CE 394K/CEE6440 GIS in Water Resources Fall 2017

Final Exam

There are three questions on this exam. Do all three. For each of the first two questions, prepare a 2-page typed essay (2 pages x 2 essays = 4 pages total). For the third question use ArcGIS (and Excel/Word) to prepare the map and answers requested. *Combine solutions together in the order of the questions in a single PDF document*, and submit through the class Canvas website, by 11:59 PM on Friday, December 15.

This is a take-home exam. You are honor bound not to discuss this exam with your colleagues in the class. Your answers should be the result of your work and thought alone. Be assured that if essentially the same idea appears in answers from more than one person, it is fairly easy to recognize that when the grading is being done. If that happens, it is not clear from whom the idea originated and who is just using somebody else's knowledge. So, keep your ideas to yourself!

Questions 1 and 2 require you to read and synthesize information from term projects by other students in the class. The term papers that you choose to describe in answering Questions 1 and 2 should be mutually exclusive, that is, if you focus on particular term papers in answering one of the questions, don't focus on the same papers when answering the other question. The term projects can be found at:
Texas: http://www.caee.utexas.edu/prof/maidment/giswr2017/TermProject/TermProject.htm
Utah: http://hydrology.usu.edu/dtarb/giswr/2017/students.html

You are encouraged to look at term projects from all locations in preparing your answers since this will give you a greater body of information to speak from.

What we are looking for in grading your answers to this question is:

- **Knowledge of the facts.** Make sure you lay out the facts of what has actually been done before you start offering opinions about what could have or should have been done. Make sure you discuss what was actually done in the term papers not just about the general subject itself.
- **Thoughtful evaluation.** How do you evaluate the advantages and limitations of the principles, methods and data that have been used? How does the knowledge you've learned in this class relate to the world around us? I am looking for a sense of reflection here, of seeing you set individual situations and facts in a larger context in an intelligent way.
- **Effective use of Maps.** Identify specific maps from these projects that you think are effective and explain why they are effective.

In your answers, you must refer specifically to work presented in term papers prepared in this course this semester. In other words, I am not looking here just for a general statement about your opinions in the field but rather a deduction based on the term papers presented in this class of what has been done and how you judge the effectiveness of that.

Questions

1. Compare and contrast two papers dealing with the same theme

Choose two term papers that deal with the same or similar themes or topics. Neither of these papers should be your own term paper. The papers that you choose may be from any of the participating universities. Briefly summarize the contents of the papers (the problem examined, the method of analysis, the results achieved). Compare and contrast the approaches to the problem that the two papers took. Which technical approach do you think was more effective? Why? Which paper does a more effective job of communicating its results? Why? Suppose you were undertaking a study of this same subject. Having studied these two papers, what have you learned about how to go about your investigation effectively? What would you do differently from what the authors of these papers did?

2. Write an assessment of the utility of GIS in a particular subject area

Student term papers on a range of topics have been presented. Select four papers that fall within a similar subject area and present a critique of how effective GIS is in its application in this subject area. What is the scope of the subject area? How has GIS been used? What types of problems have been solved effectively? What limitations exist that have yet to be overcome in the application of GIS in this area? You are encouraged to look at and use papers from both Utah and Texas where they address similar subject areas.

