Connect to Database*** button. Click **Edit SWAT Input** from toolbar and from the drop down, click ***Reservoirs***.



89. Select the Reservoir and click OK.

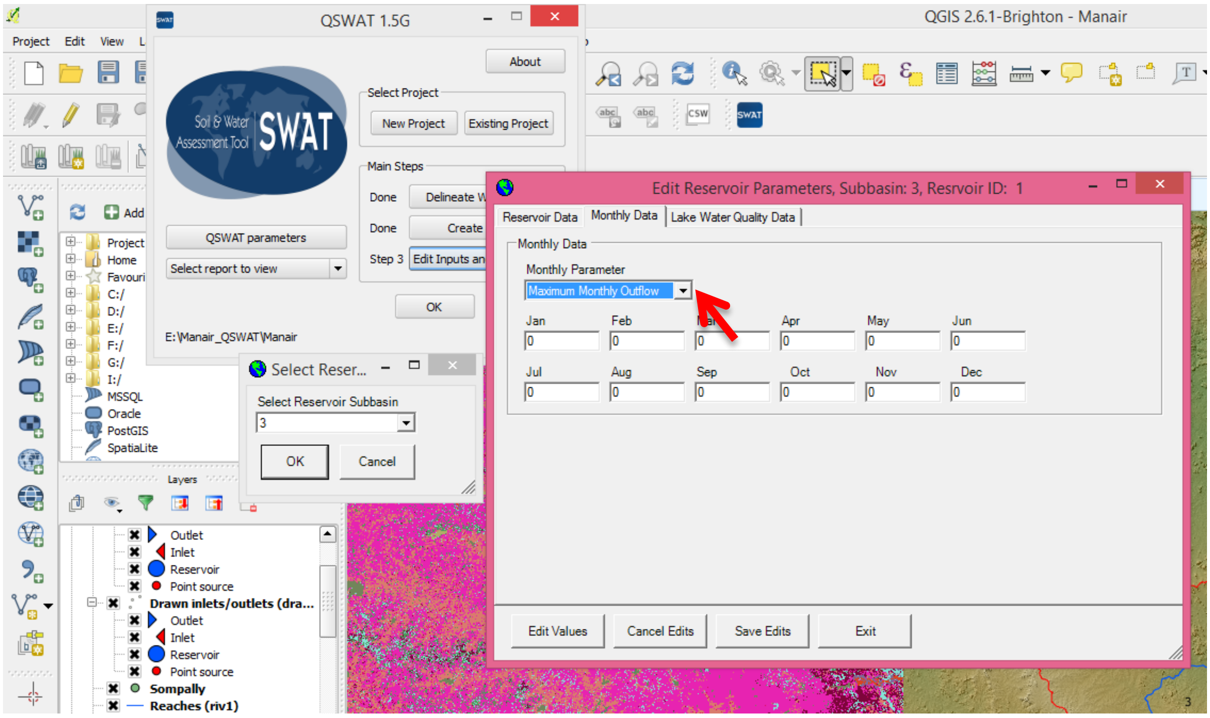


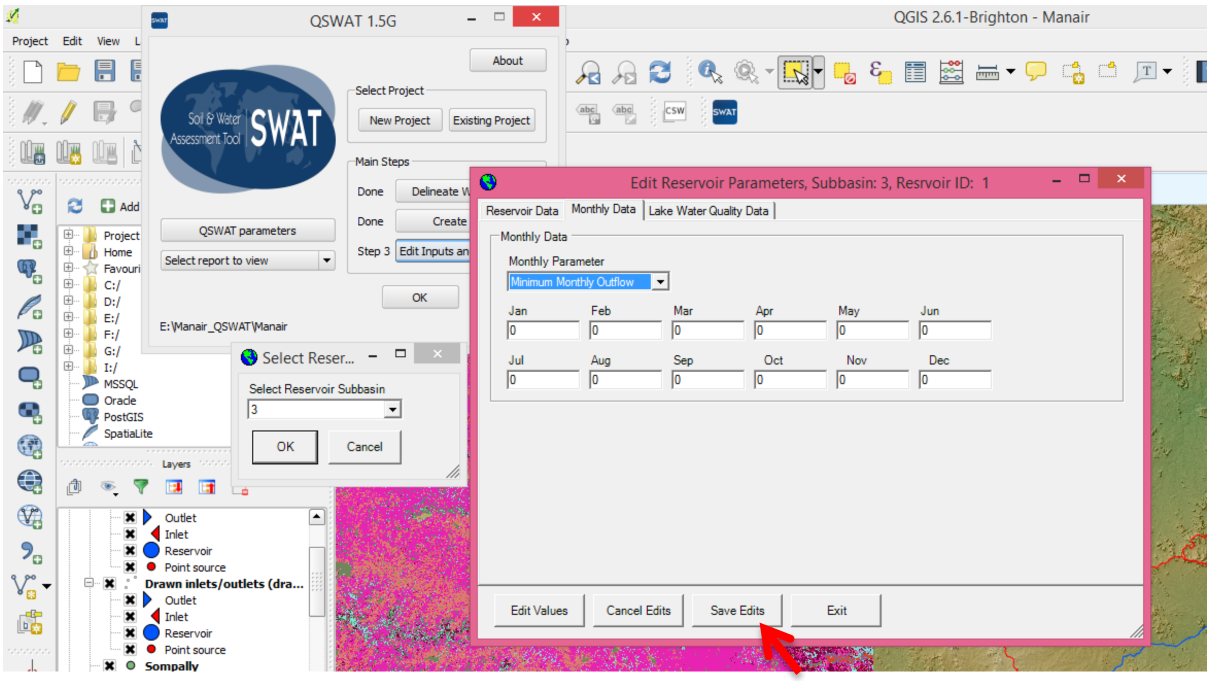

90. Click ***Edit Values*** to edit the parameters. **(Refer SWAT Documentation)**



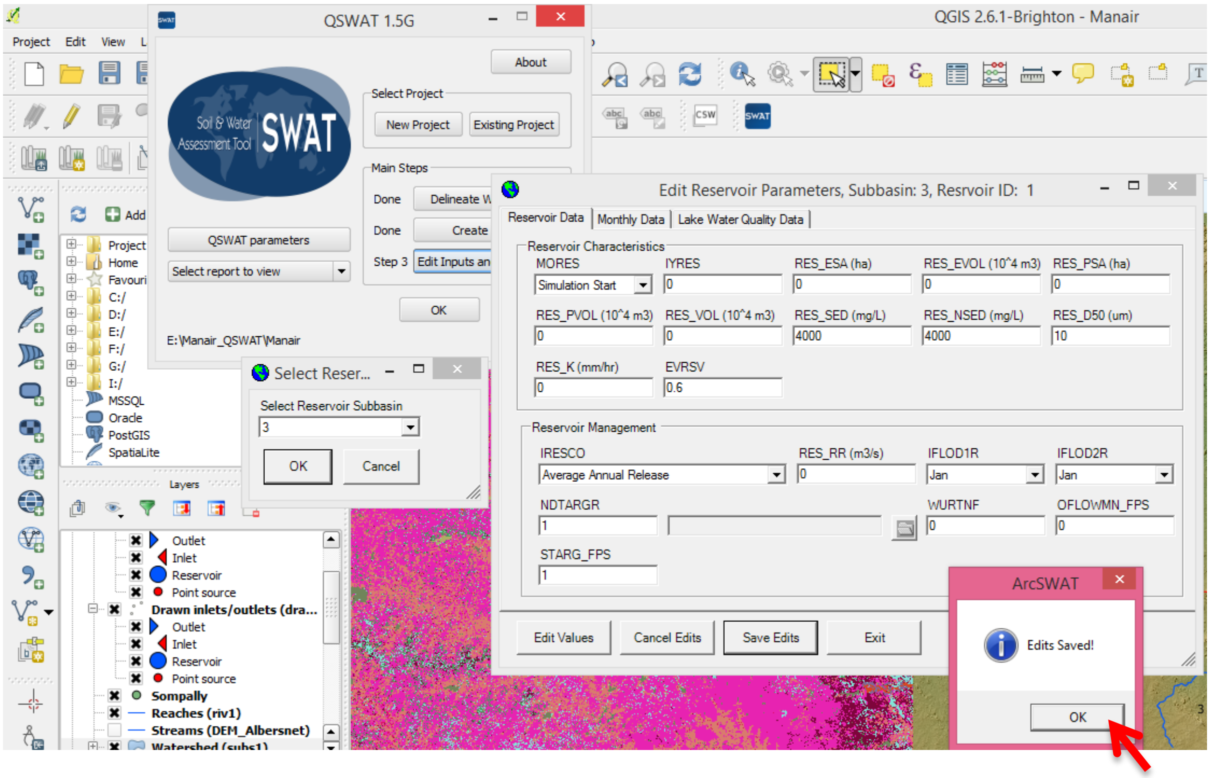

91. Provide the corresponding values for IYRES, RES_ESA, RES_EVOL, RES_PSA, RES_PVOL, RES_VOL, IFLOD1R, IFLOD2R, NDTARG, and STARG_FPS.

92. Click on Monthly Data tab and provide the maximum monthly outflow values. Then select minimum monthly outflow from the drop down and provide the respective values. Click on ***Save Edits.***



