

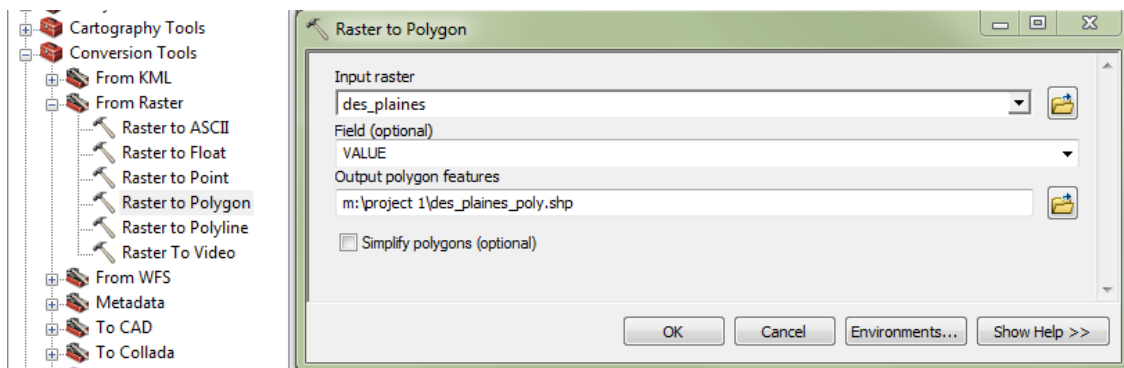
## ***Lab 1: Landuse and Hydrology, learning ArcGIS***

### **III. GRID CALCULATIONS**

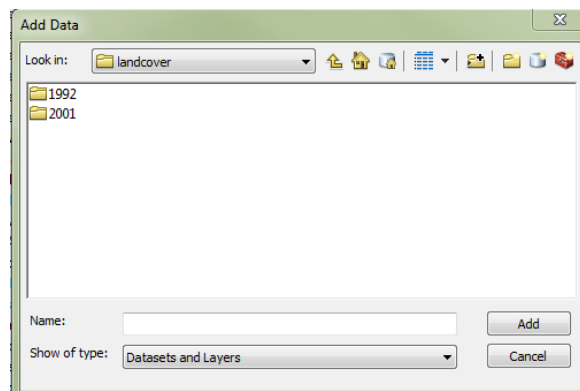
By now you have built proficiency in the basic operations of working with grids and shapefiles. Today, you will be developing a slightly more advanced skill—quantitatively comparing grid values. In these kinds of tasks, it is important to keep in mind the spatial resolution and projections of the different data sources before doing complex grid calculations. However, the two landcover datasets from the USGS that we are using are at the same spatial resolution and projection, making them easier to compare.

On your own:

1. *Start ArcMap and open your arc project saved from last time*
2. *Convert both watershed grids into shapefiles (or polygons)...under ArcToolbox >> Data Conversion Tools >> From Raster >> Raster to Polygon. Once you have converted your watersheds to shapefiles you now have the ability to make the fill invisible and choose a separate color for the watershed outline.*



3. *Add the 1992 (00875048) and the 2001 (66309504) landcover data to the map from the C:\geomorphology folder (or wherever you saved the source data)*

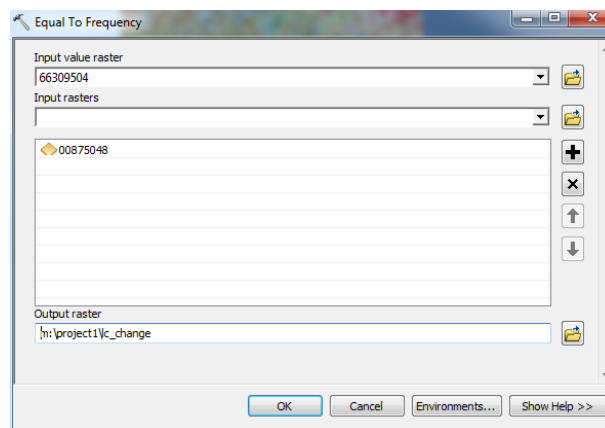


You are about to perform mathematical operations using multiple grids. Unfortunately, the landcover classification scheme for 1992 and 2001 are not identical. Not only have the datasets been processed differently, but they have

