



Watershed Modelling using the SWAT Model



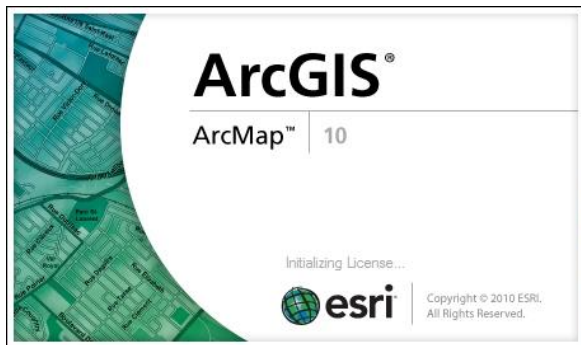
Notes on ArcSWAT ArcGIS Interface for SWAT

12th to 13th November 2013

Heraklion, Crete, Greece

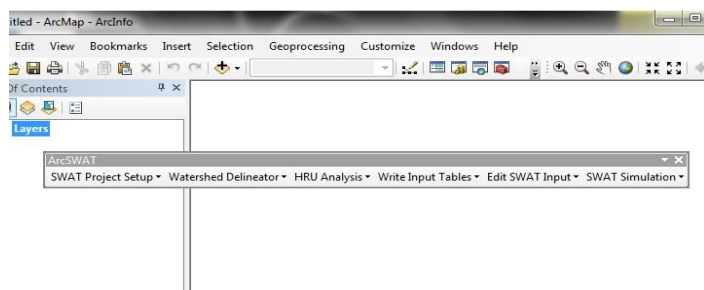
Technical University of Crete

Dionissis Efstathiou, George Giannakis, Sofia Nerantzaki,
Nikos Nikolaidis



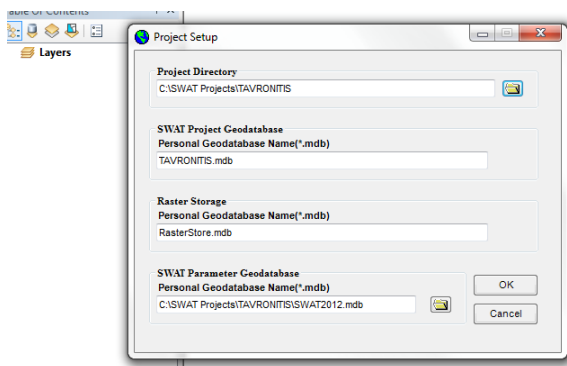
01 Start ArcMap

Start **ArcMap**. Before proceeding, make sure that you have already installed the ArcSWAT extension and graphical user input interface for SWAT.



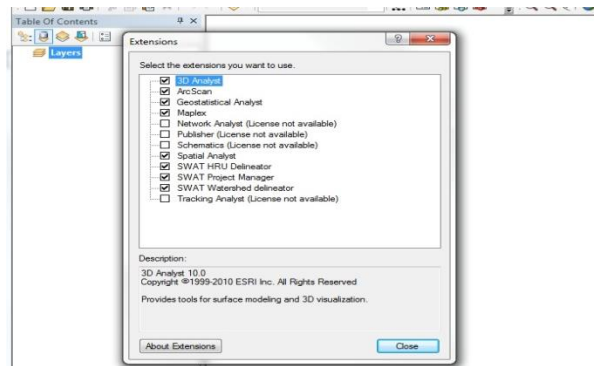
03 Show ArcSWAT Toolbar

Under the Customize menu, go to Toolbars and select the ArcSWAT menu.



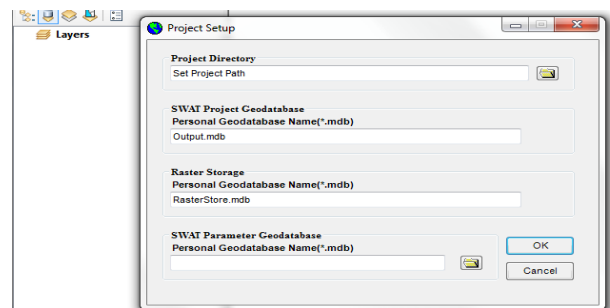
05 Project Directory

Select the directory for the current project. It is the location where all files will be placed. The SWAT Project geodatabase and Raster Storage will be automatically initialized. The SWAT Parameter Geodatabase.



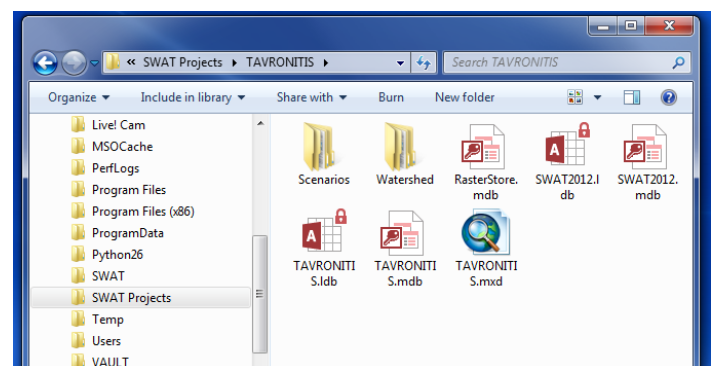
02 ArcSWAT extension

Under the Customize menu, click the Extensions button. The Extensions menu will appear. Enable the extensions “SWAT HRU Delineator”, “SWAT Project Manager” and “SWAT Watershed delineator”.



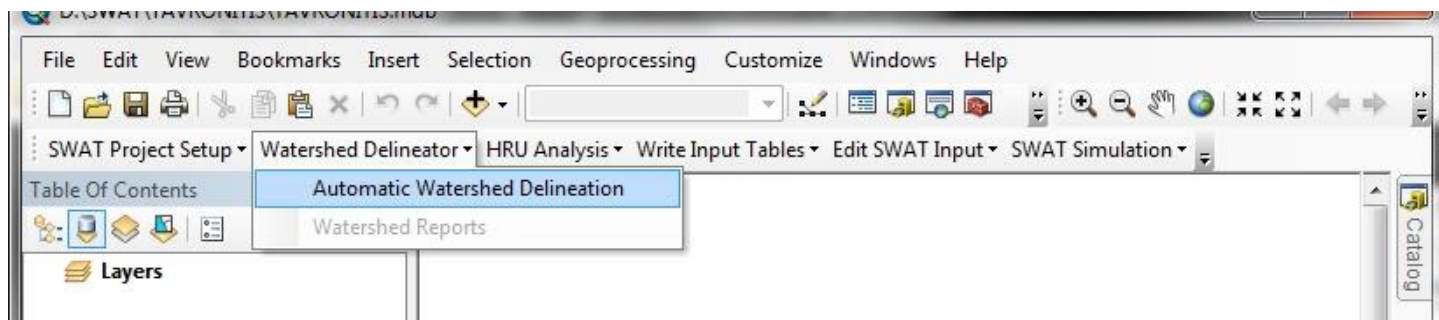
04 New SWAT Project

In order to create a new SWAT project and setup working directory and geodatabases, select the SWAT Project Setup menu and click the New SWAT Project button.



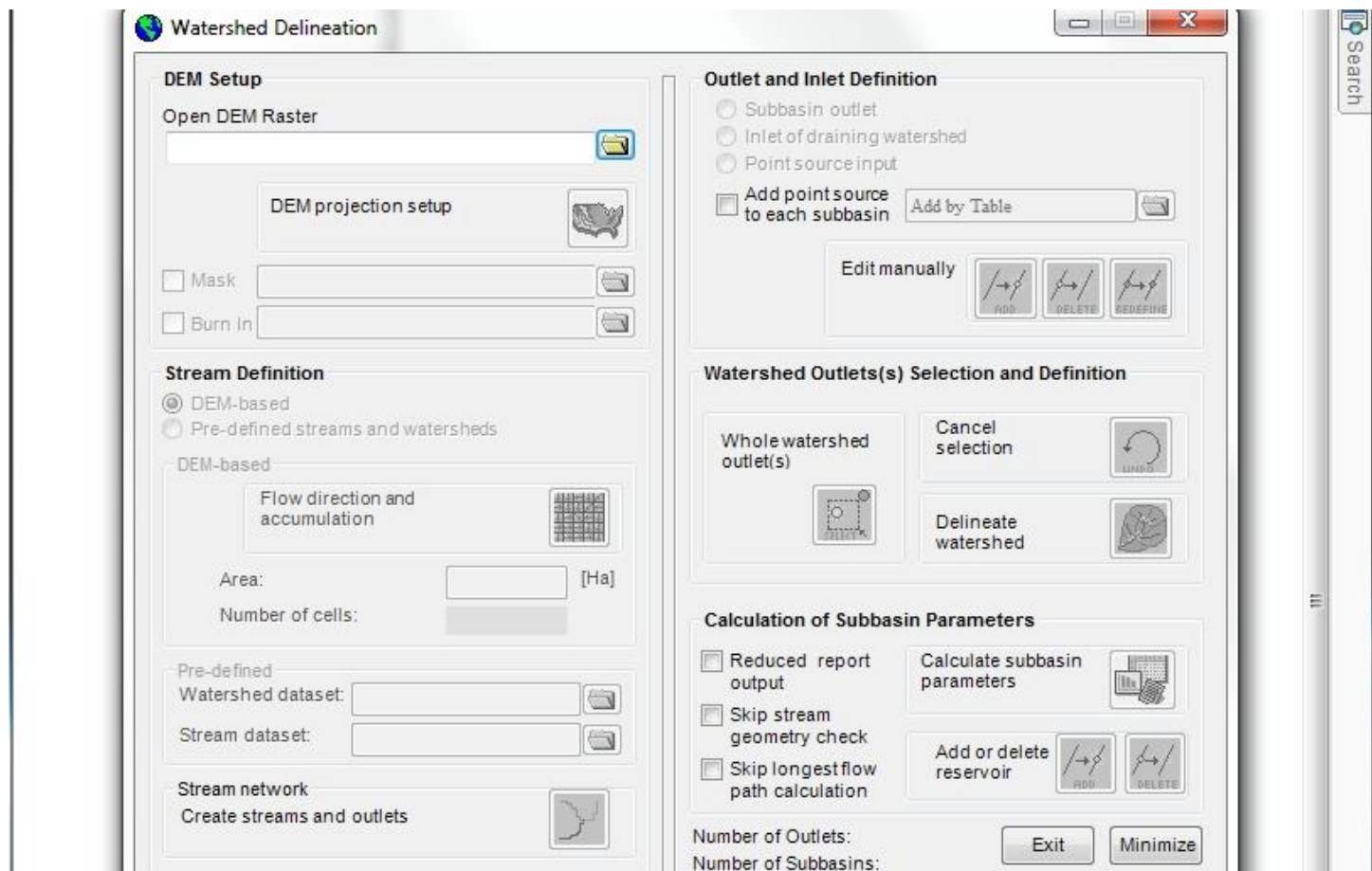
06 Project's Directory

After pressing the OK button in the previous step, two folders (Scenarios, Watershed), two geodatabases and an .mxd file will be created inside the project's folder.



07 Watershed Delineation menu

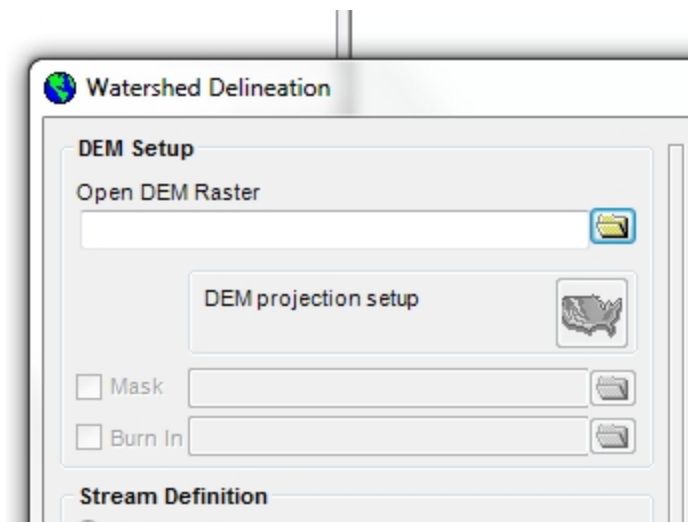
Under the **Watershed Delineator** menu, click the **Automatic Watershed Delineation** button.



08 Watershed Delineation window

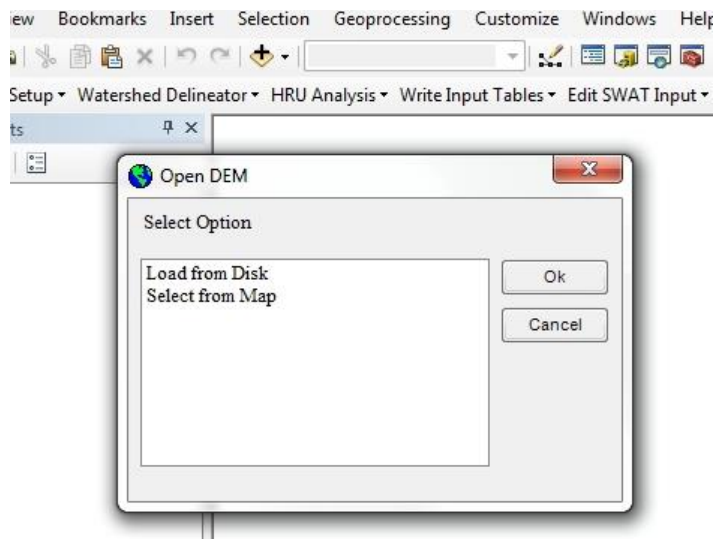
The Watershed Delineation window will appear. This tool is divided into the following sections:

- **DEM Setup,**
- **Stream Definition,**
- **Outlet and Inlet Definition,**
- **Watershed Outlet(s) Selection and Definition.**
- **Calculation of Subbasin Parameters**



09 DEM Setup

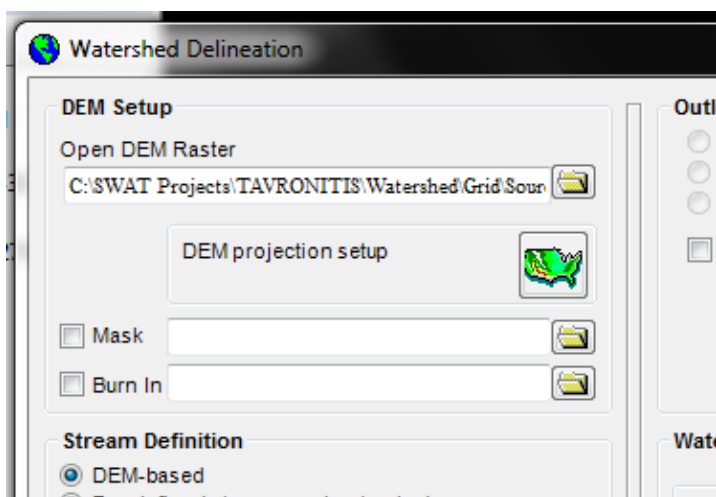
Click the “folder” icon in order to add the DEM grid which will be used at the project.



10 Load DEM grid

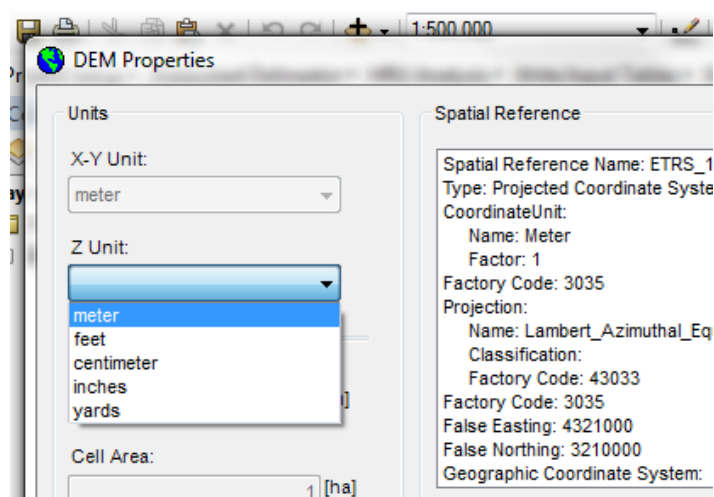
A new window will appear with options, **Load from Disk** and **Select from Map**.

*If the grid isn't loaded in the .mxd file, select **Load from Disk** and go to the directory where the DEM grid is stored.*



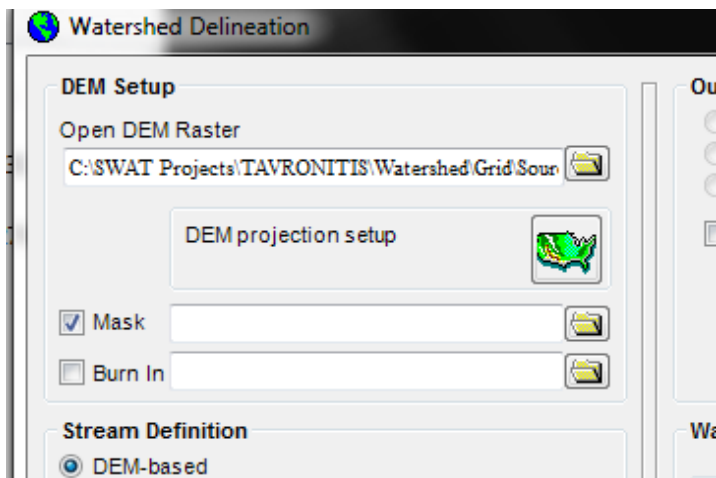
11 DEM projection setup

After loading the DEM grid, the **DEM projection setup** button will be enabled. By clicking it, a new window with information about the DEM will be displayed.