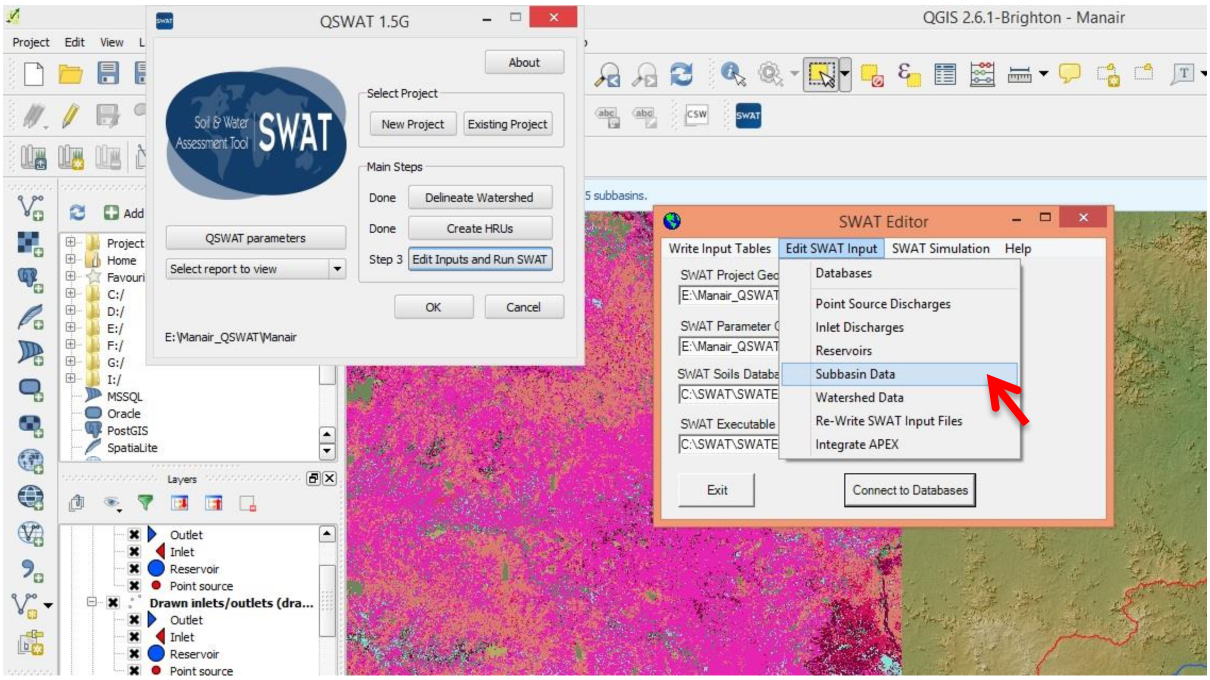



93. Click OK and close the dialog box. This saves the characteristics of the reservoir added.

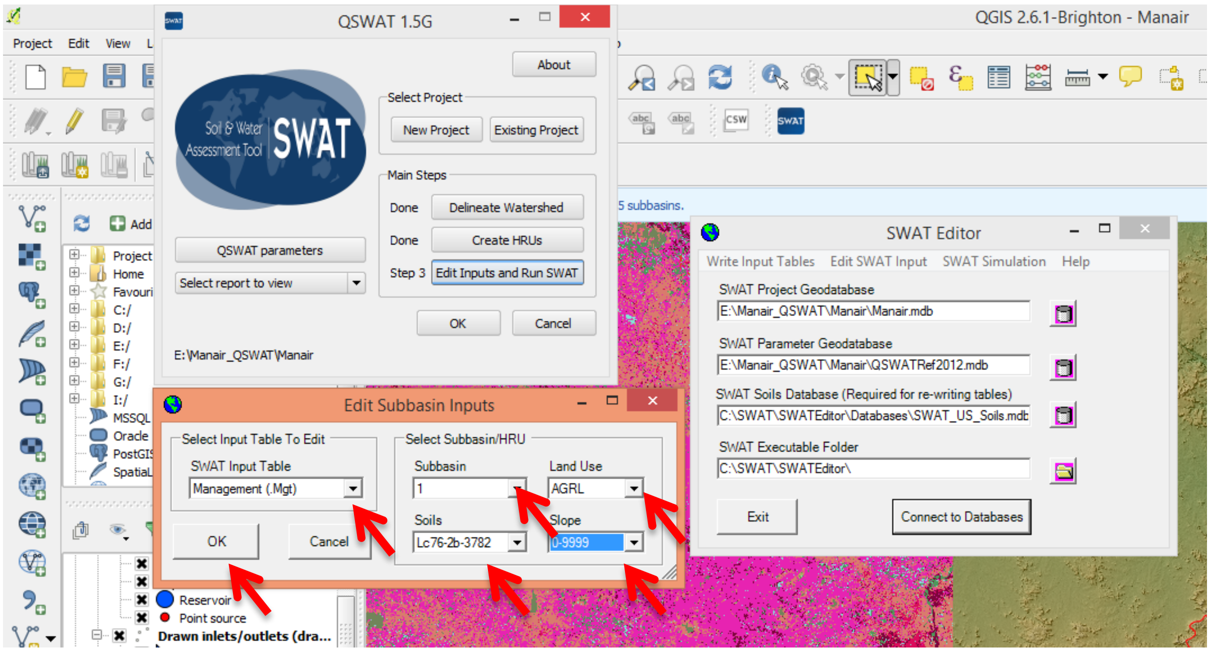



## MANAGEMENT PRACTICES

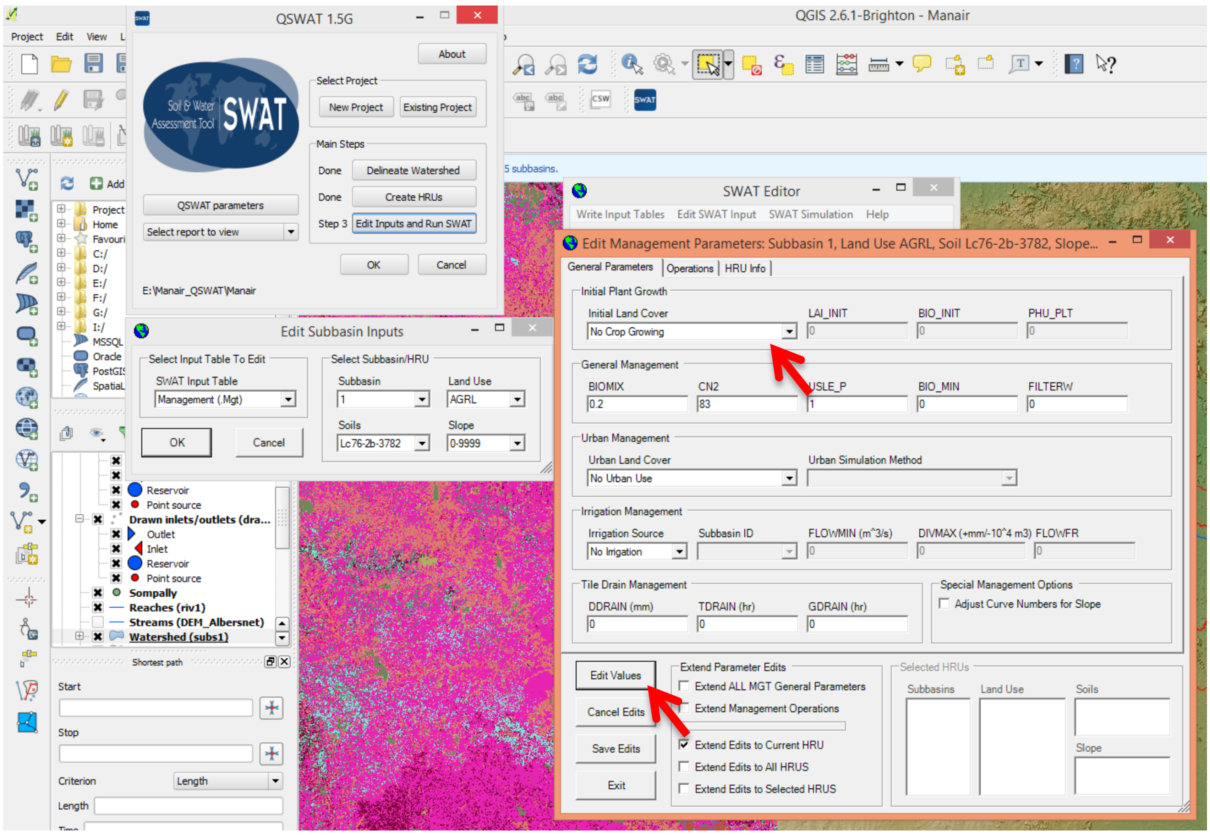
94. Click on ***Subbasin Data*** in Edit SWAT Input dropdown.