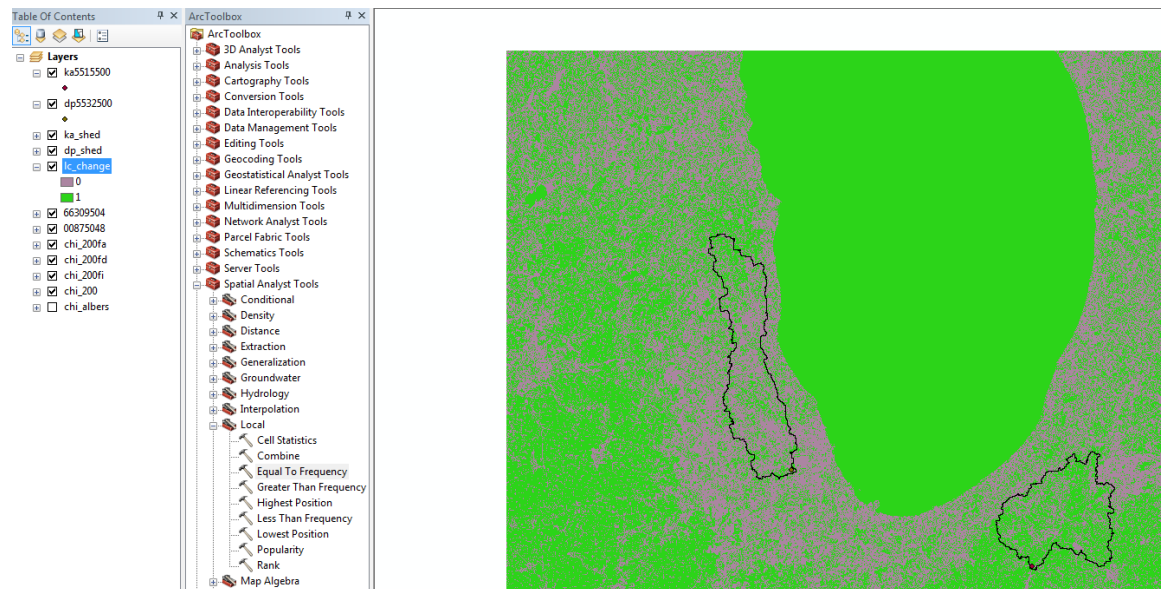
been classified differently as well. This warrants caution in doing a comparison. However, I want you to get practice doing these kinds of grid operations, and you will find the slight offset in the classification scheme will not dramatically affect the results. We will use two methods.

4. *As a first method, compare these two landcover datasets by finding where the two grids are equal to each other...under ArcToolbox >> Spatial Analyst >> Local >> Equal To Frequency.*

*Your **Input value raster** can be either one of the two landcover grids as long as you select the other one as an **Input raster**. Make sure to save the output under a name you will be able to remember:*

