

Lab 1: Landuse and Hydrology, learning ArcGIS

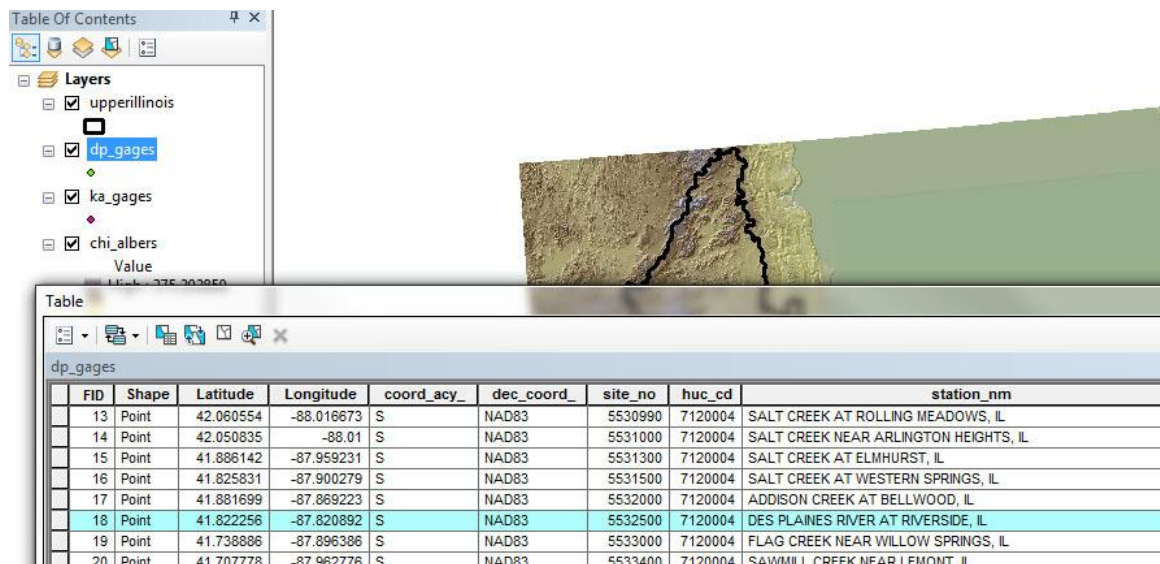
II. MANIPULATING DATA

As you experienced in the first lab session when you created a hillshade, high resolution data can be unwieldy if you are trying to perform complex operations. On the other hand, low resolution data may be insensitive to the geomorphological features you are interested in or may create interpolation artifacts.

The basin in which the Des Plaines and Kankakee River lay is too large to work with the DEM in its current resolution. So, we are going to resample this data before we use the Hydrology tools ArcMap provides. As we start quantitatively describing the basin, think about which characteristics of the basin are/aren't well-captured at low-resolution.

As a class:

1. Start ArcMap through MyApps and open your arc project from your M:drive
2. Open the attribute table for dp gages by right clicking on it in the layer list
3. Select gage #5532500 by clicking in the grey box to the left of the row



The screenshot shows the ArcMap interface. On the left, the 'Table of Contents' window displays a list of layers: 'upperillinois', 'dp_gages', 'ka_gages', and 'chi_albers'. The 'dp_gages' layer is selected. In the foreground, the 'Table' window is open, displaying the attribute table for the 'dp_gages' layer. The table has the following columns: FID, Shape, Latitude, Longitude, coord_acy_, dec_coord_, site_no, huc_cd, and station_nm. Row 18 is highlighted in blue, indicating it is the selected record.

FID	Shape	Latitude	Longitude	coord_acy_	dec_coord_	site_no	huc_cd	station_nm
13	Point	42.060554	-88.016673	S	NAD83	5530990	7120004	SALT CREEK AT ROLLING MEADOWS, IL
14	Point	42.050835	-88.01	S	NAD83	5531000	7120004	SALT CREEK NEAR ARLINGTON HEIGHTS, IL
15	Point	41.886142	-87.959231	S	NAD83	5531300	7120004	SALT CREEK AT ELMHURST, IL
16	Point	41.825831	-87.900279	S	NAD83	5531500	7120004	SALT CREEK AT WESTERN SPRINGS, IL
17	Point	41.881699	-87.869223	S	NAD83	5532000	7120004	ADDISON CREEK AT BELLWOOD, IL
18	Point	41.822256	-87.820892	S	NAD83	5532500	7120004	DES PLAINES RIVER AT RIVERSIDE, IL
19	Point	41.738886	-87.896386	S	NAD83	5533000	7120004	FLAG CREEK NEAR WILLOW SPRINGS, IL
20	Point	41.707778	-87.962776	S	NAD83	5533400	7120004	SAWMILL CREEK NEAR LEMONT, IL

