Introduction to AGWA 3.0
The Automated Geospatial Watershed Assessment Tool

Land Cover Change and Hydrologic Response

Introduction	In this exercise you will investigate the manner in which land cover changes over a 5 year period have affected runoff processes in/around Denver, CO.
Objective	To familiarize yourself with AGWA and the various uses and limitations of hydrologic modeling for landscape assessment.
Assignment	Run the SWAT model on a HUC10 watershed in the Middle South Platte-Cherry Creek HUC8 and the KINEROS model on a HUC12 using 2006 and 2011 NLCD land cover.

An Introduction to Land Cover Change Assessment

The basic tenet of watershed management is that direct and powerful linkages exist among spatially distributed watershed properties and watershed processes. Stream water quality changes, especially due to erosion and sediment discharge, have been directly linked to land uses within a watershed. For example, erosion susceptibility increases when agriculture is practiced on relatively steep slopes, while severe alterations in vegetation cover can produce up to 90% more runoff than in watersheds unaltered by human practices.

The three primary watershed properties governing hydrologic variability in the form of rainfall-runoff response and erosion are soils, land cover, and topography. While topographic characteristics can be modified on a small scale (such as with the implementation of contour tillage or terracing in agricultural fields), variation in watershed-scale hydrologic response through time is primarily due to changes in the type and distribution of land cover.

Watershed modeling techniques are useful tools for investigating interactions among the various watershed components and hydrologic response (defined here as rainfall-runoff and erosion relationships). Physically-based models, such as the KINEmatic Runoff and EROSion model (KINEROS) are designed to simulate the physical processes governing runoff and erosion (and subsequent sediment yield) on a watershed. Lumped parameter models such as the Soil & Water Assessment Tool (SWAT) are useful strategic models for investigating long-term watershed response. These models can be useful for understanding and interpreting the various interactions among spatial characteristics insofar as the models are adequately representing those processes.

The percentage and location of natural land cover influences the amount of energy that is available to move water and materials. Forested watersheds dissipate energy associated with rainfall, whereas watersheds with bare ground and anthropogenic cover are less able to do so. The percentage of the watershed surface that is impermeable, due to urban and road surfaces, influences the volume of water that runs off and increases the amount of sediment that can be moved. Watersheds with highly erodible soils tend to have greater potential for soil loss and sediment delivery to streams than watersheds with non-erodible soils. Moreover, intense precipitation events may exceed the energy threshold and move large amounts of sediments across a degraded watershed (Junk et al., 1989; Sparks, 1995). It is during these events that human-induced landscape changes may manifest their greatest negative impact.

The Study Area

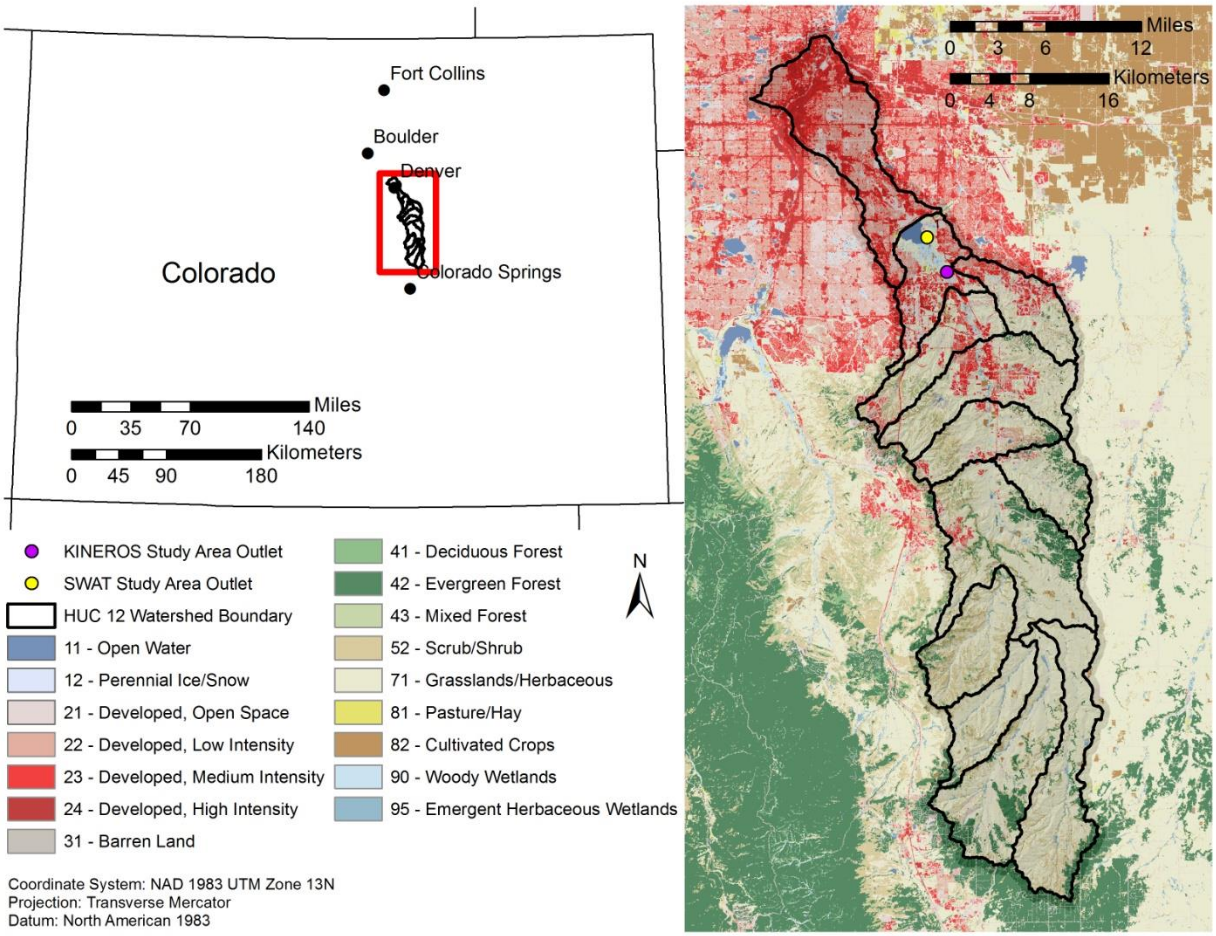


Figure 1. Location Map of the study area, near Denver, Colorado.

This exercise examines the effects of land cover change on the hydrology of a particular watershed near Denver, Colorado. The results disclose immediate changes to the hydrologic regime that are attributable to development and land cover change.

Getting Started

Start ArcMap with a new empty map. Save the empty map document as **tutorial_SouthPlatte** in the **C:\AGWA\workspace\tutorial_SouthPlatte** directory (The default workspace location will need to be created by clicking on *Create New Folder* button in the window that opens.). If the ***AGWA Toolbar*** is not visible, turn it on by selecting ***Customize > Toolbars > AGWA Toolbar*** on the ArcMap Main Menu bar. Once the map document is opened and saved, set the Home, Temp, and Default Workspace directories by selecting ***AGWA Preferences*** from ***AGWA Tools > Other Options*** on the ***AGWA Toolbar***.

- AGWA Home Directory: **C:\AGWA**
- AGWA Temporary Files Directory: **C:\AGWA\temp**
- Default Workspace location: **C:\AGWA\workspace\tutorial_SouthPlatte**

> The Home directory contains all of the look-up tables, datafiles, models, and documentation required for AGWA to run. If this is set improperly or you are missing any files, you will be presented with a warning that lists the missing directories or files that AGWA requires.
>
> The Temp directory is where some temporary files created during various steps in AGWA will be placed. You may want to routinely delete files and directories in the Temp directory if you need to free up space or are interested in identifying the temporary files associated with your next AGWA use.
>
> The Default Workspace directory is where delineation geodatabases will be stored by default. This can be a helpful timesaver during the navigation process if you have a deeply nested directory structure where you store AGWA outputs.

GIS Data

Before adding data to the map, connections to drives and folders where data are stored must be established if they have not been already. To establish folder connections if they don't already exist, click on the ***Add Data*** button below the menu bar at the top of the screen. In the Add Data form that opens, click the ***Connect to Folder*** button and select **Local Disk (C:)**.

Navigate to the **C:\AGWA\gisdata\tutorial_SouthPlatte** folder and add the following datasets and layers:

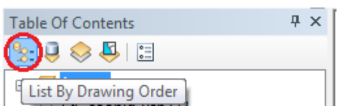
- **demf10m** – Filled digital elevation model (10 m resolution)
- **facg10m** – Flow accumulation grid (10 m)
- **fdg10m** – Flow direction grid (10 m)
- **huc12.shp** – 12-digit hucs for the Cherry Creek Watershed
- **NHD_flowLine_withDigitized.shp** – NHDPlus stream network with defined flow direction
- **nlcd2006** – Classified land cover from 2006
- **nlcd2011** – Classified land cover from 2011
- **outlet_KINEROS.shp** – Piney Creek watershed outlet
- **outlet_SWAT.shp** – Upper Cherry Creek watershed outlet
- **pcp_gage.shp** – SWAT rain gages
- **ssurgo_PineyCreek.shp** – Soil Survey Geographic Database for Piney Creek watershed

- **statsgo.shp** – State Soil Geographic Database for the Cherry Creek watershed
- **SWAT_pcp1990.csv** – unweighted daily precipitation data for SWAT

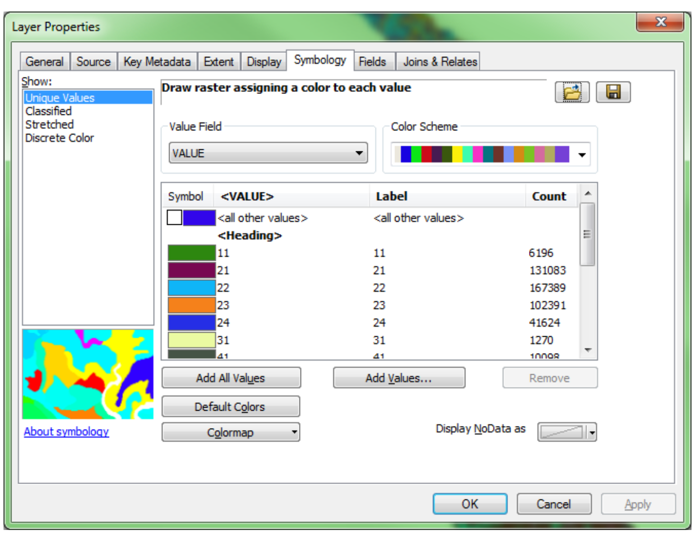
You will also need to add the following files from the **C:\AGWA\datafiles** folder:

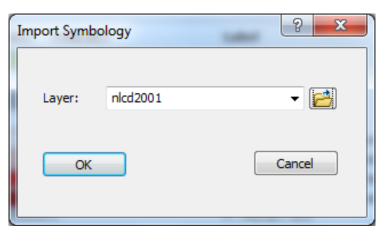
- **lc_luts\mrlc2001_lut.dbf** – MRLC look-up table for 2006 and 2011 NLCD land cover
- **wgn\wgn_us83.shp** – Weather generator stations for SWAT

You may want to collapse the legends and rearrange the order of the layers to better see what is going on. Click on the minus box next to the layer name in the ***Table of Contents*** to collapse the legend, or right-click on the Layers dataframe and select ***Collapse All Layers***. Click and drag the layers by their names in ***Table of Contents*** to rearrange layer order. If you cannot rearrange the layer order, you may need to select the ***List By Drawing Order*** button in the ***Table Of Contents***.



