EENS 204	Natural Disasters
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Homework Assignment VI. Flooding Exercises

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1. Flood frequency information can be determined from knowledge of the peak discharge (highest discharge) in any given year provided enough years of information has been collected. This allows one to relate the expected recurrence interval for a given discharge, and determine the probability that a flood of a given discharge will occur in any given year. The recurrence interval for a given discharge can be calculated by first ranking the discharges.

    a. In the table below for Fema Creek, Pennsylvania, fill in the Rank column. To do this, enter a 1 for the maximum discharge that has occurred during the 20 years of available data. The second highest discharge will be given a rank of 2, etc. with the lowest discharge given a value of 20. **(1 point)**

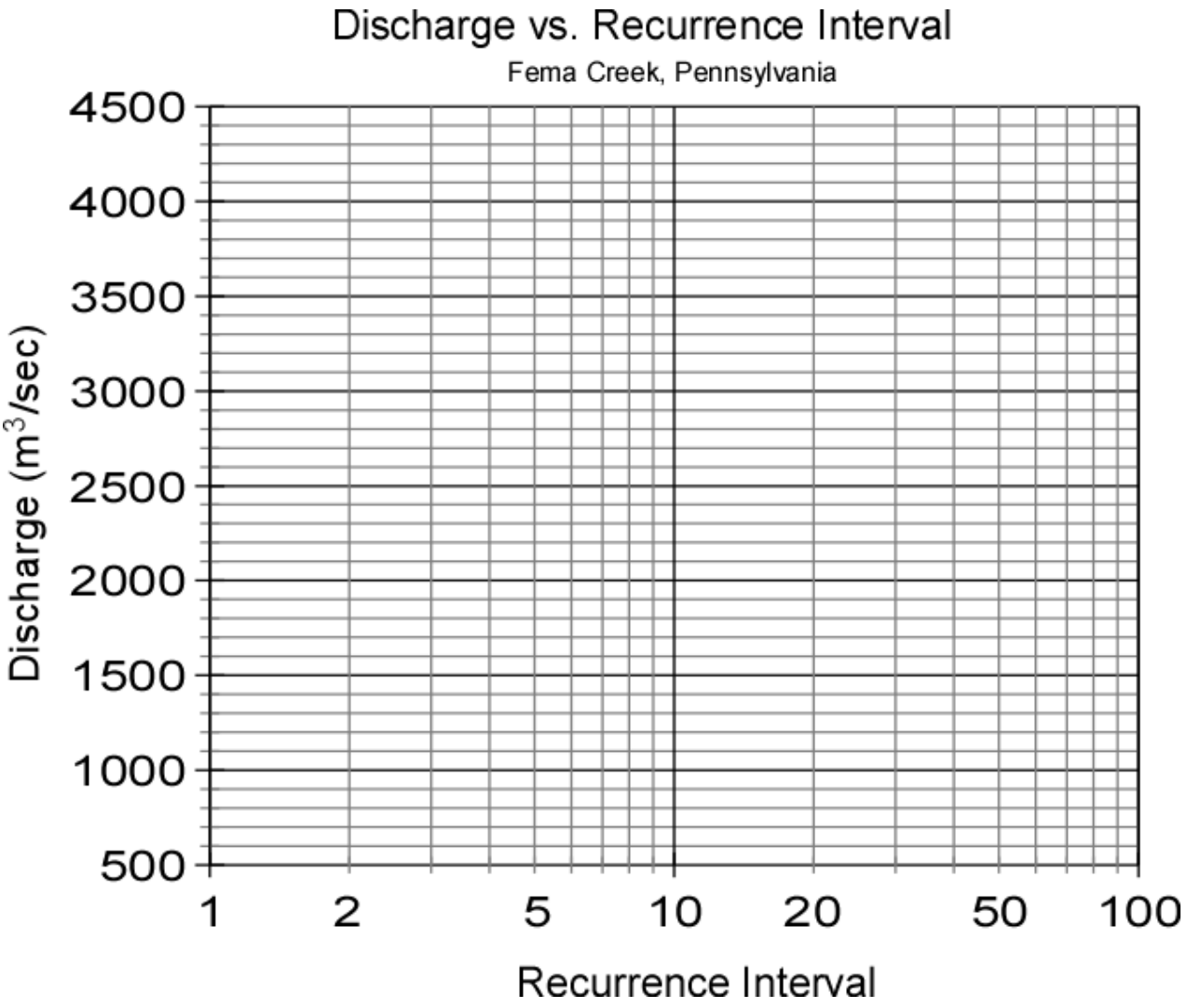
Date	Discharge (m^3/sec)	Rank, m	Recurrence Interval
13-Mar-86	650		
06-Mar-87	1080		
28-Feb-88	1320		
04-Mar-89	3100		
22-Mar-90	1910		
03-Mar-91	690		
12-Mar-92	820		
01-Feb-93	610		
04-Apr-94	1230		
02-May-95	1000		
16-Mar-96	780		
06-Jul-97	2500		
21-Feb-98	810		
30-Jan-99	1400		
16-Mar-00	1450		
21-Feb-01	1150		
12-May-02	1640		
08-Apr-03	2220		
01-Mar-04	1730		
08-Feb-05	880		