3. Close the attribute table and notice how it highlighted the gage you selected on the map

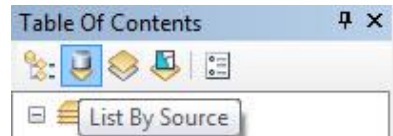
On your own:

4. Select Gage # 5515500 in the Kankakee River basin

These are the two gages we will be using for this case study. So let's bring in the actual data. As a class:

5. Add the data by using the Add Data button.
The input table is:

project1\arcmap\gages\dp_5532500.csv
 The Table of Contents view will automatically switch from 'List by Draw Order' to 'List by Source' since the data are not yet recognized as a spatial data layer.



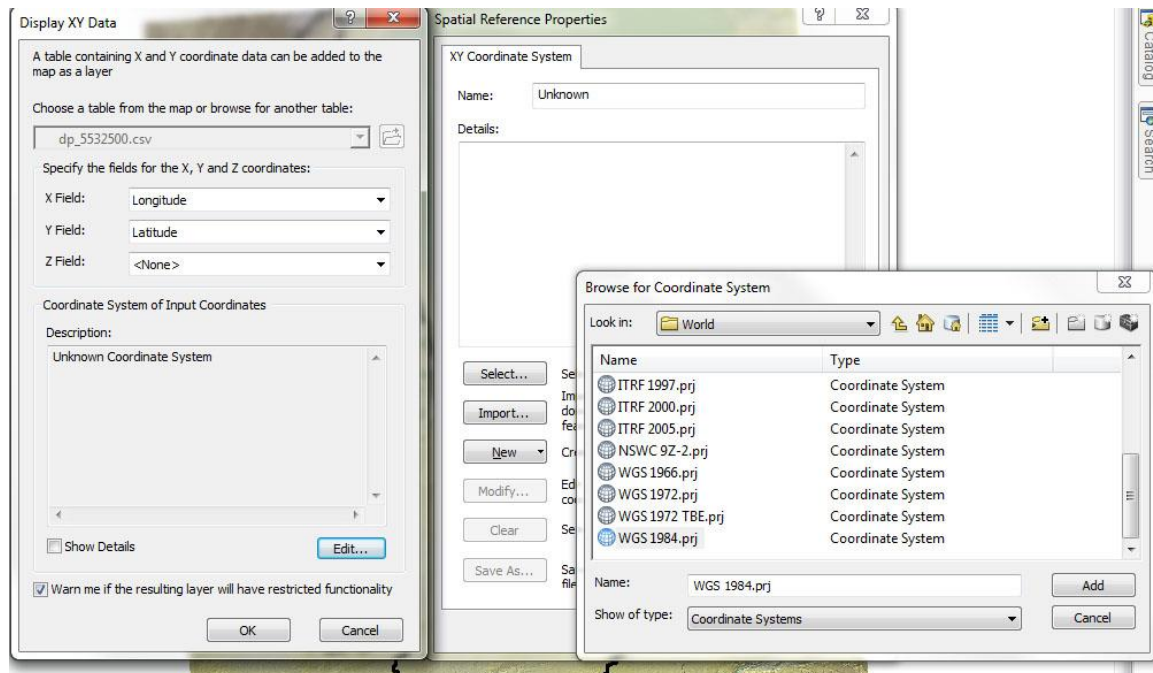
Right-click on the data table and select 'Add XY data'
 Arc will automatically find the appropriate x,y fields (Longitude, Latitude)
 But you do need to select a projection by:

clicking on the edit button

clicking on the select button in the new dialog box

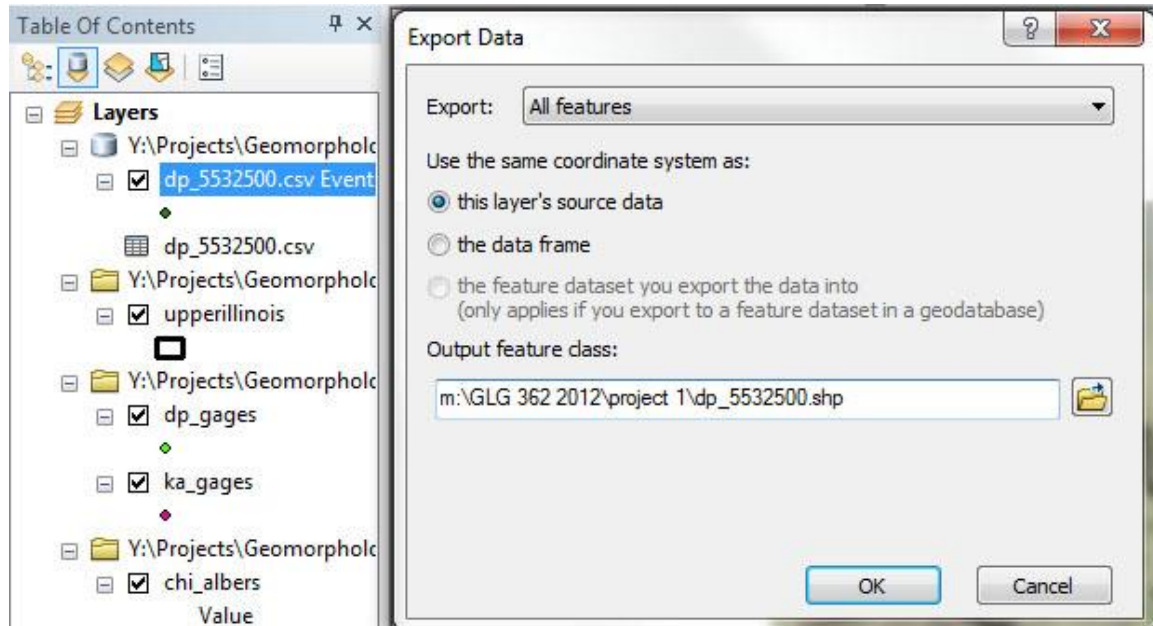
selecting Geographic >> World >> WGS 1984

close out each dialog box by confirming the selection



The point will be added to your project as an Event layer, separate from the data table.

6. Turn this new data into an Arc layer by right clicking on *dp_5532500.csv* Events and selecting *Data >> Export Data* and saving it as a shapefile. Make sure you name the output and save it to your M:drive.



On your own:

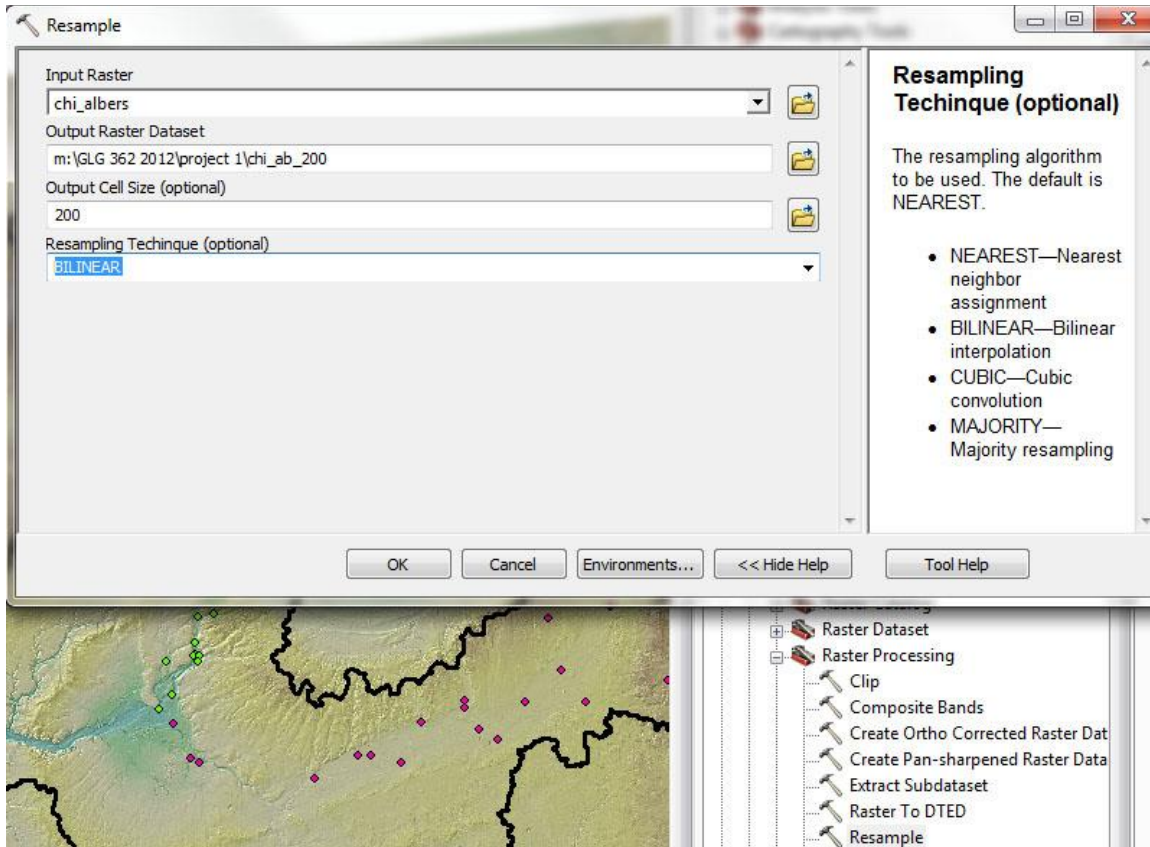
7. Repeat steps 5 & 6 for the Kankakee River gage (*ka_5515500.csv*): Add the xy data and save it as a shapefile