To better visualize the different land cover types and associate the pixels with their classification, load a legend into the ***nlcd2006*** and ***nlcd2011*** datasets. To do this, right click the layer name of the **nlcd2006** dataset in the ***Table of Contents*** and select ***Properties*** from the context menu that appears. Select the ***Symbology*** tab from the form that opens. In the ***Show*** box on the left side of the form, select ***Unique Values*** and click the ***Import*** button  on the right. Click the file browser button, navigate to and select **C:\AGWA\datafiles\renderers\nlcd2001.lyr** and click on ***Add***.Click ***OK*** to apply the symbology and exit the ***Import Symbology*** form. Click on ***Apply*** in the ***Layer Properties*** form and then on ***OK*** to exit this form.





The ***nlcd2006*** and ***nlcd2011*** datasets have the same legend and classification, so repeat the same procedure for the ***nlcd2011*** dataset.

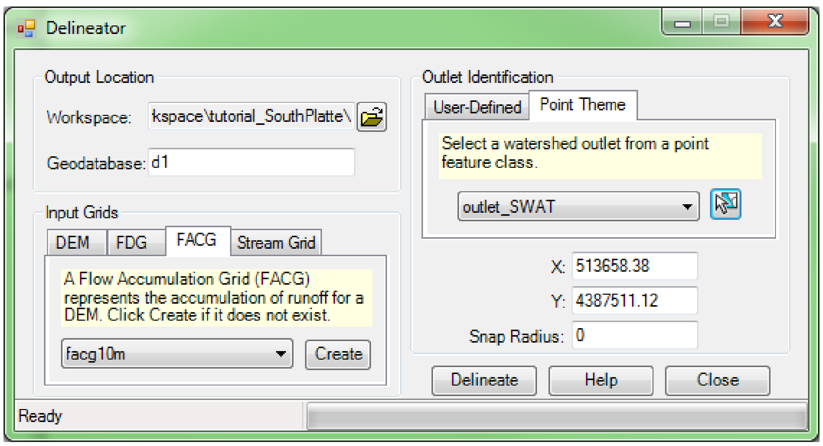
Part 1: Modeling Runoff at the Basin Scale Using SWAT

In Part 1, you will evaluate the impact of land use change from 2006 to 2011 using the National Land Cover Database (NLCD) on the Cherry Creek watershed down to the Cherry Creek Reservoir using the SWAT model. Watershed delineation, discretization, and parameterization will be covered, along with precipitation input file preparation, model execution, and results visualization.

Step 1: Delineating the watershed

1. Perform the watershed delineation by selecting ***AGWA Tools > Delineation Options > Delineate Watershed***.

   DESCRIPTION In the ***Delineator*** form, several parameters are defined including the output location, the name of the delineation, the digital elevation model (DEM), the flow direction grid (FDG), the flow accumulation grid (FACG), the watershed outlet location, and a search radius from the outlet location which AGWA will use to locate the most downstream location to use as the watershed outlet.



   1.1. ***Output Location*** box

      1.1.1. ***Workspace*** textbox: navigate to and select/create **C:\AGWA\workspace\tutorial_SouthPlatte**

      1.1.2. ***Geodatabase*** textbox: enter **d1**

   1.2. ***Input Grids*** box

      1.2.1. ***DEM*** tab: select **demf10m** (do not click Fill)

      1.2.2. ***FDG*** tab: select **fdg10m** (do not click Create)

      1.2.3. ***FACG*** tab: select **facg10m** (do not click Create)

      1.2.4. ***Stream Grid*** tab: do nothing

   1.3. ***Outlet Identification*** box

      1.3.1. ***Point Theme*** tab: select **outlet_SWAT**

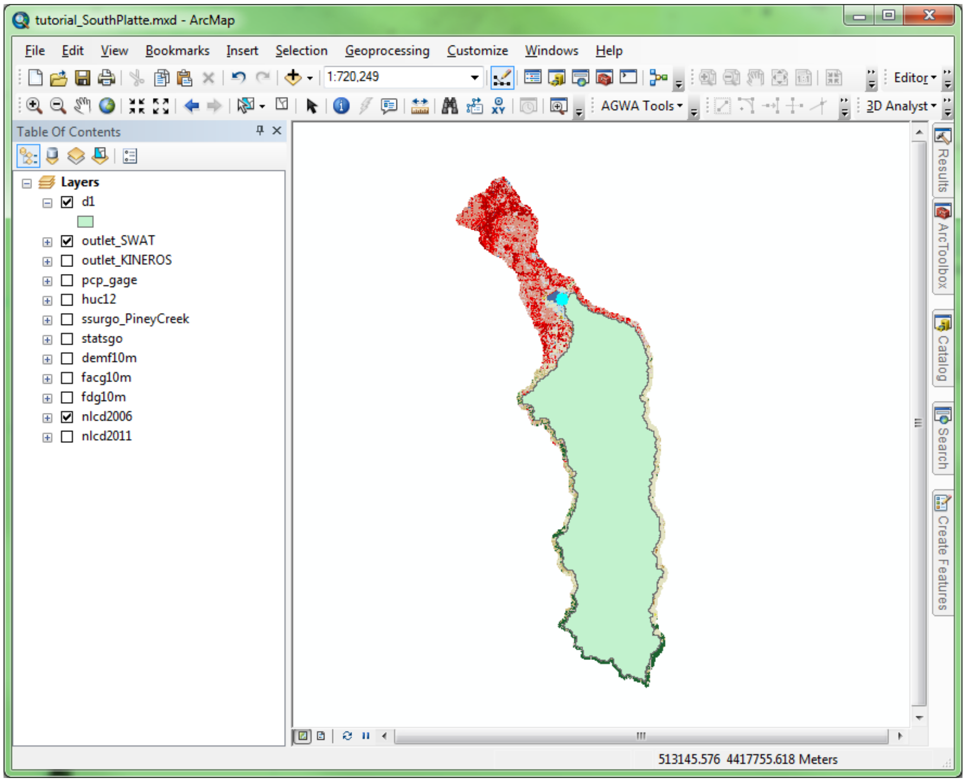
      1.3.2. Click the ***Select Feature*** button  and draw a rectangle around the point.

      NOTE The selection is restricted to the selected point theme. If more than one point exists in the selected point theme and the drawn rectangle intersects multiple points, the first intersected point in the point theme attribute table will be selected.

   1.4. Click ***Delineate***.

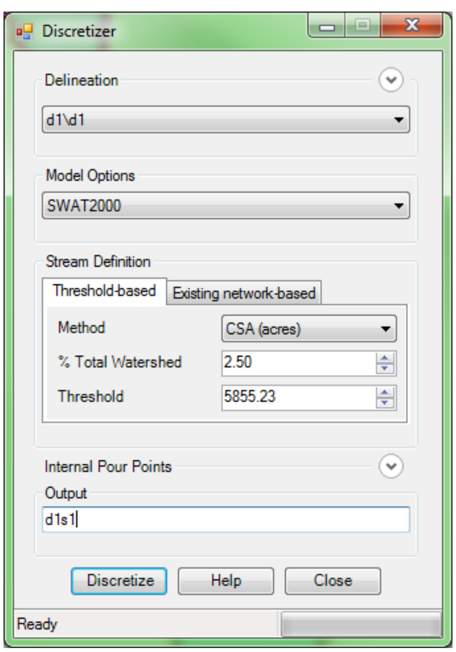
   1.5. Save the map document and continue to the next step.

At this point, the Cherry Creek watershed is delineated. The workspace specified is the location on your hard drive where the delineated watershed is stored as a feature class in a geodatabase. The discretization created next will also be stored in the geodatabase.



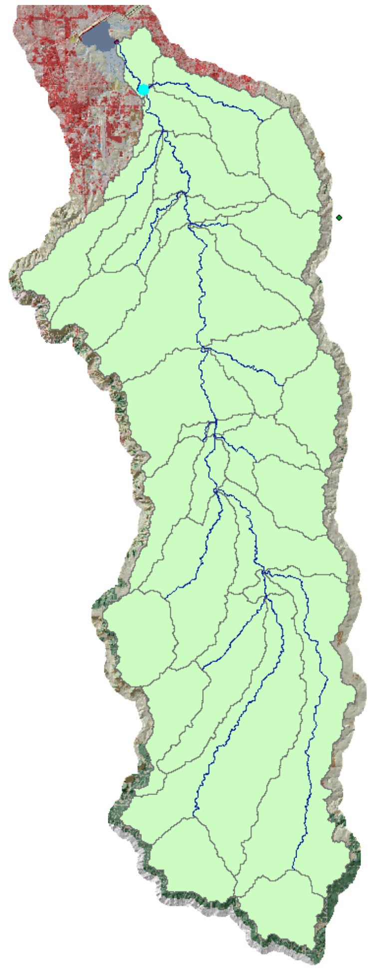
Step 2: Discretizing or subdividing the watershed

2. Perform the watershed discretization by selecting ***AGWA Tools > Discretization Options > Discretize Watershed.***



2.1. ***Delineation*** box: select **d1\d1**
2.2. ***Model Options*** box: select **SWAT2000**
2.3. ***Stream Definition*** box
   2.3.1. ***Threshold-based*** tab
      2.3.1.1. ***Method***: select **CSA (acres)**
      2.3.1.2. ***% Total Watershed***: do nothing (the default is 2.5% of the total watershed area)
      2.3.1.3. ***Threshold***: do nothing(the default 2.5% of area equates to 5855.23 acres)
2.4. ***Internal Pour Points*** dropdown: do nothing
2.5. ***Output*** textbox: enter **d1s1**
2.6. Click ***Discretize***.
2.7. Save the map document and continue to the next step.

Discretizing breaks up the delineation/watershed into model specific elements and creates a stream feature class that drains the elements. The CSA, or Contributing/Channel Source Area, is a threshold value which defines first order channel initiation, or the upland area required for channelized flow to begin. Smaller CSA values result in a more complex watershed, and larger CSA values result in a less complex watershed. The default CSA in AGWA is set to 2.5% of the total watershed area. The discretization process created a subwatersheds layer with the name **subwatersheds_d1s1** and a streams map named **streams_d1s1**. In AGWA discretizations are referred to with their geodatabase name as a prefix followed by the discretization name given in the *Discretizer* form, e.g. **d1\d1s1**.