b. After you have filled in the Rank column, you can now calculate the recurrence interval for each peak discharge. The recurrence interval, R, is given by the ***Weibull Equation***:

$$R = (n+1)/m$$

where n is the number of years over which the data was collected (20 years in this case) and m is the rank of each peak discharge. Use this equation to calculate the recurrence interval for each peak discharge. **(2 points)**

c. Next, use the graph below to plot a graph of discharge (on the y-axis) versus recurrence interval (on the x-axis). Note that the x-axis is a logarithmic scale, and thus you should try to estimate as best you can where the data point will fall between the lines on the graph. Once you have plotted the points use a ruler to draw the best fit straight line through the data points (lay a ruler on the graph and try to draw a line that most closely approximates all of the data points). **Do not draw lines that connect individual data points**. **Make sure you turn in the completed table above and the graph below**. **(2 points)**



d. By extrapolating your line on the graph, determine the peak discharge expected in a flood with a recurrence interval of 50 years and 100 years. These are the discharges expected in a 50 year flood and a 100 year flood. **(1 point)**

e. From reading of your text and lecture notes, is it possible that discharges associated with a 100 year flood could occur 5 years apart, 10 years apart, or even one year apart? **(0.5 point)**

f. The annual exceedence probability, P_e, is the probability that a given discharge will occur in a given year. It is calculated as the inverse of the recurrence interval, R:

$$P_e = 1/R$$

Thus, the probability that a flood with a ten year recurrence interval will occur in any year is 1/10 = 0.1 or 10%. What are the probabilities that a 50 year flood and a 100 year flood will occur in any given year? **(1 point)**

g. The mean annual discharge can be calculated by summing the peak annual discharges and dividing by the number of years. What is the mean annual discharge for Fema Creek? **(0.5 point)**

h. Flood stage, or bankfull stage on Fema Creek occurs at a discharge of 1600 m^3/sec. What is the recurrence interval of such a discharge according to your graph? **(1 point)**

i. Someone has offered to sell you a 4-bedroom 2-story house with a 2 car garage and swimming pool on a 1 acre lot on a relatively flat piece of ground on the banks of Fema Creek for what seems like a reasonable price of $75,000. The last time the house was flooded it cost $56,000 to repair the flood damage. How often has the house been flooded in the last 20 years? What is the probability that the house will be flooded in the first year that you own it? Would you still consider buying the house? Why or why not? **(2 points)**

2. You have been reassigned to head up the Fargo, North Dakota office of your company, Denyallclaims Insurance, Inc. You are aware that in 1997 the Red River of the North, which runs through Fargo, crested at the highest level recorded in this century, and you are concerned about buying property and living in the area of Fargo. One of the other executives in your company has an uncle that lives in Fargo, and he assures you that while flooding was severe in 1997, this was a 200 year flood, and such a flood will not occur for another 200 years! You know from taking a natural disasters class that his statement is hogwash, so you decide to check out the discharge history of the Red River in Fargo on the internet. Because you took a course in natural disasters, you know that if you visit the web site of the U.S.G.S. Water Resources Division:

http://water.usgs.gov/nwis/

you can obtain discharge data from thousands of gaging stations throughout the United States. Go to this web site and do the following:

On the upper right-hand side of the page are boxes that you can set to take you more directly to the information you want. Under the line that says "Data category", use the down arrow next to the box to change the box to read "Surface Water".

Under the line that says "Geographic Area", use the down arrow next to the box to change the box to read "North Dakota". This will take you to the North Dakota surface water page.

