CEE6440/CE 394K.3 GIS in Water Resources Fall 2015
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 or Word document, and submit through the class Canvas website, by 11:55 PM on Friday, December 11.

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/giswr2015/TermProjectProposals/TermProjList.htm
Utah: http://www.neng.usu.edu/cee/faculty/dtarb/giswr/2015/students.html

You are encouraged to look at term projects from both locations in preparing your answers since this will give you a greater body of information to speak from. At least one of the projects reviewed in one of the questions should be from an institution other than yours.

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? We are 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 year. In other words, we are 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 either 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

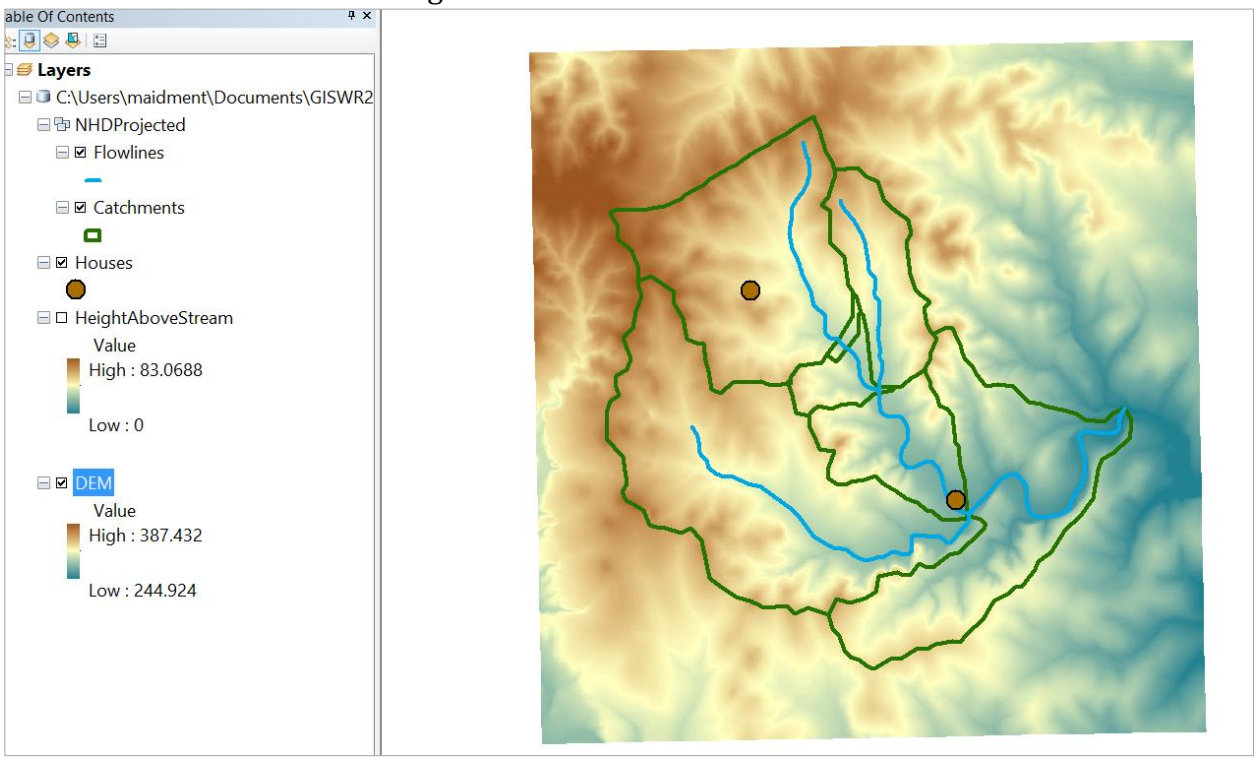
Student term papers on a range of topics have been presented. Select four papers that fall within a similar subject area and present a critique of how effective GIS is in its application in this subject area. What is the scope of the subject area? How has GIS been used? What types of problems have been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

3. Hydrology of Bear Creek in 2015 Halloween Flood

The Onion Creek watershed has been the focus of several lectures throughout the semester. It is of particular interest because of recent flood conditions, notably October 30/31, 2015. Your goal is to investigate the hydrology of the Bear Creek watershed, a tributary of Onion Creek, using the skills you have learned throughout the semester. The information that you'll need to complete this question is contained in the zip file: http://www.neng.usu.edu/cee/faculty/dtarb/giswr/2015/Final.zip

This includes the following data:

- Bear Creek Geodatabase holding



  - NHDProjected/Catchments. 7 Catchments from the NHDPlus projected to a Texas Centric coordinate system.
  - NHDProjected/Flowlines. 7 Flowlines from the NHDPlus dataset projected to a Texas Centric coordinate system.
  - DEM. A 10 m digital elevation model in meters projected from the National Elevation dataset 1/3 arc second DEM.
  - HeightAboveStream. A raster giving the height above the nearest stream in meters computed using the TauDEM D-Infinity Distance Down function.
  - Houses. A shape feature class giving the hypothetical location of two houses A and B.
- **Precip.csv**. Daily precipitation data for rain gauges in and near this area from the National Climate Dataset from October 30 and 31, 2015. In this dataset Latitude and Longitude are given in NAD 1983 geographic coordinates and the columns PRCP1030 and PRCP1031 give precipitation in 10ths of mm on each of these days.