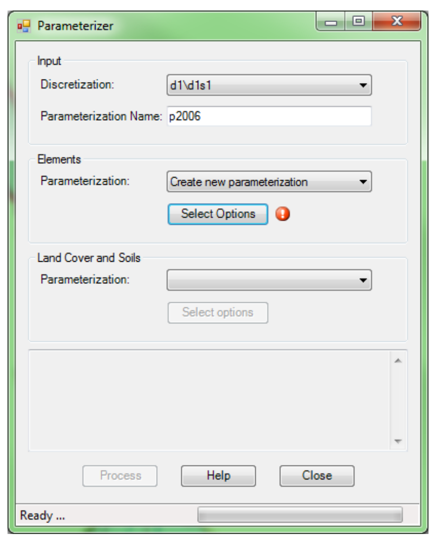


Step 3: Parameterizing the watershed elements for SWAT

3. Perform the element, land cover, and soils parameterization of the watershed by selecting ***AGWA Tools > Parameterization Options > Parametrize***.
   - 3.1. ***Input*** box
     - 3.1.1. ***Discretization***: select **d1\d1s1**
     - 3.1.2. ***Parameterization Name***: enter **p2006**
   - 3.2. ***Elements*** box
     - 3.2.1. ***Parameterization***: select **Create new parameterization**
     - 3.2.2. Click ***Select Options***. The ***Element Parameterizer*** form opens.
   - 3.3. In the ***Element Parameterizer*** form
     - 3.3.1. ***Hydraulic Geometry Options*** box
       - 3.3.1.1. Select the **Default** item.

         Do not click the ***Recalculate*** button.

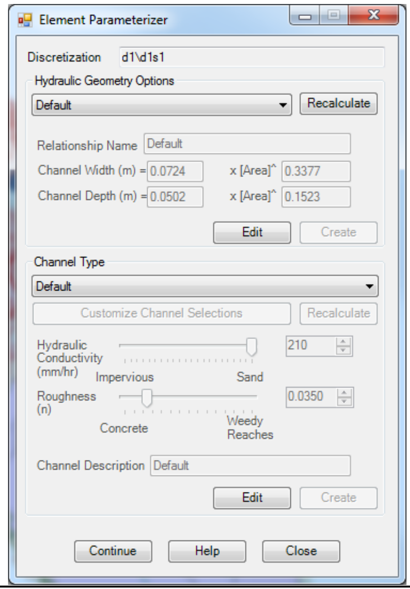
         Do not click the ***Edit*** button.



3.3.2. ***Channel Type*** box

3.3.2.1. Select the **Default** item.

3.3.3. Click ***Continue***. You will be returned to the ***Parameterizer*** form to create the Land Cover and Soils parameterization.



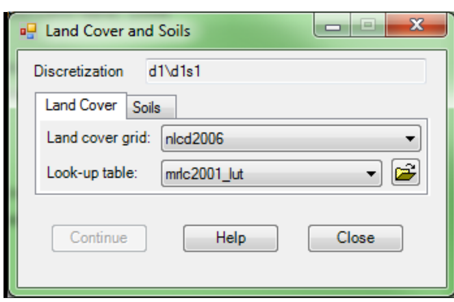
Element parameterization defines topographic properties of the subwatershed and channel elements. The properties defined depend on the model, but examples of SWAT properties include mean elevation, max flow length, and average slope for subwatershed elements and routing sequence, average slope, and channel dimensions for channel elements. The *Hydraulic Geometry Options* set channel dimensions using relationships between channel contributing area and channel depth/height. The *Channel Type* selection sets the infiltrability, roughness, and for KINEROS, the armoring of the channel elements. The channel type parameters can vary from developed, concrete channels with low roughness and zero infiltrability to natural, very weedy reaches with high roughness and high infiltrability. The **Default** *Hydraulic Geometry Options*, unless edited, is equivalent to the *Walnut Gulch Watershed , AZ* relationship. The **Default** *Channel Type*, unless edited, is equivalent to the *Natural* channel type.

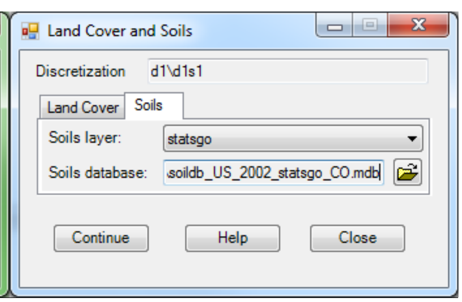
3.4. Back in the ***Land Cover and Soils*** box of the ***Parameterizer*** form

3.4.1. ***Parameterization***: select **Create new parameterization**

3.4.2. Click ***Select Options***. The ***Land Cover and Soils*** form opens.

3.5. In the ***Land Cover and Soils*** form





3.5.1. ***Land Cover*** tab

3.5.1.1. ***Land cover grid***: select **nlcd2006**

3.5.1.2. ***Look-up table***: select **mrlc2001_lut**

3.5.2. ***Soils*** tab

3.5.2.1. ***Soils layer***: select **statsgo**

3.5.2.2. ***Soils database***: navigate to and select **C:\AGWA\gisdata\tutorials\tutorial_SouthPlatte\soildb_US_2002_statsgo_CO.db**

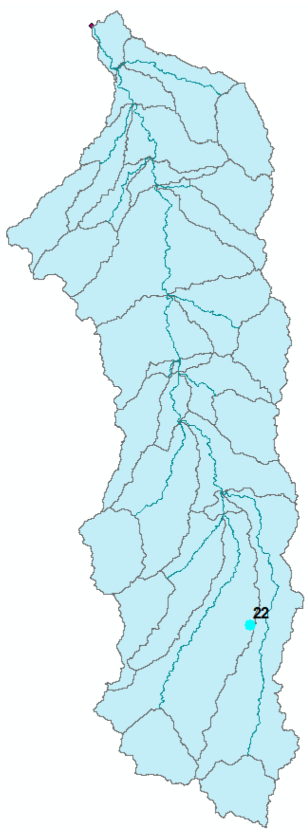
Land cover and soils parameterization defines land cover and soils properties of the subwatershed elements. The properties defined depend on the model, but examples of SWAT properties include the dominant soil type/id, curve number, and percent cover for subwatershed elements.

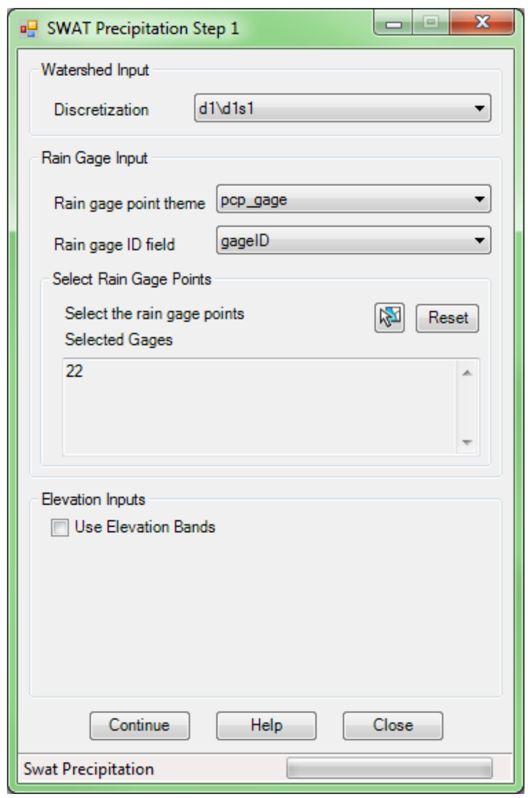
3.6. Click ***Continue***. You will be returned to the ***Parameterizer*** form where the ***Process*** button will now be enabled.

3.7. In the ***Parameterizer*** form, click ***Process***.

Step 4: Preparing SWAT precipitation files

4. Write the SWAT precipitation file for the watershed by selecting ***AGWA Tools > Precipitation Options > Write SWAT Precipitation***.





4.1. ***SWAT Precipitation Step 1*** form

4.1.1. ***Watershed Input*** box:

4.1.1.1. ***Discretization***: **d1\d1s1**

4.1.2. ***Rain Gage Input*** box:

4.1.2.1. ***Rain gage point theme***: **pcp_gage**

4.1.2.2. ***Rain gage ID field***: **gageID**

4.1.3. ***Select Rain Gage Points*** box

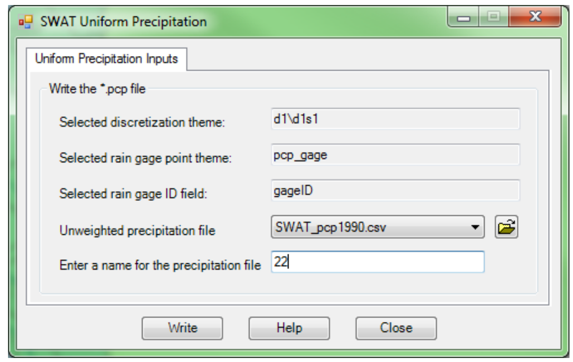
4.1.3.1. Click the ***Select Feature*** button to select the rain gage with ***gageID 22*** in the view (the figure, above left, displays the location of the gage). The id number, ***22***, of the selected gage will be displayed in the ***Selected Gages*** textbox.

4.1.4. ***Elevation Inputs*** box:

4.1.4.1. ***Use Elevations Bands*** checkbox: leave unchecked.