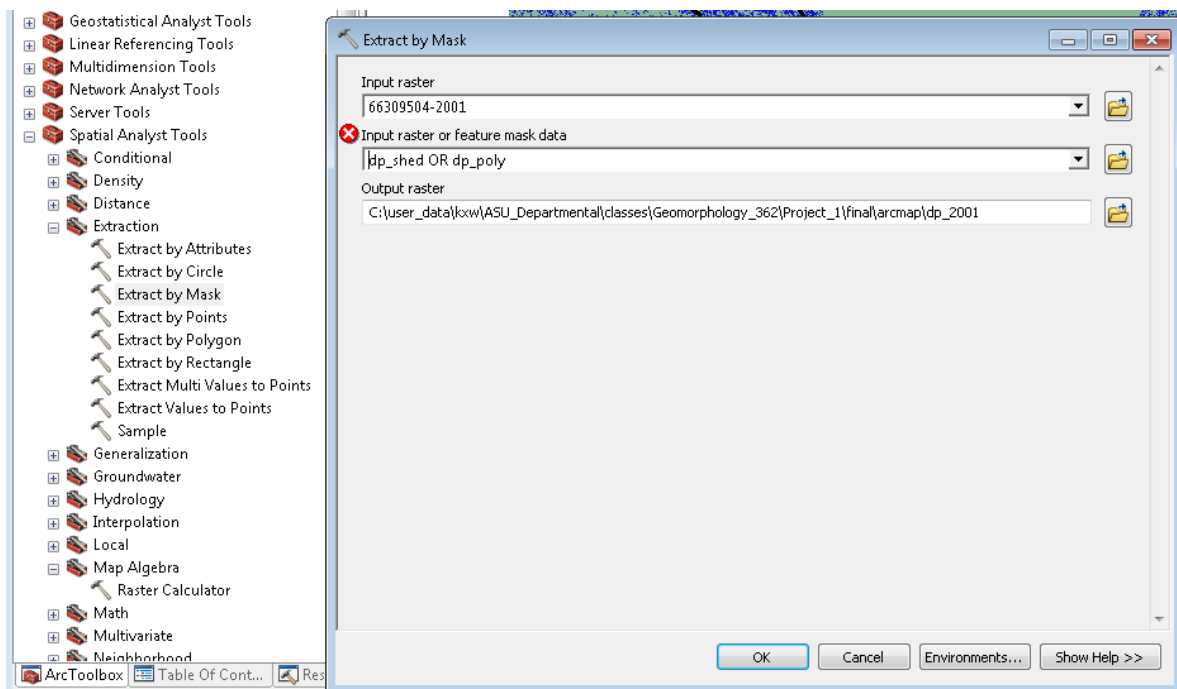


This should produce a grid of zeros (where the two landcover classifications do not match) and ones (where the two landcover classifications do match). It should look something like this:

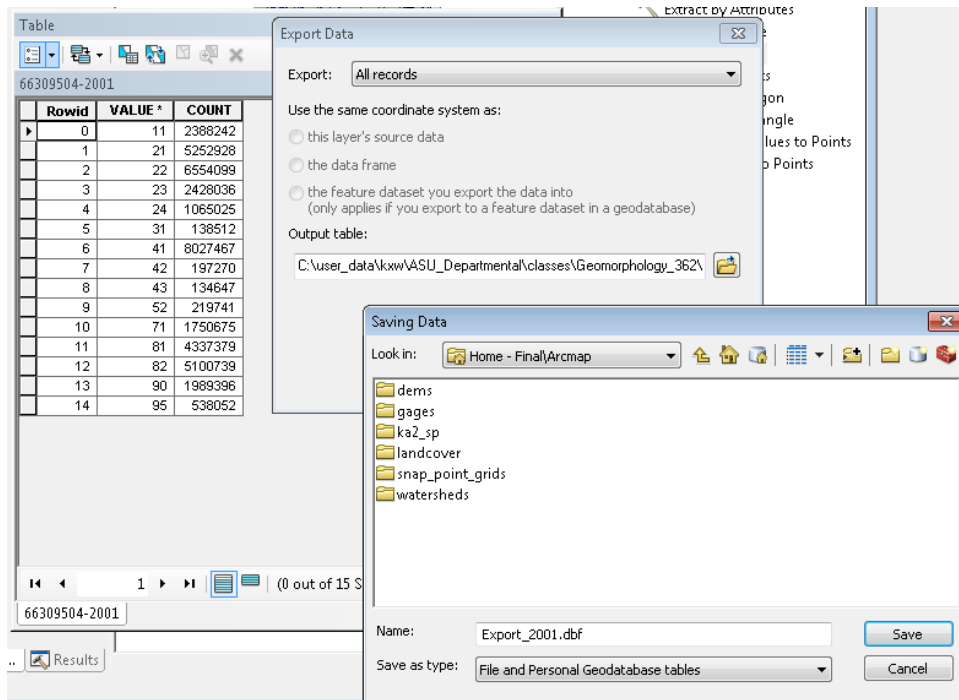


These results give us a first estimate about change, but they don't tell us about the surface is actually being classified. So let's go back to the 2001 data to look at the proportions of landcover classes in the two watersheds.

5. *Go back to the 2001 data and extract the data within each watershed. To do this, you will create a new layer for just the area within the Des Plaines (and then the Kankakee) watershed...under ArcToolbox >> Spatial Analyst Tools >> Extraction >> Extract by Mask.*
6. *Your **Input raster** should be the 2001 landuse (66309504). And the **feature mask data** is your watershed boundary layer (you may use either the watershed layer you made in step2 or the watershed raster from lab1b).*