These are the two gages we will be comparing to see if landcover change has altered the hydrology of the basins. As you wait for the computer to execute the following steps, ponder the following question:

- Do you think these gages comparable enough to make fair comparison of landcover change? How could you tell?
- How can we use the topographic data to assess this question?

Now we need to prep the elevation data so that we can extract useful information about our watersheds from it. For the next set of steps, save all of your new grids on the M:\ drive. The first grid we will create is a resampled dem at a lower resolution. This is necessary because the following steps are computationally demanding and would take too long at the current 30 meter resolution. As a class:

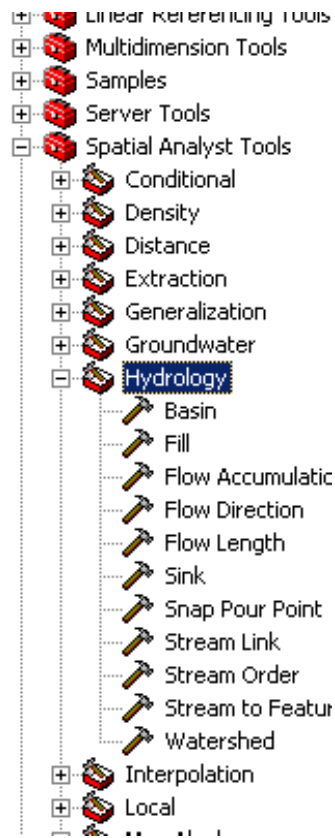
8. *Resample the elevation grid to 200 meters using a bilinear technique...in the ArcToolbox double click on Data Management Tools/Raster/Raster Processing/Resample*