4.1.5. Click ***Continue***.

4.2. ***SWAT Uniform Precipitation*** form



4.2.1. ***Write the *.pcp file*** box:

4.2.1.1. ***Selected discretization theme*** (disabled): ***d1\d1s1***

4.2.1.2. ***Selected rain gage point theme*** (disabled): ***pcp_gage***

4.2.1.3. ***Selected rain gage ID field*** (disabled): ***gageID***

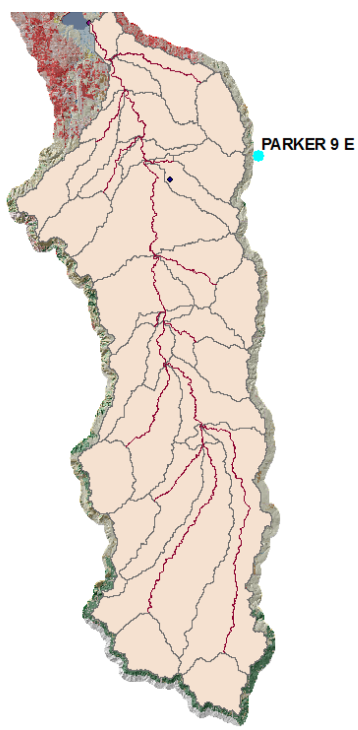
4.2.1.4. ***Unweighted precipitation file***: **SWAT_pcp1990.csv**

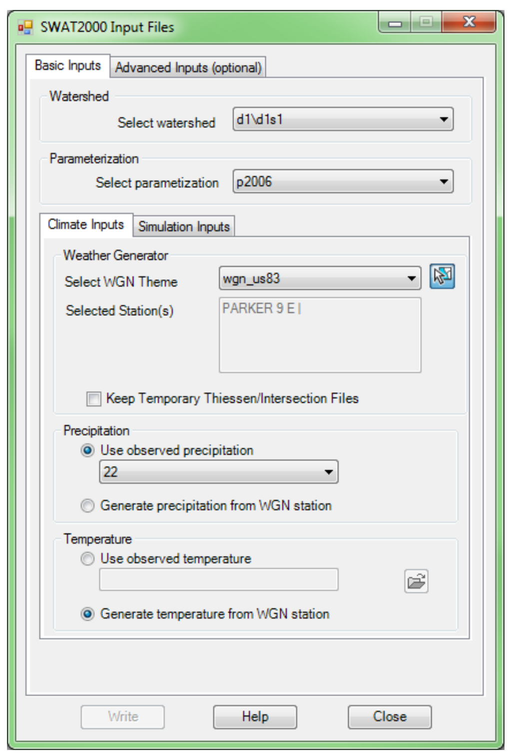
4.2.1.5. ***Enter a name for the precipitation file***: **22**

4.2.1.6. Click ***Write***.

Step 5: Writing SWAT input files

5. Write the SWAT input files by selecting ***AGWA Tools > Simulation Options > SWAT2000 Options > Write SWAT2000 Input Files***.





5.1. ***Basic Inputs*** tab:

5.1.1. ***Watershed*** box: select **d1\d1s1**

5.1.2. ***Parameterization*** box: select **p2006**

5.1.3. ***Climate Inputs*** tab:

5.1.3.1. ***Weather Generator*** box:

5.1.3.1.1. ***Select WGN Theme***: select **wgn_us83**

5.1.3.1.2. ***Selected Station***: **PARKER 9 E** (see above figure for location)

5.1.3.1.3. ***Keep Temporary Thiessen/Intersection Files***: leave unchecked

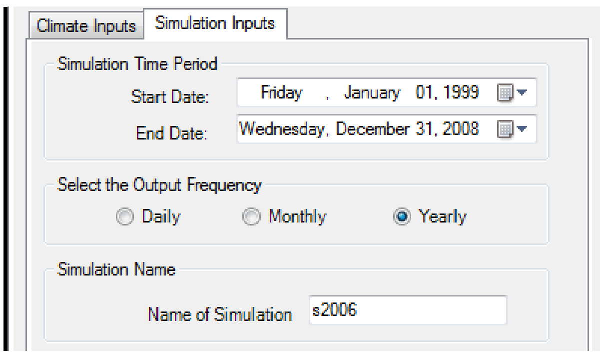
5.1.3.2. ***Precipitation*** box:

5.1.3.2.1. ***Use observed precipitation***: select **22**

5.1.3.3. ***Temperature*** box:

5.1.3.3.1. Generate temperature from WGN station

5.1.4. ***Simulation Inputs*** tab:



5.1.4.1. ***Simulation Time Period*** box:

5.1.4.1.1. ***Start Date***: **Friday, January 1, 1999**

5.1.4.1.2. ***End Date***: **Wednesday, December 31, 2008**

5.1.4.2. ***Select the Output Frequency*** box: select **Yearly**

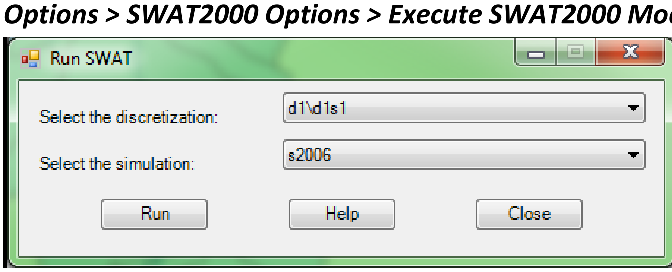
5.1.4.3. ***Simulation Name*** box: enter **s2006**

5.1.5. Click ***Write***.

Step 6: Executing the SWAT model

Executing the SWAT model opens a command window where the model is executed. By default, the command window stays open so that success or failure of the simulation can be verified.

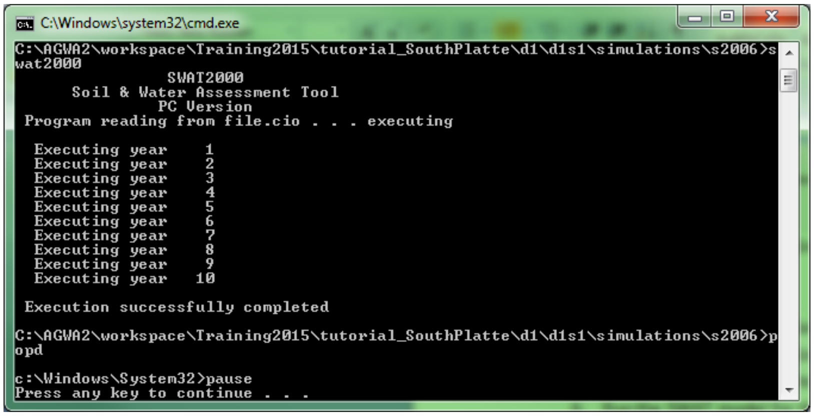
6. Execute the SWAT model for the Cherry Creek watershed by selecting ***AGWA Tools > Simulation Options > SWAT2000 Options > Execute SWAT2000 Model***.



6.1. ***Select the discretization***: select **d1\d1s1**

6.2. ***Select the simulation***: select **s2006**

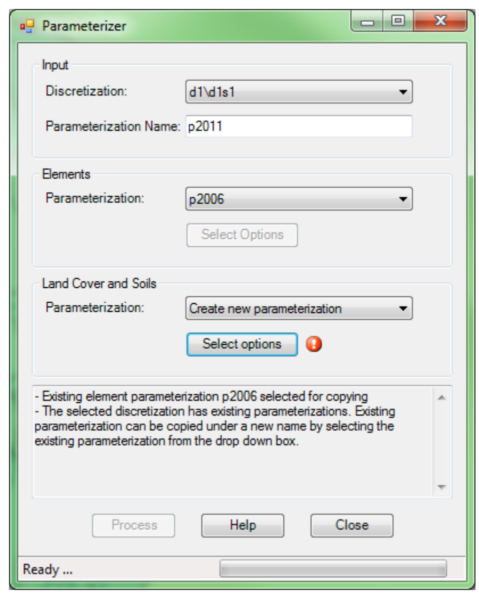
6.3. Click ***Run***. The command window will stay open so that successful completion can be verified. Press any key to continue.



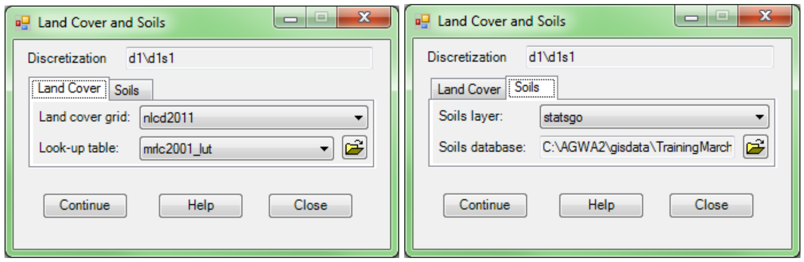
6.4. Close the ***Run SWAT*** form.

At this point, the 2006 land cover has been simulated; 2011 land cover will be parameterized and simulated next. Model input/output files were written into a subdirectory of the workspace following the name of the geodatabase and discretization.

Step 7: Repeat for NLCD 2011 landcover



7. Rerun the land cover and soils parameterization of the watershed with the 2011 land cover by selecting ***AGWA Tools > Parameterization Options > Parameterize***.
   7.1. ***Input*** box
      7.1.1. ***Discretization***: select **d1\d1s1**
      7.1.2. ***Parameterization Name***: enter **p2011**
   7.2. ***Elements*** box
      7.2.1. ***Parameterization***: select **p2006**
      Land cover change is the emphasis of this exercise, and because no other changes will be made, the element parameterization can be copied from the previous parameterization.
   7.3. ***Land Cover and Soils*** box
      7.3.1. ***Parameterization***: select **Create new parameterization**
      7.3.2. Click ***Select Options***. The ***Land Cover and Soils*** form opens.
   7.4. In the ***Land Cover and Soils*** form
      7.4.1. ***Land Cover*** tab
         7.4.1.1. ***Land cover grid***: select **nlcd2011**
         7.4.1.2. ***Look-up table***: select **mrlc2001_lut**



7.4.2. ***Soils*** tab

7.4.2.1. ***Soils layer***: select **statsgo**

7.4.2.2. ***Soils database***: navigate to and select **C:\AGWA\gisdata\tutorials\tutorial_SouthPlatte\soildb_US_2002_statsgo_CO.mdb**

The **nlcd2006** and **nlcd2011** datasets have the same classification, so the same look-up table is used for both datasets.

7.5. Click ***Continue***. You will be returned to the ***Parameterizer*** form where the ***Process*** button will now be enabled.

7.6. In the ***Parameterizer*** form, click ***Process***.

8. Write the SWAT simulation input files representing the new parameterization by selecting the ***Write SWAT2000 Input Files*** menu item from the ***AGWA Tools > Simulation Options > SWAT2000 Options*** menu.

