Introduction to AGWA 3.0
The Automated Geospatial Watershed Assessment Tool

Assessing the Impact of an Artificial Constructed Wetland on Storm Runoff

Introduction	In this exercise you will use the Add Diversions tool to incorporate a constructed wetland adjacent to the outlet channel.
Goal	To familiarize yourself with AGWA to analyze the impact of a common BMP in an urban setting within the South Platte River Basin.
Assignment	Use KINEROS2 to assess the relative impact of constructed wetlands in an urban setting.

An Introduction to Wetlands and Urbanization in the South Platte River Basin

Changes in land-use and land cover are critical in the determination of water availability, quality, and demand. The consequences of human modification of the Earth's surface for extraction of natural resources, agricultural production, and urbanization may rival those that are anticipated via climate change (Vitousek 1994, Vörösmarty et al. 2000, Chapin et al. 2002, DeFries and Eshleman 2004, Brauman et al. 2007, Whitehead et al. 2009).

Changes in land cover and availability of natural resources will affect the types of ecosystem services human populations have come to rely on. For example, wetland acreage across the United States has decreased by up to 91% in states like California where land conversion to agriculture, industrial or urban has occurred since the 18th century; in Colorado the estimated percentage of wetland acreage lost by 1980 was 50% (Mitsch and Gosselink 1993). Wetlands provide many ecosystem services including erosion control, sediment and pollutant filtering, and flood control (Costanza et al. 1997, Mitsch and Gosselink 2000). These services are especially important in a human-dominated watershed where high volumes of runoff carrying sediment and pollutants can contribute to localized water quality impairments and runoff pulses (Strange et al. 1999).

As populations grow, it will be ever more important to restore and maintain the ecosystem services that wetlands provide. This may take place in the form of restoration or rehabilitation of existing wetlands or in the form of constructed wetlands. In order to preserve the functionality of existing wetlands or replicate that function in a constructed wetland, site characteristics and storm water characteristics need to be taken into account (U.S. EPA 1996). The main goal of constructed wetlands would be to mitigate the effects of storm water runoff in developed watersheds.

For the purpose of this tutorial, a generic constructed wetland will be created and simulated on a small, developed watershed within the South Platte River Basin.

The Study Area

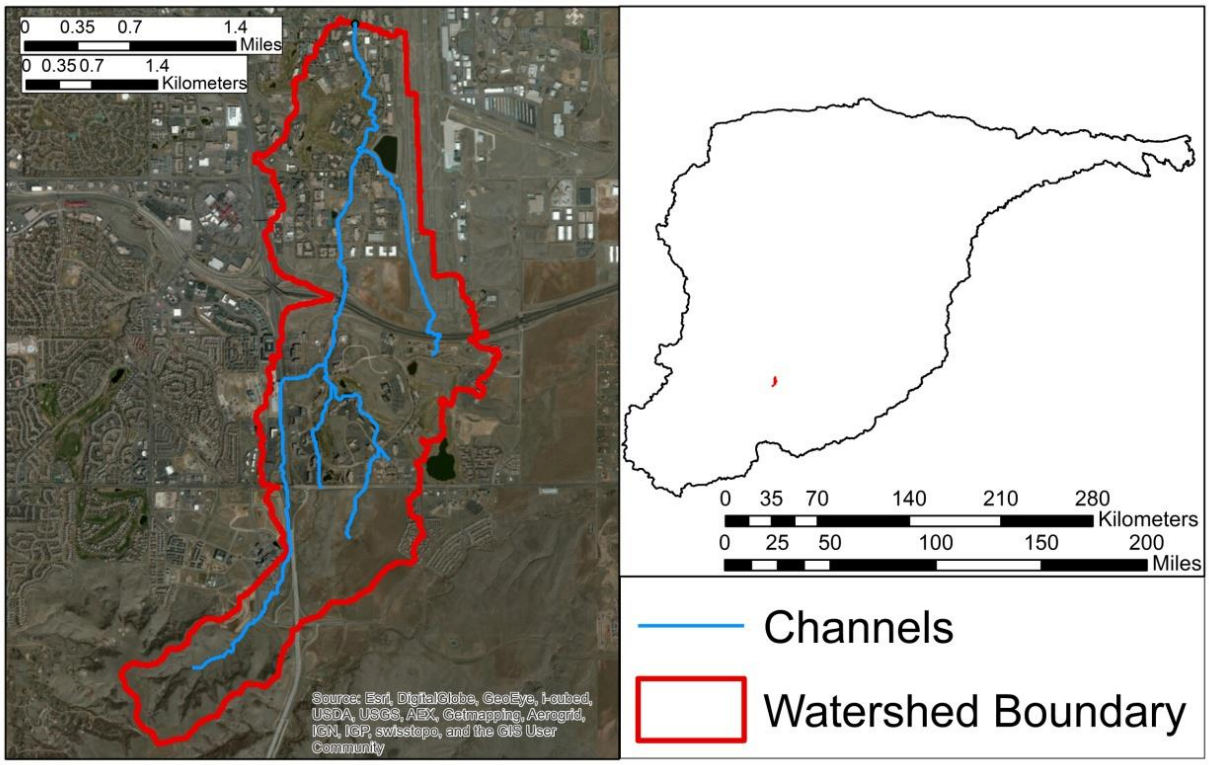
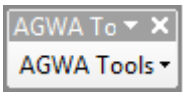


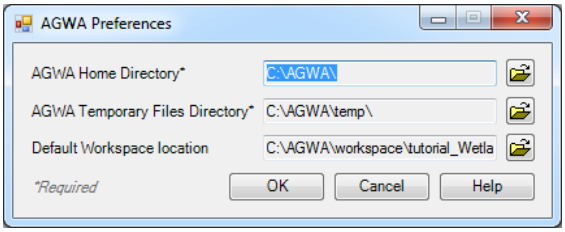
Figure 1. Location Map of the study area within the South Platte River Basin.

This exercise examines the effects of constructed wetlands on runoff in a small watershed within the South Platte Basin. The watershed contains a variety of developed lands, including sports parks, golf courses, housing developments, and a regional airport. In order to demonstrate the localized effect of constructed wetlands on the water balance, the small watershed will be modeled using KINEROS2 (Figure 1).

Getting Started

Start ArcMap with a new empty map. Save the empty map document as **tutorial_Wetlands** in the **C:\AGWA\workspace\tutorial_Wetlands** directory. 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 Tools -> Other Options***> ***AGWA Preferences*** on the ***AGWA Toolbar***.