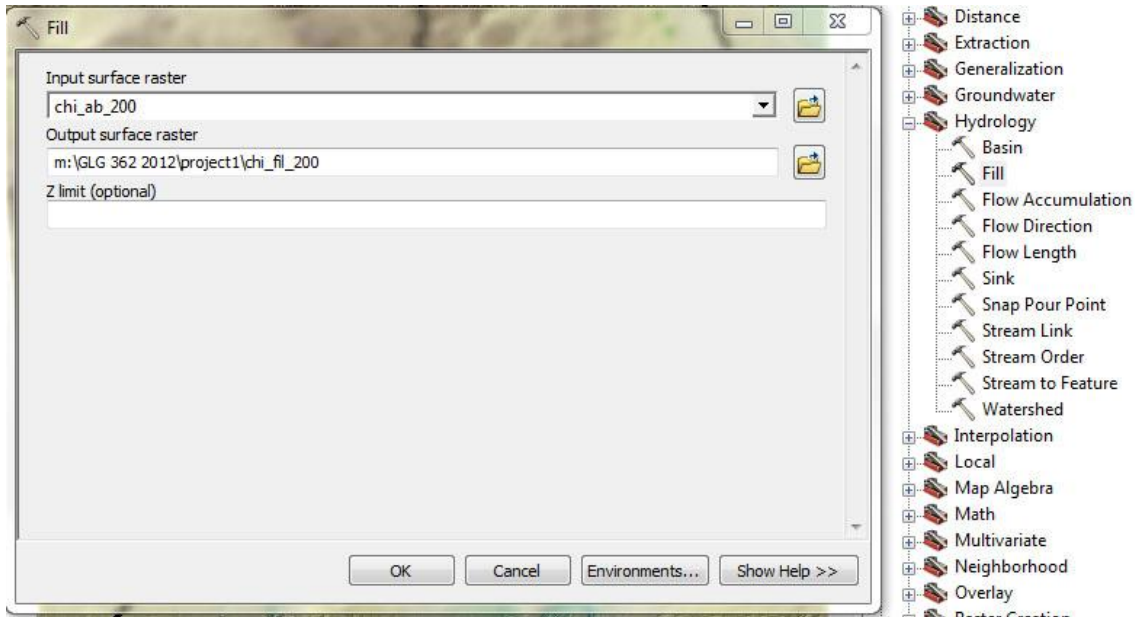
Be sure to change Resampling Technique to BILINEAR.

The next set of operations can each be found in the Hydrology toolbox and can take some time to execute so BE PATIENT. The goal of these steps is to model the way in which water interacts with the land surface. We will be using the basic principle that water flows downhill to create a channel network and watershed boundaries from our resampled DEM. On your own, see if you can build a channel network and gage specific watershed boundaries:

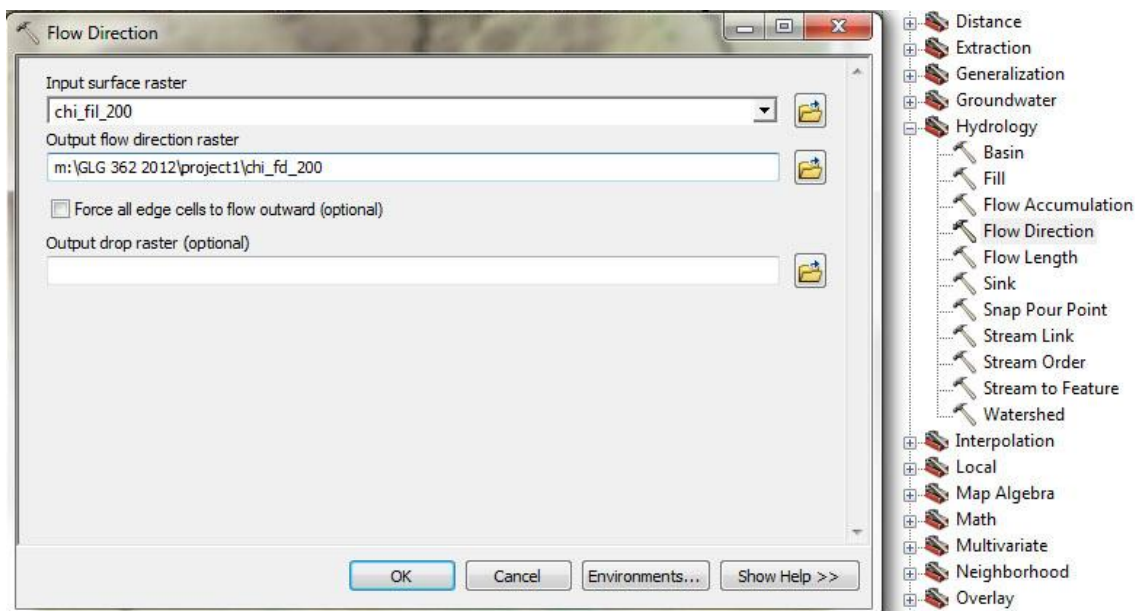
9. Find the hydrology toolbox...under ArcToolbox/ Spatial Analyst Tools/ Hydrology