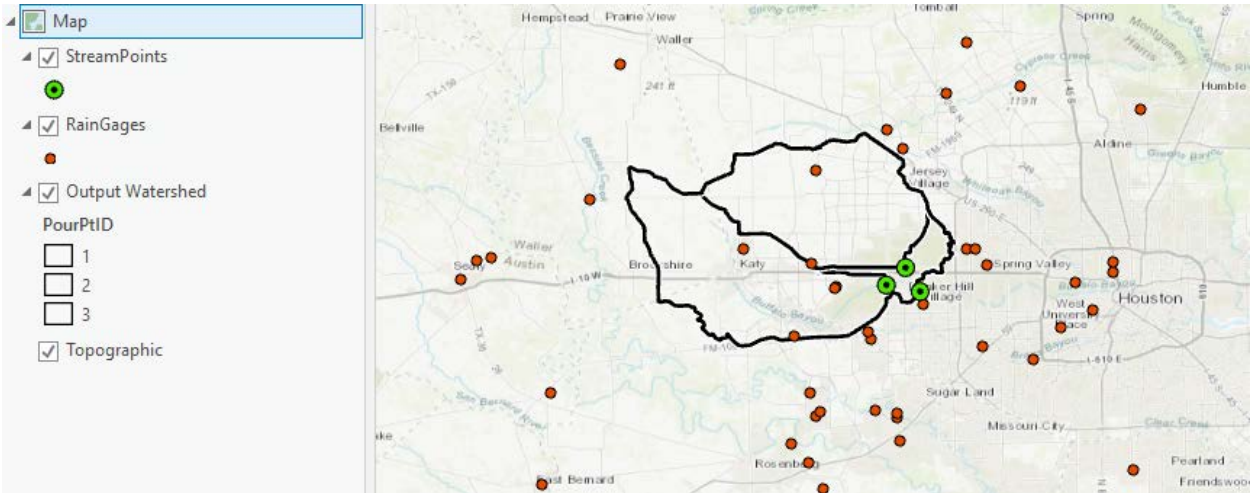
3. GIS Analysis of Hurricane Harvey

The following data relating to Houston and Hurricane Harvey has been assembled and provided to you in the zip file http://hydrology.usu.edu/dtarb/giswr/2017/GISWRFinal2017.zip.

Files included are

- HarveyRainfall.csv. This gives rainfall in inches for each of the 5 days involved, and a total.
- Sites.csv. This gives locations of the Buffalo Bayou near Addicks USGS gage 08073500, and outlets of two flood control reservoirs, Barker Reservoir and Addicks Reservoir. Latitude and longitude use the NAD 1983 Datum.
- BuffaloFlow.xlsx. This gives Discharge measured at the Buffalo Bayou near Addicks USGS gage.

The Figure below illustrates this data. The watersheds draining to the Buffalo Bayou stream gage and the outlets of the two reservoirs are shown.



Questions

1. **Watershed map.** Delineate the watersheds draining to each of the sites given and prepare a watershed map. Include NHDPlus streams within Buffalo Bayou watershed on this map. Determine the area of each watershed and report this in both Square Kilometers and Acres. (There are 247.1 acres in a square kilometer)

2. **Landcover.** Prepare a map showing land cover in these watersheds. Obtain Land Cover data from the National Map as you did for Exercise 2. Determine the area (in km^2) and percentage of each watershed that is Developed as represented by one of the NLCD classes 22, 23, 24 representing respectively Developed - Low Intensity, Developed - Medium Intensity and Developed - High Intensity. Which watershed has the highest percentage of developed area? [Hint: You do not need to do the reclassification that was done in Exercise 2 to get your answer. It is simpler and sufficient to use tables exported and analyzed in Excel].

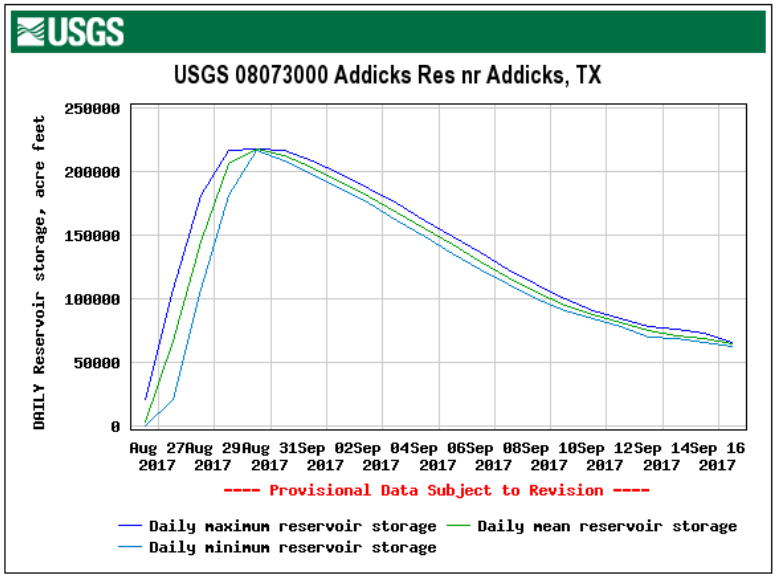
3. **Rainfall.** Prepare a map showing the location of each of the rain gages. Include the Buffalo Bayou watershed on this map. Label each rain gauge with its 5-day total rainfall in inches and use symbol size to depict the variability of rainfall across this area. Report the gage and rainfall total for the gages with maximum and minimum rainfall totals within the Buffalo Bayou watershed.