8.1. ***Basic Inputs*** tab:

8.1.1. ***Watershed*** box: select **d1\d1s1**

8.1.2. ***Parameterization*** box: select **p2011**

8.1.3. ***Climate Inputs*** tab:

8.1.3.1. ***Weather Generator*** box:

8.1.3.1.1. ***Select WGN Theme***: select **wgn_us83**

8.1.3.1.2. ***Selected Station***: **PARKER 9 E**

8.1.3.1.3. ***Keep Temporary Thiessen/Intersection Files***: leave unchecked

8.1.3.2. ***Precipitation*** box:

8.1.3.2.1. ***Use observed precipitation***: select **22**

8.1.3.3. ***Temperature*** box:

8.1.3.3.1. Generate temperature from WGN station

8.1.4. ***Simulation Inputs*** tab:

8.1.4.1. ***Simulation Time Period*** box:

8.1.4.1.1. ***Start Date***: **Friday, January 1, 1999**

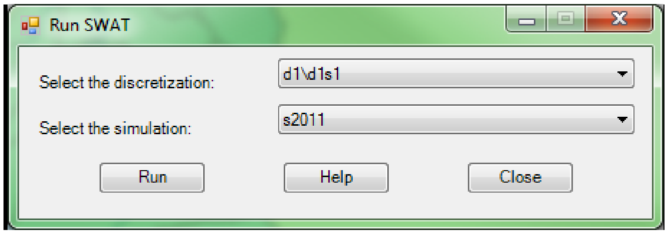
8.1.4.1.2. ***End Date***: **Wednesday, December 31, 2008**

8.1.4.2. ***Select the Output Frequency*** box: select **Yearly**

8.1.4.3. ***Simulation Name*** box: enter **s2011**

8.1.5. Click ***Write***.

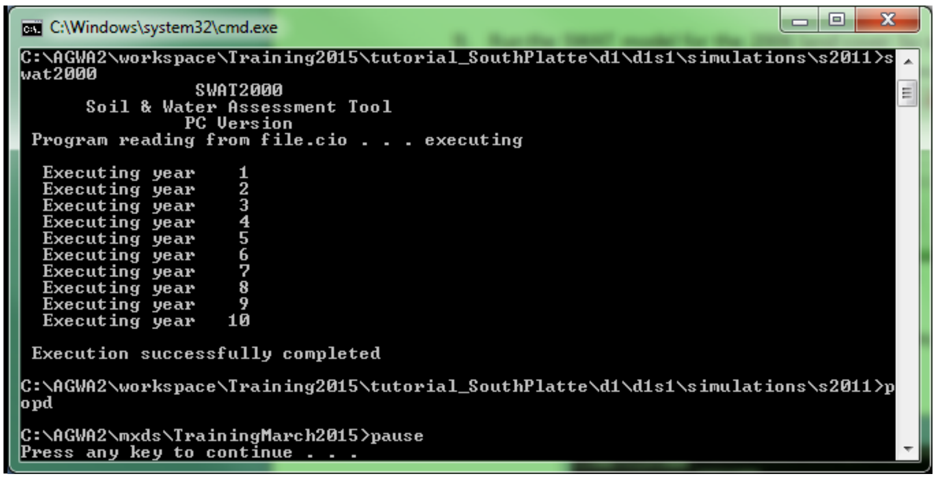
9. Run the SWAT model for the 2011 land cover by selecting the ***Execute SWAT2000 Model*** menu item from the ***AGWA Tools > Simulation Options > SWAT2000 Options*** menu.



9.1. ***Select the discretization***: select **d1\d1s1**

9.2. ***Select the simulation***: select **s2011**

9.3. Click ***Run***. The command window will stay open so that successful completion can be verified. Press any key to continue.

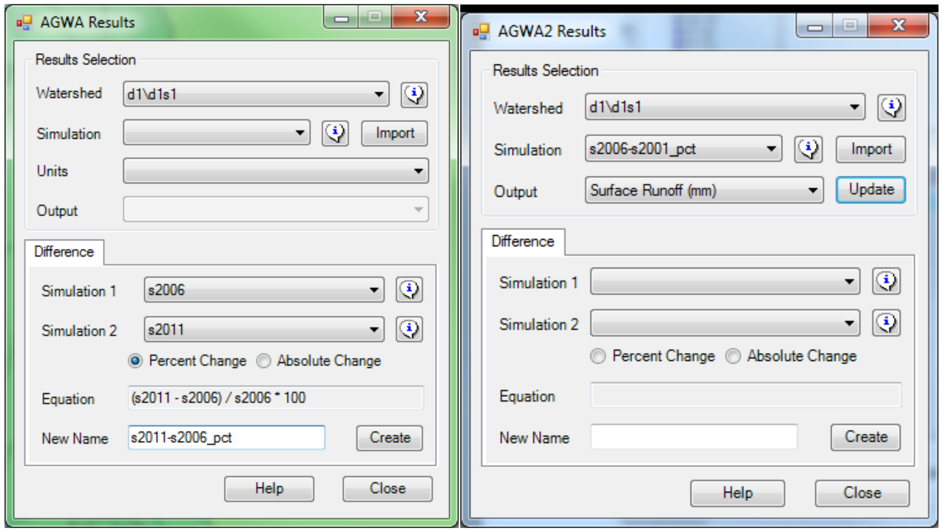


9.4. Close the ***Run SWAT*** form.

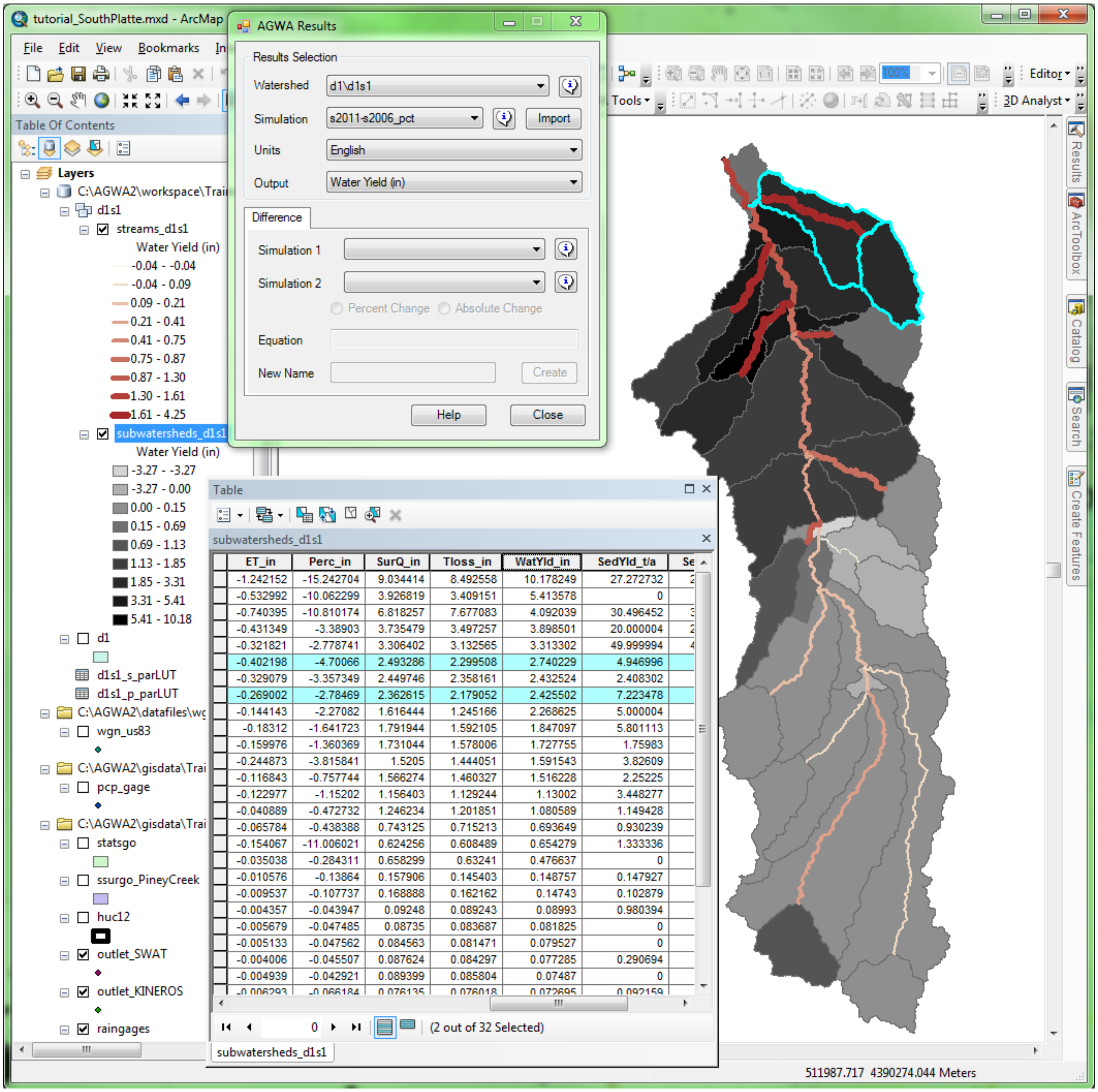
The model was run for both **nlcd2006** and **nlcd2011** land covers and now the model results will be imported into AGWA. These results will then be differenced to visually see how the land cover changes impact the hydrology of the watershed.

Step 8: Viewing the results

10. Import the results from the two simulations by selecting ***AGWA Tools > View Results > SWAT Results > View SWAT2000 Results***.



11. ***Results Selection*** box
    - 11.1.1. ***Watershed***: select **d1\d1s1**
    - 11.1.2. ***Simulation***: click ***Import***
        - 11.1.2.1. ***Yes*** to importing **s2006**
        - 11.1.2.2. ***Yes*** to importing **s2011**
12. Difference the 2006 and 2011 simulation results.
    - 12.1. ***Difference*** tab
        - 12.1.1. ***Simulation1***: select **s2006**
        - 12.1.2. ***Simulation2***: select **s2011**
        - 12.1.3. Select ***Percent Change*** radiobutton
        - 12.1.4. ***New Name***: enter **s2011-s2006_pct**
        - 12.1.5. Click ***Create***
13. View the differenced results.
    - 13.1. ***Results Selection*** box
        - 13.1.1. ***Watershed***: select **d1\d1s1**
        - 13.1.2. ***Simulation***: select **s2011-s2006_pct**
        - 13.1.3. ***Units:*** select **English** (Note: unit selection is arbitrary when viewing percent difference)
        - 13.1.4. ***Output***: select **Water Yield (in)**