7. *Right click the layer in the layer list to use the attribute table and the chart below to find the proportion of different landcover types in the basin. Classify each different landcover description as urban, agriculture, forest or wetland (use your judgment here) to fill out the table at the end of the lab. You are also welcome to create your own classification scheme or include an "other" column. **Now that you've seen this key, think about you could modify the change detection analysis that we did above to make it better.***
8. *To efficiently analyze the attribute table data, you can export to excel so you can easily compute percentages of each class (and of change data later). Select Export from the attribute table "Table Options" pull down menu, export all records as a dbf file. Dbf files can be opened in excel (note this is handy since attribute tables of all shapefiles are already dbf files).*

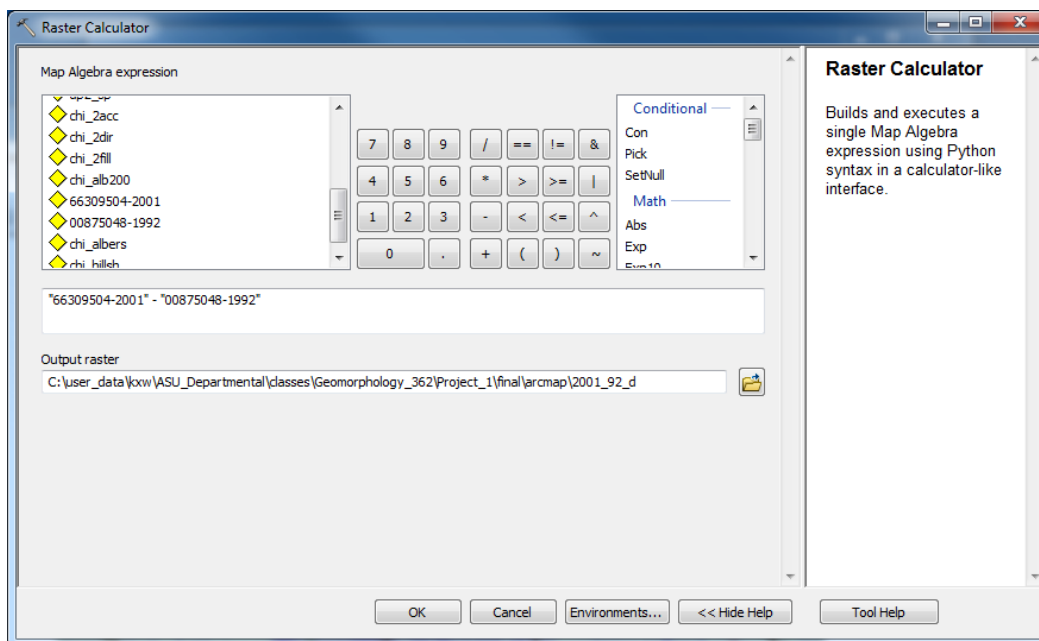


NLCD 1992 Class Code	NLCD 1992 Description	NLCD 2001 Class Code	NLCD 2001 Description	Modified Anderson Level I
11	Open Water	11	Open Water	1
12	Perennial Ice, Snow	12	Perennial Ice, Snow	8
85	Urban, Recreational Grasses	21	Developed, Open Space	2
21	Low Intensity Residential	22	Developed, Low Intensity	2
22	High Intensity Residential	23	Developed, Medium Intensity	2
23	Commercial, Industrial, Trans.	24	Developed, High Intensity	2
31	Bare Rock, Sand	31	Barren Land, Rock, Sand, Clay	3
		32	Unconsolidated Shore*	3
32	Quarry, Strip Mine, Gravel Pit	31	Barren Land, Rock, Sand, Clay	3
33	Transitional Barren	31	Barren Land, Rock, Sand, Clay	3
33	Transitional Barren	31	Barren Land, Rock, Sand, Clay	3
41	Deciduous Forest	41	Deciduous Forest	4
42	Evergreen Forest	42	Evergreen Forest	4
43	Mixed Forest	43	Mixed Forest	4
		51	Dwarf Scrub**	8
51	Shrubland	52	Shrub, Scrub	5
61	Orchards, Vineyards, Other			6
71	Grasslands, Herbaceous	71	Grassland, Herbaceous	5
		72	Sedge, Herbaceous**	8
		73	Lichens**	8
		74	Moss**	8
81	Pasture, Hay	81	Pasture, Hay	6
82	Row Crops	82	Cultivated Crops	6
83	Small Grains	82	Cultivated Crops	6
84	Fallow	82	Cultivated Crops	6
85	Urban, Recreational Grasses	21	Developed, Open Space	2
91	Woody Wetlands	90	Woody Wetlands	7
92	Emergent, Herbaceous Wetland	95	Emergent Herbaceous Wetlands	7

OK, lets learn another way to manipulate grid (raster) data in ArcGIS to do a little better to quantify % change in landuse despite the frustrating change in the classification scheme used between 1992 and 2001 (note: changing classification schemes defeats much of the purpose of this kind of data, so when it becomes necessary, every effort should be made to either retain “legacy” classifications as well in new data, or revise old data to update them into the new classification scheme).