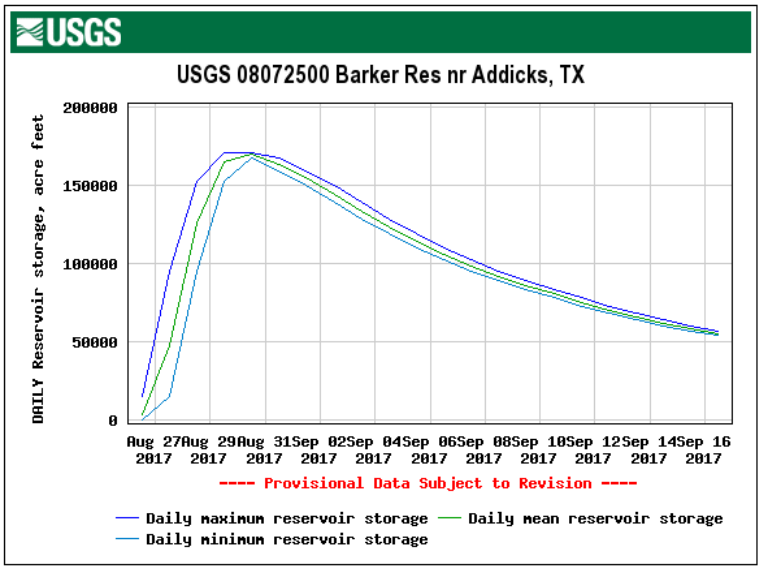
4. **Basin Rainfall Volume**. Use one of the rainfall area averaging methods you have learned to determine the Buffalo Bayou area average rainfall for each of the 5 days of data and the total for all 5 days of Hurricane Harvey data given. Prepare a graph giving the Buffalo Bayou area average rainfall for each day in inches. Determine the 5-day total rainfall in inches and in acre-feet (i.e. the volume over the watershed area).

5. **Hydrologic analysis.** The file BuffaloFlow.xlsx gives the daily discharge from the Buffalo Bayou USGS gage in cubic feet per second. Determine the volume of water that flowed through the gage on Buffalo Bayou from 25 August to 17 September in acre-feet. What percentage of the volume of the rainfall is this (compare to your rainfall volume above)? Draw a chart of the streamflow hydrograph. [Hint: To convert from Discharge in cfs to Discharge in ac-ft/day multiply by 86400 sec/day and divide by 43560 ft^2/acre. Then add up ac-ft/day totals to get the total for the full period.]

6. **Total water balance.** During and after Hurricane Harvey, there was also water stored, spilled and released from Addicks and Barker Reservoirs. The data below gives information for each of these

Reservoir	Addicks	Barker	Total
Maximum Storage (ac-ft)	217,000	167,800	384,800
Maximum Storage Date	30 August	30 August	
Initial Storage (ac-ft)	0	0	0
Ending Storage (ac-ft)	66,000	53,980	119,890
Maximum Storage Date	16 Sept	16 Sept	





Consider the following water balance equation

Inflow = Outflow + Change in Storage

Inflow is the volume of precipitation. Outflow is the Discharge volume past Buffalo Bayou gage. Change in storage is the net change in storage in these reservoirs.

Determine the water balance error or unaccounted for water given the data you have, in ac-ft. Determine the depth of water in inches represented by the volume discrepancy you determine. [Hint: Divide by the Buffalo Bayou basin area in acres and convert from feet to inches]. Write a brief analysis of the magnitude and sign of this discrepancy considering possible causes. Explain whether your calculations indicate that there are undetermined inflows, or undetermined losses. Be as quantitative as possible in this analysis, but keep your writing to less than 0.5 pages. [Hint: Think about evaporation, water infiltrated and retained in the soil, and inaccuracies in both the precipitation and discharge. Precipitation varies spatially across the watershed as you saw above. Discharge has never been as high as it was during this event, so measured flow has uncertainty. Which of these uncertainties do you need to call upon to explain your calculations?]