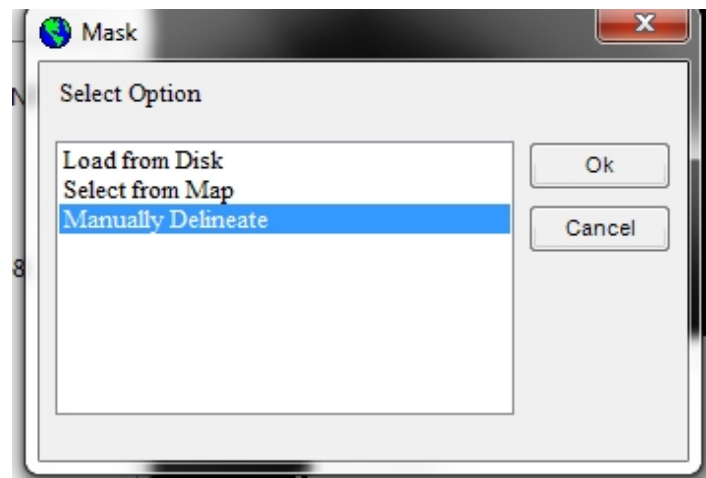
12 DEM properties

In the DEM Properties window, the user must select the appropriate Z Unit in order to be consistent with the X-Y units.



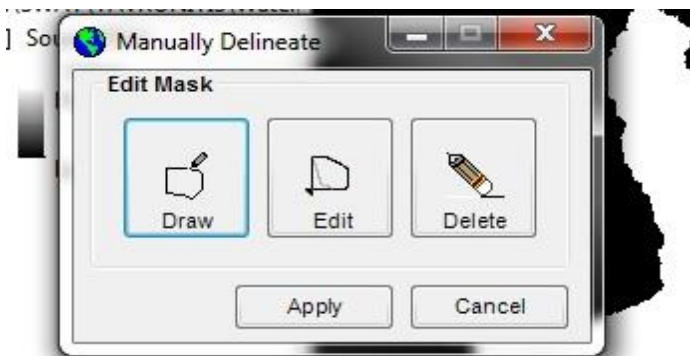
13 Mask (optional)

In order to focus on the desired watershed area and speedup the processing time, the interface gives the option to import or create a grid map that selects the stream network of the watershed.



14 Manually create mask

For demonstration purposes, select manual delineation.



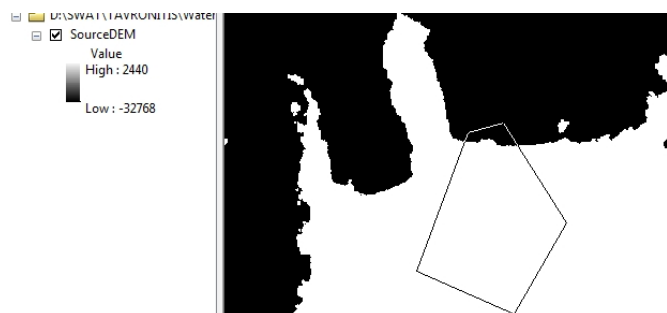
15 Manually Delineate

A tool will appear with the options of drawing, editing and deleting a polygon in ArcMap. Select the **Draw** button to manually trace the area that encloses the watershed.



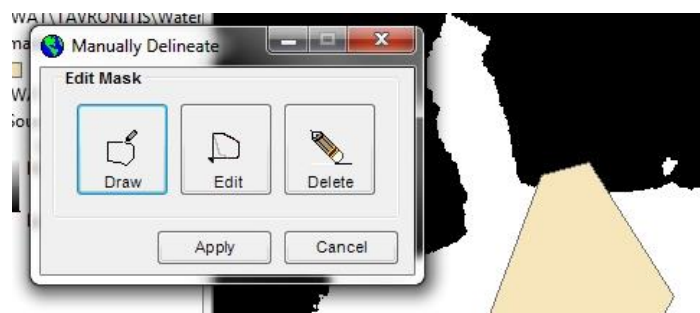
16 Draw polygon

A new popup window will appear, indicating that the tool has entered drawing mode.



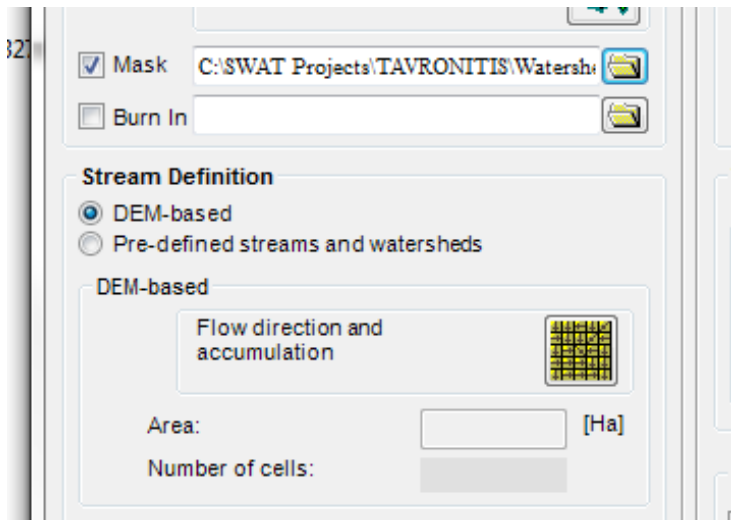
17 Draw polygon Mask

By left clicking the mouse, the user can set the corners of the polygon. By double clicking the left mouse button, the polygon is set.



18 Finalize polygon Mask

The "Manually Delineate" window will reappear. Click APPLY if satisfied with the polygon area. This will create the MASK Grid and add it to the Watershed view.

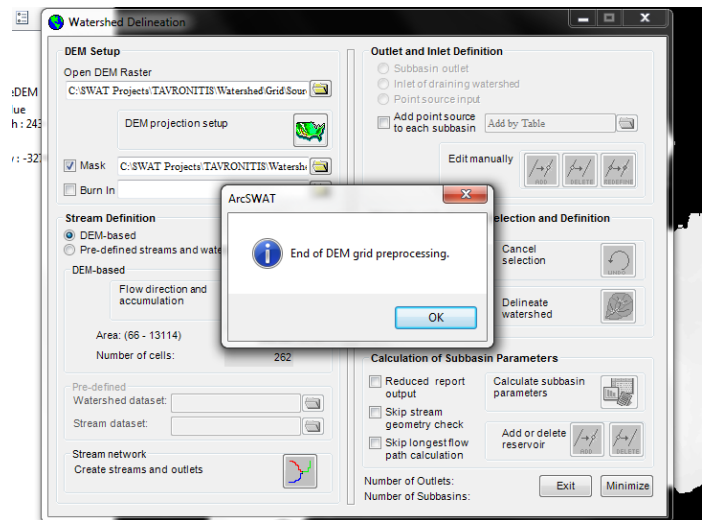


19 Stream Definition

The Stream Definition tool, defines the Stream network and the subbasin outlets.

There are two methods for defining the watershed and stream network. The DEM-based and the Pre-defined streams and watersheds.

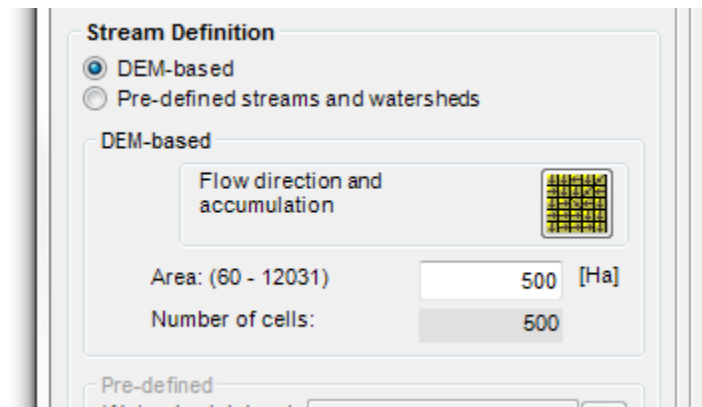
For the purposes of this tutorial, we'll use the DEM threshold based method to delineate the watershed and stream network.



20 Flow Direction and Acc

After selecting the DEM-based option (from the previous step), click the **Flow direction and accumulation** button.

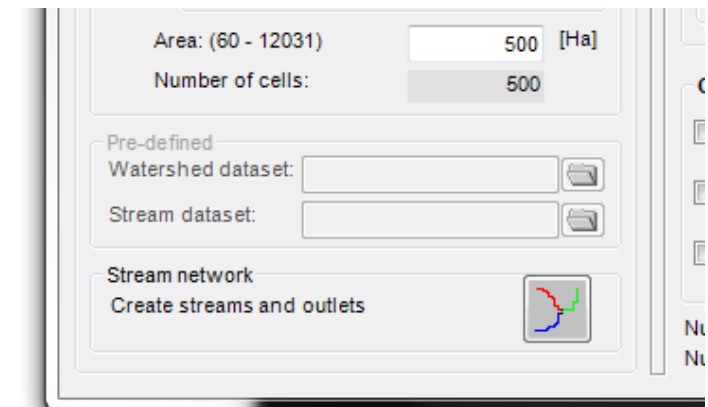
After this step is completed, a popup window will appear, indicating the completion of this process. Click OK.



21 Set threshold value

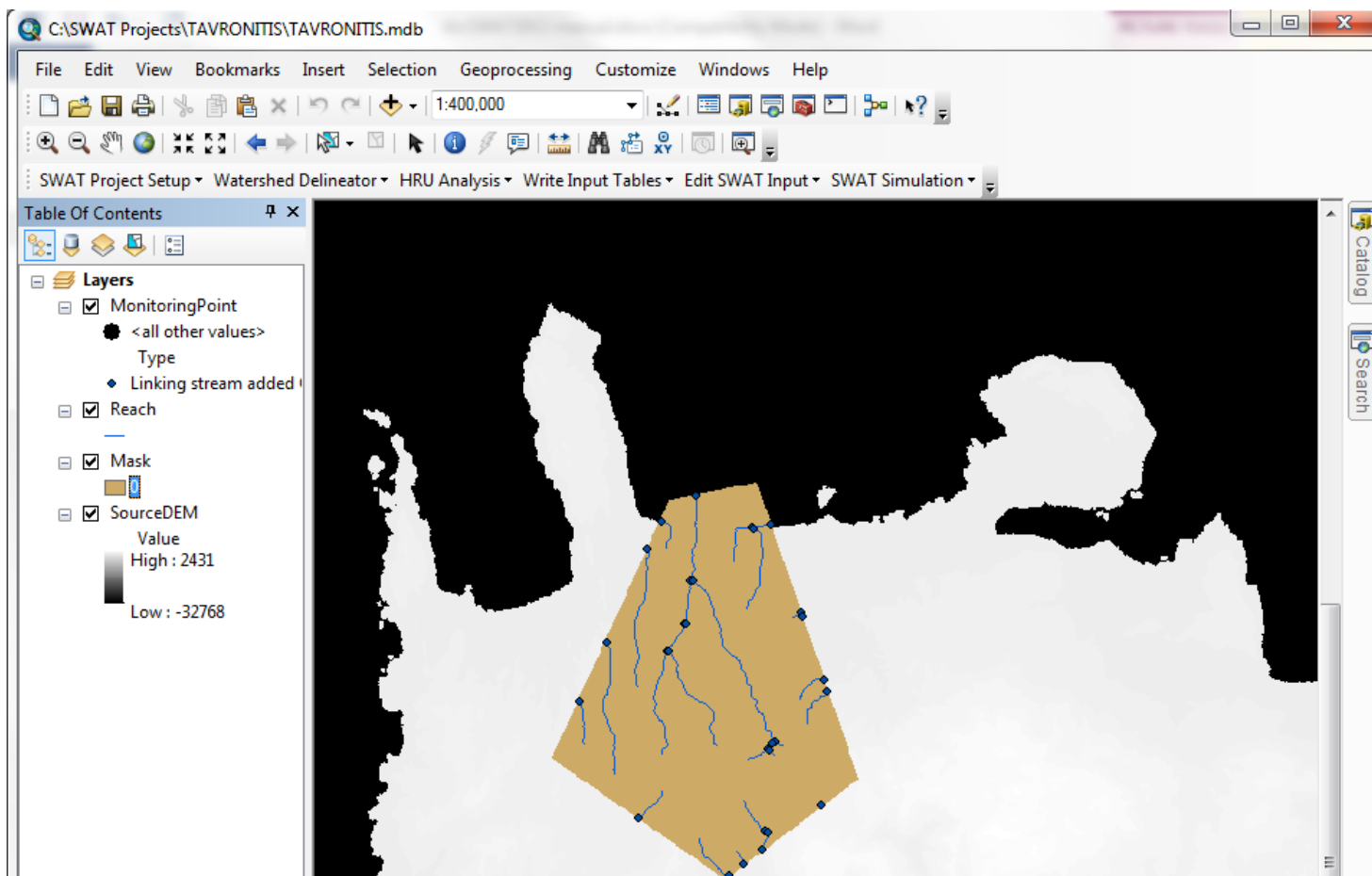
A min max and suggested subwatershed area (in hectares) is shown in the Area box. The user can change the suggested value within the min-max boundary values.

Set the value to 500.



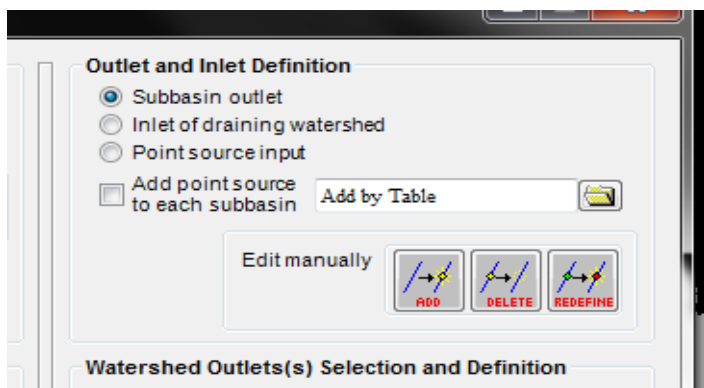
22 Create streams - outlets

After setting the threshold value to 500ha, proceed with the creation of the stream network and outlets, by clicking the **Stream network** button.



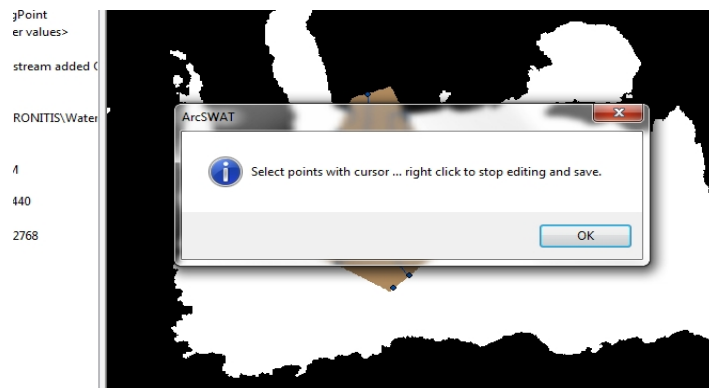
23 Stream Preprocessing outcome

The outcome of the Stream network delineation is displayed on the DEM map grid, on top of the Mask. Since the Mask area exceeds that of the watershed, adjacent subwatersheds are included. That is why the delineation process has calculated portions on neighboring stream networks and outlets.



24 Outlet & Inlet Definition

In this step we are going to define the final outlets by omitting those that do not refer to our watershed and secondly, to manually add an outlet. Press the Delete button to start removing the outlet points that are not needed.

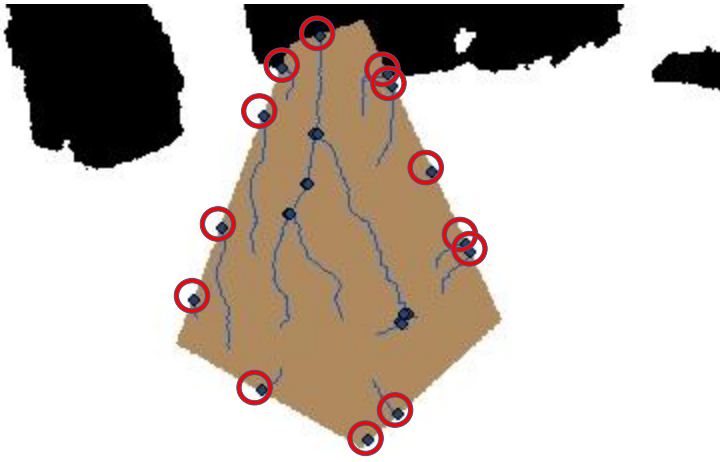


25 Remove Outlets

A message window will appear notifying the user on how to delete outlets.