95. In the Edit Subbasin Inputs dialog box, select Management (.Mgt) from SWAT Input Table dropdown, 1 from Subbasin dropdown, respective Land Use, soils and slope. Click OK.

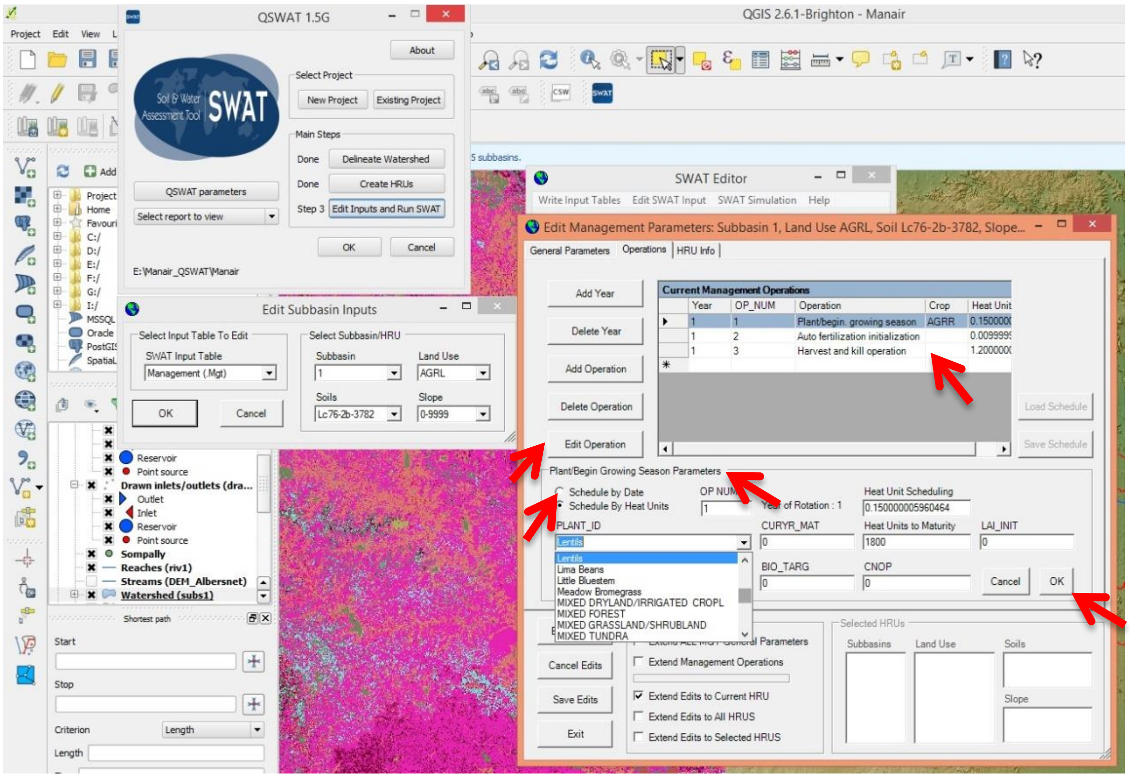


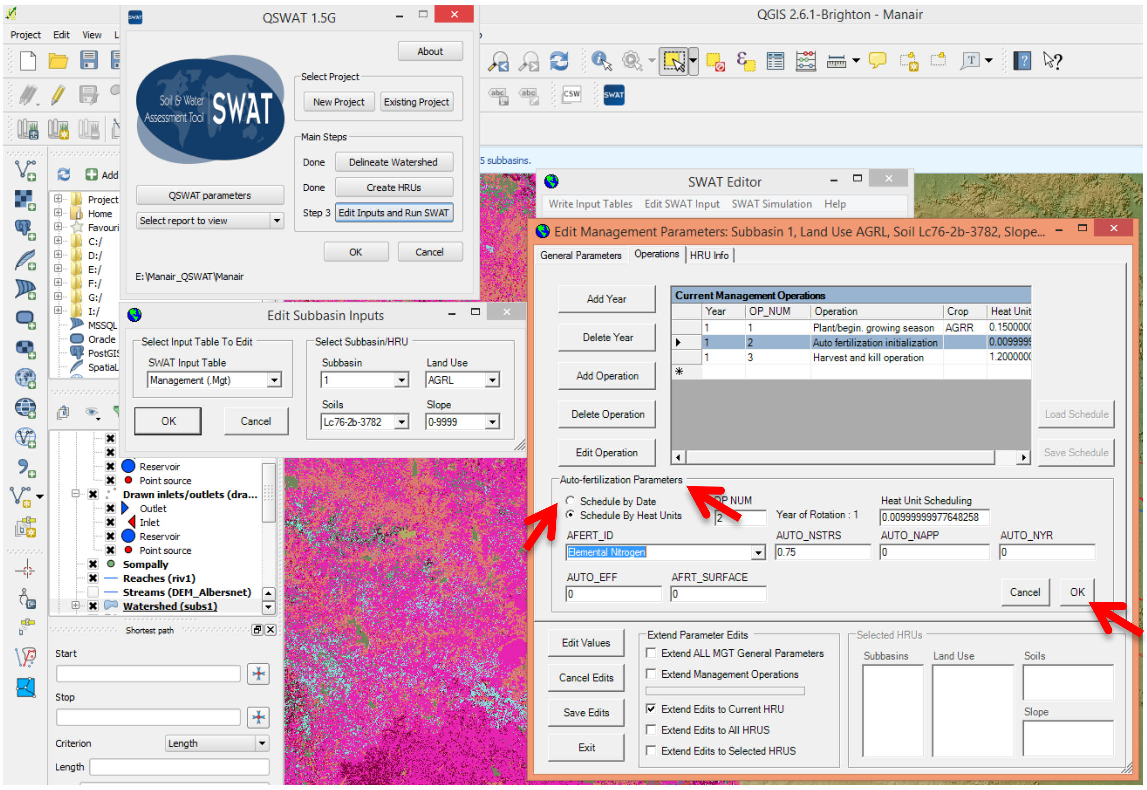

96. Click Edit Values and provide the respective values for the parameters required. **Refer