tutorial_SouthPlatte.mxd - ArcMap
File Edit View Bookmarks
Table Of Contents
Layers
C:\AGWA2\workspace\Trai
d1s1
streams_d1s1
Water Yield (in)
-0.04 - -0.04
-0.04 - 0.09
0.09 - 0.21
0.21 - 0.41
0.41 - 0.75
0.75 - 0.87
0.87 - 1.30
1.30 - 1.61
1.61 - 4.25
subwatersheds_d1s1
Water Yield (in)
-3.27 - -3.27
-3.27 - 0.00
0.00 - 0.15
0.15 - 0.69
0.69 - 1.13
1.13 - 1.85
1.85 - 3.31
3.31 - 5.41
5.41 - 10.18
d1
d1s1_s_parLUT
d1s1_p_parLUT
C:\AGWA2\datafiles\wg
wgn_us83
C:\AGWA2\gisdata\Trai
pcp_gage
C:\AGWA2\gisdata\Trai
statsgo
ssurgo_PineyCreek
huc12
outlet_SWAT
outlet_KINEROS
raingages
AGWA Results
Results Selection
Watershed d1\d1s1
Simulation s2011-s2006_pct
Import
Units English
Output Water Yield (in)
Difference
Simulation 1
Simulation 2
Percent Change
Absolute Change
Equation
New Name
Create
Help
Close
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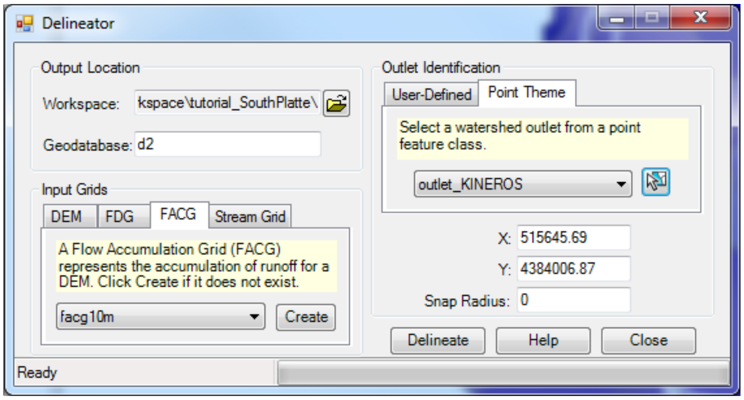
Editor
3D Analyst
Results
ArcToolbox
Catalog
Search
Create Features
Table
subwatersheds_d1s1
ET_in | Perc_in | SurQ_in | Tloss_in | WatYld_in | SedYld_t/a | Se
-1.242152 | -15.242704 | 9.034414 | 8.492558 | 10.178249 | 27.272732
-0.532992 | -10.062299 | 3.926819 | 3.409151 | 5.413578 | 0
-0.740395 | -10.810174 | 6.818257 | 7.677083 | 4.092039 | 30.496452
-0.431349 | -3.38903 | 3.735479 | 3.497257 | 3.898501 | 20.000004
-0.321821 | -2.778741 | 3.306402 | 3.132565 | 3.313302 | 49.999994
-0.402198 | -4.70066 | 2.493286 | 2.299508 | 2.740229 | 4.946996
-0.329079 | -3.357349 | 2.449746 | 2.358161 | 2.432524 | 2.408302
-0.269002 | -2.78469 | 2.362615 | 2.179052 | 2.425502 | 7.223478
-0.144143 | -2.27082 | 1.616444 | 1.245166 | 2.268625 | 5.000004
-0.18312 | -1.641723 | 1.791944 | 1.592105 | 1.847097 | 5.801113
-0.159976 | -1.360369 | 1.731044 | 1.578006 | 1.727755 | 1.75983
-0.244873 | -3.815841 | 1.5205 | 1.444051 | 1.591543 | 3.82609
-0.116843 | -0.757744 | 1.566274 | 1.460327 | 1.516228 | 2.25225
-0.122977 | -1.15202 | 1.156403 | 1.129244 | 1.13002 | 3.448277
-0.040889 | -0.472732 | 1.246234 | 1.201851 | 1.080589 | 1.149428
-0.065784 | -0.438388 | 0.743125 | 0.715213 | 0.693649 | 0.930239
-0.154067 | -11.006021 | 0.624256 | 0.608489 | 0.654279 | 1.333336
-0.035038 | -0.284311 | 0.658299 | 0.63241 | 0.476637 | 0
-0.010576 | -0.13864 | 0.157906 | 0.145403 | 0.148757 | 0.147927
-0.009537 | -0.107737 | 0.168888 | 0.162162 | 0.14743 | 0.102879
-0.004357 | -0.043947 | 0.09248 | 0.089243 | 0.08993 | 0.980394
-0.005679 | -0.047485 | 0.08735 | 0.083687 | 0.081825 | 0
-0.005133 | -0.047562 | 0.084563 | 0.081471 | 0.079527 | 0
-0.004006 | -0.045507 | 0.087624 | 0.084297 | 0.077285 | 0.290694
-0.004939 | -0.042921 | 0.089399 | 0.085804 | 0.07487 | 0
(2 out of 32 Selected)
subwatersheds_d1s1
511987.717 4390274.044 Meters

Some of the subwatersheds experienced up to a 10% increase in water yield caused by changes in land cover between 2006 and 2011. In part 2 of this tutorial, we will zoom in to one of the subwatersheds that experienced a high increase in surface runoff and model it in more detail using the KINEROS model.

Step 1: Delineating the watershed

14. Perform the watershed delineation by selecting ***AGWA Tools > Delineation Options > Delineate Watershed***.



14.1. ***Output Location*** box

14.1.1. ***Workspace*** textbox: navigate to and select/create **C:\AGWA\workspace\tutorial_SouthPlatte**

14.1.2. ***Geodatabase*** textbox: enter **d2**

14.2. ***Input Grids*** box

14.2.1. ***DEM*** tab: select **demf10m** (do not click Fill)

14.2.2. ***FDG*** tab: select **fdg10m** (do not click Create)

14.2.3. ***FACG*** tab: select **facg10m** (do not click Create)

14.2.4. ***Stream Grid*** tab: do nothing

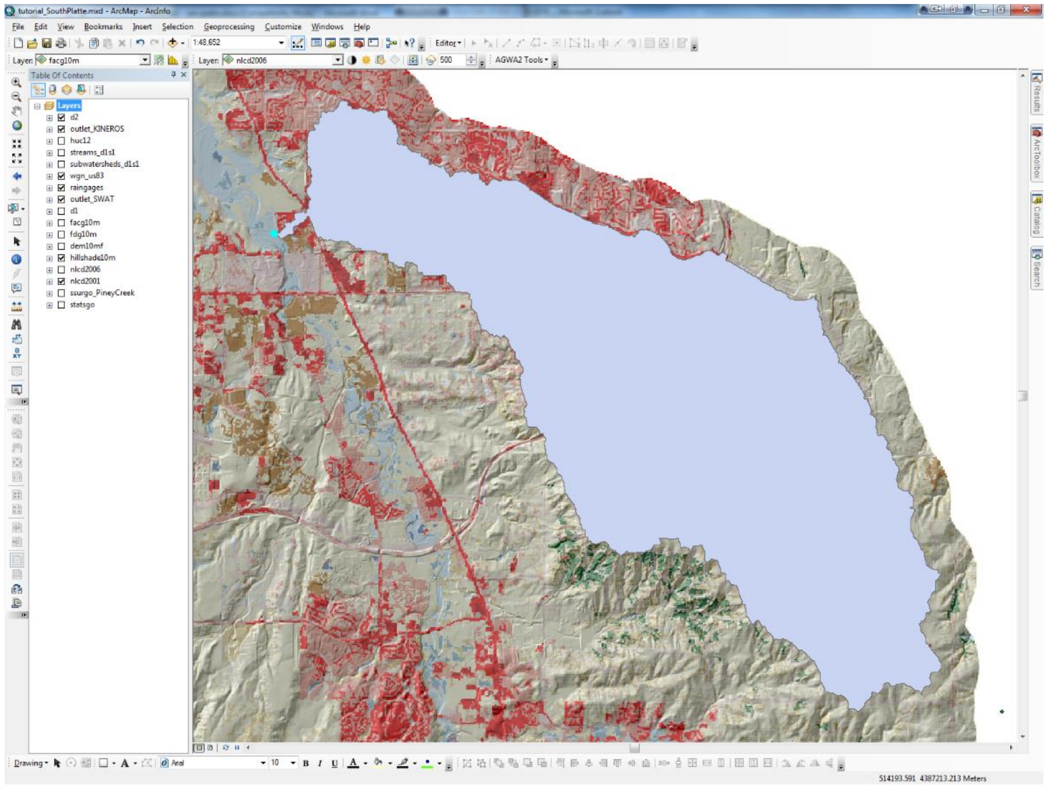
14.3. ***Outlet Identification*** box

14.3.1. ***Point Theme*** tab: select **outlet_KINEROS**

14.3.2. Click the ***Select Feature***  button and draw a rectangle around the point.

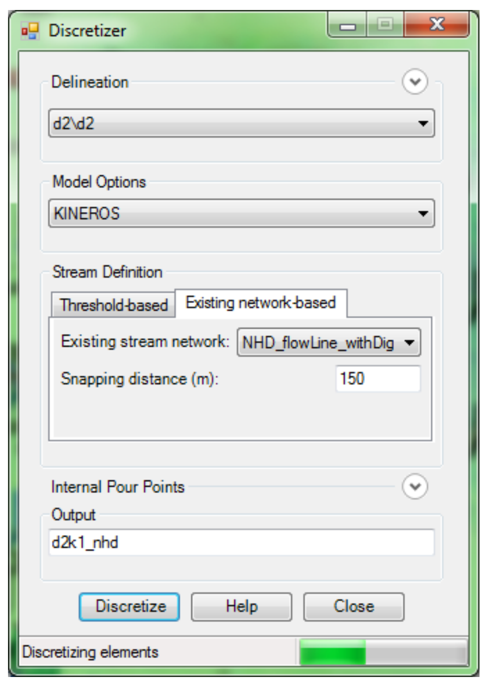
14.4. Click ***Delineate***.

14.5. Save the map document and continue to the next step.



Step 2: Discretizing or subdividing the watershed

15. Perform the watershed discretization by selecting ***AGWA Tools > Discretization Options > Discretize Watershed.***



15.1. ***Delineation*** box: select **d2/d2**

15.2. ***Model Options*** box: select **KINEROS**

15.3. ***Stream Definition*** box

15.3.1. ***Existing network-based*** tab page

15.3.1.1. ***Existing stream network***: **NHD_flowLine_withDigitized**

NOTE: NHD Flowlines are part of the National Hydrography Datasets feature-based database. NHDPlus Version2 is the most recent edition and can be found at www.horizon-systems.com/NHDPlus/NHDPlusV2_data.php.

