CEE6400 **GIS in Water Resources** **Fall 2013**

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 11:59 PM on Friday, December 13.

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/giswr2013/TermProjProp/TermProjList.htm
Utah: http://www.neng.usu.edu/cee/faculty/dtarb/giswr/2013/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. 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? The papers that you select for this question may be from any of the participating universities. You are encouraged to look at and use papers from both Utah and Texas, where they address similar subject areas.

3. Hydrologic Assessment of Onion Creek Flooding

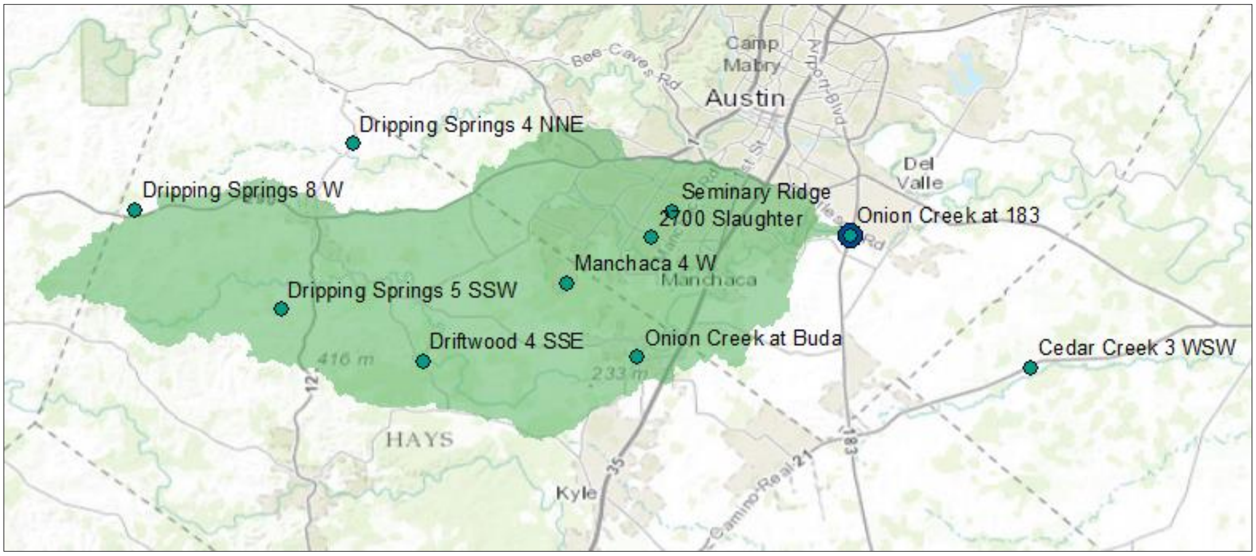
The information that you'll need to complete this question is contained in the zip file:
http://www.caee.utexas.edu/prof/maidment/giswr2013/final/final.zip

Name	Type	Compressed size
LDAStools	ArcGIS Geoprocessing Pa...	1,140 KB
Rainfall	Microsoft Excel Comma S...	1 KB
Streamflow	Microsoft Excel Comma S...	1 KB

It includes two .csv files, one for **Rainfall** and the other for **Streamflow** for the recent Halloween storm and flood on Onion Creek in Austin, Texas. It also includes the **LDAStools** you used in Exercise 5 to acquire regional scale precipitation data for this storm. You will also need to use the ESRI services for:
Elevation: http://elevation.arcgis.com/arcgis/services
Landscape: http://landscape2.arcgis.com/arcgis/services
When you are in ArcGIS you will need to SignIn with your ESRI Global Account so that you are authorized to use these services.