SWAT Documentation**. ***(Note: For Rabi crop Initial Land cover should be provided)***

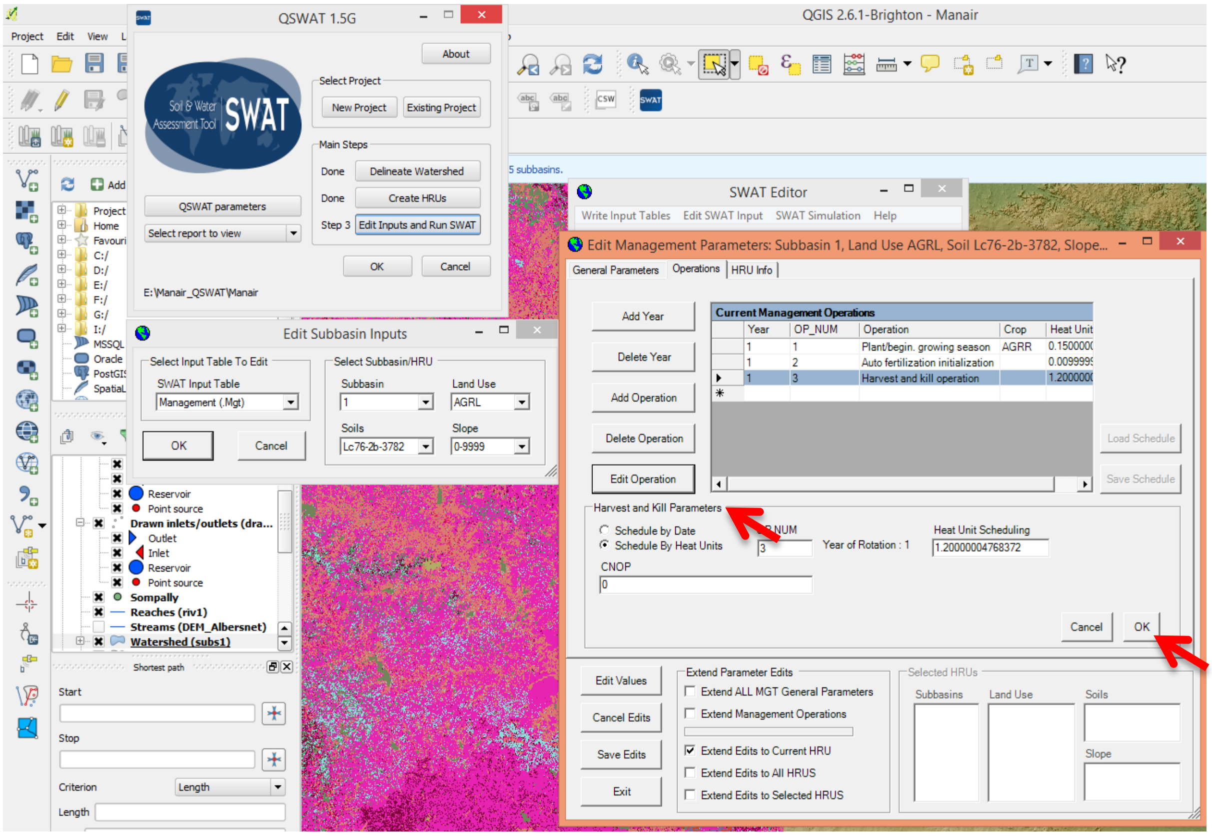


97. Click ***Operations*** tab and click ***Edit Operation*** button for Operations such as ***Plant/begin, growing season, Auto fertilization initialization, Harvest and kill operation*** that are already listed.