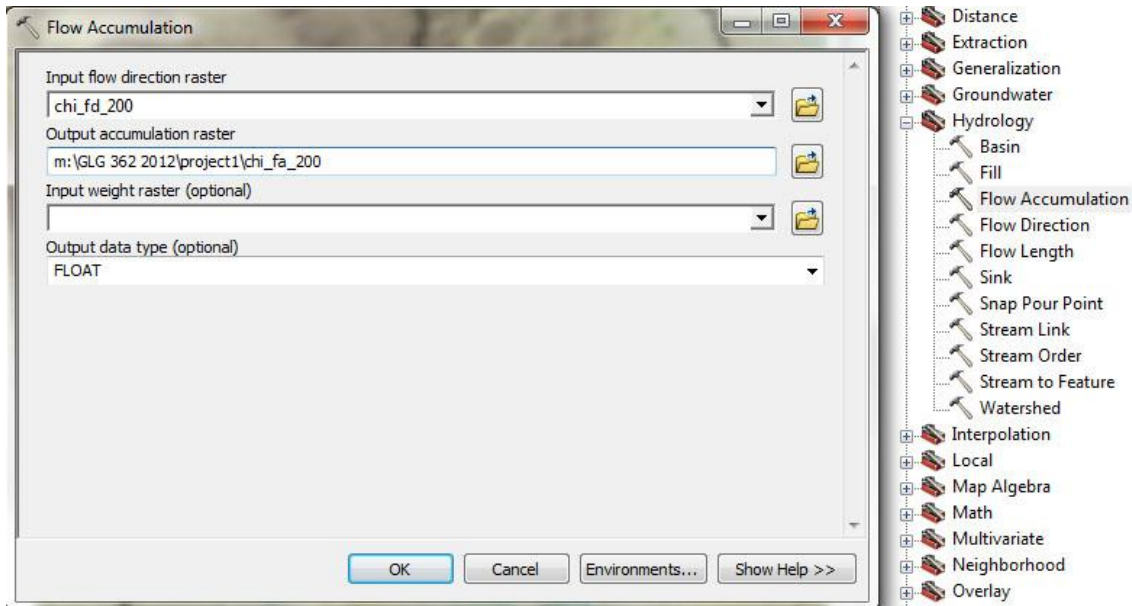
10. *Fill the 200 m DEM:* In order to create a cohesive channel network we have to fill all the internal sinks in the DEM. These “sinks” may be naturally occurring basins or relics of the low resolution DEM we are using. Not filling them would prevent us from creating a continuously flowing channel across the landscape.



11. *Create a Flow Direction grid using your filled DEM as an input:* The flow direction grid operates on the principle that water flows downhill. Each pixel in our filled DEM will flow into a neighboring pixel by following the steepest gradient. The flow direction grid defines the direction that each pixel drains; each of the eight colors represented on the grid represents one of the eight possible flow paths available to each pixel.

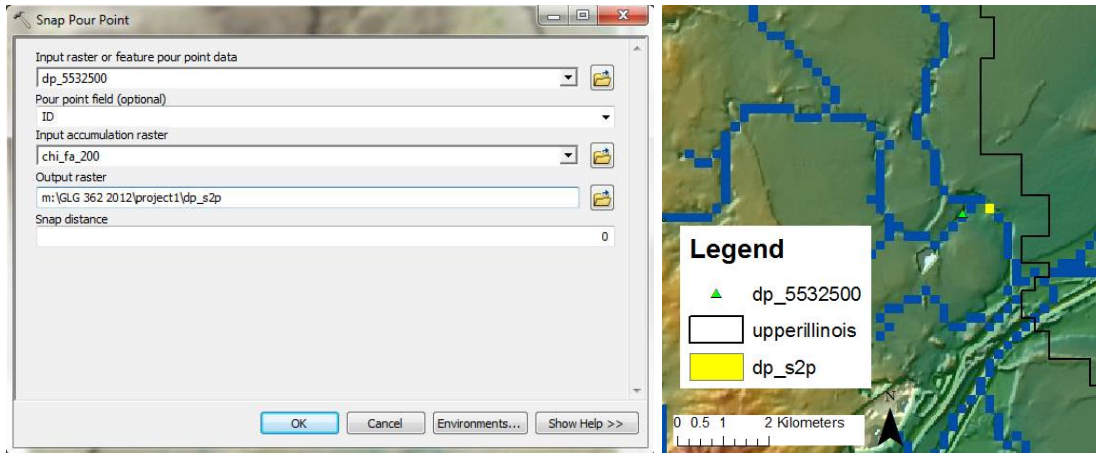


12. Create a Flow Accumulation grid using your Flow Direction grid as an input: The flow accumulation grid assigns a value to each pixel which represents the total number of pixels that drain into the pixel in question from upstream. This step will take upwards of five minutes to execute depending on busy the server is.