Next, click on the button that says "Daily Data" from the selection of buttons on the left-hand side of the page. This will take you to the Daily Streamflow for North Dakota page. Here we need to specifically search for the Data we want. To make things simpler, I have provided you with the station number of the gaging station in Fargo. This is **05054000**. So put a check mark in the box next to "Site Number" and remove the check mark in the box next to "Site Type", then click on the Submit button.

On the page that comes up, there is a box into which you should enter the Site Number - **05054000** and click on the dot next to "exact match". Under "Available Parameters, put a check mark in the box next to "Streamflow ft^3/s", Now scroll down and make sure the "Table of Sites Sorted by Site Number" is selected. Scroll down and under "Retrieve USGS Surface-Water Daily Data for Selected Sites" select the date range from a First date of **1977-01-01** to a Last date of **2006-12-31**. Then Scroll down further and under "Output Options" make sure "Graphs of Data" is selected and that there is a check mark in the box next to "Use arithmetic Y-axis for discharge". Now click on the "Submit" button. A page with a table and a graph should load. Scroll down and look at the graph. It should have the title "USGS 050504000 RED RIVER OF THE NORTH AT FARGO, ND" If it doesn't have this title, go back and start again. The graph appears near the bottom of the page. You might want to print this graph for later use in answering questions (a) and (d), below.

a. The graph shows mean discharge on a daily basis versus time for the 30 year period. Look at the graph. Floodstage for this gaging station is about 3500 ft^3/sec. Over this 30 year period, how many times has the Red River exceeded flood stage (note that each peak in the data represents a separate event)? In what year did the highest discharge occur, and what was the value of that discharge? **(2 points)**

b. Notice that there seems to be a periodicity to where the peaks of high discharge occur on the hydrograph (that is the distance between peak discharge points are approximately equally spaced). In order to better understand what may be the cause of this periodicity, and perhaps the cause of the flooding, we want to look at the data over a shorter period of time. Use the Back button on your web browser to return to Site Selection Page and ask to retrieve data over a shorter period of time (10 years), this time use range between **1988-01-01** to **1997-12-31**. Click on the "Submit" button again, and on the page that loads, scroll down to look at the graph that is eventually displayed. What is your best estimate the approximate month or months in which the peak discharge occurs in each year of this 10 year period? Knowing that North Dakota is in the northern part of the United States, why do you think that the peak discharge occurs in this month or range of months? **(2 points)**

c. To find out more about floods on the Red River of the North go to the Fargo Flood Home Page:

http://www.ndsu.nodak.edu/fargoflood/

then page down and select the link - "Flood Information for Fargo". Now answer the question - What makes the Red River Valley so prone to flooding? **(2 points)**

d. Is there any information at this web site that suggests that any floods have occurred at Fargo since the 1997 floods? If so, when were these flood sand how severe were they? (**Note**: to answer this question, you might want to consult flood hydrographs for the 1997 flood, and the graph you printed earlier, and compare them with each other and to the flood frequency diagram for the Red River at Fargo that appears in your lecture notes). **(1 point)**

e. What precautions should you take in choosing your home and home site in the Fargo area if you decide to move there to head up the Denyallclaims office in Fargo? Is there any information or links on the Fargo Flood Home Page that would help you in making this decision? If so, describe any information that is available.**(2 points)**

f. From what you have learned by visiting the web sites for this assignment, how to you respond to your friend's uncle who said that severe flooding would not occur for another 200 years? **(1 point)**

3. Go back to the USGS water resources data base page:

http://waterdata.usgs.gov/nwis/

We next want to look at some data for the area of Rapid Creek, South Dakota. So, make sure "Surface Water" and "South Dakota" are selected at the top of the page. On the next page, click on the "Daily Data" button. Again we know the site number that we want - it is **06414000**, so on the "Site Selection Criteria" page, put a check mark in the box next to "Site Number" and remove the check mark in the box next to "Site Type", then click on the Submit button. Enter the number **06414000** in the box under "Site Number", then and scroll down and under "Available Parameters, put a check mark in the box next to "Streamflow ft^3/s". Now scroll down and make sure the "Table of Sites Sorted by Site Number" is selected. Scroll down further and under "Output Options" make sure "Graphs of Data" is selected and that there is a check mark in the box next to "use arithmetic Y-axis for discharge". Now click on the "Submit" button. A screen for the stream gauge on Rapid Creek at Rapid City, S. Dakota will come up.