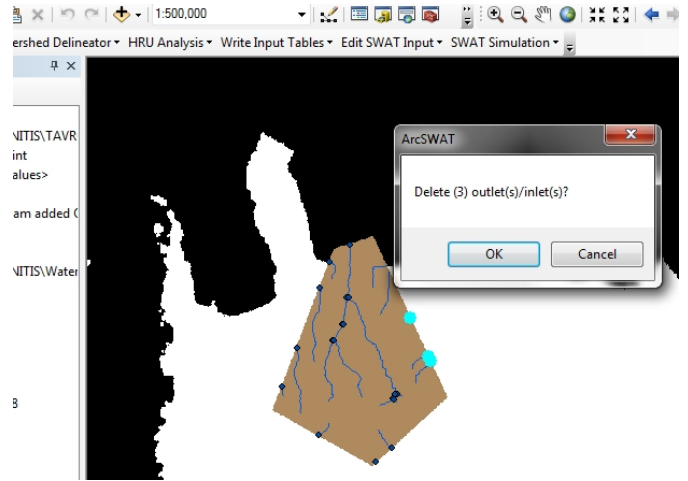
- Selecting with cursor and deleting
- Right click to stop editing

Press **OK** to continue.



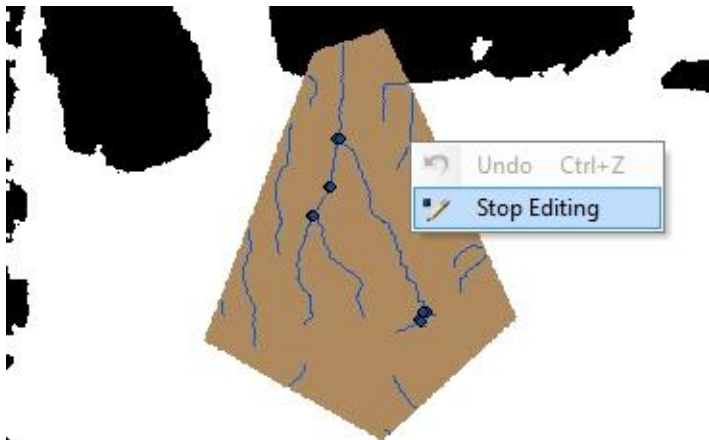
26 Remove Outlets (cont...)

The outlets to be deleted are those in circles
(for demonstration purposes only).



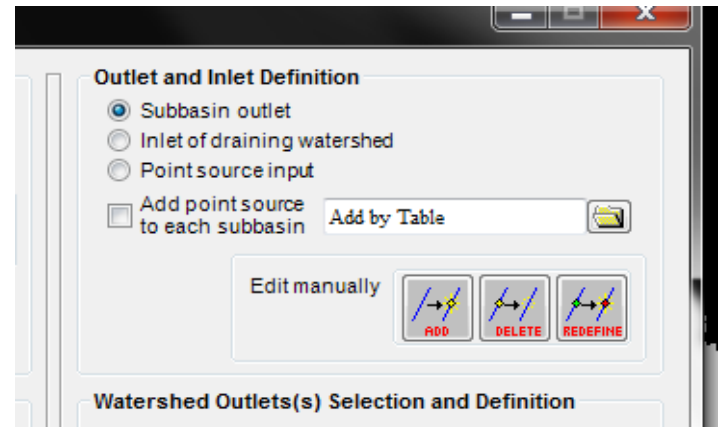
27 Remove Outlets (cont...)

Every time you select one or more outlets, a confirmation popup window, appears. Press OK to delete the selected outlets.



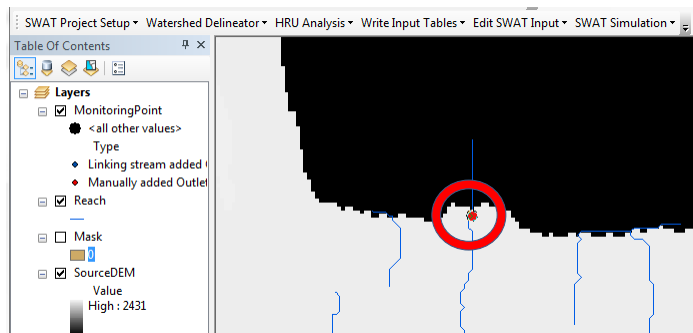
28 Remove Outlets (cont...)

In order to stop removing any more outlets, right click and select **Stop Editing**.



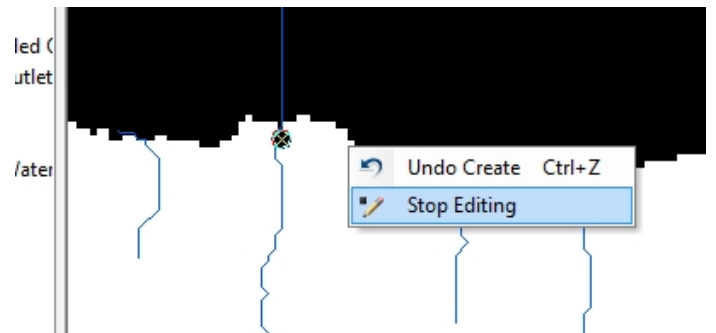
29 Add Outlet

The **Watershed Delineation** window will reappear. Press the **ADD** button to add the outlet point(s).



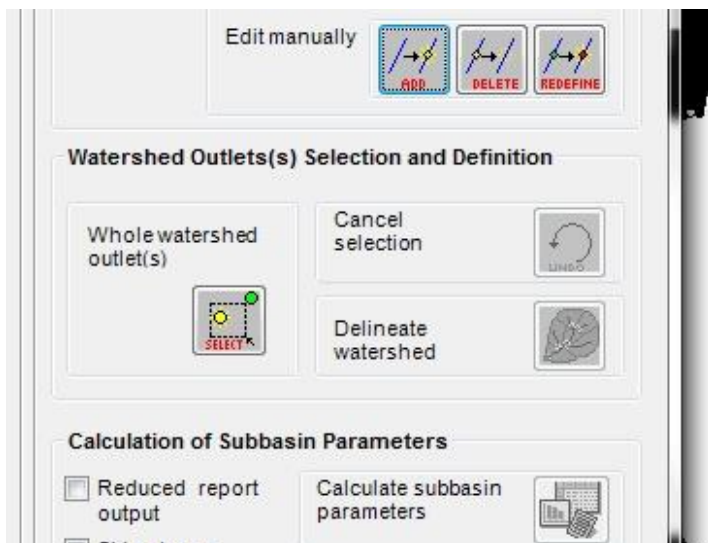
30 Add Outlet (cont...)

Add an outlet at the end of the watershed.



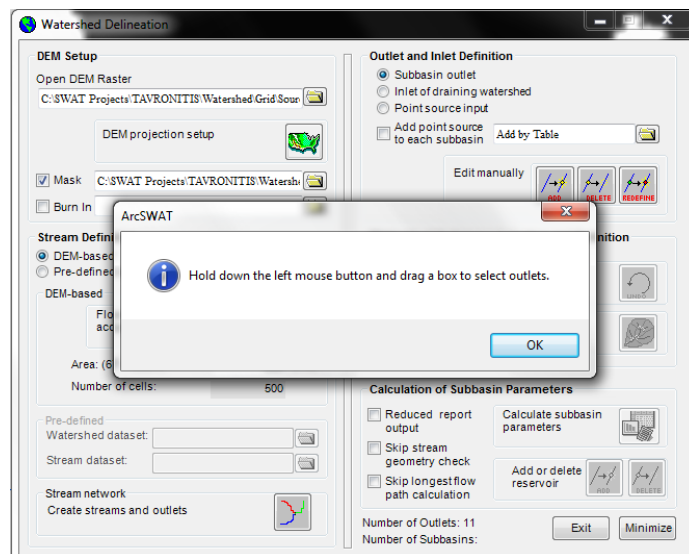
31 Add Outlet (cont...)

In order to stop adding any more outlets, right click and select **Stop Editing**.



32 Watershed Outlet

The **Watershed Delineation** window will reappear. Click on the **SELECT** button to choose the outlet that he added in Step30 which is the outlet of the whole watershed.



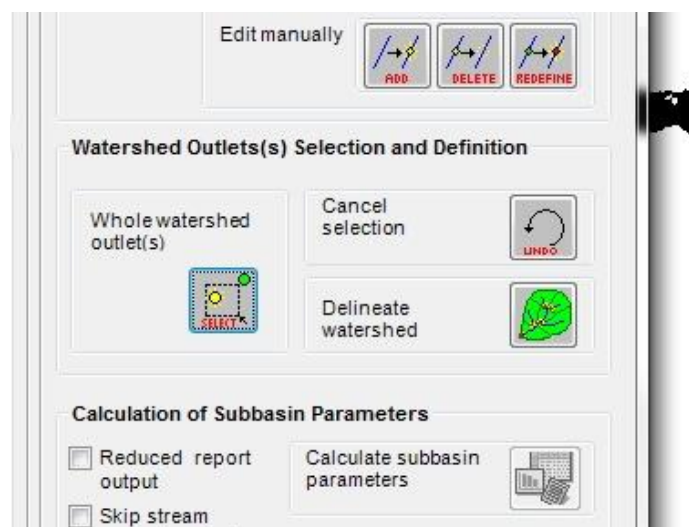
33 Watershed Outlet

A message window will appear notifying the user on how to select the watershed outlet. Press **OK** to continue.



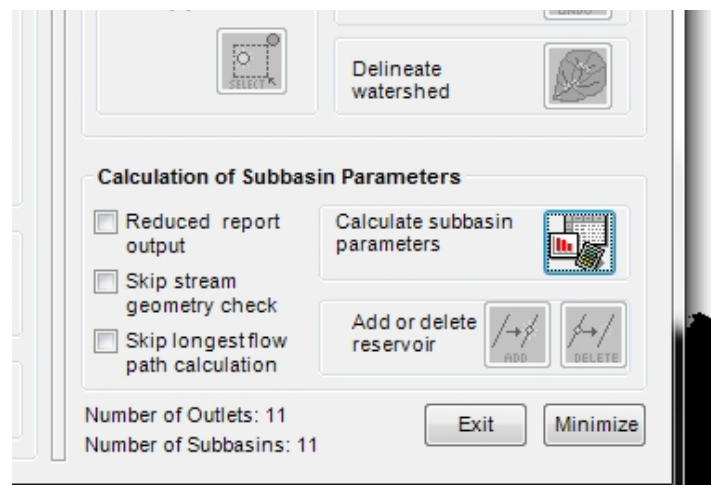
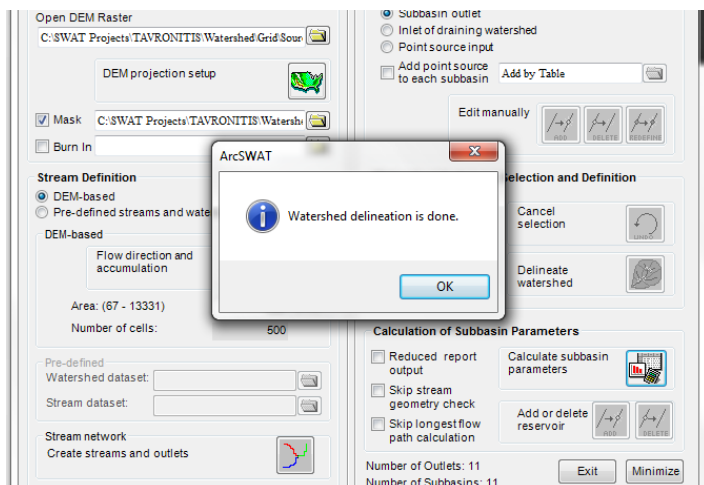
34 Watershed Outlet

Hold down the left mouse button and draw a box surrounding the watershed outlet. A confirmation popup window, appears. Press **OK** to continue.



35 Delineate Watershed

After selecting the Whole Watershed Outlet, the **Delineate watershed** button will be enabled. Click on the button to proceed with the delineation of main watershed and subbasins.



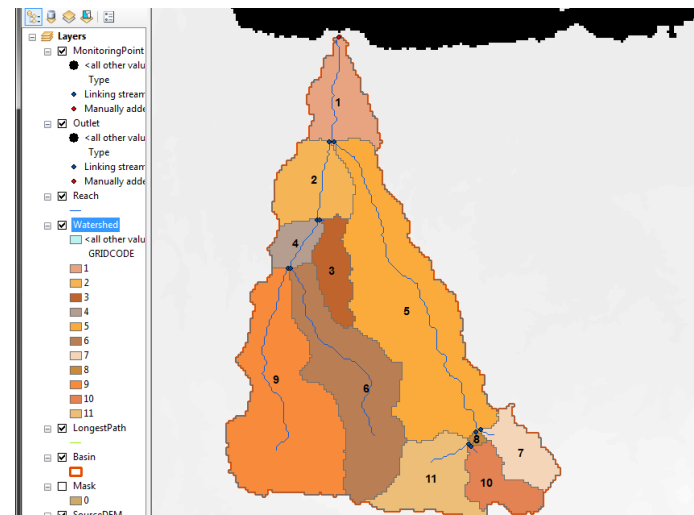
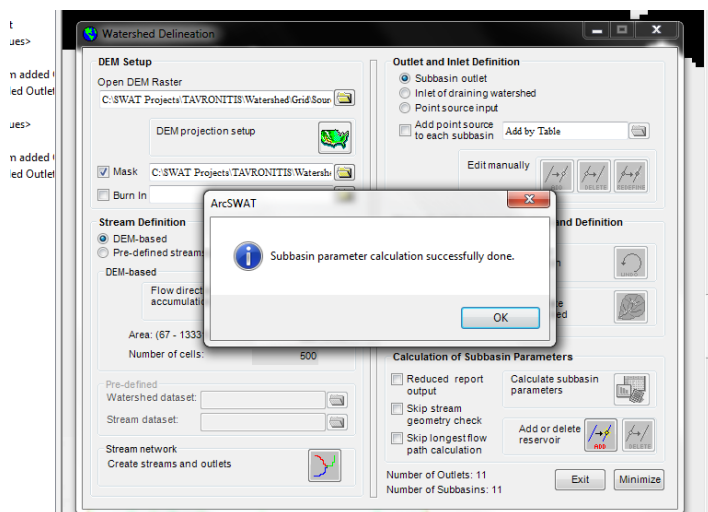
36 Delineate Watershed

Once the watershed delineation is completed the delineated watershed will be added to the view and a popup windows will appear informing the user that the delineation is done. Press **OK** to continue.

37 Calculate parameters

Click on the **Calculate subbasin parameters** button. This function calculates geomorphic parameters for each subbasin and the relative stream reach.

*Keep the **Reduced report output** selection unchecked in order to calculate elevation at every subbasin and not only for the full watershed level.*

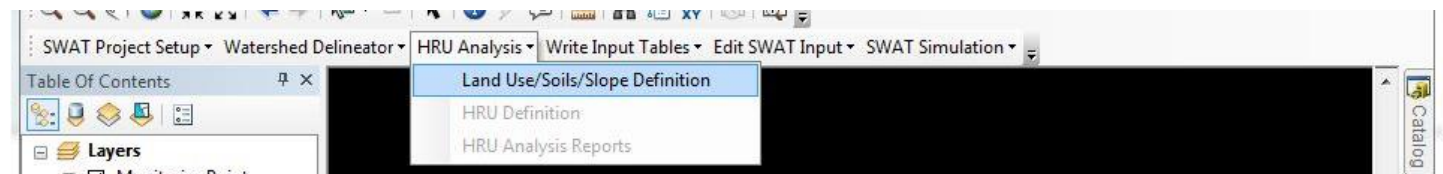


38 Calculate parameters

When the calculation process finishes, a dialog box will appear. Press **OK** to continue.

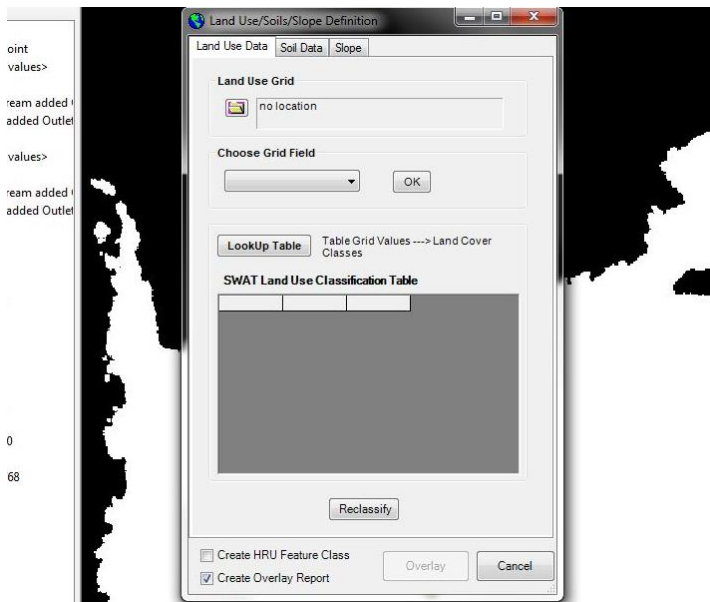
39 Delineated Watershed

This is the view of the delineated watershed and of all the included layers.



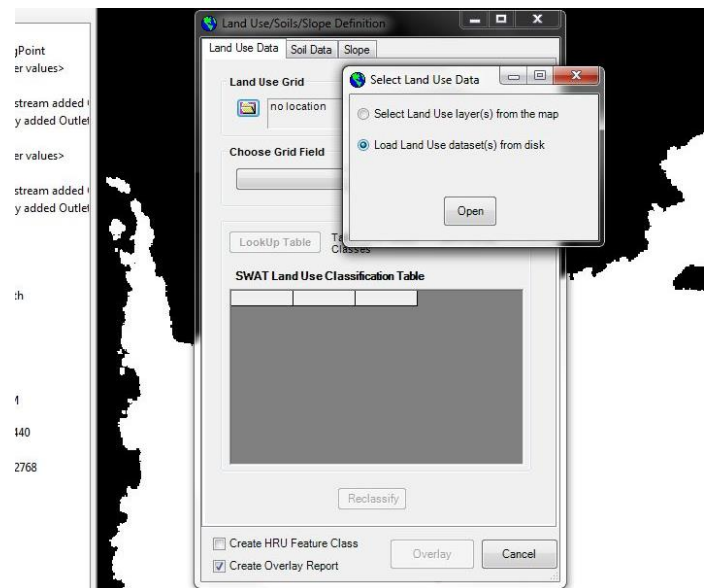
40 HRU Analysis

Under the **HRU Analysis** menu, click the **Land Use/Soils/Slope Definition** button.