(Further documentation on this data is available at http://www.ncdc.noaa.gov/cdo-web/datasets)

- **BearCk.txt**. USGS NWIS streamflow from Station 08158810 near Driftwood, Tx. This is just for October 30 and 31.

Following is additional information from the stream gauge

USGS 08158810 Bear Ck bl FM 1826 nr Driftwood, TX

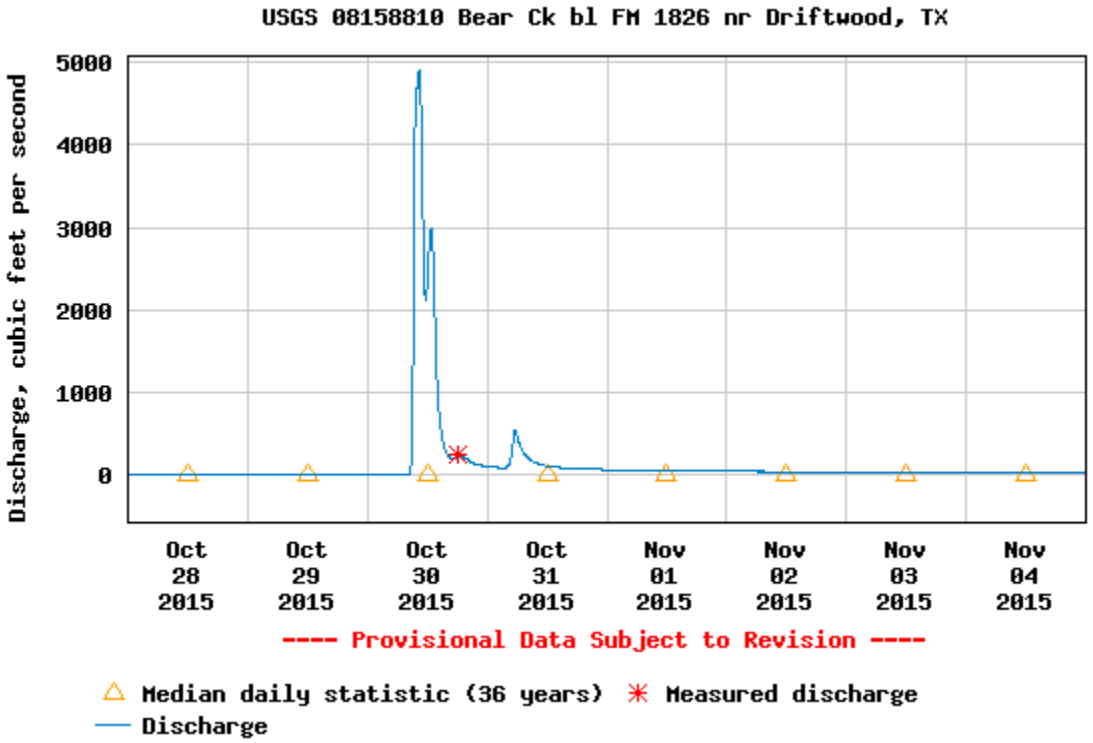
Available data for this site | SUMMARY OF ALL AVAILABLE DATA | GO