9. *Navigate to ArcToolbox >> Spatial Analyst Tools >> Map Algebra >> Raster Calculator. Use this to evaluate the expression of differencing the 2001 and 1992 data. This will be useful to more accurately determine the total amount of landcover change that occurred between 1992 and 2001.*

**NOTE: output Raster name MUST begin with a letter: dif\_01\_92 works.**

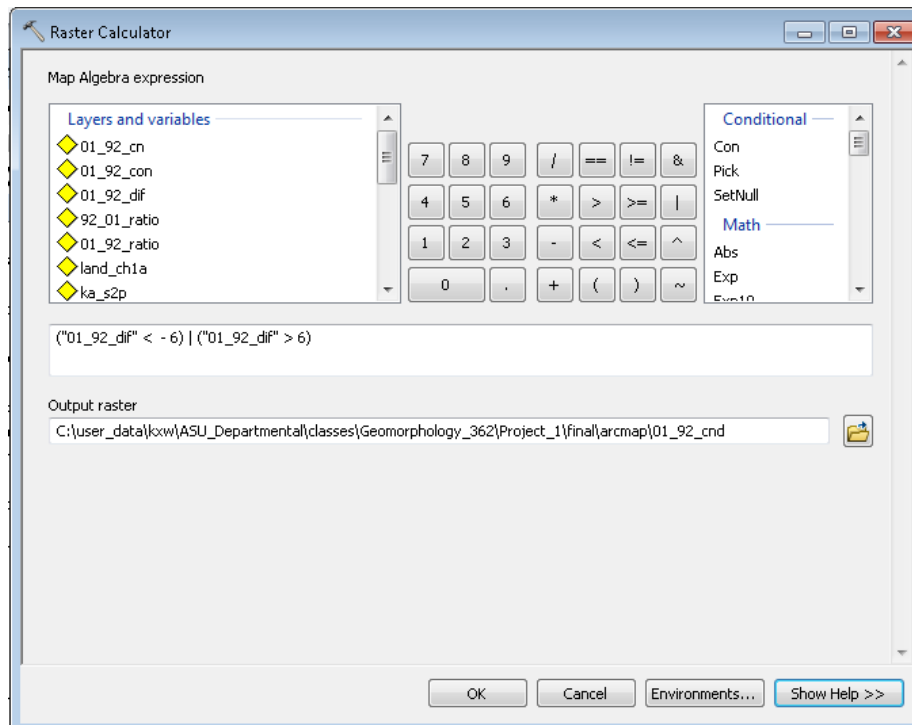


10. *Right click on the difference grid (01\_92\_dif in examples below) you just created and open the attribute table. Each value represents a possible solution to subtracting the value of a particular pixel from the 1992 landcover grid from the same pixel from the 2001 landcover grid. Since significant landuse changes (not just classification changes) will yield differences >5, we can use the number of pixels with values either <-5 or >5 to record the amount of landuse change (with one minor exception). You can view which pixels did not change at all by selecting the row for VALUE = 0, these will highlight on the screen in cyan (this is the same as the answer obtained in Step 4, a large but incomplete fraction of the pixels with no change in landuse).*

Rowid	VALUE	COUNT
49	-9	169558
50	-8	17431
51	-7	1591
52	-4	52261
53	-3	40399
54	-2	299335
55	-1	3114411
56	0	75870151
57	1	8196887
58	2	483568
59	3	149259
60	4	79331
61	5	3588
62	7	134
63	8	266305
64	9	81152
65	10	84789
66	11	344505
67	12	24345
68	13	222024
69	14	47877
70	18	28547
71	19	24852

11. You can use the Raster Calculator again to find all cells with values  $< -6$  OR  $> 6$  (areas of landuse change) within the each watershed (Des Plaines and Kankakee). NOTE: you must include the parentheses and the vertical bar is the boolean operator “OR”:

**NOTE: output Raster name MUST begin with a letter: cnd\_01\_92 works.**



12. Repeat steps 5 and 6 to extract the resulting data for each watershed alone.

You will now have 2 grids extracted for each watershed: 2001 landcover (DP and KA) and 2001-1992 landuse change (DP and KA).