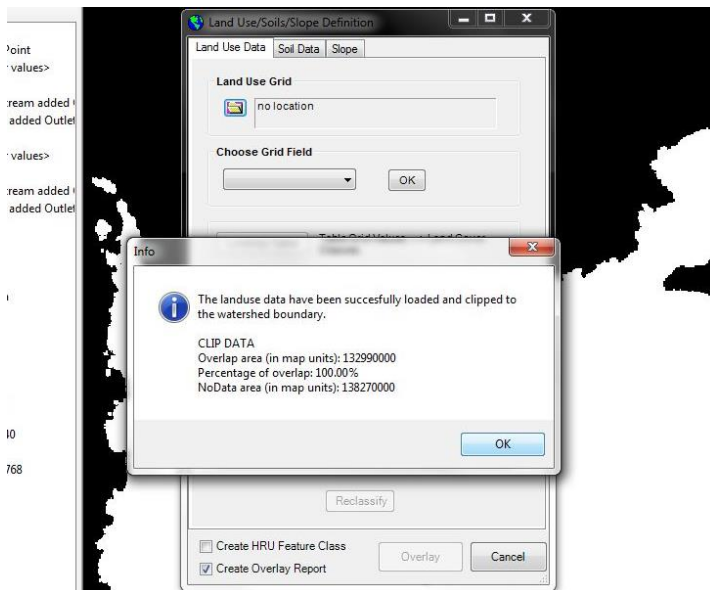
41 Land Use Definition

The **Land Use/Soils/Slope Definition** window will appear. Select the Land Use Grid file folder open button.



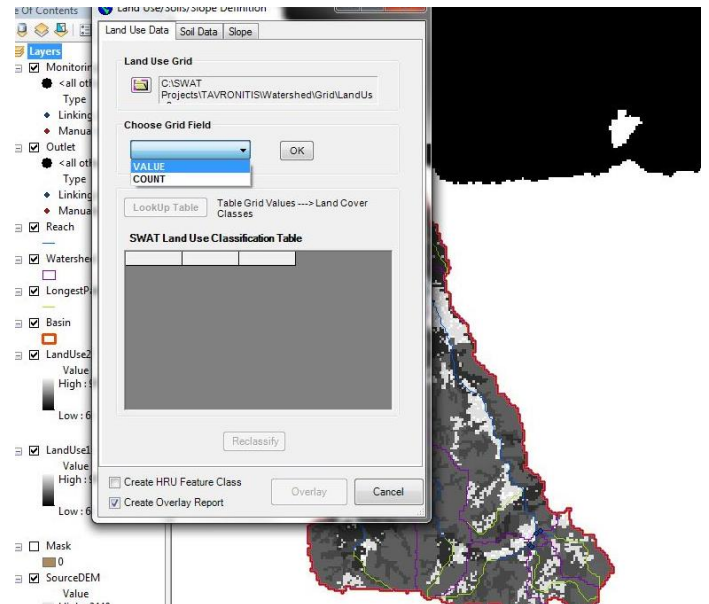
42 Select Land Use Data

From the new window, select the **Load Land Use Dataset(s) from disk** and click **Open**. Click **Yes** for the projection information dialog box.



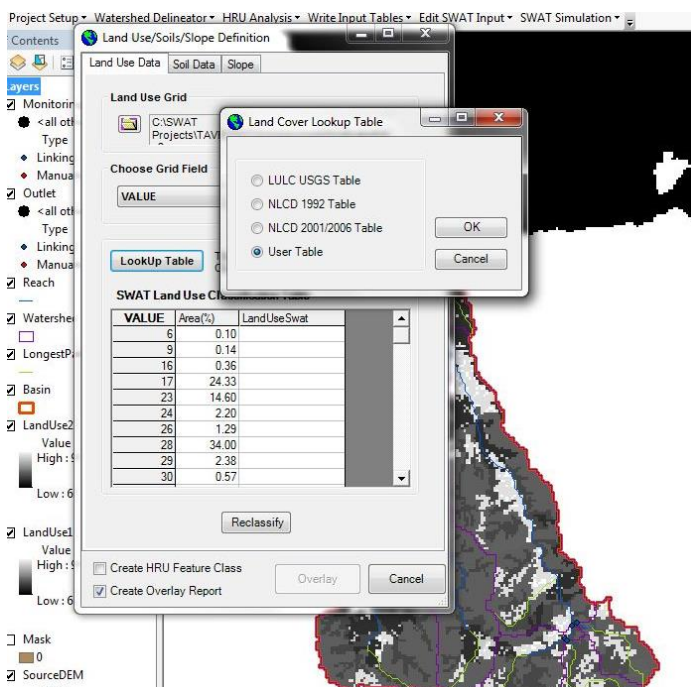
43 Land Use Data Info

After loading the land use file, an information window will appear showing details about the land use grid. Press **OK** to continue.



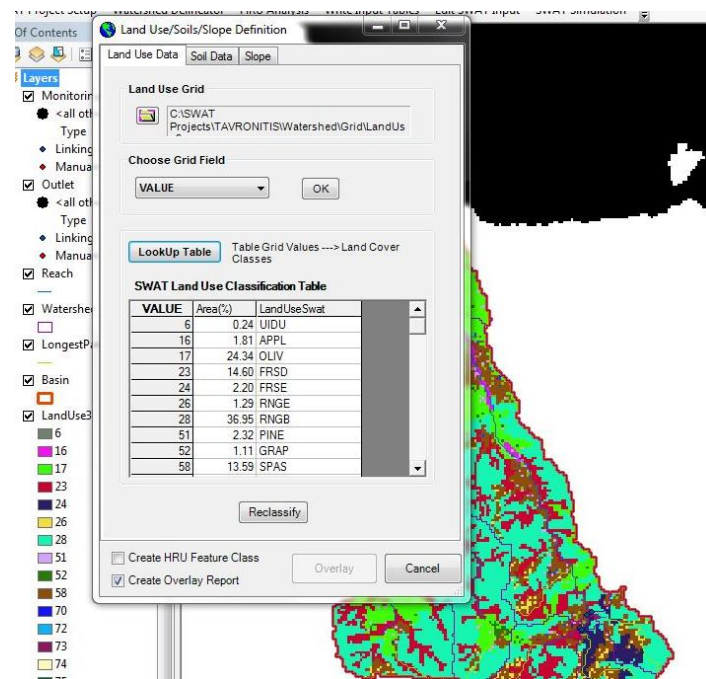
44 Choose Grid Field

Choose the **Value** option in the grid field and press **OK**. It'll be used as index to define the land use types. In the **SWAT Land Use Classification Table** box, a 3-column table will be created. The 1st column **VALUE** contains the unique values from the Grid field above. The 2nd column shows the area of each type of land use and the 3th column contains the corresponding landuse names in the SWAT database.



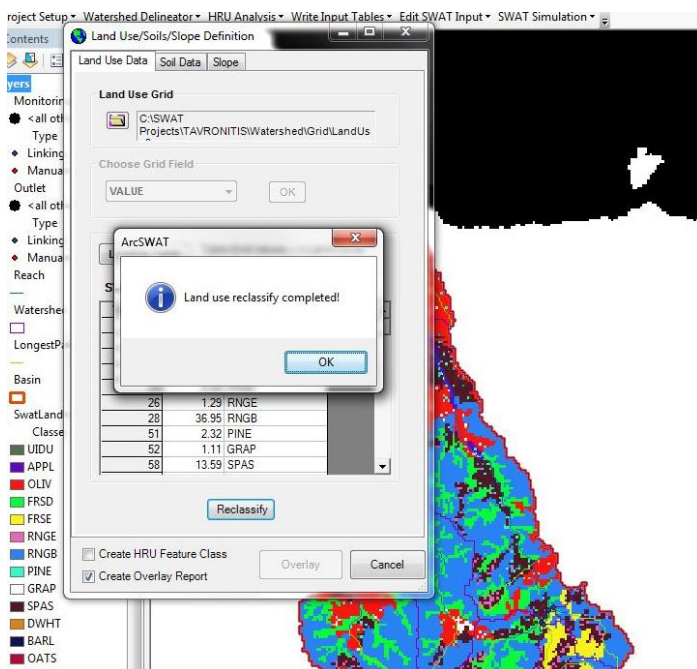
45 Land Use lookup table

In order to fill the 3rd column the user must import a lookup table. Press the **Look-up Table** button and in the new **Land cover Lookup Table** window, select **User Table**. Click OK and load the appropriate file (.txt or .dbf).



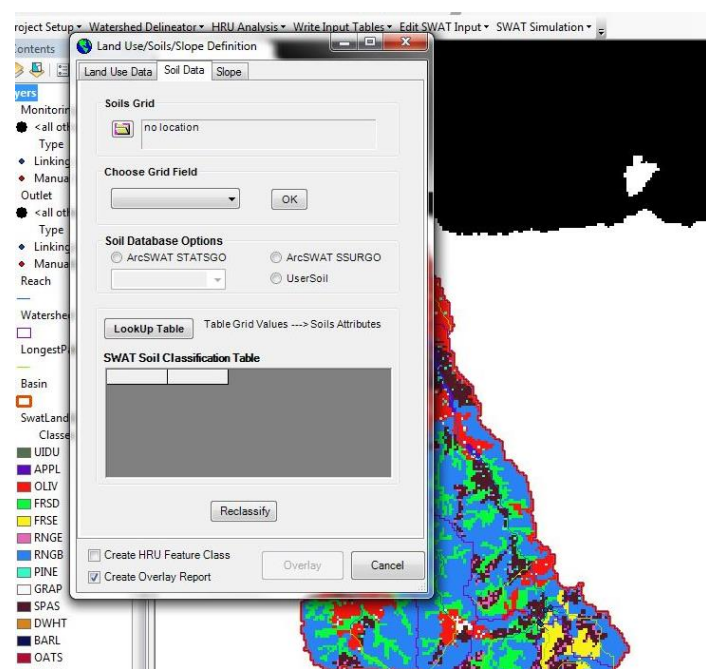
46 Reclassify

After filling the 3rd column which assigns a SWAT DB land cover description to each gridcode value, press the **Reclassify** button. The landuse map will be reclassified according to the SWAT database land cover (3rd column) values.



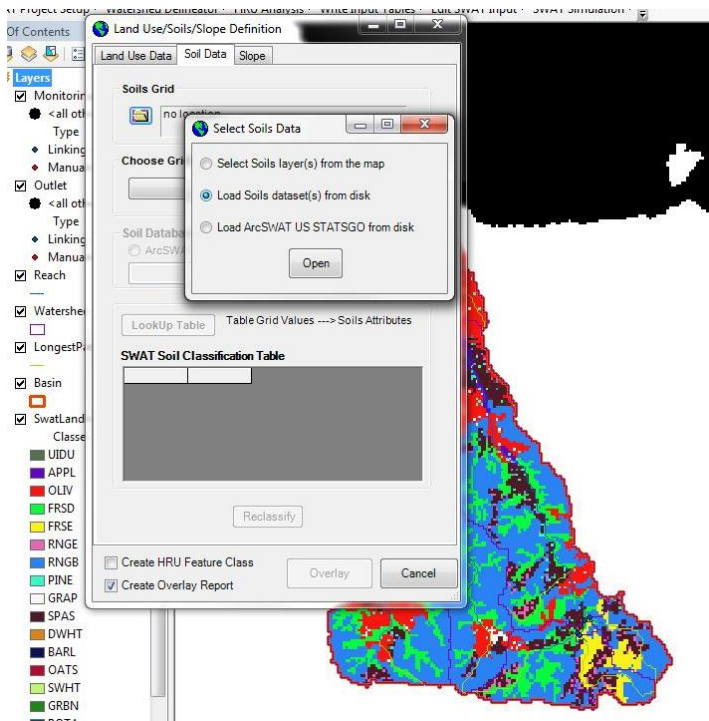
47 Reclassify completed

When the reclassify process is completed a dialog window will appear. Press **OK** to continue.



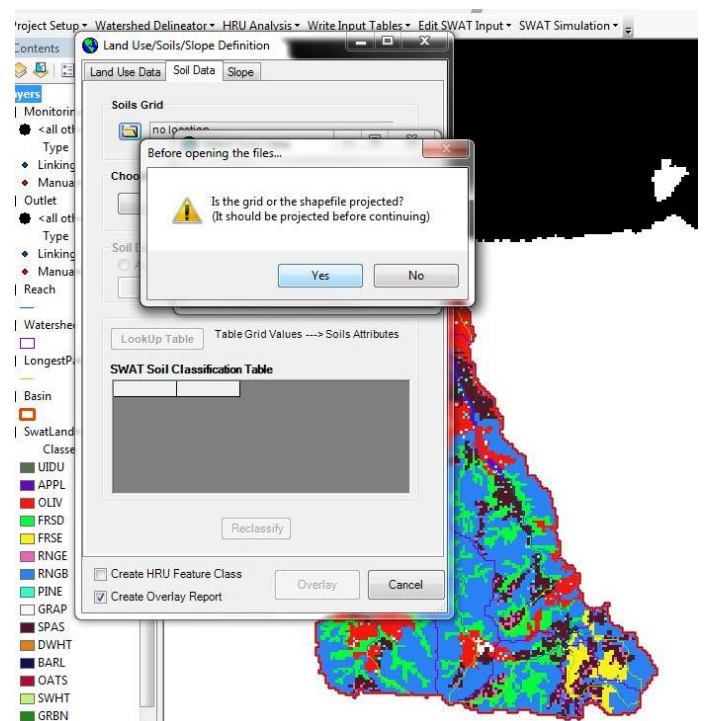
48 Soils Definition

In the **Land Use/Soils/Slope Definition** window select the **Soil Data** tab.



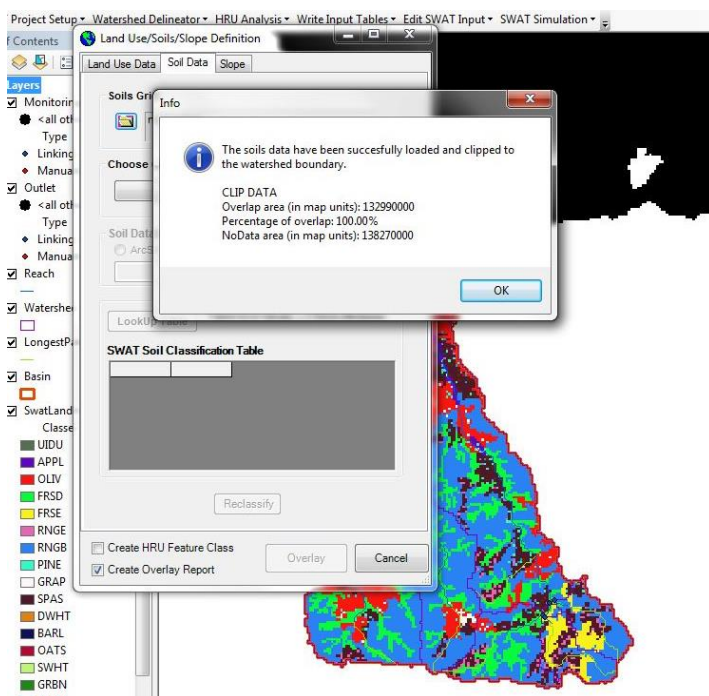
49 Select Soils Data

As with the Land Use process, select the Soils Grid file folder open button. From the new window, select the **Load Soils Dataset(s) from disk** and click **Open**.



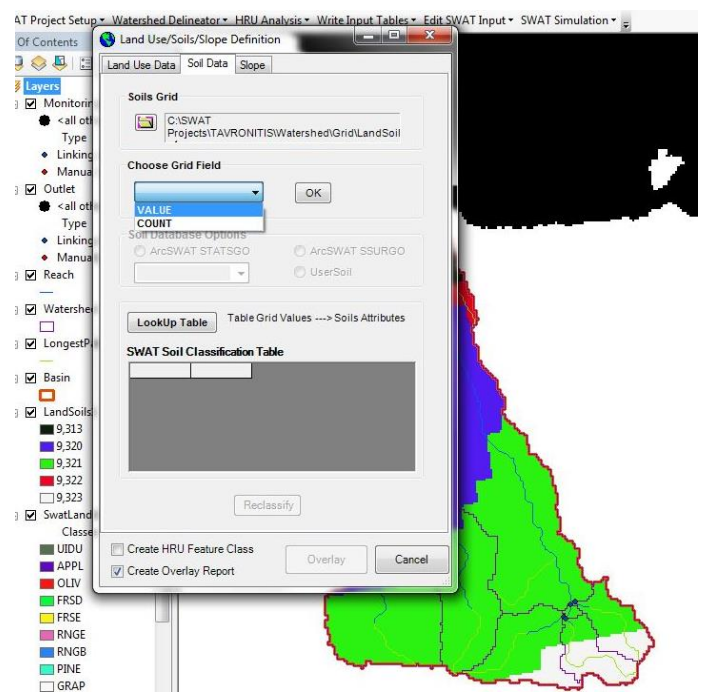
50 Select Soils Data

Click **Yes** for the projection information dialog box.