Stream Site

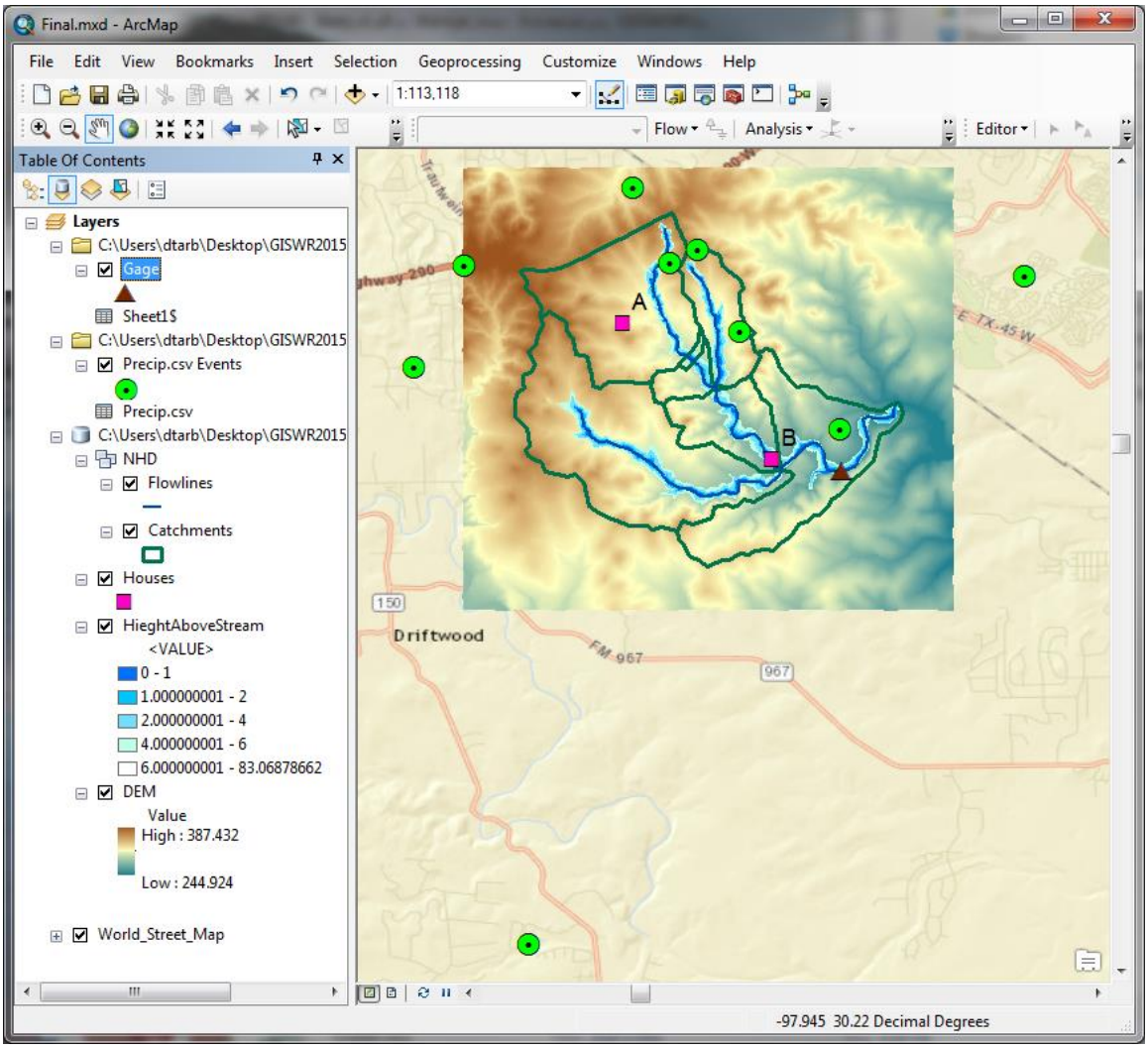
DESCRIPTION:

Latitude 30°09'19", Longitude 97°56'23" NAD27
Hays County, Texas, Hydrologic Unit 12090205
Drainage area: 12.2 square miles
Contributing drainage area: 12.2 square miles,
Datum of gage: 860 feet above NGVD29.

Following is the Hydrograph from the USGS website that indicates a peak flow close to 5000 cfs on October 30 and that essentially all the runoff from rain on these two days occurred on October 30 and 31.



The following screen shot from ArcMap illustrates some of this data



Note that the stream gage is about half way down the flowline of the most downstream catchment.

1. Watershed.

Delineate the watershed draining to the stream gage using appropriate DEM based methods. Determine the watershed area (in mi^2). Determine the length of NHDPlus streams draining to this gage (in mi). Report the drainage density (mi^{-1}).

Prepare an ArcGIS layout map where you show the catchments, topography and streams nicely symbolized. Include other information of interest. Include a scale and north arrow. This is your chance to demonstrate the cartography skills developed during this class.

2. Precipitation.

Determine the storm total (both days) area average precipitation over each NHDCatchment and over the watershed draining to the gage. Report your results in mm in a table.

Determine the storm total precipitation at each of the houses A and B in mm.

3. Streamflow

Determine the volume of streamflow by summing the USGS hydrograph values for October 30 and 31 and properly accounting for the time steps at which they are reported. Report your answer in ft^3.

4. Runoff ratio

From your answer to 2 convert precipitation in mm to ft and multiply by the area of the watershed converted into ft^2 to determine the volume of precipitation in ft^3. Calculate and report the runoff ratio. Discuss whether this seems reasonable.

5. Height above nearest stream flood mapping

The height above the nearest stream raster gives, for each grid cell, the height in meters above the nearest stream and provides an approximate way to map potential flood extent and depth. Use raster calculator to compute a FtAboveStream raster in ft (multiplying by 3.28). Use this to develop a potential flood map showing areas that would be inundated by floods with a depth of 10 and 15 ft above the stream. Present your map as an ArcGIS layout depicting the flooded area overlaying the topography or appropriate basemap. Again demonstrate your GIS map making skills. Include as part of your layout a frame zoomed in to depict the potential flooding in the vicinity of house B.

6. Flooding of houses

For each of the houses A and B determine the depth of flooding (if any) that would occur for a flood that reaches a height of 15 ft above the streams. Report your answers in ft.

7. Extending this idea

Suppose that a flood forecasting model produced the flow depth in each NHDPlus stream in real-time. Write an assessment in which you consider what would be involved in going from this information to a real-time map of potential flood depth using height above the stream and NHDPlus catchments. In this assessment suggest the data model (organization of tables and rasters) that you would use to facilitate this and the GIS computational steps you would suggest to achieve this. Draw a flowchart of how the workflow might operate.