Problem Set #4

12.102 Environmental Earth Sciences
Due Nov. 3

FLOODS & RECURRENCE INTERVALS

This exercise utilizes the wealth of water measurement data available online through the Water Resources Division of the United States Geological Survey (USGS). You'll obtain a dataset of peak annual discharge measured at a gauging station at St. Paul, MN on the Mississippi river. Instructions for obtaining the specific data follow; you are also encouraged to browse these pages to see the staggering amount of raw data available for potential analysis!

(1) Go to the URL http://www.usgs.gov
(2) On the map of US on the right-hand side of the page, click on Minnesota
(3) Click on Water Resources Information under Highlighted Minnesota Links
(4) Click on Water Data -->Online USGS Data...-->Surface Water
(5) Click on Peaks, then check the site number box and SUBMIT
(6) Type in the site number 05331000 and for output format, select the tab-delimited text file sorted by year. Alternatively, open the data in your browser and use the "save as" command to get the tab-delimted text file.
(7) Once you have the tab-delimited file you should be able to open it in a spreadsheet program (e.g. Microsoft Excel)

The data file has a lot of abbreviation and formatting symbology, but you should easily pick out the pertinent information including the year (column 3) and discharge (column 5). Note that discharge is listed in units of cubic feet per second (cfs). Using this data, you can now construct a number of recurrence interval curves:

1) Rank the peak annual discharges in order of decreasing magnitude (the highest being number one, the lower being equal to the number of years of record); compute the "recurrence interval" in years by the formula $T = (N + 1)/M$, where T is the recurrence interval, N is the number of years of record, and M is the rank of the event; plot the results in a graph of recurrence interval (x-axis) versus annual maximum discharge (y-axis). Use a log scale for the x-axis. (15 pts)

2) Fit a curve through the points in some remotely precise way, and explain your method. From the graph, determine the magnitude of the "10-year flood" and "100-year flood". Evaluate how sensitive these estimates are to your method of fitting the data. (15 pts)

3) Now divide the data set into two periods, one from 1893-1949, and the other from 1949-2004. Recalculate the recurrence intervals for these two periods and plot these two new data series on single graph of recurrence interval versus annual maximum

discharge. Again use a log scale for the recurrence interval axis (x-axis). Describe and hypothesize on causes for the differences between the two data arrays. (15 pts)

4) Note that the figure below, which shows a plot similar to the ones you just generated but for an entirely different river system, has a similar log-linear relationship. In a few paragraphs, speculate on the apparently fundamental earth processes that create such relationships. (15 pts)

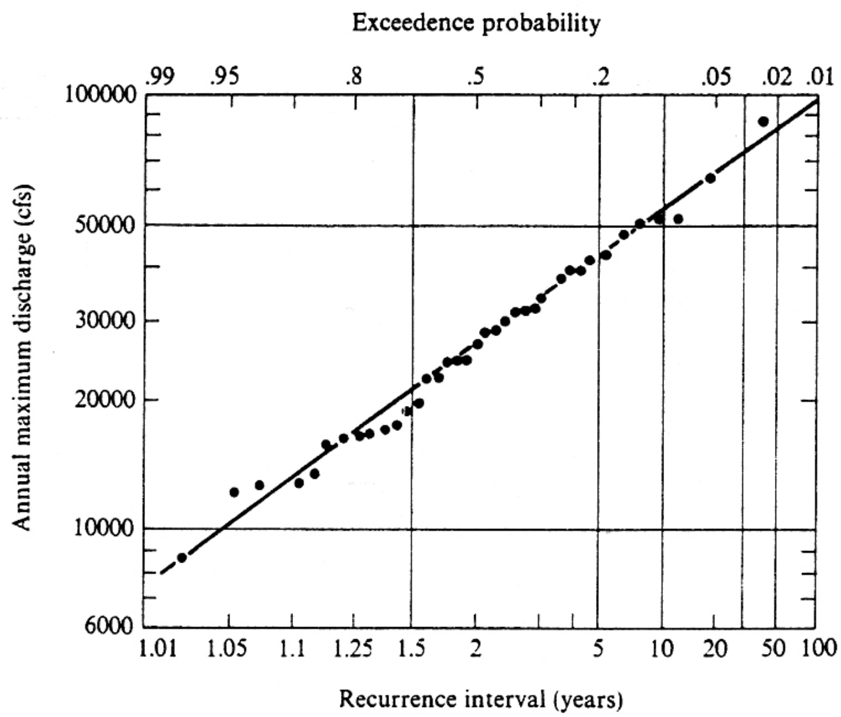

Figure 10-13 Flood-frequency curve plotted on logarithmic probability paper, Tana River at Garissa, Kenya, 1934–1970. The scale at the top is the probability that the discharge is equaled or exceeded in any given year. The bottom scale, recurrence interval, is the average number of years in which the annual peak equals or exceeds the discharge given on the ordinate. (Data from the Ministry of Water Development, Nairobi.)