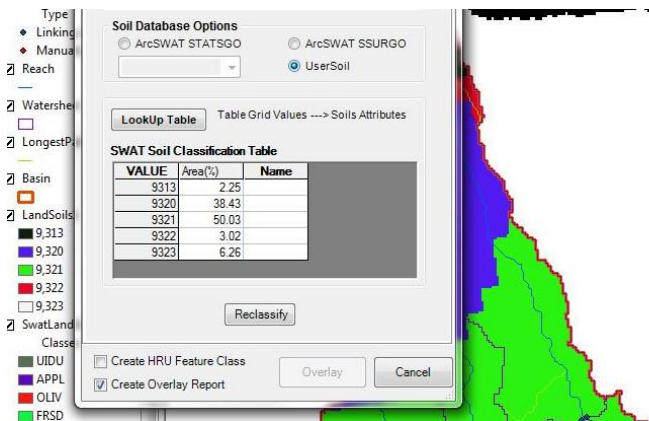
51 Soils Data Info

After loading the soils file, an information window will appear showing details about the soils grid. Press **OK** to continue.



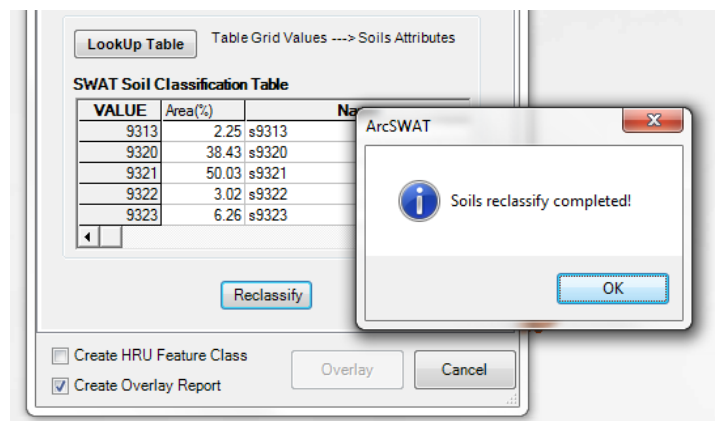
52 Choose Grid Field

Choose the **Value** option in the grid field and press **OK**. This will be used as index to define the soil types.



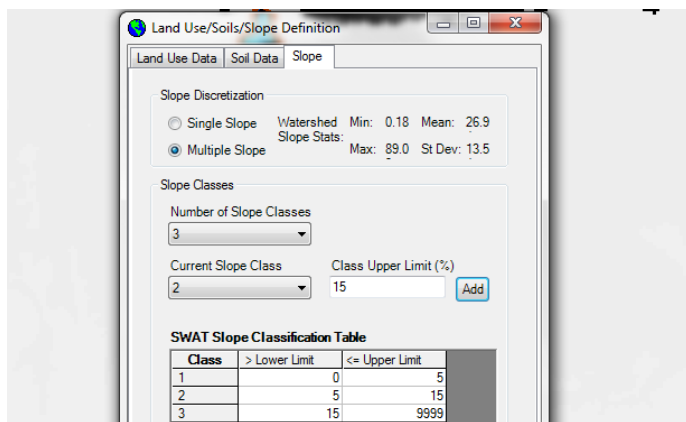
53 Soils Classification Table

In the **SWAT Soil Classification Table** box, a new 3-column table will be created. The 1st column VALUE contains the unique values from the Grid field above. The 2nd column shows the area of each type of soil and the 3th column contains the corresponding soils names in the SWAT database.



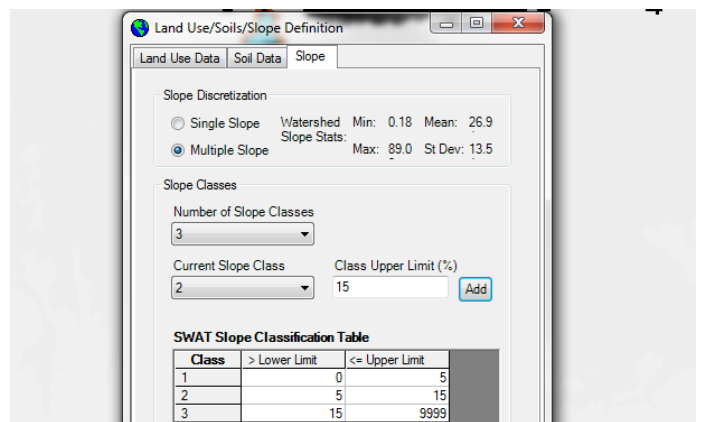
54 Soils Reclassify

In order to fill the 3rd column the user must import a lookup table. Press the **Look-up Table** button and in the new **Soils Lookup Table** window, select **User Table**. Click OK and load the appropriate file (.txt or .dbf). When finished, press the **Reclassify** button. When the reclassify process is completed a dialog window will appear. Press **OK** to continue.



55 Slope Definition

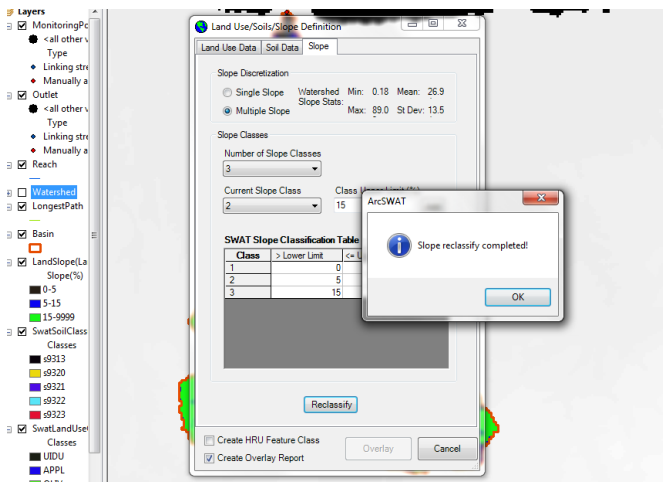
In the **Land Use/Soils/Slope Definition** window select the **Slope** tab. Select **Multiple Slope** to set different slope classes.



56 Slope Definition

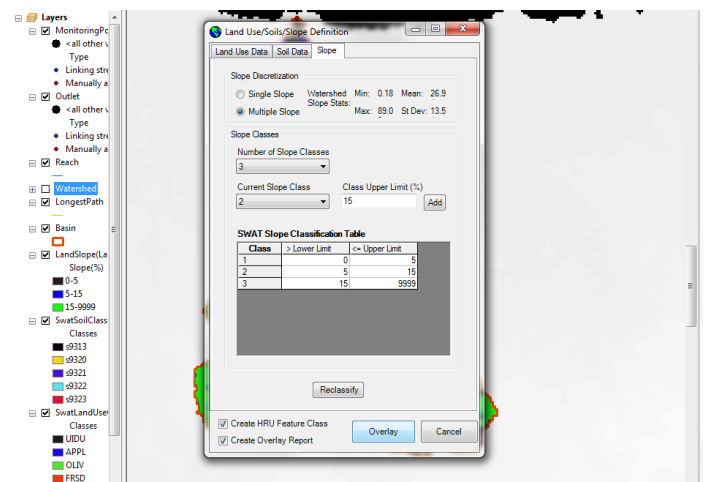
In the **Number of Slope Classes** set the value to 3. And for each slope class the Lower and Upper Limit are the following:

- Class 1: (Lower Limit: 0, Upper Limit 5)
- Class 2: (Lower Limit: 5, Upper Limit 15)
- Class 3: (Lower Limit: 15, Upper Limit 9999)



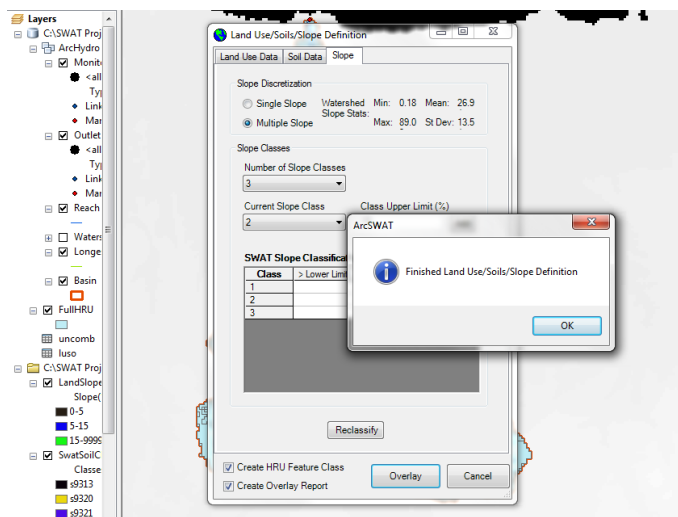
57 Slope Reclassification

Click **Reclassify** to add the classified slope layer to the map. When the reclassify process is completed a dialog window will appear. Press **OK** to continue.



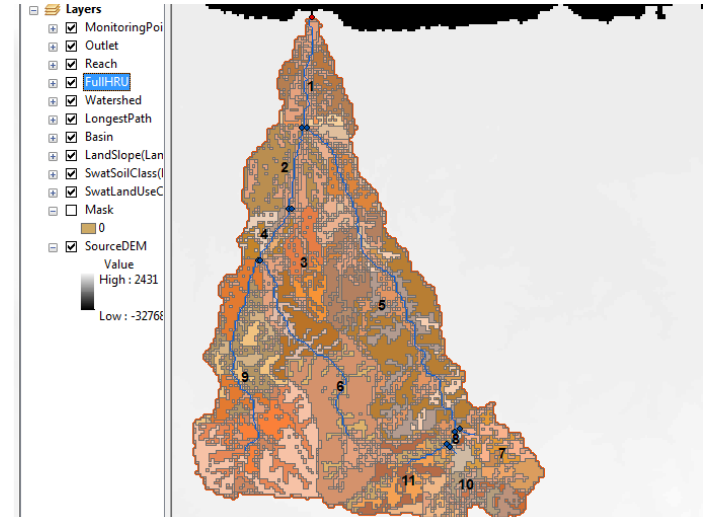
58 Calculate Overlay

When the Landuse, Soils and Slope layers are classified, check the **Create HRU Feature Class** and **Create Overlay Report** options and click the **OVERLAY** button.



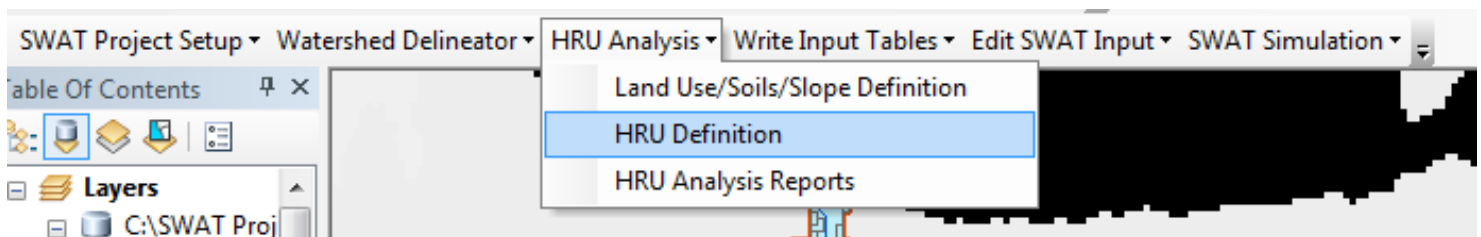
59 Overlay Completed

When the **OVERLAY** process is completed a dialog window will appear. Press **OK** to continue.



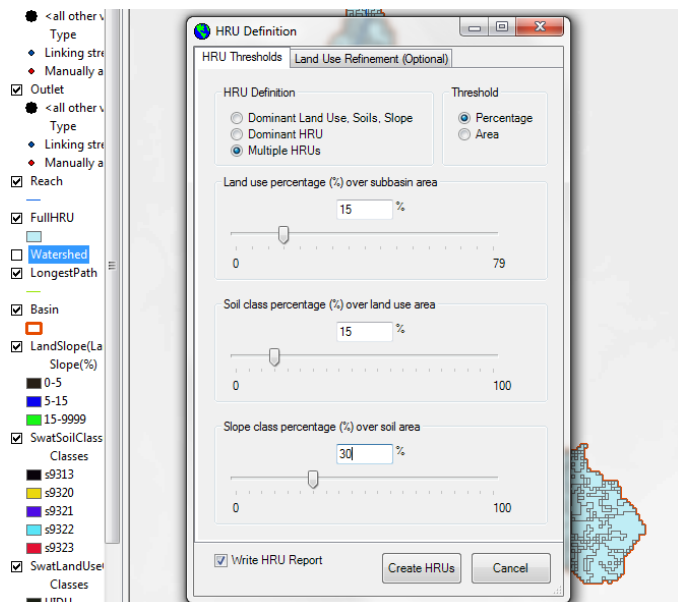
60 HRU Layer

A layer of the HRUs with the unique combination of landuse, soil and slope.



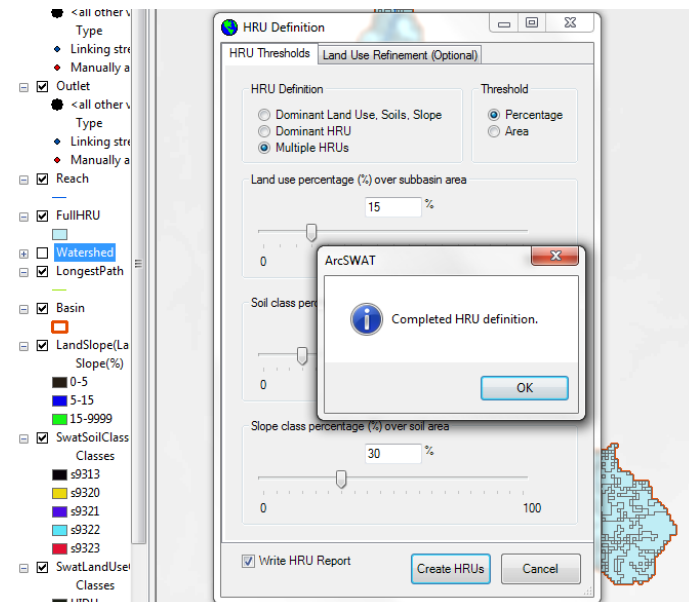
61 HRU Definition

Under the **HRU Analysis** menu, click the **HRU Definition** button. With this tool, the user can determine the HRU distribution within the watershed.



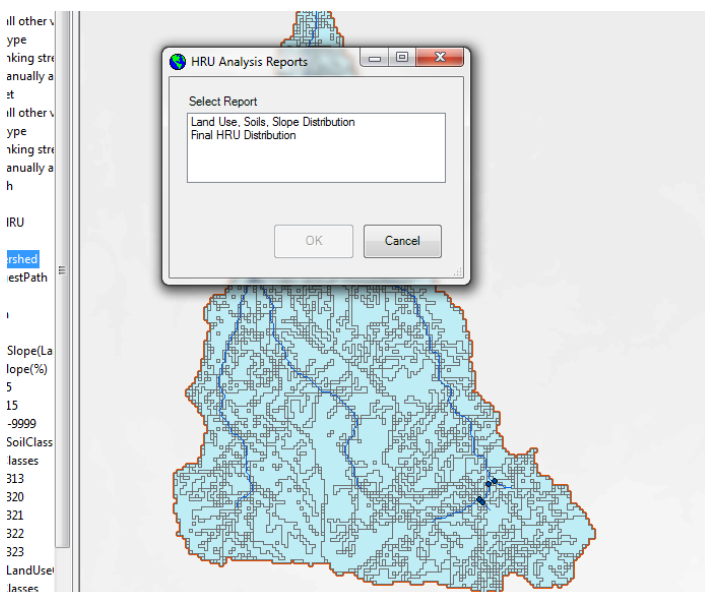
62 HRU Definition window

There are two main options in the HRU definition. The **Dominant HRU** (1 HRU per subbasin) and the **Multiple HRUs** (multiple HRUs per subbasin). Select the latter and set the thresholds for Landuse %, Soil Class % and Slope Class % to 15 15 and 30 respectively.



63 Delineate HRUs

Press the **Create HRUs** button to delineate the HRU distribution. When the process is completed a dialog window will appear. Press **OK** to continue.



64 HRU Analysis Report

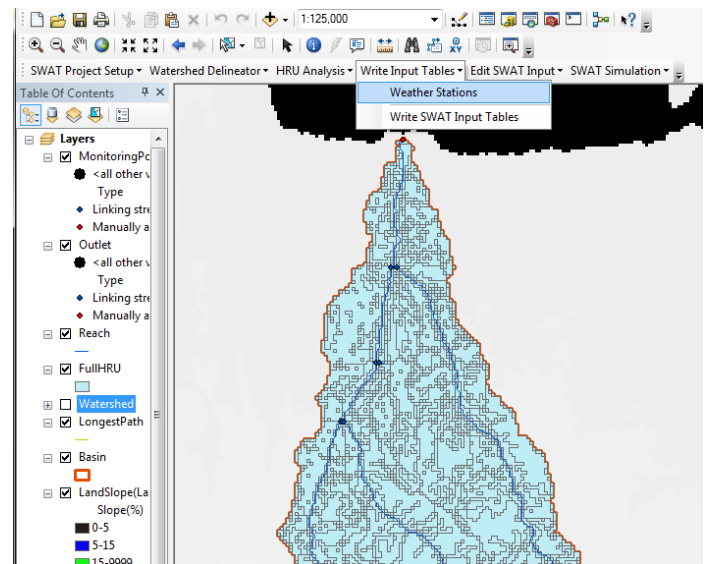
Under the **HRU Analysis** menu, click the **HRU Analysis Report** button. With this tool, the user has access to the two reports created after the HRU Analysis.

