

ES476/576 Hydrology Flood Frequency Analysis Exercise

The recurrence interval of a given flood discharge is commonly calculated from a set of historical data. The "annual peak discharge" represents the maximum discharge recorded at the station for a given water year. Recurrence interval of annual peak discharge represents an estimation, based on the historical record, of the probability of a given flood discharge occurring over a given time period. For example, the "100 yr flood" is a flood-discharge magnitude that has a probability of occurring once every 100 yrs. Generally, the lower the magnitude of event, the statistically more frequent the chance of occurring, and vice-versa. Once the recurrence intervals for given discharges are calculated, the relations may be visually plotted on a semi-log graph for visual analysis (Discharge on linear y-axis, and recurrence interval on log x-axis).

Methods of Calculation

1. Visit the lab section of the hydrology class web site "SURFACE WATER HYDROLOGY TECHNIQUES - Flood Frequency Analysis Exercise"

2. Read over the "Background Reading: Overview of Flood Frequency Analysis" and "Flood Frequency Terminology" documents; familiarize yourself with the general techniques.

3. Create a subfolder on your H:\ drive, and download the following data files:

Western Oregon Peak Flow Data Records (*.xls)
(Peak Q data for select rivers of the Coast Range and Western Cascades)

Simplified Log Pearson Type III Flood Frequency Worksheet (*.xls)
(automated flood frequency calculator worksheet)

4. Print out the "Alsea River Flood Frequency Tutorial / Example" document available on the web site, in the "Flood Frequency Analysis Exercise" section.

5. Enter into the Excel Spreadsheet environment using your favorite WOU network computer.

6. Using the peak Q discharge data from the Alsea example in the tutorial, enter the data shown on the "screen shot" of "Step 2" (page 2) into the Simplified Log Pearson Type III Flood Frequency Worksheet (*.xls). Note that columns and cells automatically calculate a variety of statistical parameters once you enter the data.

7. Compare the automated calculations to the tutorial example / printout. Familiarize yourself with the statistical output parameters. Read through steps 2 through 15 of the tutorial, find the comparable results listed on the "Simplified Log Pearson Type III Flood Frequency Worksheet" that you just entered data onto.

8. Once you've familiarized yourself with the tutorial data and flood frequency calculator, plot a semi-log graph of discharge with a linear y-axis, and recurrence interval on log x-axis. Use the example output in the Alsea tutorial in "Step 16" as a guide for graph creation in excel.

9. Now that you've worked through an example using the spreadsheet calculator, let's try some other data. Open the "Western Oregon Peak Flow Data Records (*.xls)" file that you've already downloaded. Examine the worksheets. These records include historic peak discharges for eight watersheds in the Willamette Valley (Long Tom, Luckiamute, Marys, Mackenzie, South Santiam, North Santiam, Sandy, and Yamhill).

9A. Some of the rivers drain from the Coast Range, some from the Cascades, on the worksheets, identify which river belongs to which physiographic area. On a regional base map for the Willamette basin (see attached figure on page 4), identify the approximate location of each river and watershed. Label your physiographic information on each worksheet, identifying the watershed as either "Coast Range" or "Cascade".

10. For each worksheet / river, sort the peak discharges from highest to lowest in the historical record. Save your work. You have now ranked the discharges from highest to lowest.

a) Highlight all of the data cells in Excel, but NOT the Column Titles (hint: highlight all column cells, otherwise you will mix the data).

b) Use Data-Sort, to sort the data in descending order by discharge, from highest to lowest.

PRINT OUT YOUR COMPLETED DATA SHEETS!

11. Using the flood frequency calculator, now conduct a Log Pearson Type III Flood Frequency analysis for each river, based on the historical data.

- A. Enter in the location data and USGS gage ID on the calculator worksheet. **DO NOT OVERWRITE YOUR ORIGINAL WORKSHEET TEMPLATE...** "FILE-SAVE AS" and create a separate frequency calculation for each river in the data set.
- B. Paste your sorted data into the appropriate columns on the calculator worksheet.
- C. Determine the "US Regional Skew Coefficient" for each river basin from the map link provided on the lab/class web site, enter the values into the calculator, cell K-13.
- D. You will now have a completed calculation worksheet, and the calculated "Cw" value will be determined for you (Cw = weighted skewness value for the data record)
- E. Find the upper and lower Cw table values from the Frequency Factors K for Gamma and log-Pearson Type III Distributions (Haan, 1977, Table 7.7) (left hand column of table). The Frequency Factors K table is located in cell range J41 to R105, on the calculator worksheet. Copy and paste these values into the appropriate "yellow" cells. For example, if you calculated Cw value is 0.1092, then it is bracketed between Cw upper = 0.2 and Cw lower = 0.1 on the K-Factor Table.
- F. Now find the upper and lower bracketing K factor values for the 2, 5, 10, 25, 50, 100, and 200 year recurrence intervals (in the right hand columns); copy and paste these values into the appropriate "yellow" cells. For example, if the Cw upper value = 0.2, the K factors from the table are -0.033, 0.83, 1.301, 1.818, 2.159, 2.472, 2.763 for Return Times of 2, 5, 10, 25, 50, 100, and 200, respectively. To copy the table values easily into the worksheet, highlight the cells in the K-factor row and "edit-copy", then place the cursor in the corresponding cell of the calculator table and click "edit-paste"

special-values-transpose”. By transposing, the row values of K will be pasted into columns of the calculator area.

Once you pasted the K-factors, you will now have the 2, 5, 10, 25, 50, 100, 200 year recurrence interval discharges calculated for you in the final tabulation box labeled “**Q_{Tr_cfs}**”, with output in cells P28 to P34.

12. Repeat steps 10 through 12 for each of the 8 watersheds in the Willamette Valley. Tally and print your results according to River Basin, Recurrence Interval, and Estimated Discharge.