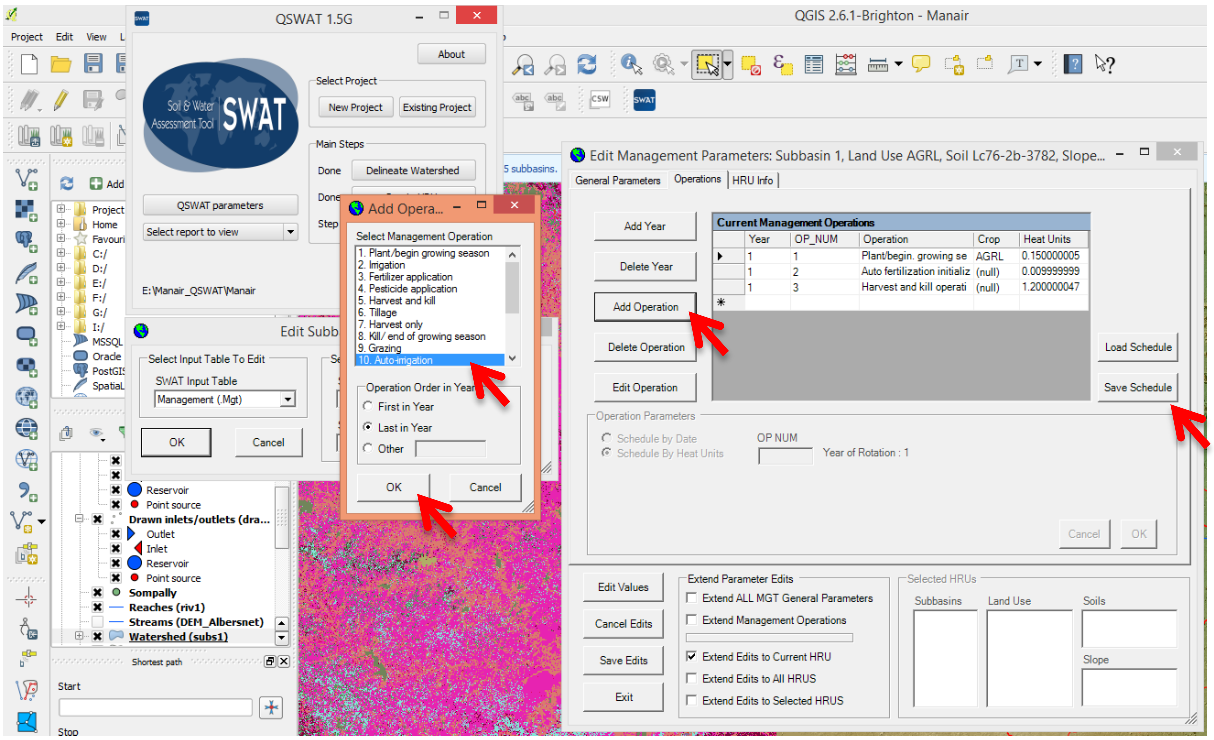
98. Provide the corresponding values for the parameters provided.