- Home: **C:\AGWA**
- Temp: **C:\AGWA\temp**
- Default Workspace: **C:\AGWA\workspace\tutorial_Wetlands**
  The default workspace location will need to be created by clicking on ***Make New Folder*** button in the window that opens.

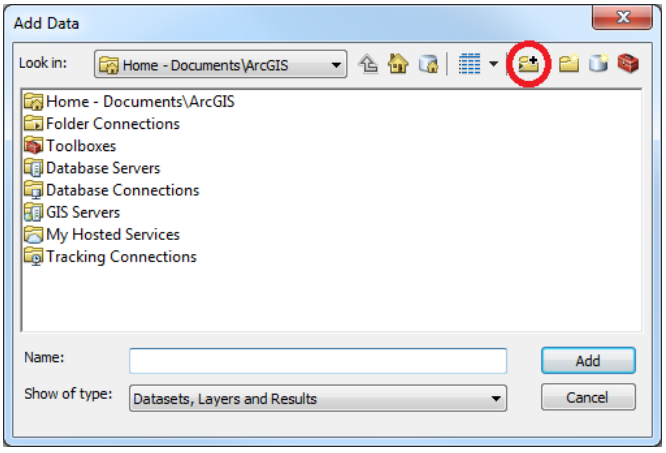
The Home directory contains all of the look-up tables, datafiles, models, and documentation required for AGWA to run. If this is set improperly or you are missing any files, you will be presented with a warning that lists the missing directories or files that AGWA requires.

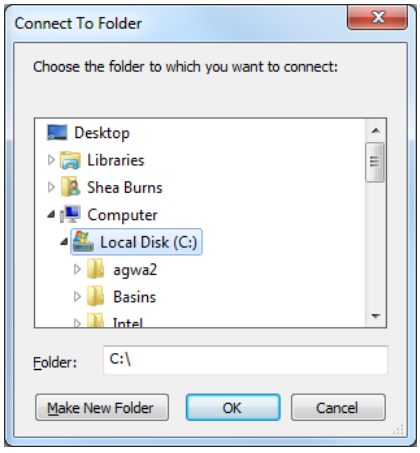
The Temp directory is where some temporary files created by AGWA will be placed. You may want to routinely delete files and directories in the Temp directory if you need to free up space or are interested in identifying the temporary files associated with your next AGWA use.

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 your data is 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:)**.





www.tucson.ars.ag.gov/agwa
www.epa.gov/esd/land-sci/agwa/

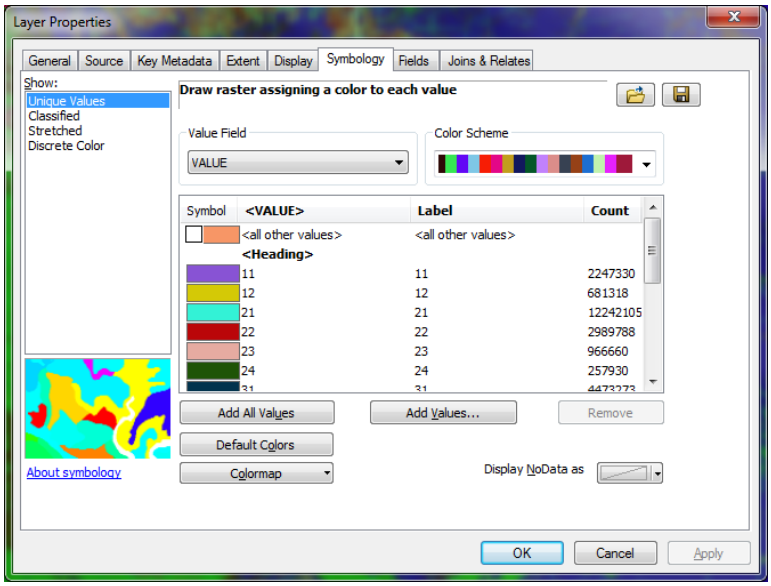
Once the folder connection is established, navigate to the **C:\AGWA\gisdata\tutorial_Wetlands** folder and add the following datasets and layers:

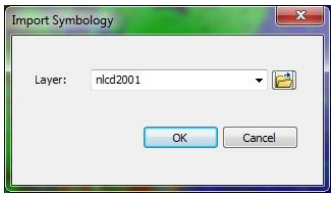
- **..\filldem10m**
- **..\facgfilldem1**
- **..\fdgfilldem10m**
- **..\nlcd2011**
- **..\soilmu_a_aoi.shp**
- **..\outlet.shp**

You will also need to add the following files from the ***C:\AGWA\datafiles*** folder by again clicking on the ***Add Data*** button:

- **..\lc_luts\mrlc2001_lut.dbf** – MRLC look-up table for 2001 and 2006 NLCD land cover
- **..\precip\tutorial_Wetlands\dsgnstrm.dbf** – Precipitation inputs for KINEROS

To better visualize the different land cover types and associate the pixels with their classification, load a legend into the ***nlcd2011*** dataset. To do this, right click the layer name of the **nlcd2011** 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  button on the right. Click the file browser button, navigate to and select **C:\AGWA\datafiles\renderers\nlcd2001.lyr** and click on ***Add***, and 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.





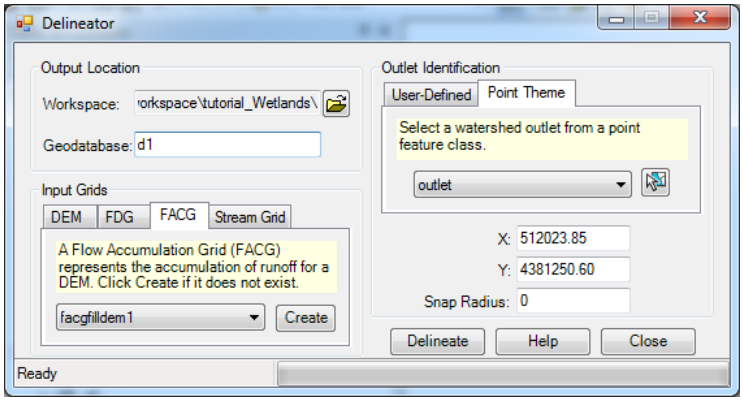
Part 1: Modeling Runoff Using KINEROS2

In Part 1, you will evaluate the water balance in a small, urban watershed in the South Platte River Basin using KINEROS2 in AGWA. Watershed delineation, discretization, and parameterization will be covered, along with precipitation inputs, model execution, and results visualization.

Step 1: Delineating the watershed

Delineating creates a feature class that represents all the area draining to a user-specified outlet.

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



1.1. ***Output Location*** box

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

DESCRIPTION The workspace specified is the location on your hard drive where the delineated watershed is stored as a feature class in a geodatabase.