File Edit Format View Help				
Watershed		Area [ha]	Area [acres]	
Number of Subbasins: 11		13299.0000	32862.4940	
LANDUSE:		Area [ha]	Area [acres]	%Wat. Area
Industrial --> UIDU		32.0000	79.0736	0.24
Apple --> APPL		241.0000	595.5231	1.81
Olives --> OLIV		3237.0000	7998.7889	24.34
Forest-Deciduous --> FRSD		1942.0000	4798.7791	14.60
Forest-Evergreen --> FRSE		293.0000	724.0177	2.20
Range-Grasses --> RNGE		172.0000	423.0206	1.29
Range-Brush --> RNGB		4914.0000	12142.7397	36.95
Pine --> PINE		309.0000	763.5545	2.32
Vineyard --> GRAP		148.0000	365.7134	1.11
Summer Pasture --> SPAS		1807.0000	4465.1874	13.59
Durum wheat --> DWHT		3.0000	7.4132	0.02
Spring Barley --> BARL		1.0000	2.4711	0.01
Oats --> OATS		16.0000	39.5368	0.12
Spring wheat --> SWHT		2.0000	4.9421	0.02
Green Beans --> GRBN		4.0000	9.8842	0.03
Potato --> POTA		14.0000	34.5947	0.11
Tomato --> TOMA		25.0000	61.7763	0.19
Carrot --> CRRT		9.0000	22.2395	0.07
Sorghum Hay --> SGHY		86.0000	212.5103	0.65
Corn Silage --> CSIL		4.0000	9.8842	0.03
Alfalfa --> ALFA		40.0000	98.8420	0.30
SOILS:				
s9313		299.0000	738.8440	2.25
s9320		5111.0000	12629.5366	38.43
s9321		6654.0000	16442.3667	50.03
s9322		402.0000	993.3621	3.02
s9323		833.0000	2058.3847	6.26
SLOPE:				
0-5		516.0000	1275.0618	3.88
15-9999		10229.0000	25276.3705	76.92
5-15		2554.0000	6311.0617	19.20
SUBBASIN #		Area [ha]	Area [acres]	%Wat. Area
1		797.0000	1969.4269	5.99
LANDUSE:				
Industrial --> UIDU		32.0000	79.0736	0.24
Apple --> APPL		63.0000	155.6762	0.47
Olives --> OLIV		523.0000	1282.3592	3.93
Range-Brush --> RNGB		37.0000	91.4289	0.28
Pine --> PINE		41.0000	101.3131	0.31
Vineyard --> GRAP		20.0000	49.4210	0.15
Summer Pasture --> SPAS		81.0000	200.1551	0.61

65 Land-Soils-Slope distr.

This report provides a detailed description of the distribution of the land use, soil, and slope classes in the watershed and all the subbasins.

SWAT model simulation Date: 11/10/2013 12:00:00 AM Time: 00:00:00 MULTIPLE HRUS Landuse/soil/slope OPTION THRESHOLDS : 15 / 15 / 30 [%] Number of HRUS: 57 Number of Subbasins: 11				
Watershed	Area [ha]	Area[acres]		
	13299.0000	32862.4940		
LANDUSE:	Area [ha]	Area[acres]	%Wat. Area	
Olives --> OLIV	3659.9273	9043.8632	27.52	
Forest-Deciduous --> FRSD	2169.4958	5360.9327	16.31	
Range-Brush --> RNBG	5474.9696	13528.9338	41.17	
Summer Pasture --> SPAS	1690.3778	4177.0080	12.72	
Forest-Evergreen --> FRSE	304.2295	751.7663	2.29	
SOILS:				
s9313	286.4933	707.9393	2.15	
s9320	4918.3794	12153.5615	36.98	
s9322	385.5468	952.7055	2.90	
s9321	6861.9630	16956.2536	51.60	
s9323	846.6375	2092.0341	6.37	
SLOPE:				
5-15	2203.8633	5445.8565	16.57	
15-9999	11095.1367	27416.6375	83.43	
SUBBASIN #	Area [ha]	Area[acres]	%Wat. Area	%Sub. Area
1	797.0000	1969.4269	5.99	
LANDUSE:				
Olives --> OLIV	797.0000	1969.4269	5.99	100.00
SOILS:				
s9313	286.4933	707.9393	2.15	35.95
s9320	124.9598	308.7820	0.94	15.68
s9322	385.5468	952.7055	2.90	48.37
SLOPE:				
5-15	754.2506	1863.7909	5.67	94.64
15-9999	42.7494	105.6360	0.32	5.36
HRUS				
1	Olives --> OLIV/s9313/5-15	286.4933	2.15	35.95
2	Olives --> OLIV/s9320/5-15	82.2104	0.62	10.31
3	Olives --> OLIV/s9320/15-9999	42.7494	105.6360	5.36
4	Olives --> OLIV/s9322/5-15	385.5468	952.7055	2.90
	Area [ha]	Area[acres]	%Wat. Area	%Sub. Area

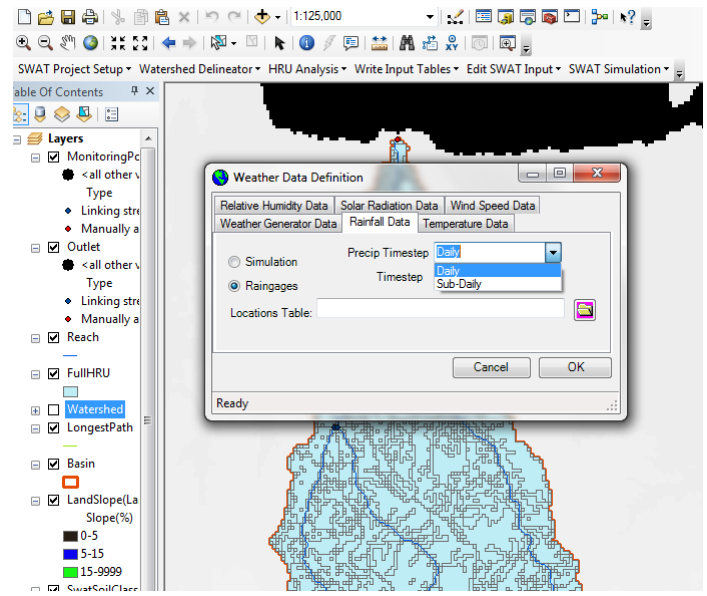
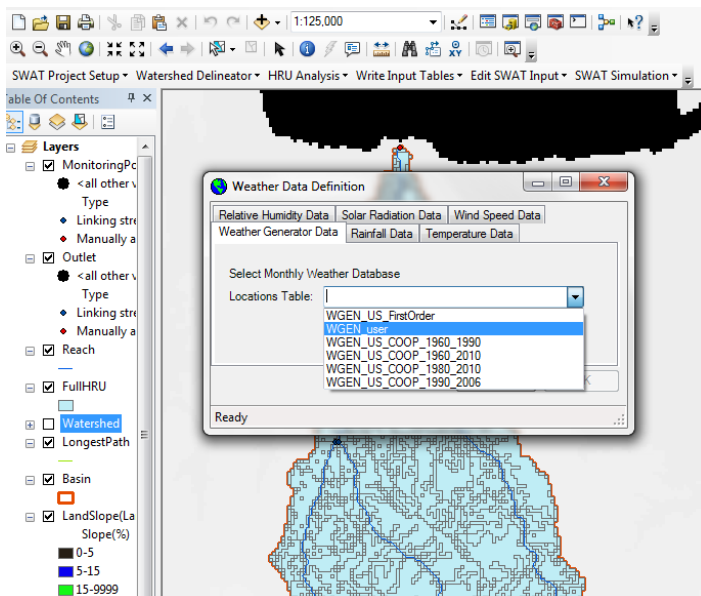


66 Final HRU distribution

This report provides a detailed description of the distribution of the land use, soil, and slope classes after application of thresholds for the watershed and all the subbasins.

67 Weather Stations

After the HRU definition process is completed, the user must import weather data. Under the **Write Input Tables** menu, click the **Weather Stations** button.

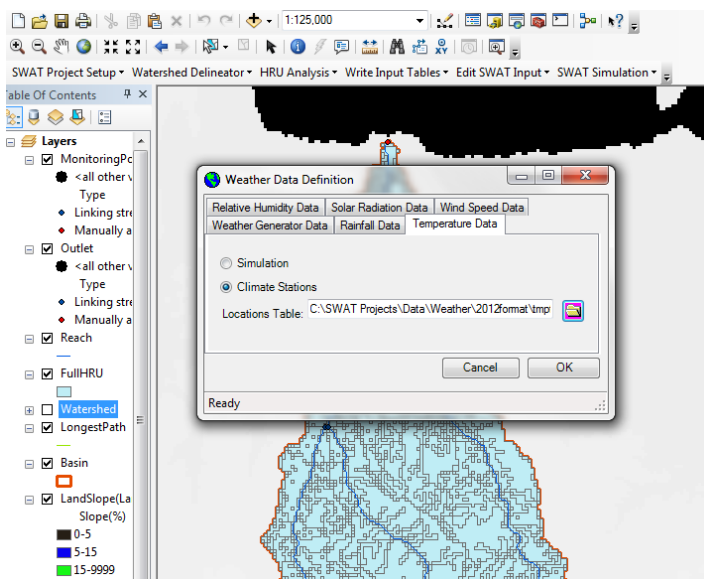


68 Weather Gen. Data

The **Weather Data Definition** window will appear where the user can import rainfall, temperature and other weather data. In the **Weather Generator Data** tab, select the **WGEN_user** option for the **Locations Table** field.

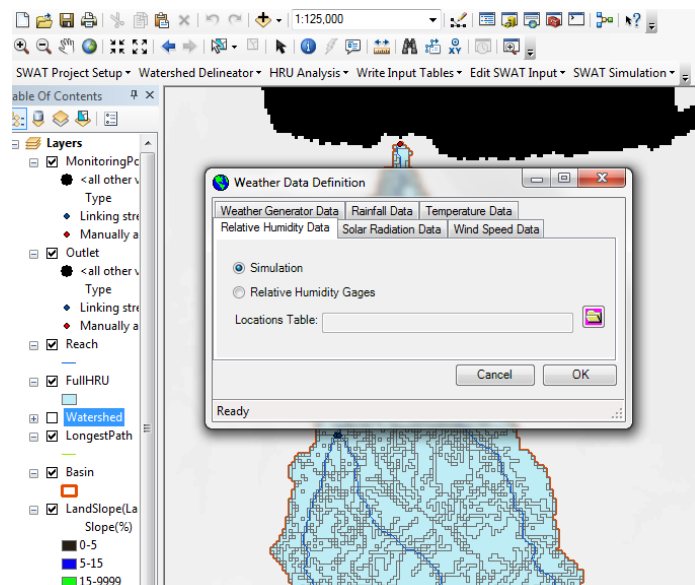
69 Rainfall Data

Under the **Rainfall Data** tab, select the **Raingages** option and the **Daily** option in the **Precip Timestep**. Browse to the project's weather data folder and load the **pcpfork.txt** file.



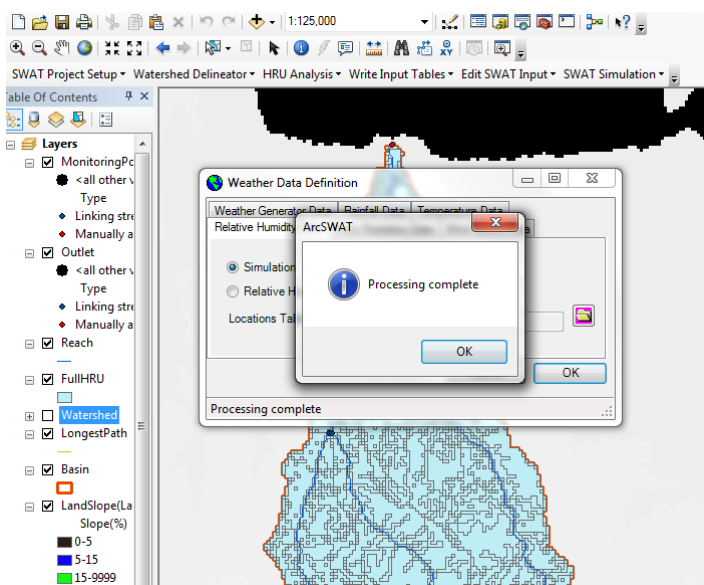
70 Temperature Data

Under the **Temperature Data** tab, select the **Climate Stations** option. Browse to the project's weather data folder and load the **tmpfork.txt** file.



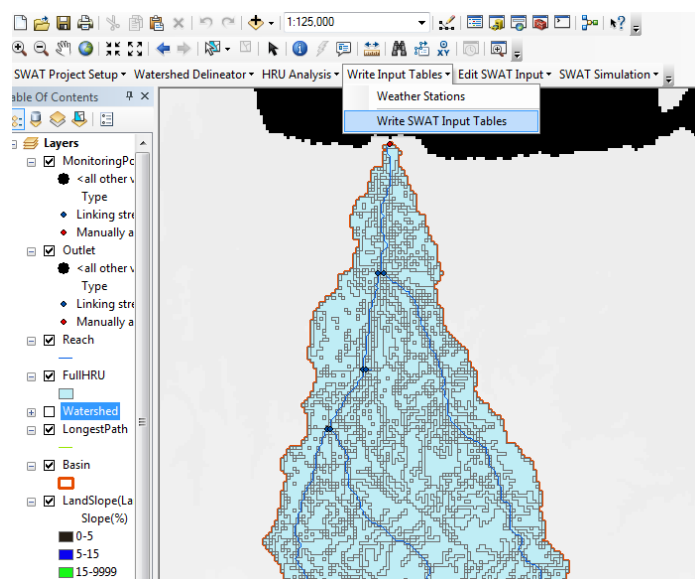
71 Other weather data

For the rest of the weather data (Relative Humidity, Solar Radiation and Wind Speed), select the simulation options. When finished, press **OK** to generate the SWAT weather input data files.



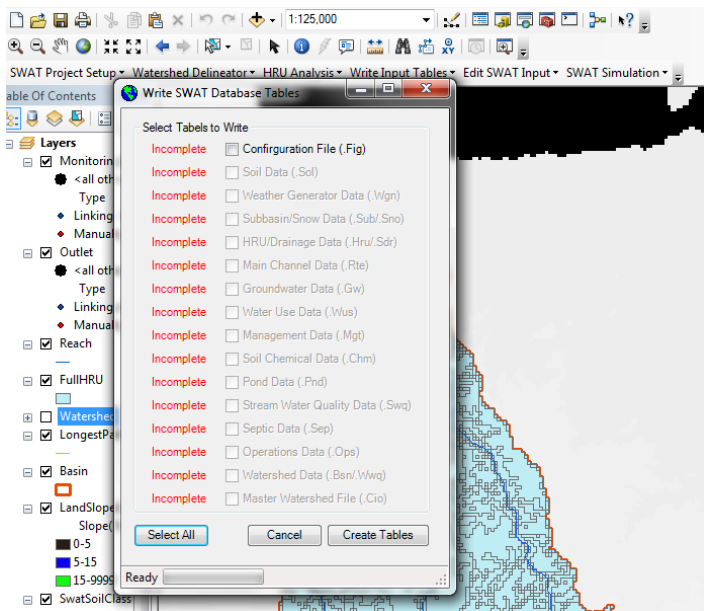
72 Weather Data

After the weather data are successfully loaded, a dialog window will appear. Press **OK** to continue.



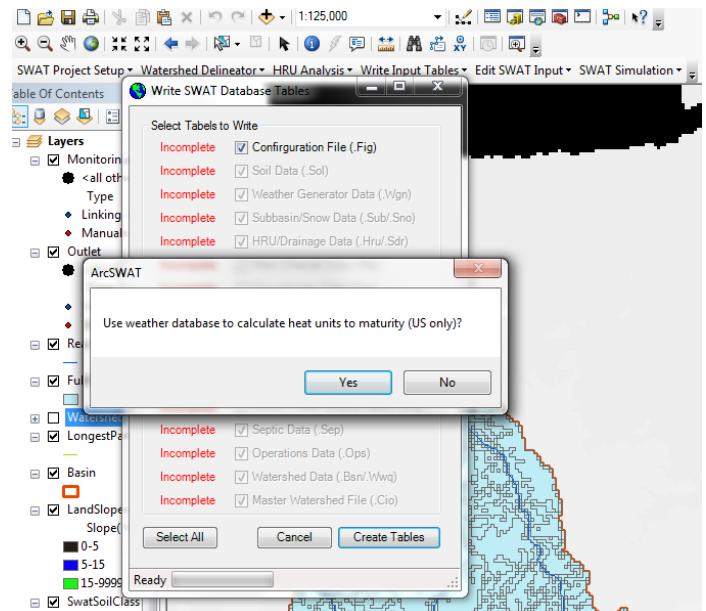
73 Write Swat Input Tables

The Write Input Tables menu allows the user to build database files containing the information needed to generate default input for SWAT. The Write command is enabled after weather data is successfully loaded.