Part 1. Introduction to the Watershed

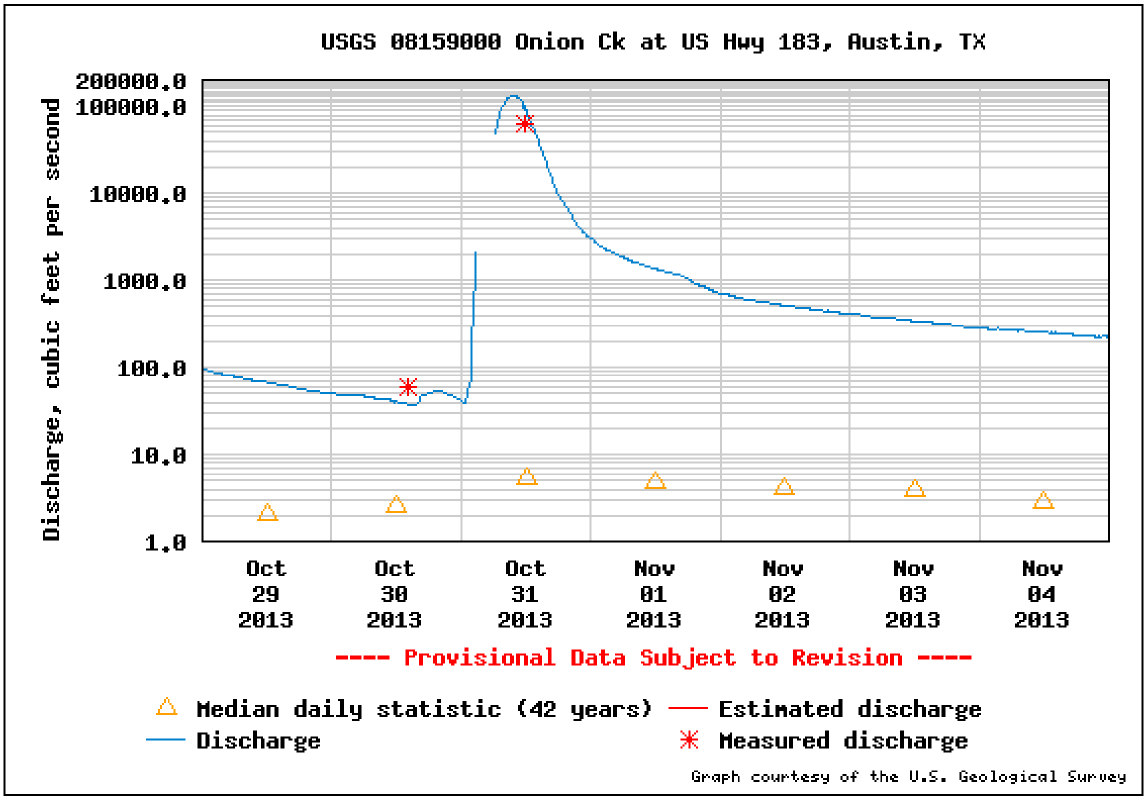
Onion Creek in the Austin area suffered catastrophic flooding on October 30/31, 2013. You will study data from ten rain gages and one stream gage for this area.



The 48 hour rainfall data are measured by the Lower Colorado River Authority at the following locations. The rainfall data from these gages for the Halloween storm were obtained from the Central Texas Hub. The Rain values are 48 hour totals in inches for the two-day period October 30-31, 2013. Latitude and longitude are with respect to the NAD 1983 horizontal datum.

Site No	Name	Rain	Latitude	Longitude
4598	Onion Creek at 183	3.78	30.17732	-97.68896
4595	Onion Creek at Buda	9.69	30.08644	-97.84853
4594	Driftwood 4 SSE	8.87	30.08340	-98.00810
4596	Manchaca 4 W	8.78	30.14163	-97.90020
19547	2700 Slaughter	5.71	30.17555	-97.83778
19525	Seminary Ridge	5.63	30.19546	-97.82140
4593	Dripping Springs 5 SSW	4.01	30.12191	-98.11356
3528	Dripping Springs 8 W	3.33	30.19627	-98.22268
4517	Dripping Springs 4 NNE	2.44	30.24574	-98.06036
5520	Cedar Creek 3 WSW	8.10	30.07826	-97.55465

Site 4598 is also the location of a USGS stream gage, station number 08159000 Onion Ck at US Hwy 183, Austin, TX. The following is discharge measured at this gauge during the period of the Halloween storm.



Site information for this station from the NWIS website (http://waterdata.usgs.gov/nwis/) is

USGS 08159000 Onion Ck at US Hwy 183, Austin, TX

Available data for this site

Stream Site

DESCRIPTION:

Latitude 30°10'40",   Longitude 97°41'18"   NAD27
Travis County, Texas, Hydrologic Unit 12090205
Drainage area: 321 square miles
Contributing drainage area: 321 square miles,
Datum of gage: 442.85 feet above   NGVD29.

To be done: Delineate the drainage area of the stream gage on Onion Creek at Highway 183 [Hint: use the ESRI elevation services]. Prepare a nice map that shows the rain gages labeled with their site names, the stream gage, and the watershed. Determine the area of the watershed (km^2) produced by the delineation process and calculate the percent difference between this area and the drainage area given by the USGS for this location.

Part 2. Land Cover in the Watershed

Land cover influences the amount of runoff that occurs during storms. The US National Land Cover Dataset (NLCD) **USA_NLCD_2006** land cover data is available from the ESRI ArcGIS Landscape2 services. In this dataset ich more detail is provided at: http://www.mrlc.gov/nlcd06_leg.php. There are eight major categories (Level 1) in this system, and 20 subcategories. Some of these are for special land cover types that do not occur in the Central Texas area.