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

NOTE You will be required to change the name of the geodatabase if a geodatabase with the same name exists in the selected workspace.

1.2. ***Input Grids*** box

1.2.1. ***DEM*** tab: select **filldem10m** (do not click Fill)

1.2.2. ***FDG*** tab: select **fdgfilldem10m** (do not click Create)

1.2.3. ***FACG*** tab: select **facgfilldem1** (do not click Create)

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

1.3. ***Outlet Identification*** box

1.3.1. ***Point Theme*** tab

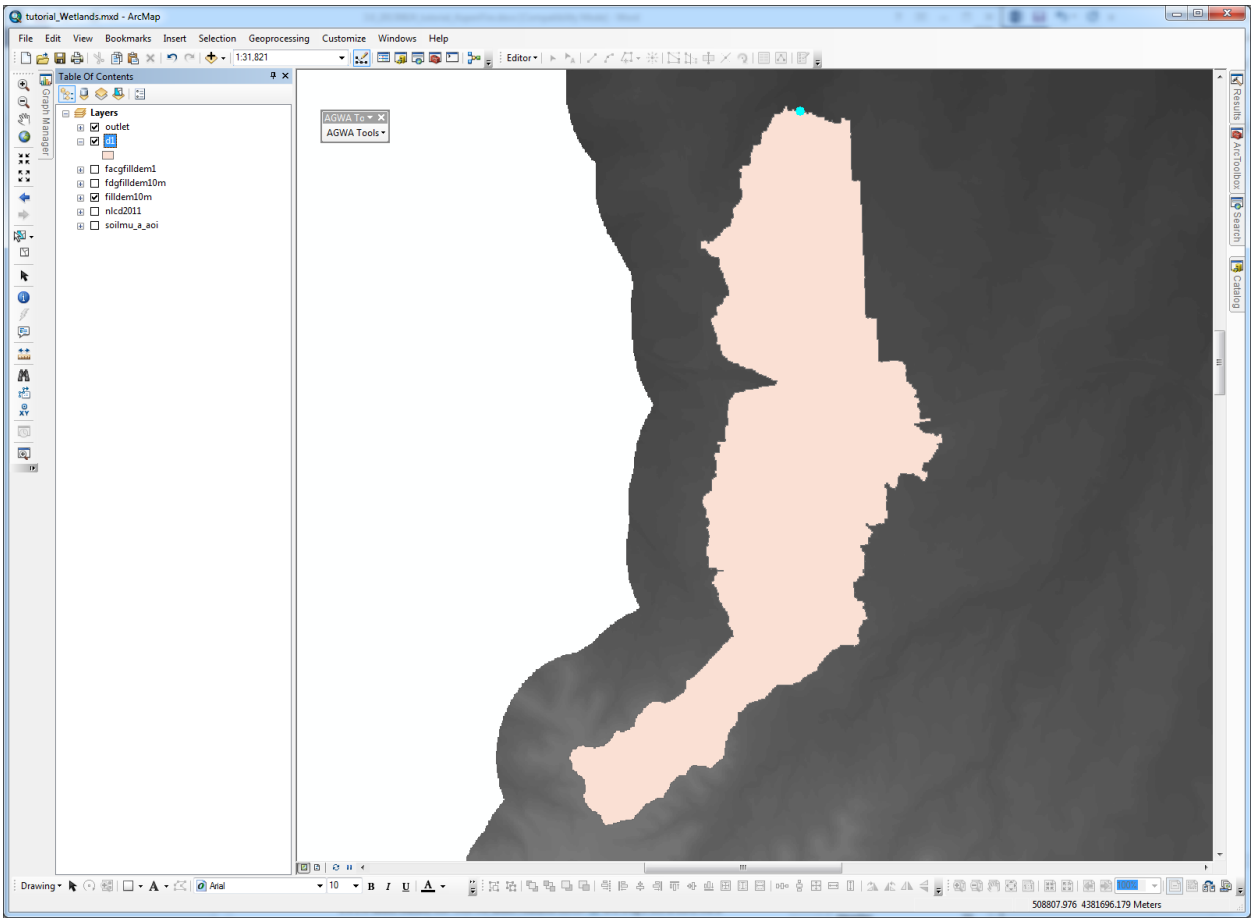
1.3.1.1. ***Outlets theme***: select **outlet**.

1.3.1.2. Click the ***Select Feature*** button and click and drag to draw a rectangle around the point.

1.4. Click ***Delineate***.

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

At this point, the 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

Discretizing breaks up the delineated watershed into model specific elements and creates a stream feature class that drains the elements.

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

    2.1. ***Input*** box
        2.1.1. ***Delineation***: select **d1\d1**
    2.2. ***Model Options*** box
        2.2.1. ***Model***: select **KINEROS**
    2.3. ***Stream Definition*** box
        2.3.1. ***Threshold-based*** tab

2.3.1.1. ***Method***: do nothing, the default is CSA (acres)

2.3.1.2. ***% Total Watershed***: do nothing (Note: this value will change when we change the CSA)

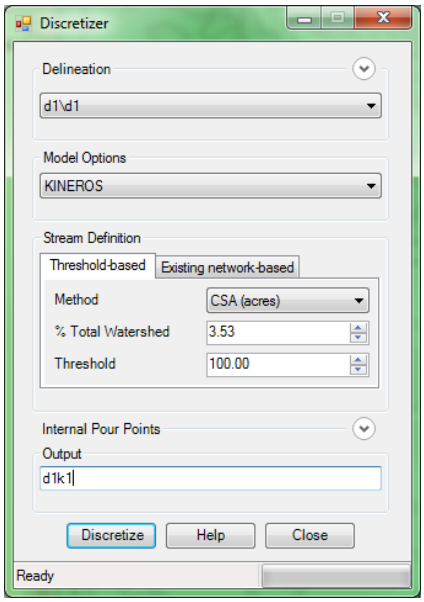
2.3.1.3. ***Threshold***: set to **100.00**