*13. Right click on the conditional layer you just extracted for the Des Plaines watershed (01\_92\_dp for example) in the layer list (or Table of Contents) to open the attribute table to find the number of pixels with landuse change (VALUE = 1). Now you can calculate the % change from 1992 to 2001 for the table on page 5 of this guide. This is most easily done if you Export the Attribute Table to a dbf file and open it in excel (see Step 8). Remember you can convert this number to an area as well (using grid size in  $m^2$ /pixel).*

Use the attribute tables to help you fill out the table on the next page. We will go over strategies to do this during class:

**NOTE: Only the FIRST column of the Table below is about changes from 1992 to 2001.** The other columns are asking about landcover characteristics in 2001 (nothing to do with the change analysis – here we are interested only in conditions in 2001 to compare to the 2001 flow hydrographs).

**Table: Summary statistics for two watersheds (or “basins” or “catchments”)**

	% CHANGE 1992-2001	% AGRICULTURE 2001	% FOREST 2001	% WETLAND 2001	% URBAN 2001
<b>Des Plaines</b>					
<b>Kankakee</b>					

14. Plot the data for the two gages (dp\_5532500.cvs & ka\_5515500.cvs in the gages folder) 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 (e.g., open dp\_5532500.dbf and save as “des\_planes\_hydrograph.xls”). 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 water year (October 1, 2000 to Sept 30, 2001 – water year 2001). Put both hydrographs on the same plot for ease of comparison. Are there any important differences in the hydrographs between the two catchments? Could landcover differences be important? What role might landcover change have played? How can you tell by looking at the hydrographs? Are there important differences in rainfall between these watersheds (in general or specifically in 2001)? [Search the web for the data you need to assess this last question].

**SEE next Page for Final Project Deliverables and Requirements**



## Final Report, Hydrology Lab

- 3 page text maximum, 2 page minimum (1.5 spaced, **figures excluded**)
- *Figures and Tables (include all in the report):*
  - Site map (Lab1A deliverable = good starting point – update with Kankakee, Des Plaines Watershed boundaries)
  - Table that include the summary statistics for the topography of the two watersheds (Lab 1B deliverable)
  - Table that includes the summary statistics for landcover change in the two watersheds (Lab 1C deliverable)
  - Hydrographs for both gages on one plot (Lab 1C deliverable)

***You have been encouraged to work in groups, but your final reports must be independent efforts. Each student should prepare final versions of figures and write their own report.***

You have already created a version of the site map and built the two tables during lab time. Once you have plotted the hydrographs, you are ready to make an interpretation of how landcover change has affected the hydrology of the upper Illinois basin. Discuss the results and the assumptions that this investigation has built upon. Focus more on results and interpretation than on methods. Avoid procedural details about how you did the lab and how ArcGIS works. Simply pick an aspect of the study that interests you, and for which you can support your interpretation with evidence from the GIS analysis.

Report should: (1) Motivate the problem; (2) Define your approach; (3) Use Figures and Tables with meaningful captions to efficiently present the results (Figs, Tables and Captions do not count against your 2 page limit); and (4) Discuss your findings, including any cautions about limitations/weaknesses in the analysis. Include appropriate discussion of what you learned in the landlab exercise about hydrograph shapes.

Have a friend read and critically assess your first draft and then refine and polish it. You will be graded in part on your writing.

Here are some things to think about as you frame your brief report:

1. How do these results support the idea that urbanized basins may escalate flood risk?
2. Do the Des Plaines and Kankakee basins provide a fair comparison for evaluating the impacts of landcover change? Why or why not?
3. Is the method used in this investigation robust? Can it apply to other landscapes? What are its weaknesses? How could you improve on it?

Feel free to focus on other aspects of this investigation if something has caught your interest. If you are unsure of its relevance, come talk to your instructor or TA. Remember that the quality of your discussion of these issues depends on how well you link your ideas to the tables and plots you have produced.