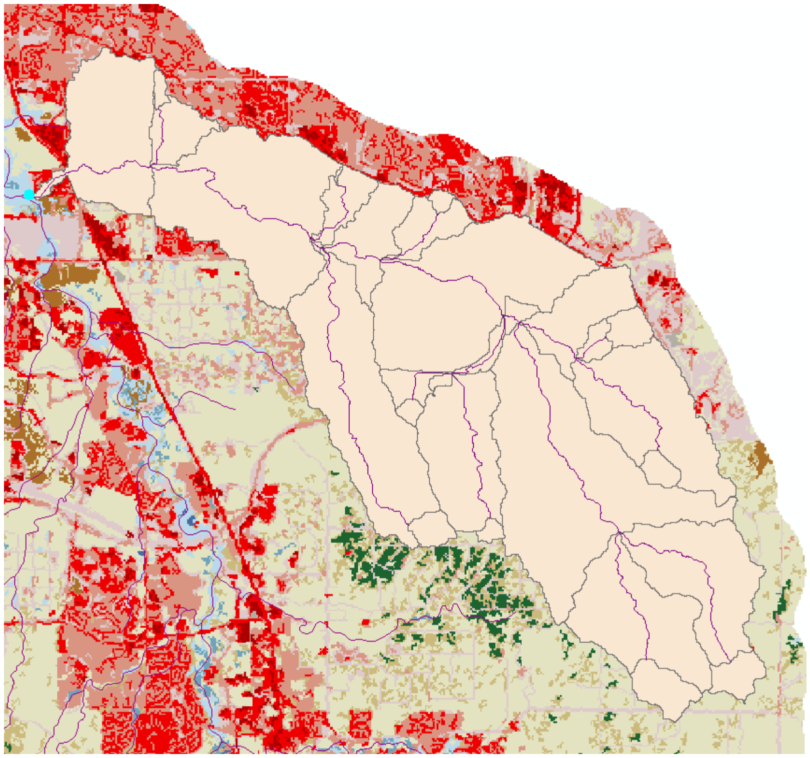
15.3.1.2. ***Snapping Distance (m)***: **150**

15.4. ***Internal Pour Points*** dropdown: do nothing

15.5. ***Output*** box: enter **d2k1_nhd**

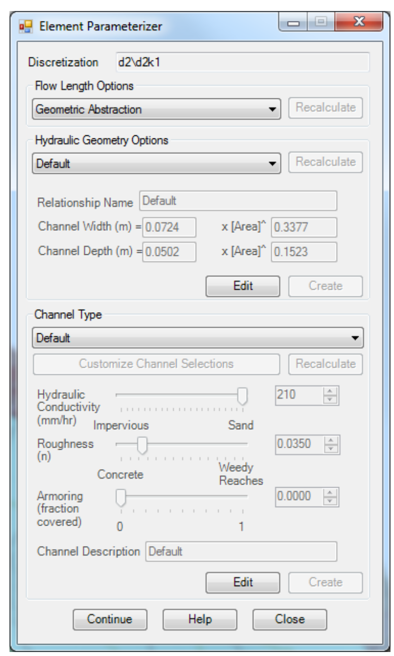
15.6. Click ***Discretize***.

15.7. Save the map document and continue to the next step.



Step 3: Parameterizing the watershed elements for KINEROS

16. Perform the element, land cover, and soils parameterization of the watershed by selecting the ***Parameterize*** menu item from the ***AGWA Tools > Parameterization Options*** menu.
    - 16.1. ***Input*** box
        - 16.1.1. ***Discretization***: select **d2\d2k1_nhd**
        - 16.1.2. ***Parameterization Name***: enter **p2006**
    - 16.2. ***Elements*** box
        - 16.2.1. ***Parameterization***: select **Create new parameterization**
        - 16.2.2. Click ***Select Options***. The ***Element Parameterizer*** form opens.
    - 16.3. In the ***Element Parameterizer*** form
        - 16.3.1. ***Flow Length Options*** box
            - 16.3.1.1. Select the **Geometric Abstraction** item.
        - 16.3.2. ***Hydraulic Geometry Options*** box
            - 16.3.2.1. Select the **Default** item.
              Do not click the ***Recalculate*** button
              Do not click the ***Edit*** button.
        - 16.3.3. ***Channel Type*** box
            - 16.3.3.1. Select the **Default** item.
        - 16.3.4. Click ***Continue***. You will be returned to the ***Parameterizer*** form to create the Land Cover and Soils parameterization.



16.4. Back in the ***Land Cover and Soils*** box of the ***Parameterizer*** form

16.4.1. ***Parameterization***: select **Create new parameterization**

16.4.2. Click ***Select Options***. The ***Land Cover and Soils*** form opens.

16.5. In the ***Land Cover and Soils*** form

16.5.1. ***Land Cover*** tab

16.5.1.1. ***Land cover grid***: select **nlcd2006**

16.5.1.2. ***Look-up table***: select **mrlc2001_lut**

16.5.2. ***Soils*** tab

16.5.2.1. ***Soils layer***: select **ssurgo_PineyCreek**

16.5.2.2. ***Soils database***: navigate to and select **C:\AGWA\gisdata\tutorial_SouthPlatte\soildb_US_2002_pineycreek.mdb**

16.6. In the ***Parameterizer*** form, click ***Process***.

> In Part 1, the smaller scale did not require high resolution soils data so the U.S. General Soil Map (STATSGO) was used at a mapping scale of 1:250000. In Part 2, because you are zooming in to a large scale, higher resolution soils data are more appropriate so SSURGO soils are used at a mapping scale of 1:24000. Note that the higher resolution data does increase processing time; STATSGO soils show 4 soil types that intersect Piney Creek whereas SSURGO soils show 244.

Step 4: Preparing KINEROS precipitation files

17. Write the KINEROS precipitation file for the watershed by selecting the ***Write KINEROS Precipitation*** menu item from the ***AGWA Tools > Precipitation Options*** menu.

17.1. ***KINEROS Precipitation*** form

17.1.1. ***Select discretization***: select **d2\d1k1_nhd**

17.1.2. ***User-Defined Depth*** tab:

17.1.2.1. ***Time Steps***: enter **37**

17.1.2.2. ***Depth (mm)***: enter **69.48**

17.1.2.3. ***Duration (hrs)***: enter **6**

17.1.3. ***Storm Location*** box:

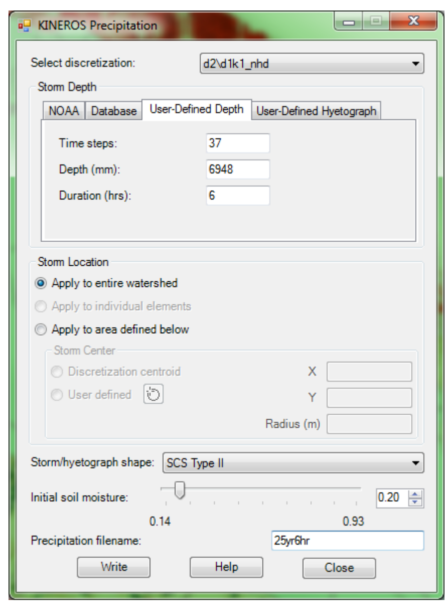
17.1.3.1. Select ***Apply to entire watershed***

17.1.4. ***Storm/hyetograph shape***: select **SCS Type II**

17.1.5. ***Initial soil moisture*** *slider*: do nothing (default is 0.20)

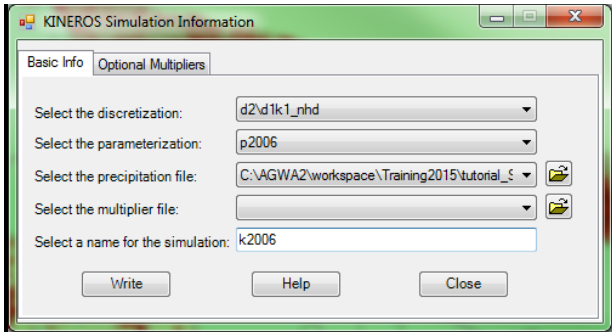
17.1.6. ***Precipitation filename***: enter **25yr6hr**

17.1.7. Click ***Write***



Step 5: Writing KINEROS input files

18. Write the KINEROS simulation input files for the watershed by selecting the ***Write KINEROS Input Files*** menu item from the ***AGWA Tools > Simulation Options > KINEROS Options*** menu.



18.1. ***Basic Info*** tab:

18.1.1. ***Select the discretization***: select **d2\d2k1_nhd**

18.1.2. ***Select the parameterization***: select **p2006**

18.1.3. ***Select the precipitation file***: select **25yr6hr**

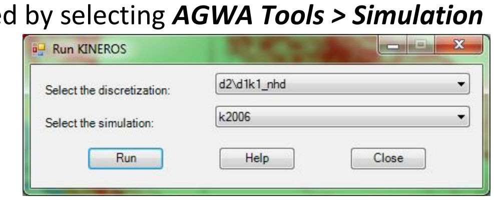
18.1.4. ***Select the multiplier file:*** leave blank

18.1.5. ***Select a name for the simulation***: enter **k2006**

18.1.6. Click ***Write***.

Step 6: Executing the KINEROS model

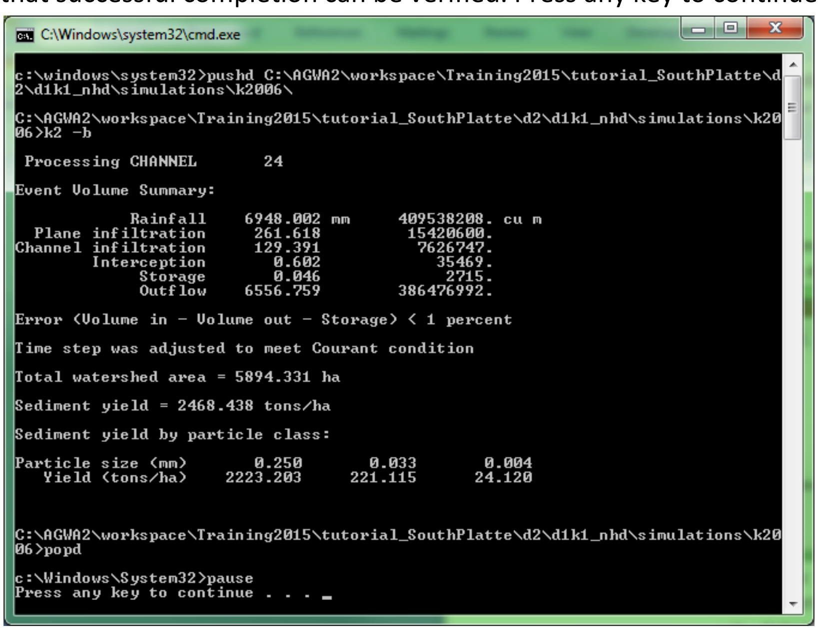
19. Execute the KINEROS model for the Piney Creek watershed by selecting ***AGWA Tools > Simulation Options > KINEROS Options > Execute KINEROS Model***.



19.1. ***Select the discretization***: select **d2\d2k1_nhd**

19.2. ***Select the simulation***: select **k2006**

19.3. Click ***Run***. The command window will stay open so that successful completion can be verified. Press any key to continue.

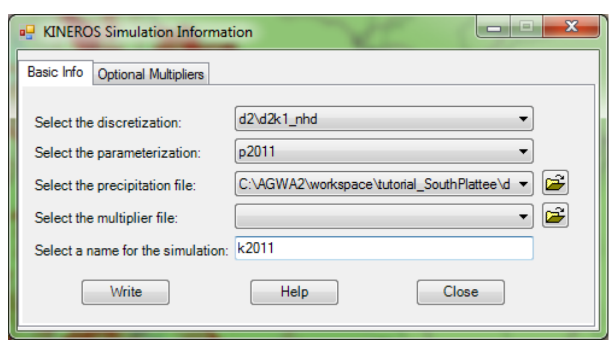


19.4. Close the ***Run KINEROS*** form.

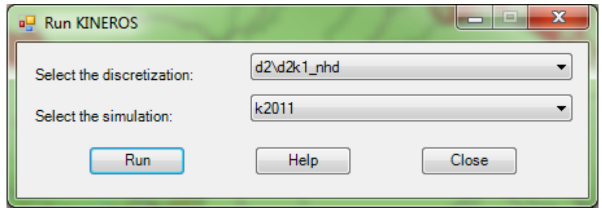
At this point, the 2006 land cover has been simulated; the 2011 land cover will be parameterized and simulated next.