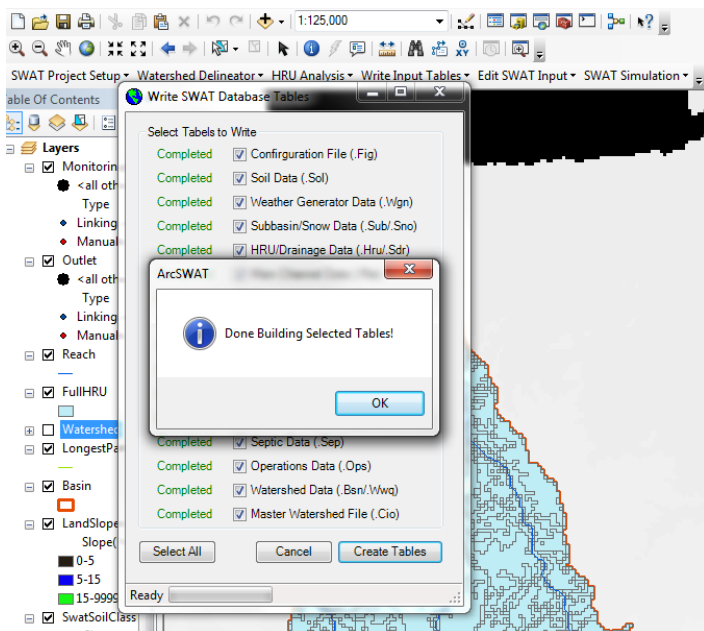
74 Write Swat Input Tables

The Write Input Tables window will appear. Click the **Select All** button and then click the **Create Tables** button



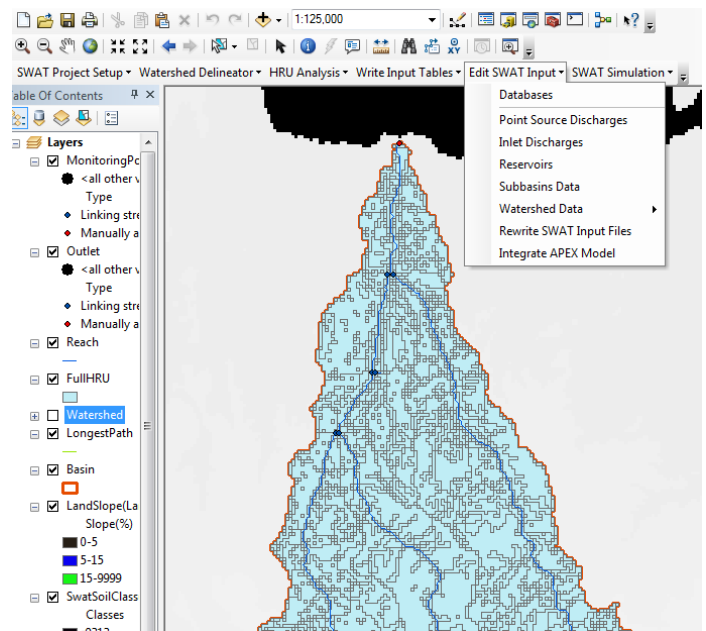
75 Write Swat Input Tables

A popup windows will ask to use weather database for estimating heat units required for plants to reach maturity. **Yes** may be chosen only for watersheds in the northern hemisphere. Click **Yes** to continue.



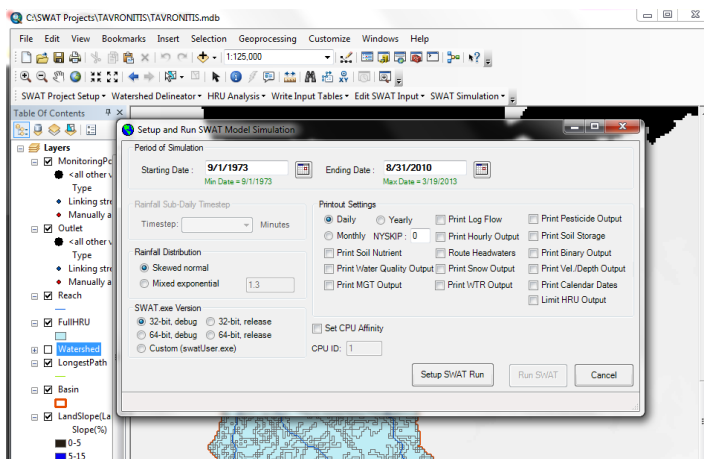
76 Write Swat Input Tables

After the Write Input Tables process is finished, a dialog window will appear. Press **OK** to continue.



77 Edit SWAT Input

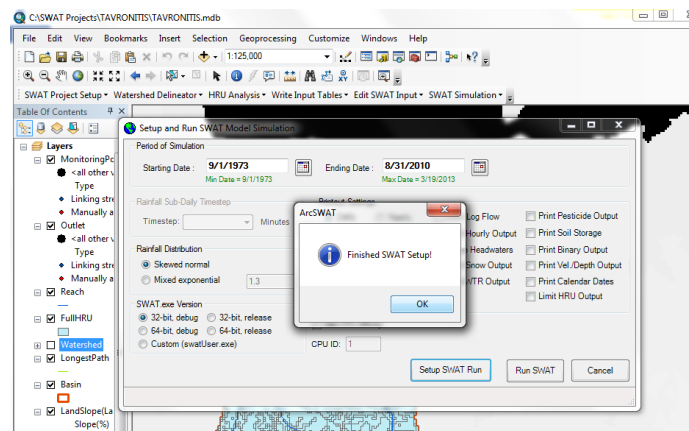
When all of the default inputs have been generated, you can move to the SWAT Simulation menu and run SWAT or edit the default inputs using the editors activated under the **Edit SWAT Inputs** menu.



78 Run SWAT

Under the **SWAT Simulation** menu, click the **Run SWAT** button. The **Setup and Run SWAT Model Simulation** window will appear. This window has several options:

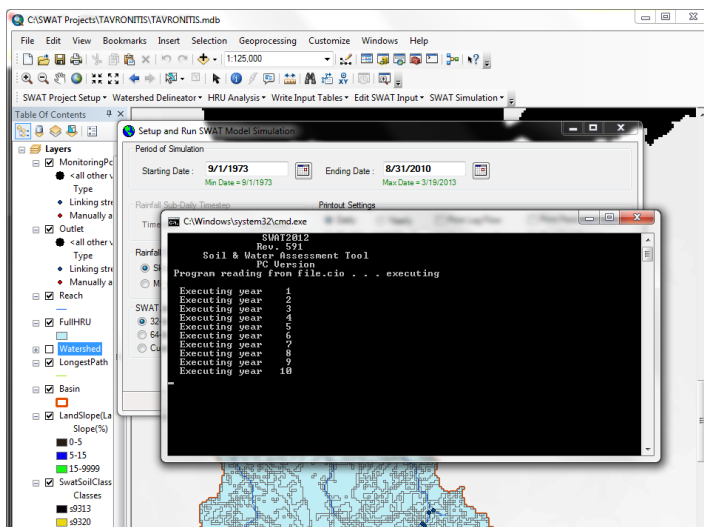
- Setting up the period of simulation (Start/End Dates)
- Rainfall Distribution (Skewed Normal, Mixed expon.)
- Printout Settings
(Set it to daily and uncheck all other option)



79 Setup SWAT Run

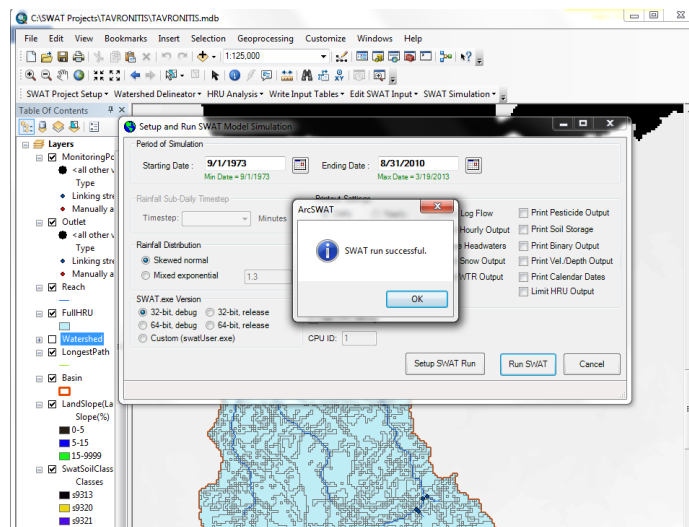
After setting the parameters, press the **Setup SWAT Run** button to generate the final input files based on the parameters defined in this window. A dialog box will appear. Press **OK** to continue.

After that press the **Run SWAT** button to execute the SWAT process.



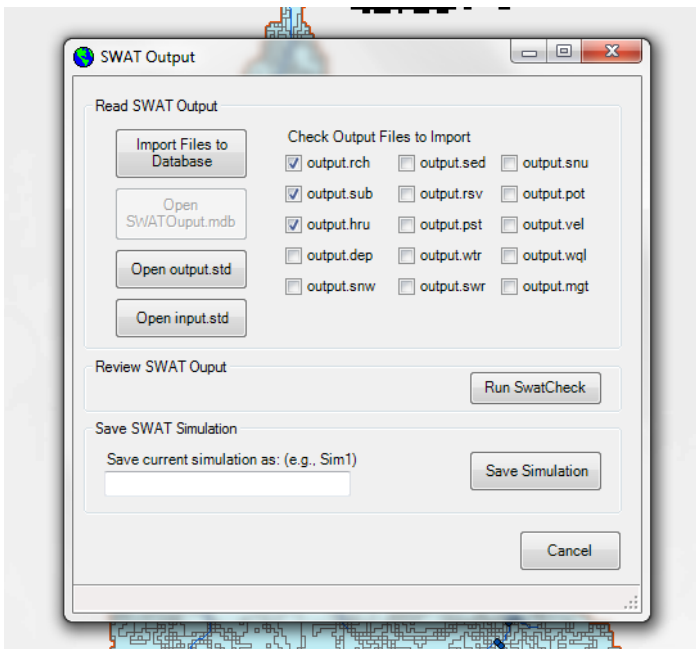
80 Run SWAT

The above command prompt window appears indicating that the SWAT model is being executed.



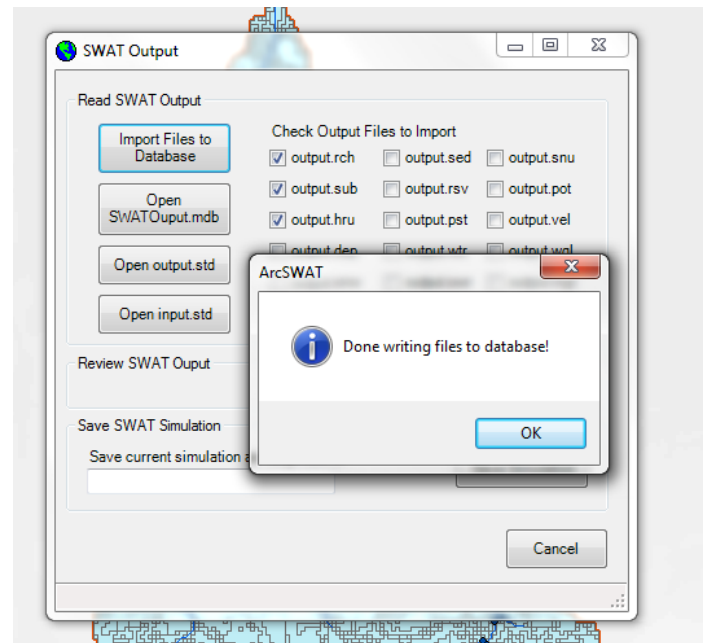
81 SWAT Run Completed

If the simulation terminates successfully, a message box will appear notifying of a successful run. Press **OK** to continue.



82 SWAT Output

If the SWAT process terminates successfully, under the **SWAT Simulation** menu click the **Read SWAT Output** button. In the new window that will appear, the user can import files to database and can also save the current simulation to a different location.

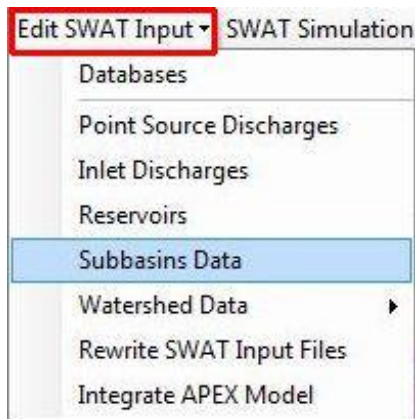


83 Import files to Access

Press the **Import Files to Database** button. With this tool the user can import the output txt files generated by SWAT to an ACCESS database. When the import process finishes a message box will appear. Press **OK** to continue.

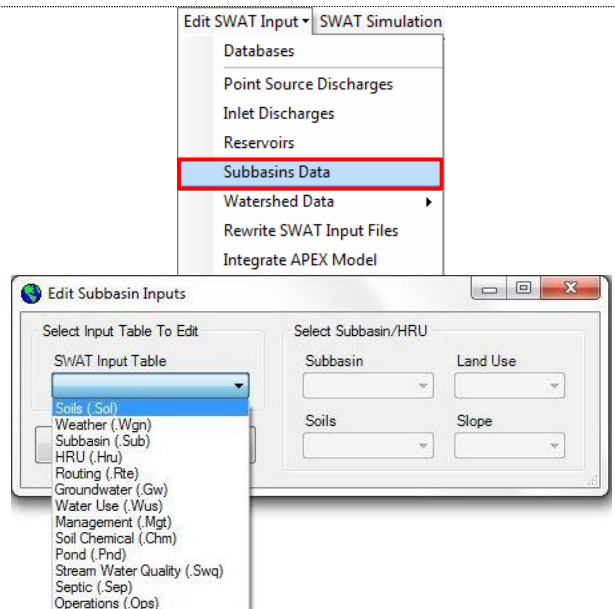
MANUAL CALIBRATION -

modify SWAT Input files



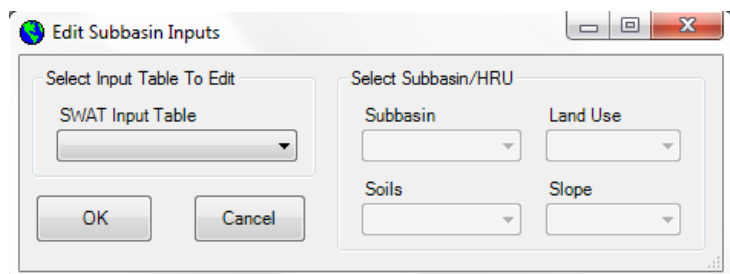
01 Edit SWAT Input

The **Edit SWAT Input** menu, allows to edit the SWAT model Databases and the Watershed database files



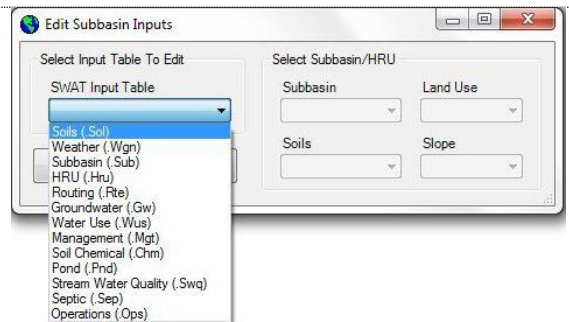
02 Subbasins Data Editing

The **Subbasins Data** menu allows the user to edit parameters/inputs including land area, channel, pond/wetland and groundwater.



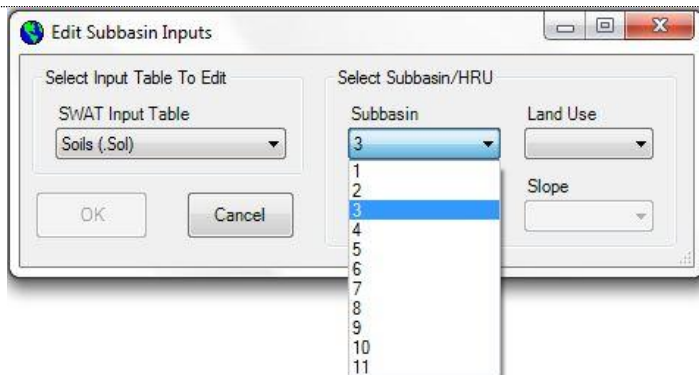
03 Subbasins Data Editing

The **Edit Subbasin Inputs** dialogue box enables the navigation and editing of the SWAT Input Data, related to Subbasins and HRUs.



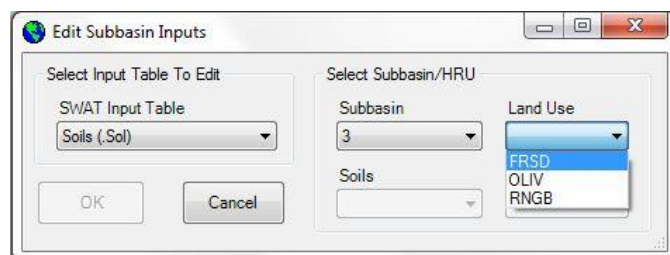
04 Select SWAT Input Table

In the **SWAT Input Table** menu, you can select the input table to be edited



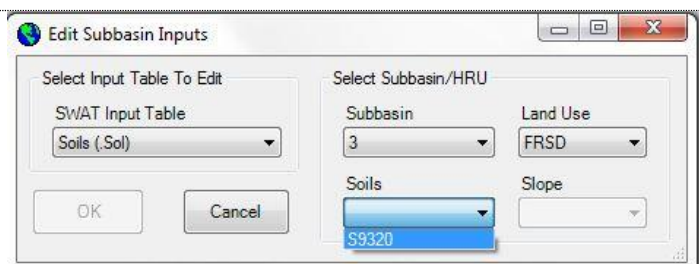
05 Selecting Subbasin

After a **SWAT Input Table** has been selected, the **Subbasin** box is enabled.