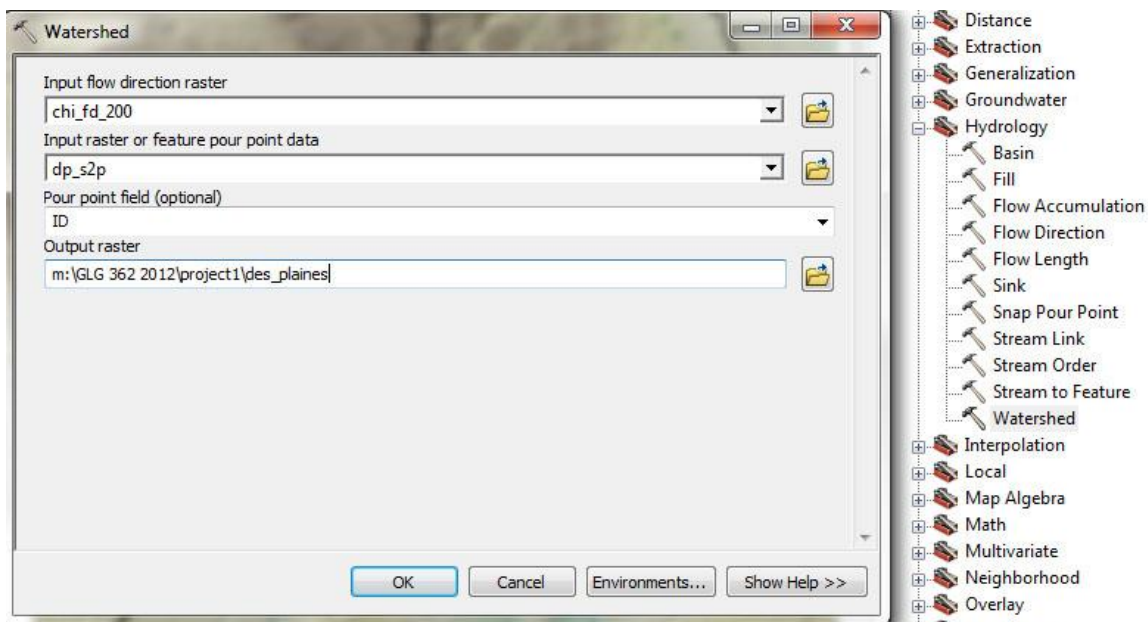
In order to determine the drainage characteristics of our selected gages we need to determine the watershed boundaries flowing through each gage. Our resampling may make our gage locations to be slightly off of the main channel. So first we will snap those locations to the flow accumulation grid, and then use the flow direction grid to delineate a watershed boundary. Let's do it with the Des Plaines River gage first. As a class:

13. *Snap Pour Point*: This tool will relocate your gage to correspond to the drainage network we just modeled. ArcMap will automatically find the largest channel within a user defined radius of the gage location. Use the measure tool (?/ruler icon) to estimate the snap distance needed to place the gage at the desired location.



If you use too large a snap distance, the gage may snap to the wrong channel. If this happens, redo the process.

14. *Create Watershed grid*



Now do the same thing for the Kankakee River. On your own:

- 15. Create a watershed boundary of the selected gage in the Kankakee River

Now lets have a first look at the discharge hydrographs of these two gages.

- 16. Plot the data for the two gages (*dp_5532500.cvs* & *ka_5515500.cvs* in the gages folder on the Q:drive) in excel to compare their responses. In Excel you can either open the source cvs files OR you can always open the dbf table associated with any shapefile, but save to a new file name/extension before making any changes (open *dp_5532500.dbf*). These data files contain no units but the values are peak daily discharge expressed in cubic feet per second (cfs). The data is expressed daily over the course of one year (2001). Put both hydrographs on the same plot for ease of comparison. What differences do you see in the hydrologic responses of these two basins? What could be the cause? Ponder this between this lab and next, and during lecture next week.