Rapid Creek drains the area of the Black Hills, a spectacular tourist site. On Friday, June 9, 1972 shortly after 6 PM a severe thunderstorm dropped about 15 inches of rain on the Black Hills over a period of less than 6 hours. You want to see what the effects of this thunderstorm were on Rapid Creek in Rapid City. So on the Rapid Creek page, choose to retrieve data for the period between **1972-06-05** and **1972-06-14**, then click on the "Go" button. After the page loads, scroll down to look at the graph. Note that the graph only reports one value of discharge for each day, and this is actually the mean (average) discharge for each day so it is difficult to know exactly what time the peak discharge occurred on the June 10. Other data suggest that the peak discharge occurred at about

12:15 AM on the morning of June 10th. Weather data indicates that the rain ended at 10:00 PM on June 9th.

Since what is shown on the graph is mean discharge, to see the peak discharge we need another graph. To get this data, go to the top of the web page. Where it says "Available data for this site", use the arrow button to change the selection to "Surface-water - Peak streamflow". A new graph will appear that will allow you to determine the peak discharge on June 10 (note that you can't limit or zoom in on the dates on this graph like you did on the daily streamflow graph, but you can be pretty sure that the high discharge value shown for 1972 represents the flood event on June 10th).

a. What was the value of peak discharge on June 10th? By what percentage did this peak discharge exceed the normal discharge (assuming normal discharge is 30 cfs)? **(2 points)**

b. Approximately what was the lag time between the end of the rainstorm and the peak discharge? (re-read the paragraphs above, that starts with "Rapid Creek drains...") before you answer this question). (**1 point)**

c. This flood killed 238 people. Why do you think it was it so costly in terms of human lives?**(1 points)**

d. What kind of flood was this? **(1 point)**

4. On August 29, 2005, Hurricane Katrina made landfall to the south of New Orleans at 6:10 AM Central Daylight Time. As we all know, the storm surge and resulting levee overtoppings and levee breaches ended up flooding a large portion of the New Orleans metropolitan area.

   I. Won Pei, the President and CEO of your company, Dennyallclaims Insurance Co., is good friends with an unnamed congressman from a northeastern state. This congressman has some questions about the flooding that he wants answered before voting on a bill to provide money for flood protection in south Louisiana. Rather than reading the extensive documentation that has been made available over the intervening years, this congressman knows that Denyallclaims employs a large number of people that took a Natural Disasters course at Tulane University in New Orleans and has asked his friend, the President and CEO of Denyallclaims, to use his employees to get some information. Since you are in limbo waiting for your assignment in Fargo to come through, you are assigned this task. In particular, the congressman wants to know why New Orleans survived the hurricane on August 29, 2005 but was flooded when levees were overtopped on the following day, August 30, 2005.

   Because you took the Natural Disasters course, you know that the New Orleans Times Picayune newspaper compiled lots of information on the timing of events as reported by the numerous agencies that investigated the disaster. This compilation is summarized in a multimedia presentation on the NOLA.com website -

   http://www.nola.com/katrina/wide.ssf?/katrina/graphics/flashflood.swf

   So, you go to that site to answer the following questions to ready yourself for your report to the boss and ultimately the congressman. (Note that you may need to download the

Flash8 Player from the link near the top right of the page in order to view the graphics).

a. Where and when (date and time) did the first flooding begin to occur in the New Orleans area? **(1 point)**

b. What was the cause of the flooding at this locality? **(1 point)**

c. Where and when (date and time) did the first levee overtoppings occur? **(1 point)**

d. Where and when (date and time) did the first levee breaches occur? **(1 point)**

e. On what day and at what time time did the populated portion of St. Bernard Parish flood? **(1 point)**

f. On what day and at what time did the flood walls on the London Avenue Canal fail resulting in flooding the Gentilly neighborhood? **(1 point)**

g. On what day and at what time did the flood walls on the 17th Street Canal fail resulting in the flooding of Lakeview, midtown New Orleans, and parts of Metairie? **(1 point)**

h. Over what time period did the rest of the area flood and why did it continue to flood over this time period? **(1 point)**

i. In two or three sentences, what do you tell the congressman concerning the questions he has about the flooding in the New Orleans area? **(1 point)**

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