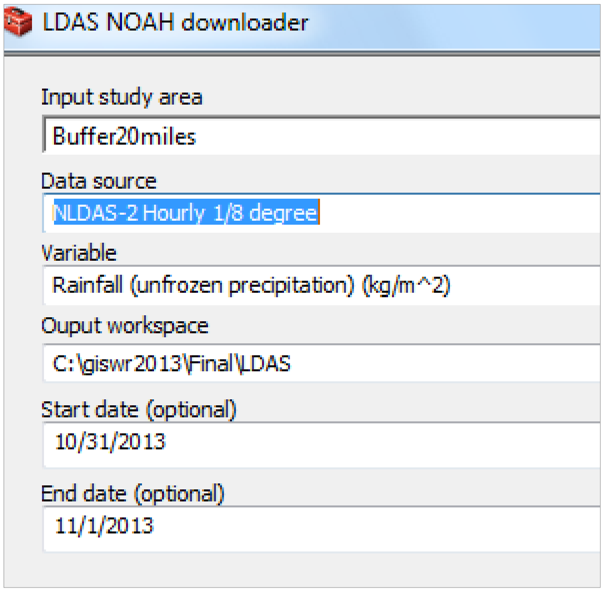
Level 1	Level 2	Description
Water	11	Open Water
	12	Perennial Ice/Snow
Developed	21	Developed, Open Space
	22	Developed, Low Intensity
	23	Developed, Medium Intensity
	24	Developed, High Intensity
Barren	31	Barren Land (Rock/Sand/Clay)
Forest	41	Deciduous Forest
	42	Evergreen Forest
	43	Mixed Forest
Shrubland	51	Dwarf Scrub
	52	Shrub/Scrub
Herbaceous	71	Grassland/Herbaceous
	72	Sedge/Herbaceous
	73	Lichens
	74	Moss
Planted/Cultivated	81	Pasture/Hay
	82	Cultivated crops
Wetlands	90	Woody wetlands
	95	Emergent Herbaceous Wetlands

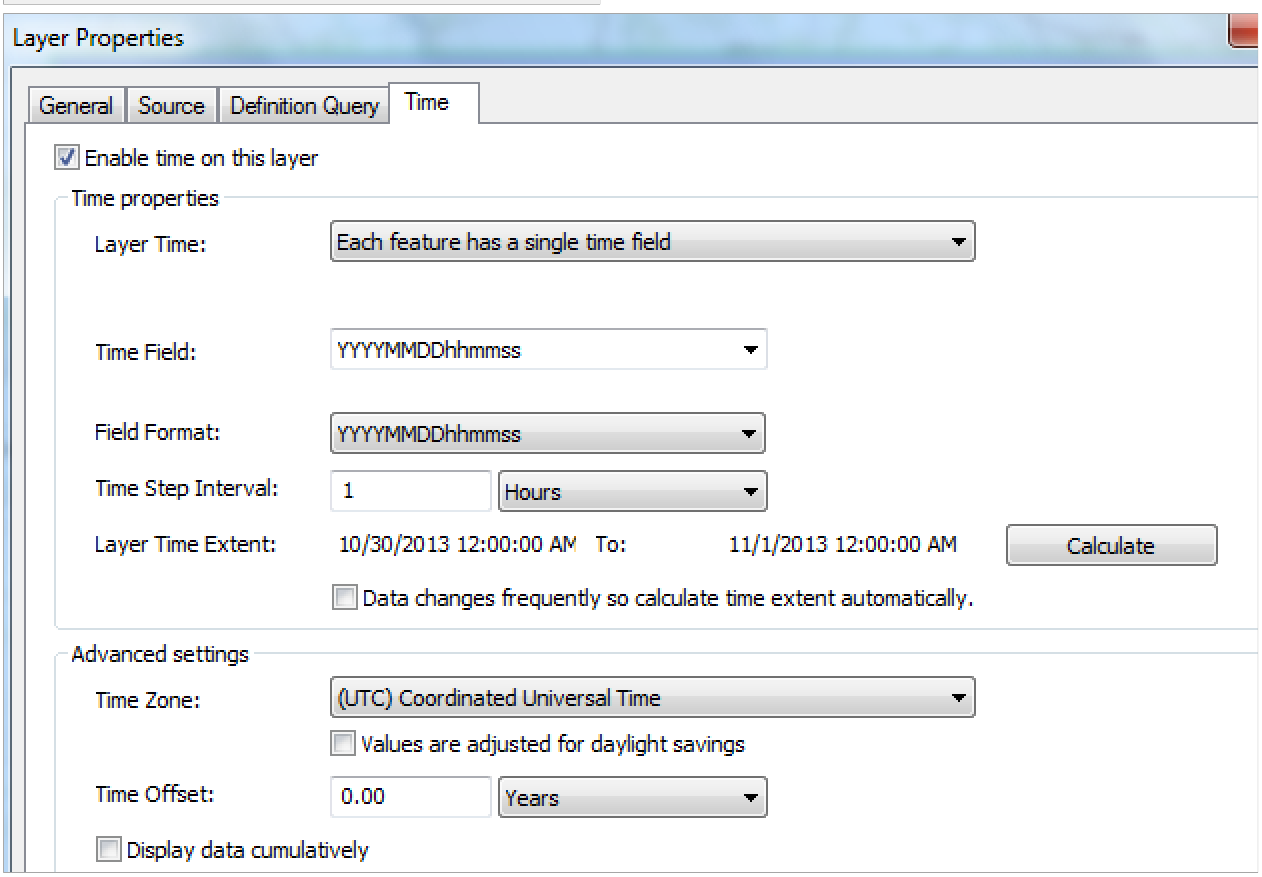
To be done: Prepare a nice map that shows the land cover distribution in the Onion Creek watershed. [Hint: Use extract by mask tool] For the Onion Creek watershed, determine the percentage of the total area covered by each of the eight Level 1 classes and present this in a Table. Write a short narrative describing the land cover in this basin.