2.4. Output box

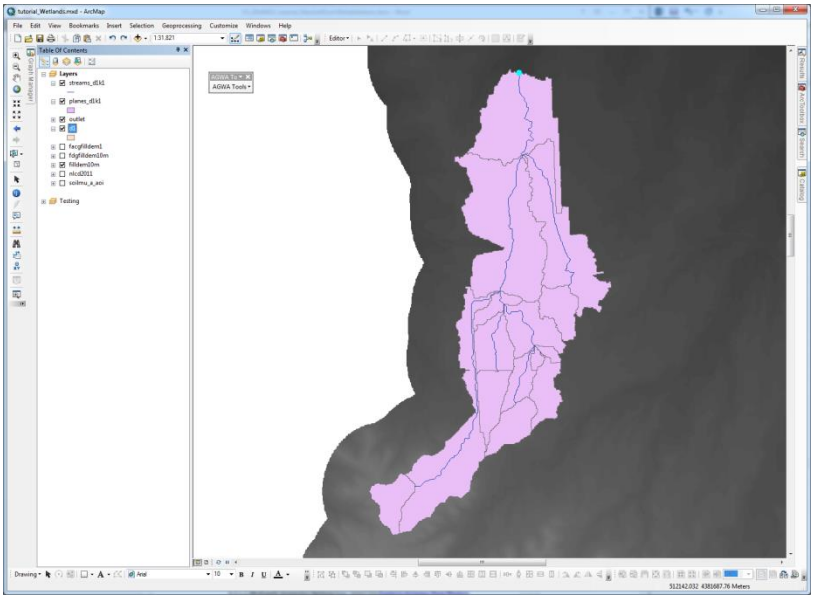
2.4.1. ***Name***: enter **d1k1**

2.5. Click Discretize.

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



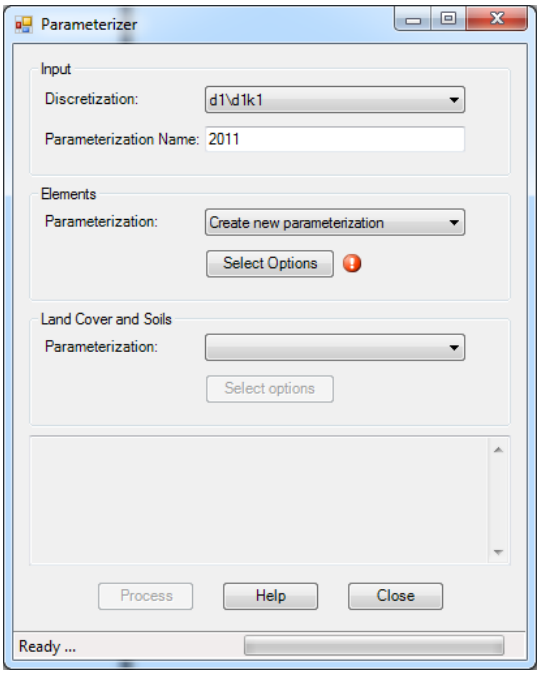
Discretizing breaks up the delineation/watershed into model specific elements and creates a stream feature class that drains the elements. The CSA, or Contributing/Channel Source Area, is a threshold value which defines first order channel initiation, or the upland area required for channelized flow 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 planes layer with the name ***planes_d1k1*** and a streams map named ***streams_d1k1***. 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\d1k1***.

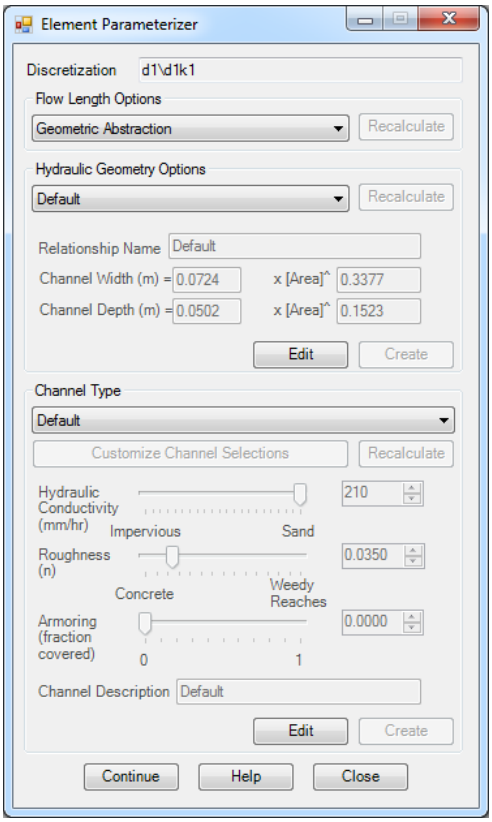


Step 3: Parameterizing the watershed elements for KINEROS

Parameterizing defines model input parameters based on topographic, land cover, and soils properties. Model input parameters represent the physical properties of the watershed and used to write the model input files.

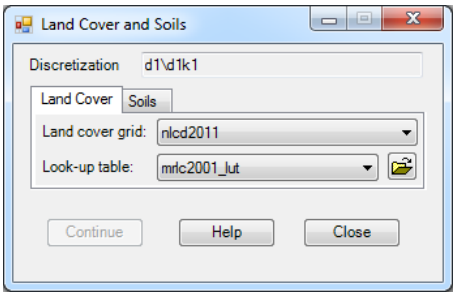
3. Perform the element, land cover, and soils parameterization of the watershed by selecting ***AGWA Tools*** > ***Parameterization Options*** > ***Parameterize***.
   3.1. ***Input*** box
      3.1.1. ***Discretization***: select **d1\d1k1**
      3.1.2. ***Parameterization Name***: enter **2011**
   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. ***Flow Length Options*** box
         3.3.1.1. Select the **Geometric Abstraction** item.
            Do not click the ***Recalculate*** button.
      3.3.2. ***Hydraulic Geometry Options*** box

3.3.2.1. Select the **Default** item.
Do not click the ***Recalculate*** button.
Do not click the ***Edit*** button.



3.3.3. ***Channel Type*** box

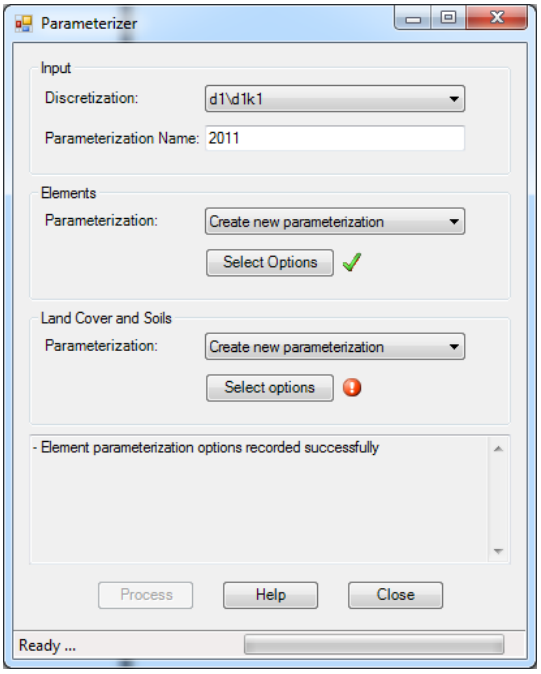
3.3.3.1. Select the **Default** item.
Do not click the ***Recalculate*** button.
Do not click the ***Edit*** button.