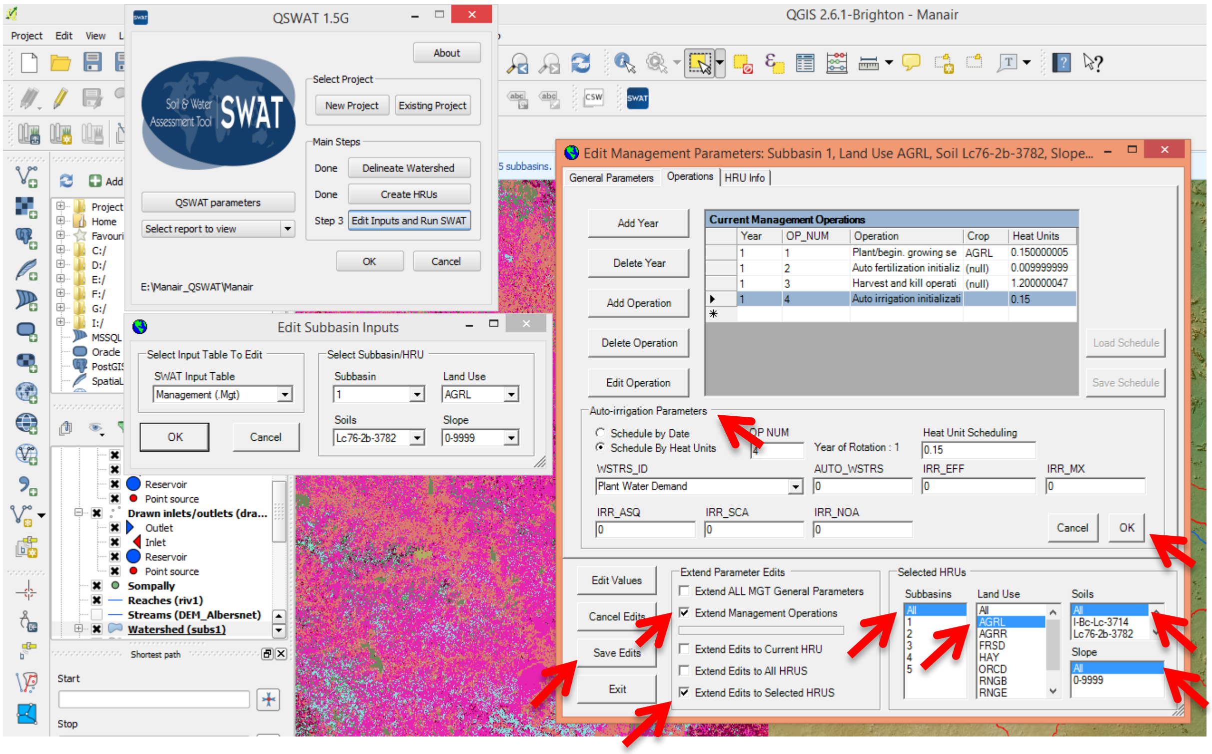





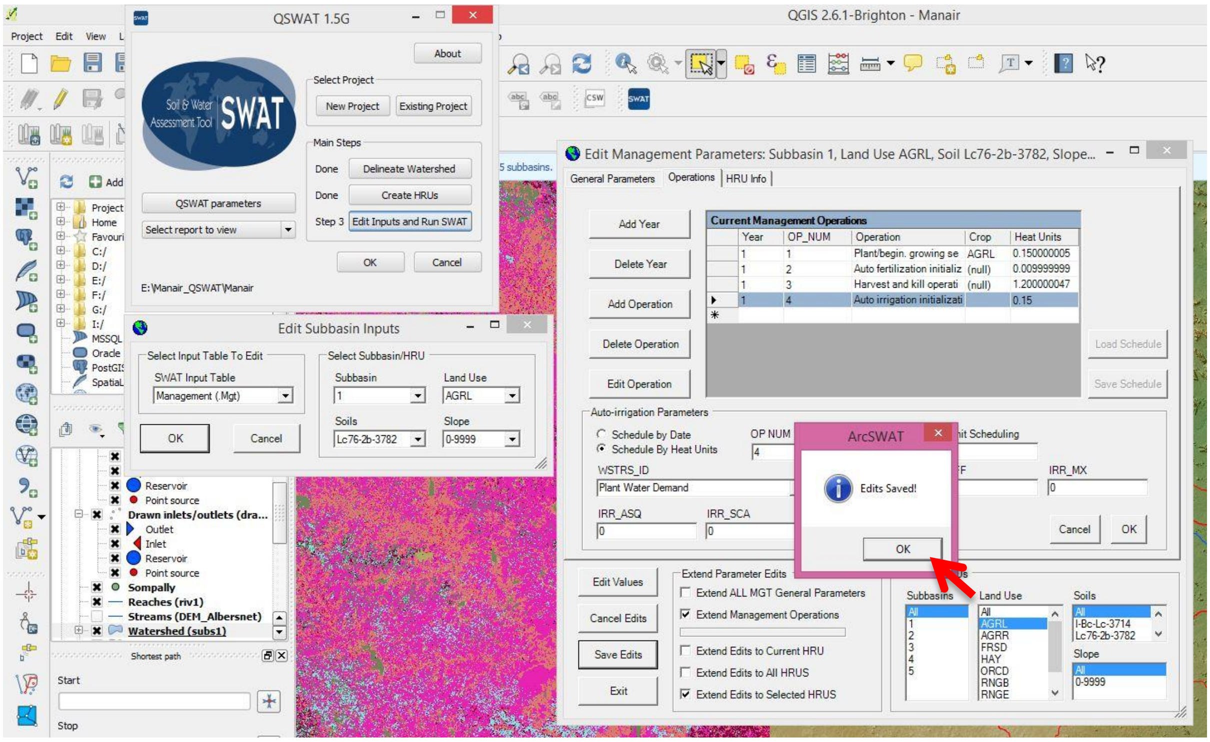
99. Add a new operation by clicking on ***Add Operation*** button and select Auto Irrigation and click OK. Once the schedule is edited, Save the Schedule by clicking on ***Save Schedule*** button.



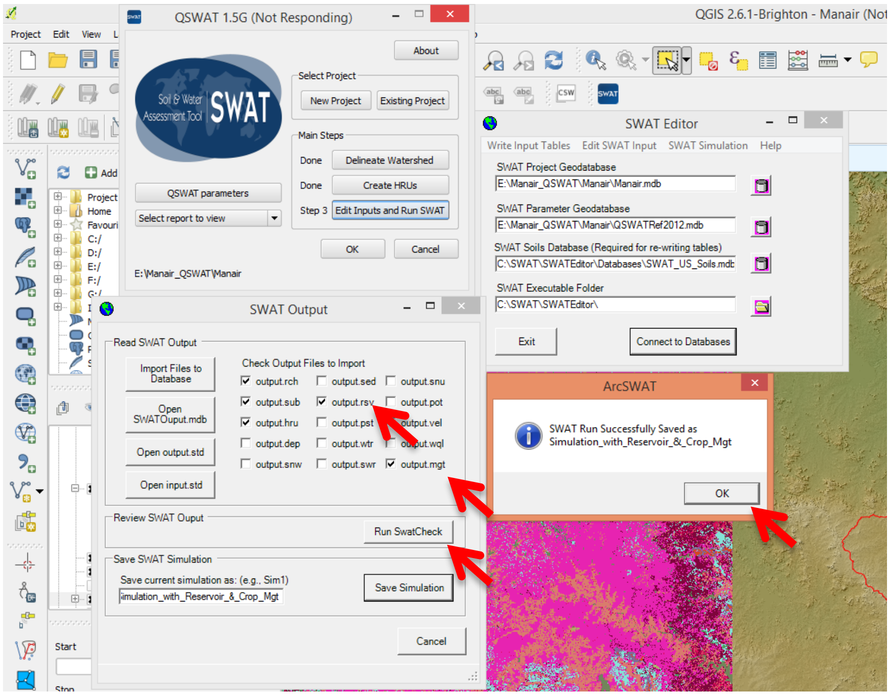
100. Provide the corresponding values for the parameters provided. Further Extend Management Operations and Extend Edits to Selected HRUs, then select Subbasins, landuse, soils, slope and Save the edits.