Finally, for this week’s deliverable, use the layer properties, attribute tables and the measure tool to fill out the table below. We will go over strategies to do this during the lab session (also see brief notes below the table).

Table: Summary statistics for two watersheds

	AREA	LENGTH/WIDTH RATIO	THRESHOLD AREA (A_T) USED	“DRAINAGE DENSITY”*	RELIEF
Des Plaines					
Kankakee					

* at the scale of our analysis (very large A_T) we are really measuring differences in network structure – we can’t measure actual drainage density this way

HINTS FOR FILLING OUT TABLE 1 (*Deliverable for this Lab*):

Always Specify UNITS for all numbers you report.

Area:

Right click on your watershed layers for the Des Plaines and Kankakee and open the Attribute table. The “count” reveals the number of pixels your watershed encompasses. Using this resolution and your DEM resolution you can calculate a watershed area.

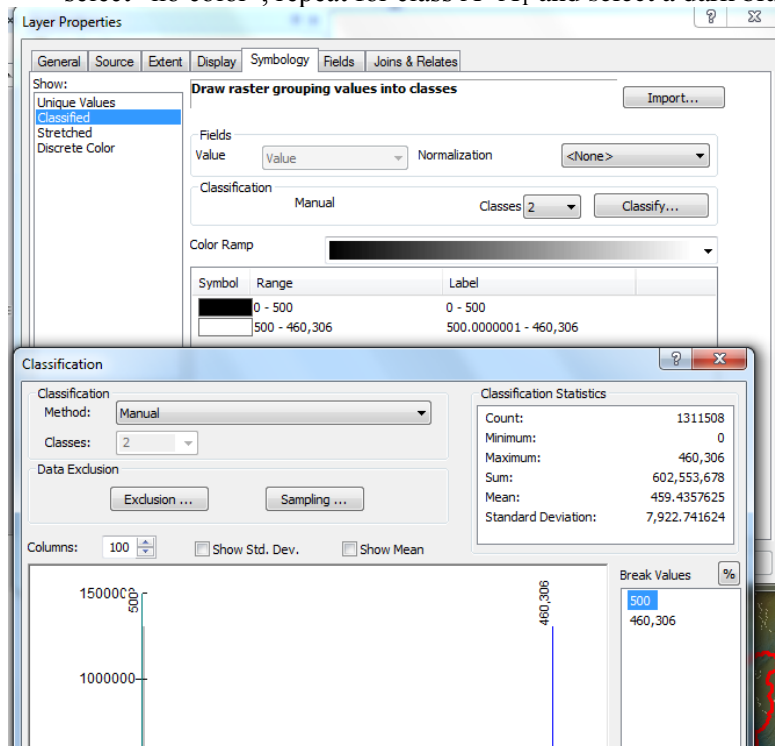
Length/With Ratio:

Use the measure tool to estimate the length to width ratio for each watershed.

 A_T Used:

To calculate Drainage Density we must first define a threshold area, A_T , which defines how much of the channel network to display. We will discuss this concept further in class. To define a threshold area for displaying the channel network:

- 1) Right click on your flow accumulation layer and go to Properties >> Symbology
- 2) Select “Classified” on the menu to the left
- 3) Under classification, designate 2 classes (default is 5) and click “classify”
- 4) Set your threshold area by changing the top “break value.” Remember, this is area in pixels so you must know your grids resolution in order to calculate A_T in square meters.
- 5) In Symbology dialog, double click the color for the classification $A < A_T$ and select “no color”, repeat for class $A > A_T$ and select a dark blue.

**“Drainage Density”:**

Measure the length of the channels in each watershed using the measure tool and divide your channel length by your area. *Note: at the scale of our analysis (very large A_T) we are really measuring differences in network structure – we can't measure actual drainage density this way.*

Relief:

Use the identify tool (icon: an “i” in a circle) and your DEM to estimate the relief of the watershed. Remember, relief is the range in elevation (max – min) within a defined area, which in this case is your watershed. Click on your map with the identify tool to bring up the identify dialog box. The drop-down menu at the top allows you to select which layers to query for attributes (select your full-resolution dem, chi_albers).