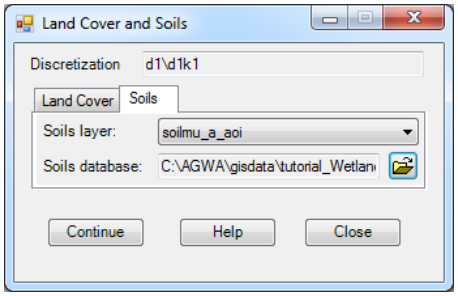
3.3.4. Click ***Continue***. You will be returned to the ***Parameterizer*** form to create the Land Cover and Soils parameterization.

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 **nlcd2011**

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

3.5.2. ***Soils*** tab

3.5.2.1. ***Soils layer***: select **soilmu_a_aoi**

3.5.2.2. ***Soils database:*** navigate to and select
C:\AGWA\gisdata\tutorial_Wetlands\wss_aoi_2014-07-10_17-33-32\soildb_US_2003.mdb

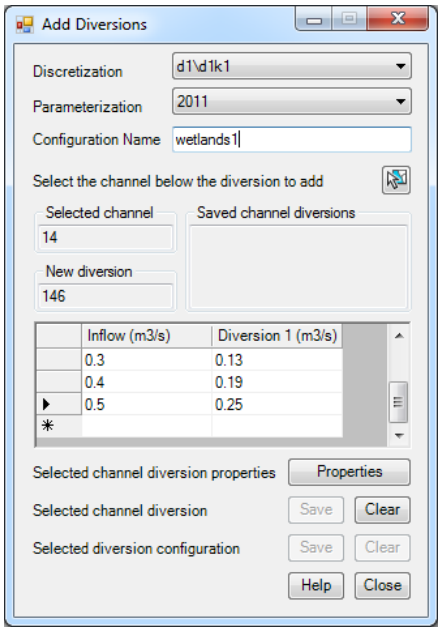
3.6. Click ***Continue***. You will be returned to the ***Parameterizer*** form where the ***Process*** button will now be enabled.

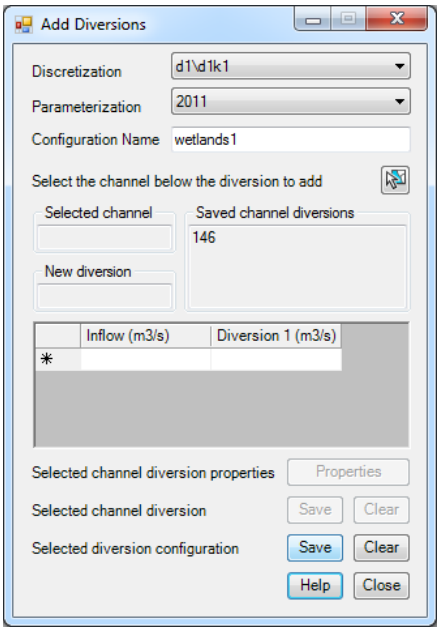
3.7. In the ***Parameterizer*** form, click ***Process***.

In the last step, parameterization look-up tables for the overland flow elements and stream elements have been created to store the model input parameters representing the physical properties of the watreshed.

Step 4: Adding a diversion to represent a constructed wetland

4. Add the KINEROS diversion for the outlet channel by selecting ***AGWA Tools > Parameterization Options > Add Diversions***.





4.1. ***Discretization***: select **d1\d1k1**

4.2. ***Parameterization***: select **2011**

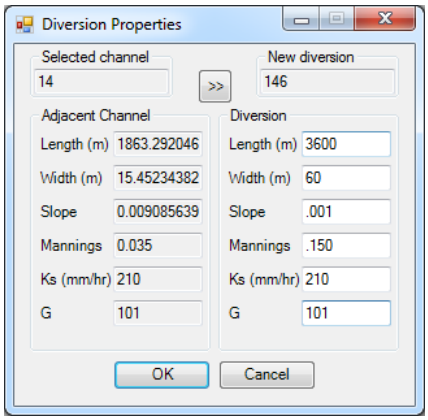
4.3. ***Configuration Name***: enter **wetlands1**

4.4. Click the ***Select Features*** tool and drag a box around the outlet channel to select it. The ***Selected channel*** should be ***14***.

4.5. In the Inflow and Diversion ratings table, enter the following values. Once all values are entered properly, no errors will be displayed in the table.

Inflow (m3/s)	Diversion 1 (m3/s)
0.0	0.00
0.1	0.01
0.2	0.07
0.3	0.13
0.4	0.19
0.5	0.25

4.6. Click the ***Properties*** button. The ***Diversion Properties*** form opens.



4.6.1. In the Diversion Properties form enter the following diversion properties:

4.6.1.1. ***Length (m)***: **3600**

4.6.1.2. ***Width (m)***: **60**

4.6.1.3. ***Slope***: **0.001**

4.6.1.4. ***Mannings***: **0.150**

4.6.1.5. ***Ks (mm/hr)***: **210**

4.6.1.6. ***G***: **101**

4.6.2. Click the ***OK*** button to return to the ***Add Diversions*** form.

4.7. Click the ***Save*** button next to ***Selected channel diversion properties***. The channel diversion is added to the ***Saved channel diversions*** box.

4.8. Click the ***Save*** button next to ***Selected diversion configuration***. The saved channel diversion is written to the diversion look-up tables stored in the ***d1*** delineation geodatabase.

4.9. Click the ***Close*** button and continue to the next step.

The added diversion and its properties were selected to represent a constructed wetland. Wetlands may exhibit added sinuosity and width compared to the channel diverted from, a lower slope so that water does not flow quickly through them, and additional vegetation which will increase the roughness significantly.

Step 5: Preparing rainfall files

5. Write the KINEROS precipitation file for the watershed by selecting ***AGWA Tools > Precipitation Options > Write KINEROS Precipitation***.