Step 7: Repeat for NLCD 2011 landcover

20. Rerun the land cover and soils parameterization of the watershed with the 2011 land cover by selecting ***AGWA Tools > Parameterization Options > Parameterize***.
    - 20.1. ***Input*** box
        - 20.1.1. ***Discretization***: select **d2\d2k1_nhd**
        - 20.1.2. ***Parameterization Name***: enter **p2011**
    - 20.2. ***Elements*** box
        - 20.2.1. ***Parameterization***: select **p2006**
    - 20.3. ***Land Cover and Soils*** box
        - 20.3.1. ***Parameterization***: select **Create new parameterization**
        - 20.3.2. Click ***Select Options***. The ***Land Cover and Soils*** form opens.
    - 20.4. In the ***Land Cover and Soils*** form
        - 20.4.1. ***Land Cover*** tab
            - 20.4.1.1. ***Land cover grid***: select **nlcd2011**
            - 20.4.1.2. ***Look-up table***: select **mrlc2001_lut**
        - 20.4.2. ***Soils*** tab
            - 20.4.2.1. ***Soils layer***: select **ssurgo_PineyCreek**
            - 20.4.2.2. ***Soils database***: navigate to and select **C:\AGWA\gisdata\tutorial_SouthPlatte\soildb_US_2002_pineycreek.mdb**
    - 20.5. Click ***Continue***. You will be returned to the ***Parameterizer*** form where the ***Process*** button will now be enabled.
    - 20.6. In the ***Parameterizer*** form, click ***Process***.
21. Write the KINEROS simulation input files representing the new parameterization by selecting ***AGWA Tools > Simulation Options > KINEROS Options > Write KINEROS Input Files.***
    - 21.1. ***Basic Info*** tab:
        - 21.1.1. ***Select the discretization***: select **d2\d2k1_nhd**
        - 21.1.2. ***Select the parameterization***: select **p2011**
        - 21.1.3. ***Select the precipitation file***: select **25yr6hr**
        - 21.1.4. ***Select the multiplier file:*** leave blank
        - 21.1.5. ***Select a name for the simulation***: enter **k2011**
        - 21.1.6. Click ***Write***.



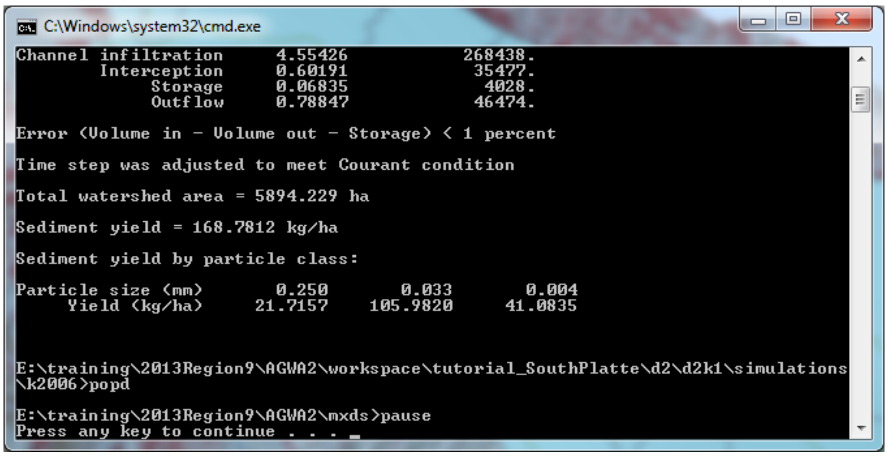
22. Run the KINEROS model for the 2011 land cover by selecting ***AGWA Tools > Simulation Options > KINEROS Options > Execute KINEROS Model***.



22.1. ***Select the discretization***: select **d2\d2k1_nhd**

22.2. ***Select the simulation***: select **k2011**

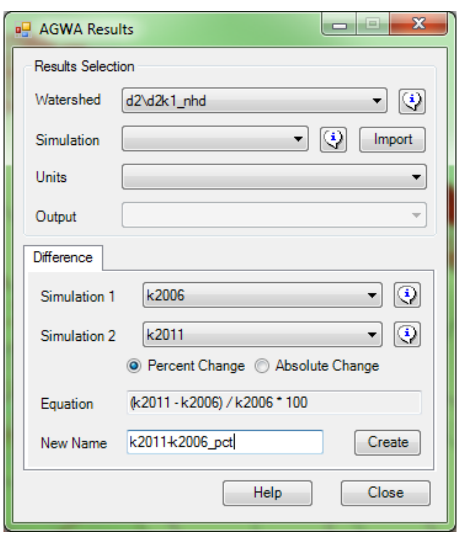
22.3. Click ***Run***. The command window will stay open so that successful completion can be verified. Press any key to continue.

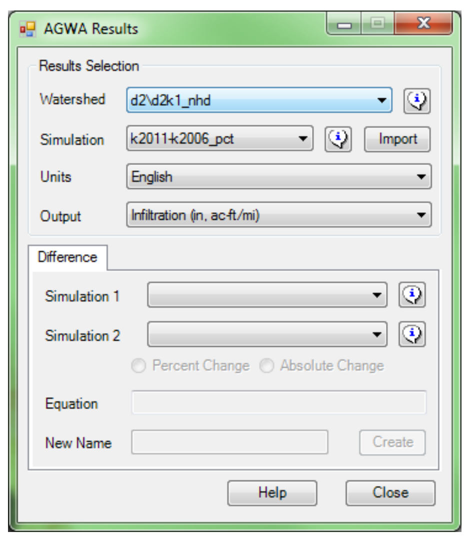


22.4. Close the ***Run KINEROS*** form.

Step 8: Viewing the results

23. Import the results from the two simulations by selecting ***AGWA Tools > View Results > KINEROS Results > View KINEROS Results***.





23.1. ***Results Selection*** box

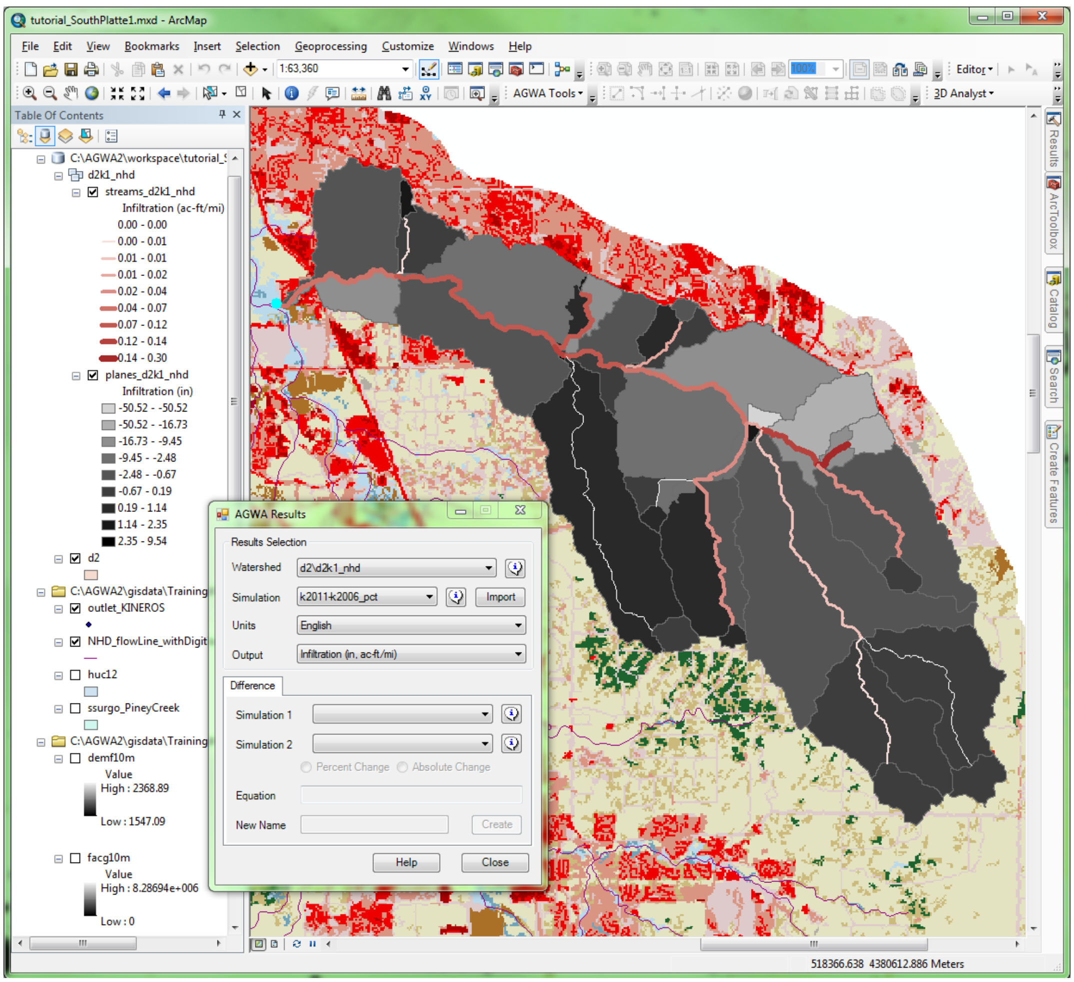
23.1.1. ***Watershed***: select **d2\d2k1_nhd**

23.1.2. ***Simulation***: click ***Import***

23.1.2.1. ***Yes*** to importing ***k2006***

23.1.2.2. ***Yes*** to importing ***k2011***

24. Difference the 2006 and 2011 simulation results.
    24.1. ***Difference*** tab
        24.1.1. ***Simulation1***: select **k2006**
        24.1.2. ***Simulation2***: select **k2011**
        24.1.3. Select **Percent Change** radiobutton
        24.1.4. ***New Name***: enter **k2011-k2006_pct**
        24.1.5. Click ***Create***
25. View the differenced results.
    25.1. ***Results Selection*** box
        25.1.1. ***Watershed***: select **d2\d2k1_nhd**
        25.1.2. ***Simulation***: select **k2011-k2006_pct**
        25.1.3. ***Units***: select **English** (Note: unit selection is arbitrary when viewing percent difference)
        25.1.4. ***Output***: select **Infiltration (in, ac-ft/mi)**



The KINEROS planes only experienced up to a 3.3% decrease in infiltration caused by changes in land cover between 2006 and 2011, however this resulted in up to a 75% increase in infiltration in the channels due to an increase in available water to infiltrate. View other outputs and examine underlying land cover change to further assess the impacts of land cover change on the Piney Creek watershed's hydrology.