101. Click OK and close the dialog box. Similarly for each Landuse, a crop is assigned with their respective parameters.



102. Further follow the steps to Rewrite the SWAT input files and Run the SWAT model (step 68 to 75).
103. Check the output.rsv and output.mgt to write reservoir and management operations to table. Click Run ***SWAT Check button*** to summarize results from SWAT simulations. Save the SWAT output as “Simulation_with_Reservoir_&_Crop_Mgt”

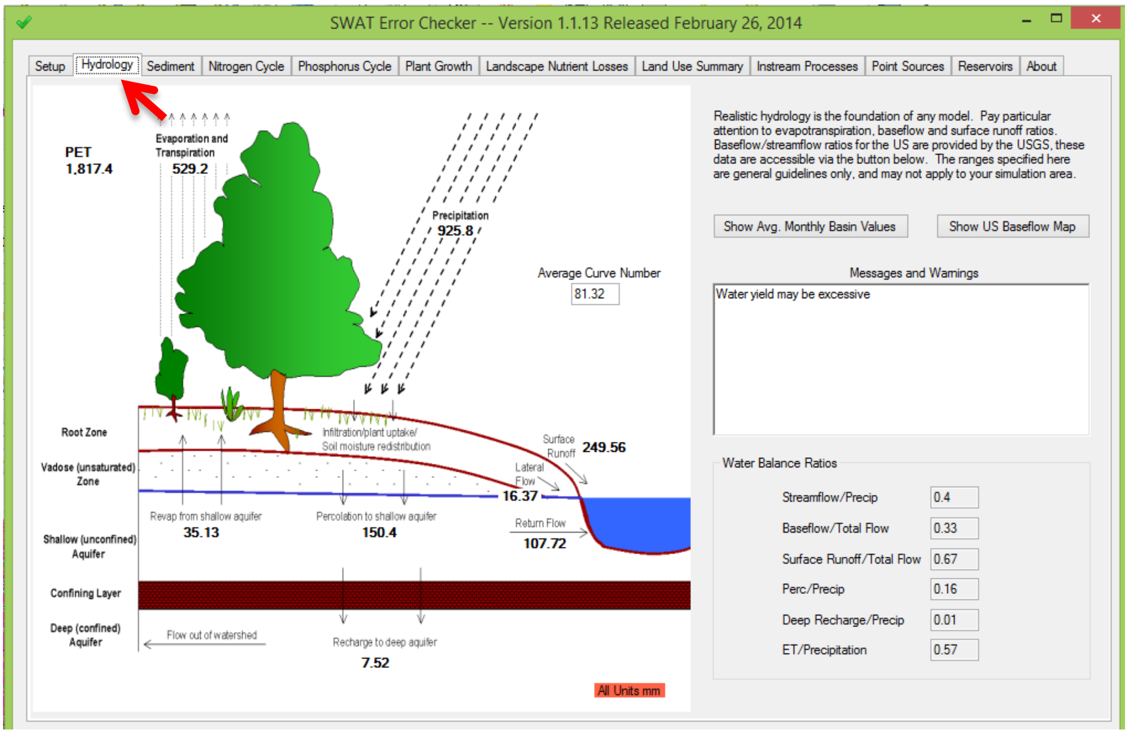



104. The simulation results are saved in the following path: Manair_QSWAT > Manair > Scenarios > Simulation_without_Reservoir_&_Crop_Mgt > TxtInOut . Thus Reservoir and management operations have been incorporated.

105. Open the ***SWATOutput.mdb*** file from the following path: Manair_QSWAT > Manair > Scenarios > Simulation_with_Reservoir_&_Crop_Mgt > TablesOut
Open the ***rsv*** table from it. Copy and paste the data into a new excel sheet and plot the Volume column.

## SWAT- Check

SWAT-Check is a tool used to summarize results from SWAT simulations. It can also provide warning that could help to improve the modeling skills in SWAT. SWAT- Check evaluates different processes in the landscape. It can be executed by locating the TxtInOut of a particular simulation. There are several windows in SWAT-Check namely Hydrology, Sediment, Nitrogen cycle, Phosphorous cycle, Plant growth, Landscape nutrient losses, Land use summary, Instream processes, point sources and Reservoirs. The Hydrology window summarizes the water balance both graphically and numerically. The sediment window summarizes graphically and numerically the sediment yield in the watershed – both in the upland and in-stream processes. The Land Use Summary window summarizes the different landscape process components for each land use type in the watershed.


SWAT Error Checker -- Version 1.1.13 Released February 26, 2014
Setup
Hydrology
Sediment
Nitrogen Cycle
Phosphorus Cycle
Plant Growth
Landscape Nutrient Losses
Land Use Summary
Instream Processes
Point Sources
Reservoirs
About
PET
1,817.4
Evaporation and Transpiration
529.2
Precipitation
925.8
Average Curve Number
81.32
Root Zone
Vadose (unsaturated) Zone
Shallow (unconfined) Aquifer
Confining Layer
Deep (confined) Aquifer
Infiltration/plant uptake/ Soil moisture redistribution
Surface Runoff
249.56
Lateral Flow
16.37
Revap from shallow aquifer
35.13
Percolation to shallow aquifer
150.4
Return Flow
107.72
Flow out of watershed
Recharge to deep aquifer
7.52
All Units mm
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.
Show Avg. Monthly Basin Values
Show US Baseflow Map
Messages and Warnings
Water yield may be excessive
Water Balance Ratios
Streamflow/Precip 0.4
Baseflow/Total Flow 0.33
Surface Runoff/Total Flow 0.67
Perc/Precip 0.16
Deep Recharge/Precip 0.01
ET/Precipitation 0.57