5.1. ***KINEROS Precipitation*** form

5.1.1. ***Select discretization***: **d1/d1k1**

5.1.2. ***Storm Depth*** box:

5.1.2.1. ***Database*** tab:

5.1.2.1.1. ***Select database***: **dsgnstrm**

5.1.2.1.2. ***Select location***: **EPA BMP SouthPlatte**

5.1.2.1.3. ***Select storm frequency (yrs)***: **10**

5.1.2.1.4. ***Select storm duration (hrs)***: **1**

5.1.3. ***Storm Location*** box

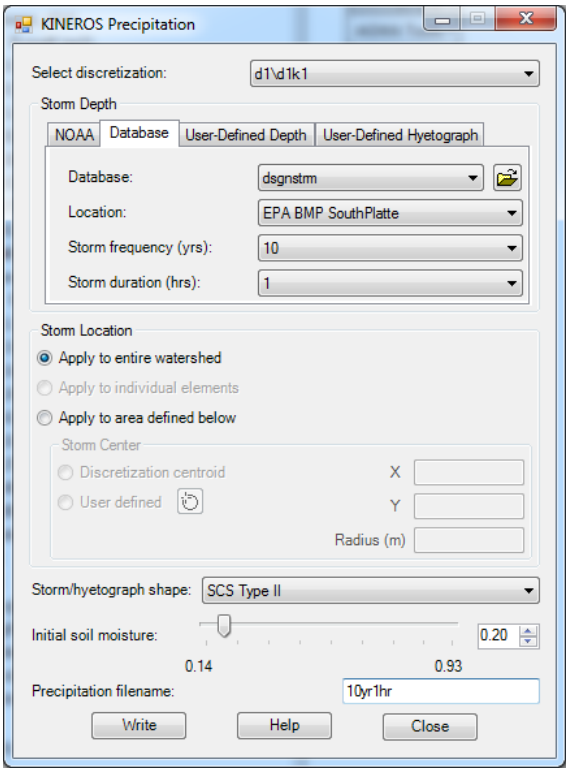
5.1.3.1. Select ***Apply to entire watershed*** radio button

5.1.4. ***Storm/hyetograph shape:*** **SCS Type II**

5.1.5. ***Initial soil moisture:*** **0.2**

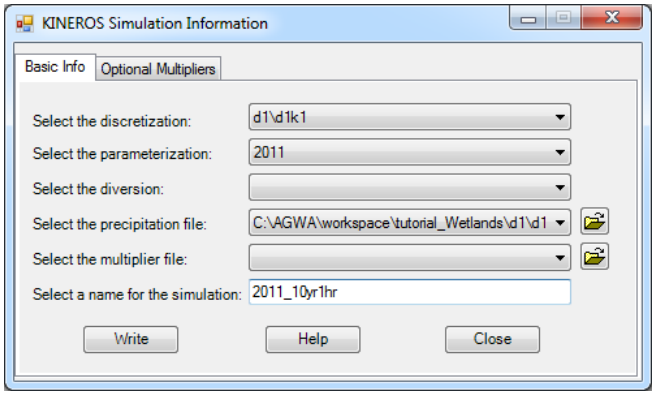
5.1.6. ***Precipitation filename:*** **10yr1hr**

5.1.7. Click ***Write***.



Step 6 & 7: Writing KINEROS input files

6. Write the KINEROS simulation input files for the watershed without the diversion by selecting ***AGWA Tools > Simulation Options > KINEROS Options > Write KINEROS Input Files***.



6.1. ***Basic Info*** tab:

6.1.1. ***Select the discretization***: **d1\d1k1**

6.1.2. ***Select the parameterization***: **2011**

6.1.3. ***Select the precipitation file***: **10yr1hr**

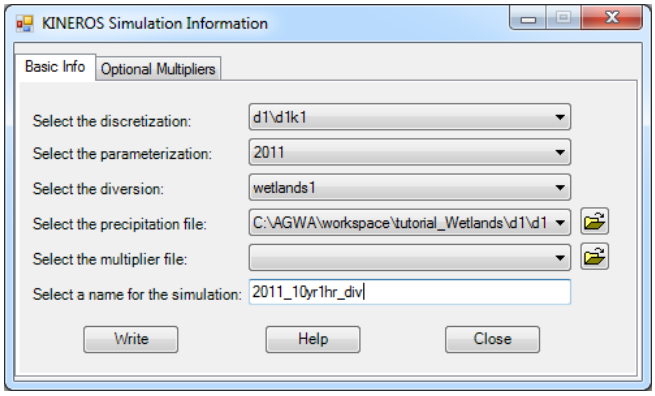
6.1.4. ***Select the diversion:*** do not select anything (leave blank)

6.1.5. ***Select the multiplier file***: do not select anything (leave blank)

6.1.6. ***Select a name for the simulation***: **2011_10yr1hr**

6.1.7. Click ***Write***.

7. Repeat Step 6 but this time write the simulation input files for the watershed with the diversion. Select ***AGWA Tools > Simulation Options > KINEROS Options > Write KINEROS Input Files***.



7.1. ***Select the discretization***: **d1\d1k1**

7.2. ***Select the parameterization***: **2011**

7.3. ***Select the precipitation file***: **10yr1hr**

7.4. ***Select the diversion:*** **wetlands1**

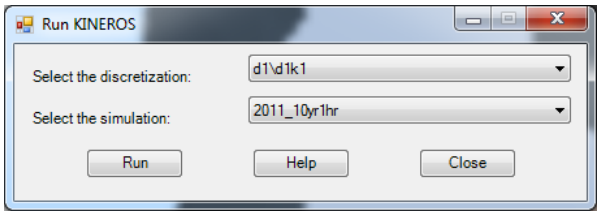
7.5. ***Select the multiplier file***: do not select anything (leave blank)

7.6. ***Select a name for the simulation***: **2011_10yr1hr_div**

7.7. Click ***Write***.

Step 8 & 9: Executing the KINEROS model

8. Run the KINEROS model for the ***d1\d1k1*** watershed by selecting ***AGWA Tools > Simulation Options > KINEROS Options > Execute KINEROS Model***.

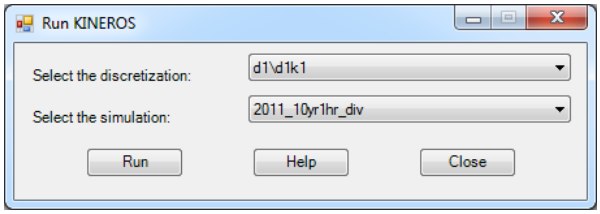


8.1. Select the discretization: select **d1\d1k1**

8.2. Select the simulation: select **2011_10yr1hr**

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

9. Repeat Step 8 but this time execute the other simulation. Select ***AGWA Tools > Simulation Options > KINEROS Options > Execute KINEROS Model***.



9.1. Select the discretization: select **d1\d1k1**

9.2. Select the simulation: select **2011_10yr1hr_div**

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

9.4. Click the ***Close*** button to close the ***Run KINEROS*** form and continue to the next step.

Steps 10 & 11: Comparing Results with and without wetlands

In Step 10, the results from both watershed representations, with and without the constructed wetlands, will be imported into AGWA. These results will then be differenced to visualize how the wetland impacts the hydrology of the watershed.