13. As you completed for the Alsea example above, plot a semi-log graph of discharge on linear y-axis, and recurrence interval on log x-axis for each of the 8 river basins in the sample set.

14. On your original data worksheets, calculate a unit discharge for each of the 2, 5, 10, 25, 50, 100, 200 flood events at each river locality. The formula for unit discharge is:

$$\text{Unit Q} = Q_p/A \quad (\text{units} = \text{cfs/sq. mi})$$

where Q_p = peak discharge, and A = drainage area above the gage station (see header information on data tables). Unit discharge accounts for the variability of flow according to drainage area (i.e. bigger watersheds inherently will have more discharge than smaller ones, all other factors being equal). By dividing the discharges by drainage area, the values are being normalized per unit drainage area, thus allowing comparison of larger size basins to smaller.

15. Tabulate all of your unit discharges in a separate summary data table with the following format

River Basin	Recurrence Interval / Unit Q						
	2	5	10	25	50	100	200
Luckiamute	--	--	--	--	--	--	-- <i>tabulate the unit Q values here</i>
Long Tom	--	--	--	--	--	--	-- <i>tabulate the unit Q values here</i>
.							
.							
Etc.							

16. Write a 1-2 page summary report of the analysis. Compare and contrast the flood recurrence intervals for the 8 drainages. What geologic / climatic / hydrologic variables account for the similarities and differences between the two physiographic regions. Do Coast Range rivers respond differently to regional hydrometeorological events than Cascade? Which environments show the highest unit discharges, the highest magnitude floods, and the most frequent flood severity? Which rivers and physiographic areas are more flood prone, and require higher levels of awareness and land-use planning in terms of flood preparedness?

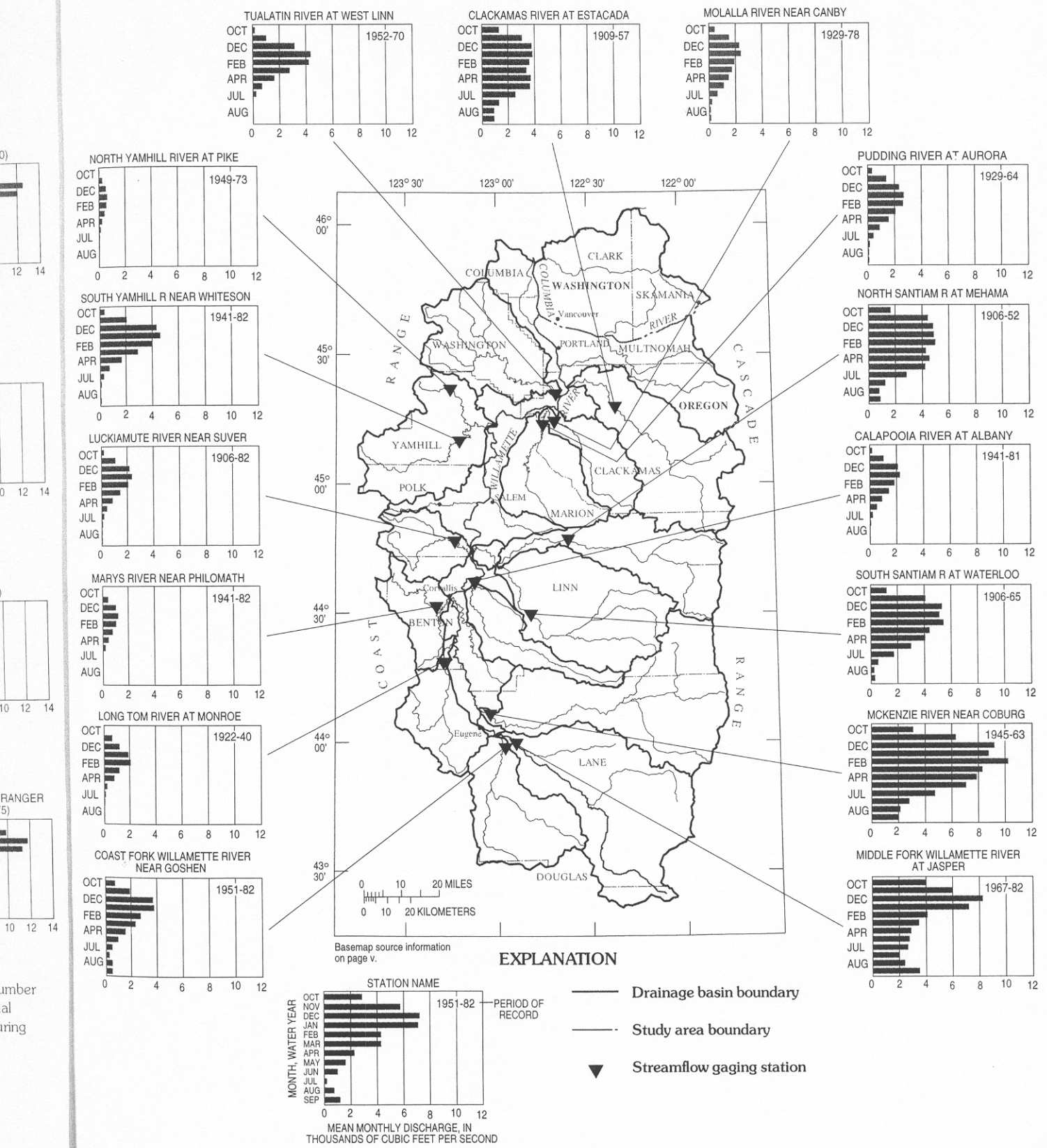


FIGURE 5.—Mean monthly discharge for selected major tributaries of the Willamette River.

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