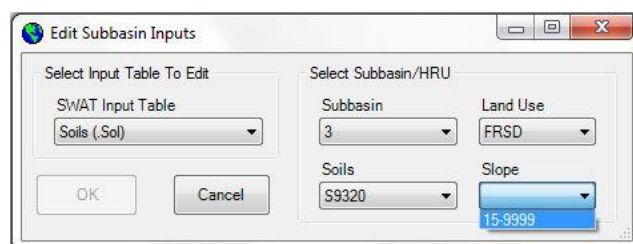
06 Selecting Land Use

After a **Subbasin** is selected, the **Land Use** box will display all the land uses available in the selected. **subbasin**



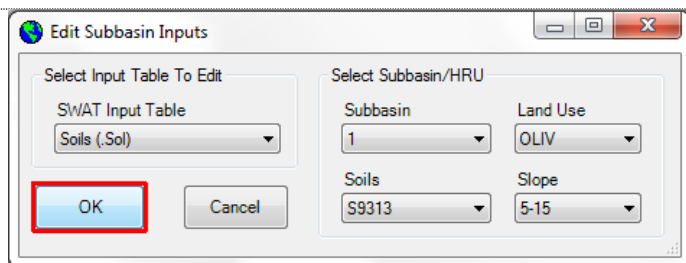
07 Selecting Soils

After a **Land Use** is selected, the **Soils** box will display all the soils available within the selected **land use** in the selected **subbasin**.



08 Selecting Slope

After a **Soil** is selected, the **Slope** box will display all the slope classes available within the selected **soil**, **land use** and **subbasin**.



09 Subbasins Data Editing

Once HRU components are selected the OK button opens the Edit Parameters dialogue window.

10 Edit Parameters

- The **Edit Values** button enables the editing of parameters.
- In the **Extend Parameter Edits** tab, there are several options for extending the edits made, to additional HRUs.
- The edits will not be saved until you click the **Save Edits** button.

11 Main Soil (.Sol) parameters for Hydrology calibration

- The **Soil Layer Parameters** can be modified for each Soil Layer
- SOL_Z(layer#)**: Depth from soil surface to bottom of layer
- SOL_AWC (layer#)**: Available Water Capacity of the soil layer
- SOL_K(layer#)**: Saturated Hydraulic Conductivity

12 Main Subbasin (.Sub) parameters for Hydrology calibration

- TLAPS**: Temperature Laps Rate. A positive/negative value denotes an increase/decrease in temperature with an increase in elevation

13 Main HRU (.Hru) parameters for Hydrology calibration

- **HRU_SLP**: Average slope steepness.
- **CANMX**: Maximum Canopy Storage. The plant canopy can significantly affect infiltration, surface runoff and Evapotranspiration.
- **ESCO**: Soil Evaporation Compensation factor. As the **ESCO** is reduced, the model is able to extract more of the evaporative demand from **lower** levels.
- **EPCO**: Plant uptake compensation factor. As **EPCO** increases, the model allows more of the water uptake demand to be met by lower layers in the soil.

14 Main Routing (.Rte)-Channel parameters for Hydrology calibration

- **CH_N2**: Manning's "n" value for the main (subbasin) channel.
- **CH_K2**: Effective Hydraulic conductivity in main channel alluvium.

15 Main Groundwater (.Gw) parameters for Hydrology calibration

- **GW_DELAY**: Groundwater delay time. The lag between the time that water exits the soil profile and enters the shallow aquifer.
- **ALPHA_BF**: Baseflow alpha factor. Is a direct index of groundwater flow response to changes in recharge. Low values indicate slow response.
- **GWQMIN**: Threshold depth of water in the shallow aquifer required for return flow to occur.
- **GW_REVAP**: Groundwater "revap" coefficient is an index of water transfer, from the shallow aquifer to

the root zone. As **GW_REVAP** approaches 0, movement of water from the shallow aquifer to the root zone is restricted.

- **REVAPMN**: Threshold depth of water in the shallow aquifer for “revap” or percolation to the deep aquifer to occur.

16 Main Management (.Mgt) parameters for Hydrology calibration

- **General Parameters**

- **CN2**: Initial SCS runoff curve number for average soil moisture. The SCS curve number is a function of the soil permeability, land use and anteceded soil water conditions.

General Parameters

Initial Plant Growth

Initial Land Cover: No Crop Growing

LAI_INIT: 0

BIO_INIT: 0

PHU_PLT: 0

General Management

BIOMIX: 0.2

CN2: 77

USLE_P: 1

BIO_MIN: 0

FILTERW: 0

Urban Management

Urban Land Cover: No Urban Use

Urban Simulation Method: [Empty]

Irrigation Management

Irrigation Source: No Irrigation

Subbasin ID: [Empty]

FLOWMIN (m³/s): 0

DIVMAX (+mm/-10⁻⁴ m³): 0

FLOWFR: 0

Tile Drain Management

DDRAIN (mm): 0

TDRAIN (hr): 0

GDRAIN (hr): 0

Special Management Options

☐ Adjust Curve Numbers for Slope

Edit Values

Cancel Edits

Save Edits

Exit

Extend Parameter Edits

☐ Extend ALL MGT General Parameters

☐ Extend Management Operations

☒ Extend Edits to Current HRU

☐ Extend Edits to All HRUS

☐ Extend Edits to Selected HRUS

Selected HRUs

Subbasins: [Empty]

Land Use: [Empty]

Soils: [Empty]

Slope: [Empty]

17 Main Management (.Mgt) parameters for Hydrology calibration

- **Operations**

- The **Edit Values** button activates the management of operations.
- After the selection of an operation the **Edit Operation** button allows to edit operation parameters.
- The **Add Operation** button allows to add operations and edit their parameters.

General Parameters

Operations

HRU Info

Add Year

Delete Year

Add Operation

Delete Operation

Edit Operation

Load Schedule

Save Schedule

Current Management Operations

Year	OP_NUM	Operation	Crop	Heat Units
1	1	Plant/begin growing se	OLIV	0.15
1	2	Auto fertilization initializ		0.16
1	3	Harvest and kill operati		1.2
*				

Plant/Begin Growing Season Parameters

☐ Schedule by Date

☒ Schedule By Heat Units

OP NUM: 1

Year of Rotation: 1

Heat Unit Scheduling: 0.15

PLANT_ID: Olives

CURYR_MAT: 0

Heat Units to Maturity: 1800

LAI_INIT: 0

BIO_INIT: 0

HI_TARG: 0

BIO_TARG: 0

CNOP: 0

Cancel

OK

Edit Values

Cancel Edits

Save Edits

Exit

Extend Parameter Edits

☐ Extend ALL MGT General Parameters

☐ Extend Management Operations

☒ Extend Edits to Current HRU

☐ Extend Edits to All HRUS

☐ Extend Edits to Selected HRUS

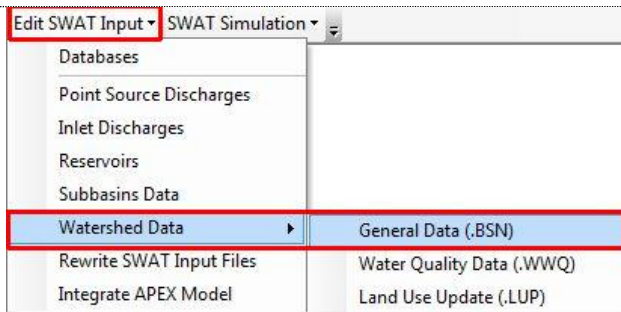
Selected HRUs

Subbasins: [Empty]

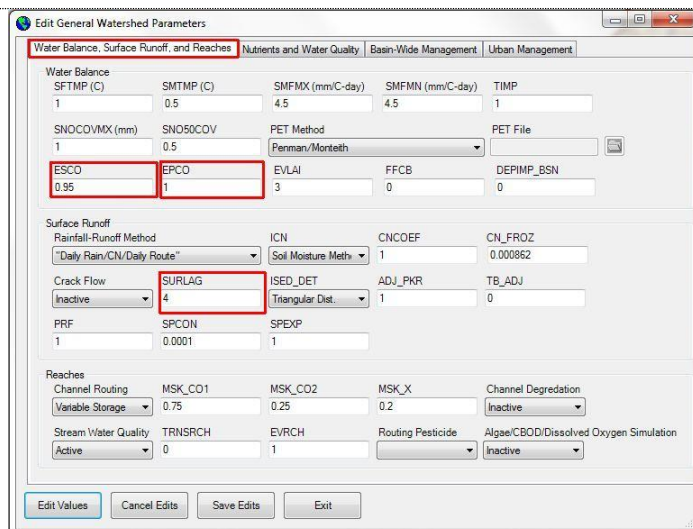
Land Use: [Empty]

Soils: [Empty]

Slope: [Empty]

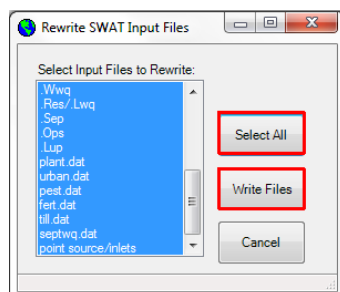
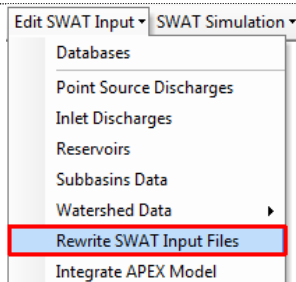


18 Watershed Data/General Data (.BSN) Editing



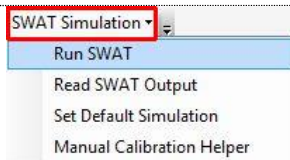
19 Water Balance, Surface Runoff and Reaches

- **ESCO, EPCO:** were described in the previous section of HRU parameters (.Hru).
- **SURLAG:** Surface runoff lag coefficient. **SURLAG** controls the fraction of the total available water that will be allowed to enter the reach on any one day.



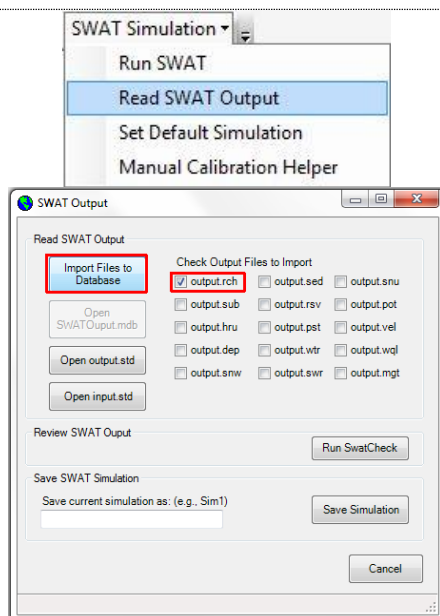
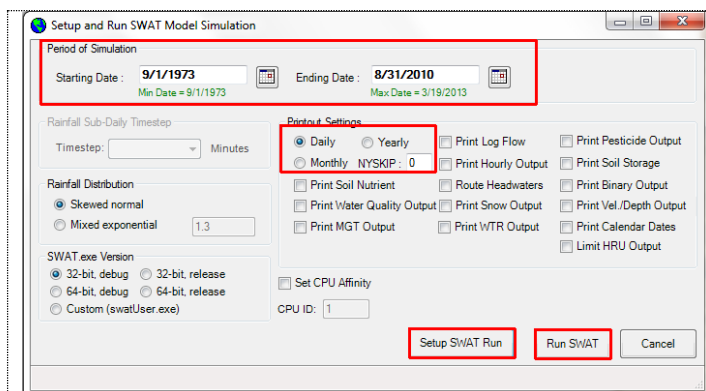
20 Rewrite Input Files

- The edited input tables must be written to the input files read by the SWAT model
- Each edited input files must be selected or **Select All** button selects them all.
- After the edited input files are selected the **Write Files** button rewrites the input files read by the model.



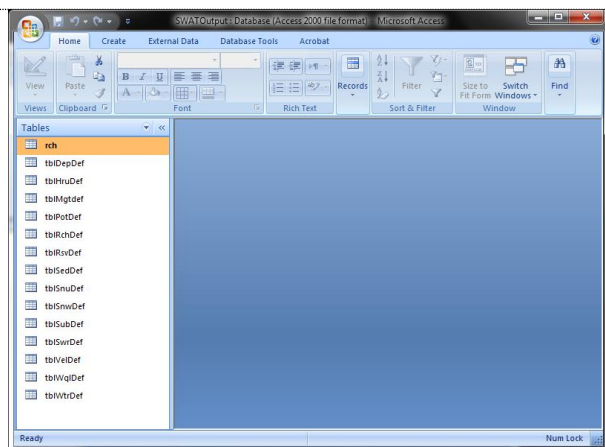
21 SWAT Simulation – Run SWAT

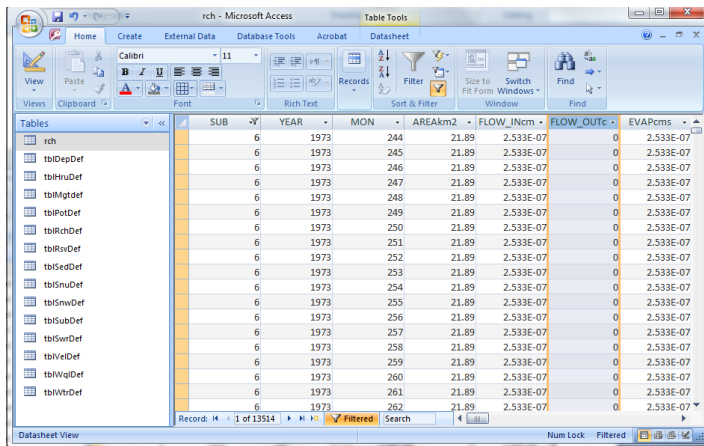
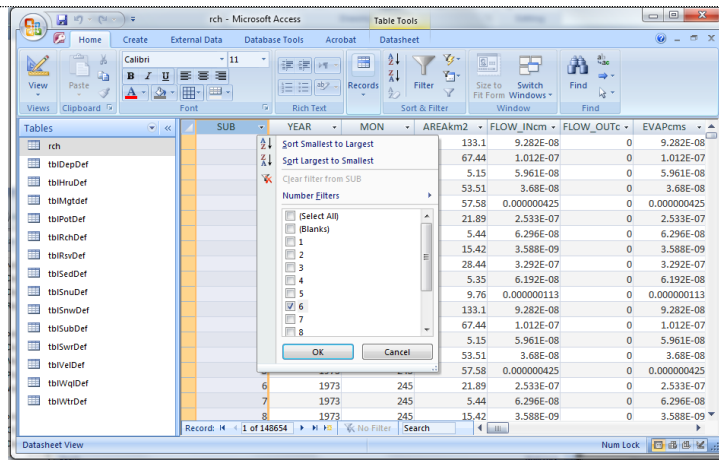
- The **SWAT Simulation** menu allows you to finalize the Set Up of input for the SWAT model and **Run SWAT** model
- The **Setup and Run SWAT Model Simulation** window opens and allows to modify the **Period of Simulation** and the **Printout Settings**.
- Once all options and parameters are defined, the **Setup SWAT Run** button generates the final input files.
- Now the model can run with the **Run SWAT** button



22 Read SWAT Output

- After a successful SWAT model run the second command in the **SWAT Simulation** menu opens the **Read SWAT Output** dialogue. This dialogue provides tools for importing the output text files generated by SWAT into an **Access database**.
- The hydrologic simulation output is included in the **output.rch**.
- After output selection, the **Import Files to Database** button imports the output files into the **Access Database**.





Recommended Calibration Values for Tavronitis Watershed

	Name	Input Table	Description	Calibrated	Range
1	SOL_AWC	.sol	Available water capacity	0.4	0.1-0.8
2	GWQMN	.gw	Threshold water depth in the shallow aquifer for flow	300-1500	50-1500
3	Gw_Revap	.gw	Groundwater “revap” coefficient	0.2	0.1-0.5
4	Tlaps	.sub	Temperature lapse rate	0	-5.7
5	CH_K2	.rte	Channel effective hydraulic conductivity	0-250	0-5000
6	ESCO	.hru/.bsn	Soil evaporation compensation factor	0.6	0.5-0.95
7	Alpha_Bf	.gw	Baseflow alpha factor	0.05	0.01-0.06
8	Sol_Z	.sol	Soil depth	100-300-700	100-700
9	Sol_K	.sol	Saturated hydraulic conductivity	25.27, 27.48	30-10
10	CN2	.mgt	SCS runoff curve number	61-79	40-80
11	HRU_SLP	.hru	Average slope steepness	0.08-0.45	1.46-45.43
12	CH_N2	.rte	Manning’s n value for main channel	0.014	0.01-0.03
13	Canmx	.hru	Maximum canopy storage	15	15
14	Revapmn	.gw	Threshold water depth in the shallow aquifer for “revap”	10	10
15	Epc0	.bsn	Plant uptake compensation factor	0.9	0.5-1
16	Gw_Delay	.gw	Groundwater delay	10,20	20-1
17	Surlag	.bsn	Surface runoff lag time	4	4