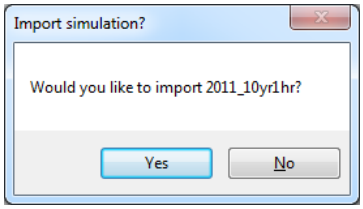
10. Import the results from the two simulations by selecting ***AGWA Tools > View Results > KINEROS Results > View KINEROS Results***.

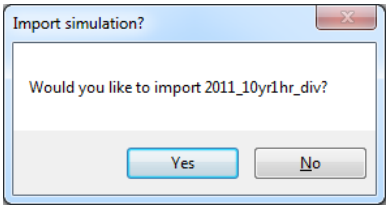
10.1. ***Watershed***: **d1\d1k1**

10.2. ***Simulation***: Click **Import**

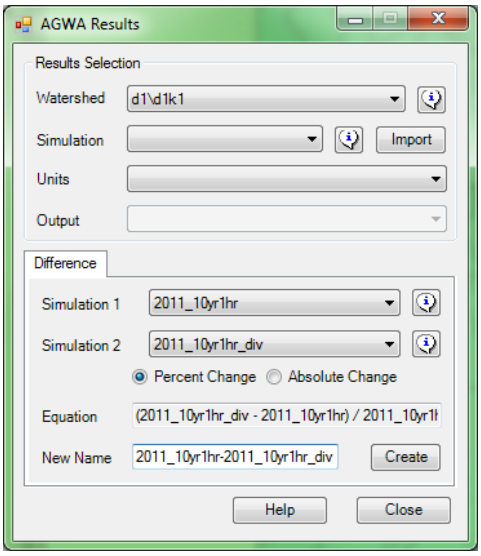
10.2.1. Click ***Yes*** when asked to import the ***2011_10yr1hr*** simulation?

10.2.2. Click ***Yes*** again when asked import the ***2011_10yr1hr_div*** simulation?





10.3. ***Difference*** tab



10.3.1. ***Simulation1***: **2011_10yr1hr**

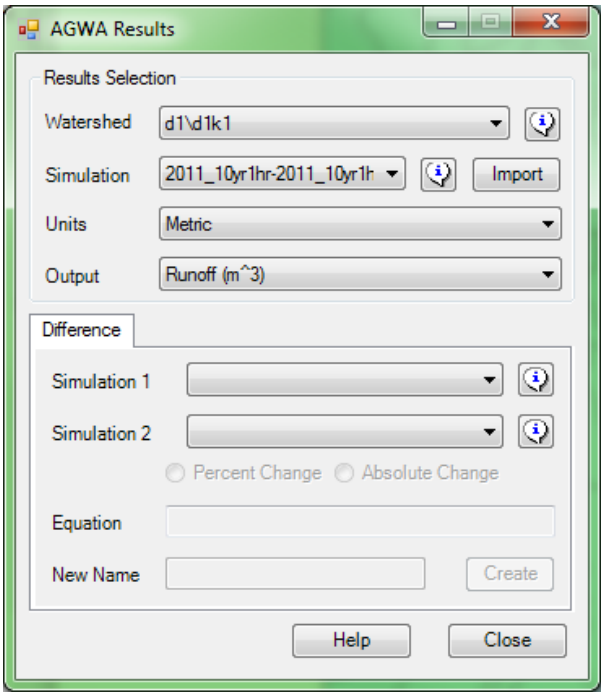
10.3.2. ***Simulation2***: **2011_10yr1hr_div**

10.3.3. Select **Percent Change** radiobutton

10.3.4. ***New Name***: **2011_10yr1hr-2011_10yr1hr_div**

10.3.5. Click **Create**

10.4. View the differenced results.



10.4.1. ***Results Selection*** box

10.4.1.1. ***Watershed***: **d1\d1k1**

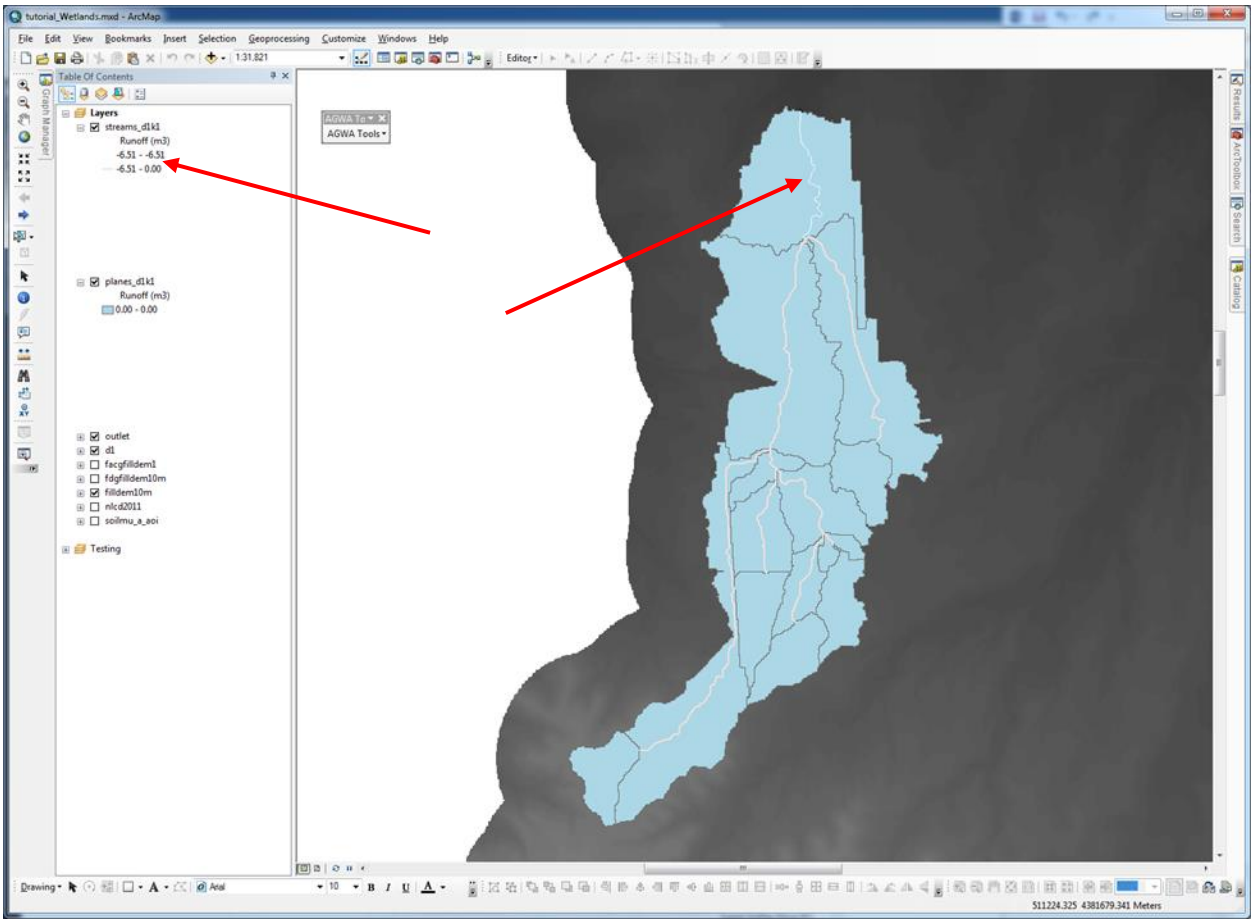
10.4.1.2. ***Simulation***: **2011_10yr1hr-2011_10yr1hr_div**