Part 3: Visualizing the Halloween Storm

The spatial and temporal pattern of the precipitation in this storm can be visualized using data from the NASA Land Data Assimilation System. We'll take a regional view of the storm. Take the Onion Creek watershed and construct a buffer polygon of width 100 miles around the watershed boundary. Use the LDAStools introduced in Exercise 5 to download NLDAS-2 NOAH **hourly** precipitation images for 10/31/2013 to 11/1/2013. Construct an **hourly** mosaic of these images and animate it. The data are in Coordinated Universal Time, which is 5 hours ahead of Austin time (Central Daily Time) during this period. Rescale the image so that the values vary between 0 and 5 mm of rainfall (kg/m^2 is equivalent to mm).

To be done: Play the animation and make a screen capture of the rainfall distribution during the most intense period of rainfall that occurred about midnight on 30 October, Austin time.





Part 4. Create a Storm Rainfall Map for the Watershed

You have rainfall data for 10 rain gages. These values are the rainfall in inches for the whole storm.

To be done: Prepare a map of the spatial distribution of total storm rainfall over the watershed. Determine the average value in inches of the total storm rainfall within the watershed area. Describe the method that you used to arrive at this value.

Part 5. Analyze the Outflow Hydrograph

The discharge data for Onion Creek at Highway 183 have been downloaded from the USGS, some gaps in the data have been filled in, and the data has been interpolated to 15 min time steps for the 48 hour period Oct 31-Nov 1. This is not the whole duration of the flood event, as the USGS discharge hydrograph shown earlier demonstrates, but this period captures the bulk of the flood waters that resulted from the Oct 30-31 rainfall. These data are in the file **Streamflow.csv** in the Final.zip file for this question described earlier. A few of the data are shown below, for a period when the discharge was over 100,000 cfs, which is an enormous flow. At the peak discharge, the water was over 40 feet deep in the center of Onion Creek! This is 15 feet beyond "Major Flood" stage, equivalent to the storm surge height of a Category 3 hurricane on the Gulf Coast. The policy response by the City of Austin after this flood is to buy out more than 100 flood-prone homes in this area.

Date and Time	Discharge (cfs)
10/31/2013 8:00	105324
10/31/2013 8:15	113362
10/31/2013 8:30	120713
10/31/2013 8:45	126437
10/31/2013 9:00	129718
10/31/2013 9:15	132999
10/31/2013 9:30	135000
10/31/2013 9:45	133883
10/31/2013 10:00	133000
10/31/2013 10:15	131155
10/31/2013 10:30	126668
10/31/2013 10:45	123001
10/31/2013 11:00	117386
10/31/2013 11:15	107003

To be done: Plot a graph showing the variation of the discharge versus time. Determine the average discharge (cfs) over this 48 hour period and find the corresponding volume of flood discharge (ft^3) and the equivalent depth of runoff over the watershed (inches). Calculate the runoff ratio that reflects the percentage of the storm rainfall that becomes discharge during this 48 hour period and discuss this value. Comment on the time lag between the peak intensity of the storm over the Onion Creek watershed (as inferred from the NLDAS-2 rainfall) and the time of peak discharge at its outlet. Do you think this is a reasonable time lag, and if so, why?