10.4.1.3. ***Units:*** **Metric** (Note: since you are viewing percent difference, unit selection is arbitrary)

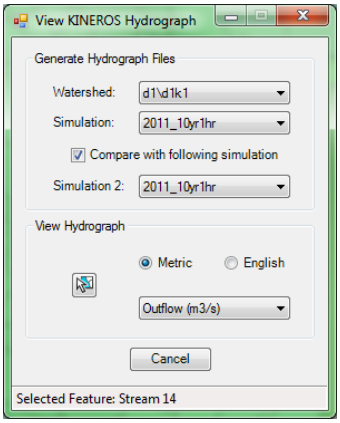
10.4.1.4. ***Output***: **Runoff (m^3)**

10.5. Click the ***Close*** button and proceed to the next step to view the outlet hydrographs.

The differences results should appear similar to the figure below. Change will only be visible in the outlet channel, but it is small so may not be obvious.



11. View and compare hydrographs for two simulations by selecting ***AGWA Tools > View Results > KINEROS Results > View Hydrograph***.



11.1. ***Generate Hydrograph Files*** box:

11.1.1. ***Watershed***: **d1\d1k1**

11.1.2. ***Simulation***: **2011_10yr1hr**

11.1.3. Check the **Compare with following simulation** checkbox.

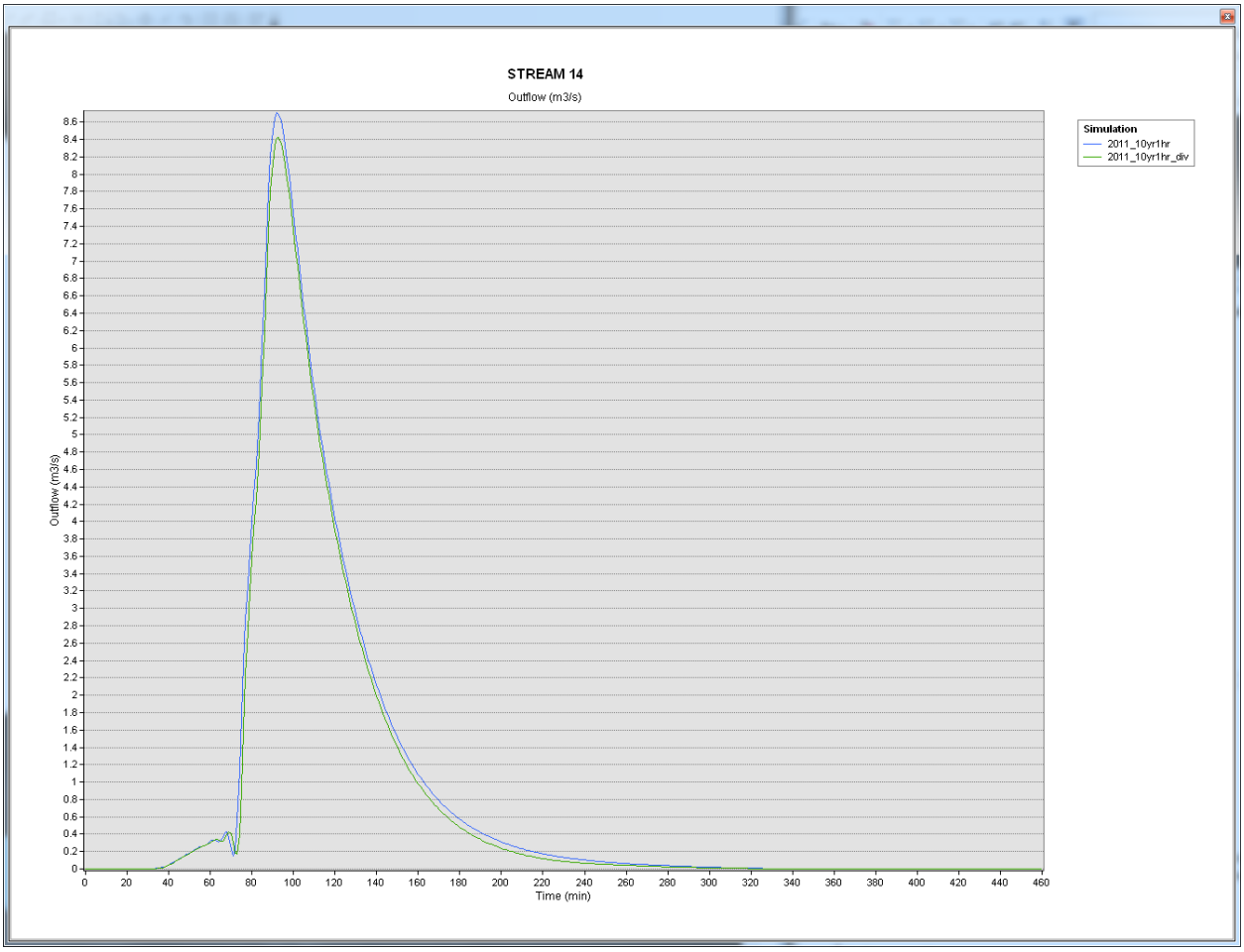
11.1.4. ***Simulation 2***: **2011_10yr1hr_div**

11.2. View Hydrograph box:

11.2.1. Click the ***Select Feature*** button and draw a rectangle around the outlet channel.

11.3. Select ***Metric.***

11.4. Select ***Outflow (m3/s)***. A graph will now open showing the hydrographs for both watershed configurations, with and without the wetlands.



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