Assignment 5 - Extreme Events

Due: Wednesday, 13 March 2019 — Total Marks: 20

Objectives

One of the most common application in hydrology is the estimation of flood magnitudes. These estimates are required for many purposes, including delineating floodplain areas and structural design (e.g. bridges). If data on annual peak flows are available for a number of years, the preferred method is to carry out a flood frequency analysis. More detail on methods for design flood estimation can be found in Linsley et al. (1982) or Bedient and Huber (1992). This exercise introduces the application of flood frequency analysis to a forested catchment in south coastal British Columbia.

Background

Flood Frequency Analysis

Flood frequency analysis involves essentially the same procedure as for carrying out a frequency analysis for rainfall intensity data. The steps for graphical analysis are summarized below:

1. For each year of streamflow data, find the peak flow.
2. Rank the peak flows such that the highest has rank $r = 1$ and the smallest has rank $r = n$, where n is the number of years of data (not counting any years with missing data).
3. Estimate the return period, T_r, for a given peak flow as

$$T_r = (n + 1)/r$$

4. Plot the peak flows on ”extreme value” graph paper, and fit a straight line through the points.
5. Read off the estimated values of Q_T from the fitted line.

Questions

Table 1 shows ranked peak flows for North Alouette River, which has a drainage area of 37.3 km^2. Figure 1 shows the intensity-duration-frequency (IDF) curves for the UBC Research Forest climate station, located in the North Alouette catchment at an elevation of 147 masl.

1. Plot the ranked discharge data on the attached extreme value graph paper. [2 marks]

2. Fit a straight line through the points and read off the values of peak flows for the following return periods: 2, 5, 10, 25, 50 and 100 years. Summarize the values in Table 2. [5 marks]

3. How well do the data appear to fit the straight line? That is, do the data appear to have been drawn from an extreme-value distribution? [3 marks]

4. Look at the dates of the peak flows. Does it appear that all the peak flows were generated by the same type of event? [2 marks]

5. Compare the magnitudes and dates of the instantaneous and daily peak flows for each year. Why might they differ? [3 marks]

6. Convert the 10-year return period annual peak flow (instantaneous) for the North Alouette River to runoff in mm hr^{-1}. [2 marks]

7. Compare this value with the 10-year return period IDF curve for precipitation shown in Figure 1. Are the values consistent with each other? What factor(s) may explain discrepancies between the two? [3 marks]

References

Bedient, P.B. and Huber, W.C. 1992. Hydrology and Floodplain Analysis, Second Edition. Addison-Wesley, Reading.

Linsley, R.K., Jr., Kohler, M.A. and Paulhus, J.L.H. 1975. Hydrology for Engineers, Second Edition. McGraw-Hill, New York.

Table 1: Annual peak flows, North Alouette River

Chronological Data					Sorted by rank of peak flow			
Year	Inst. Q_{max} (m^3 s^{-1})	Date Inst. Q_{max}	Daily Q_{max} (m^3 s^{-1})	Date Daily Q_{max}	Year	Q_{max} (m^3 s^{-1})	Rank	T_r (yr)
1969	60.6	4-Jan	34.8	4-Jan	1986	162	1	20
1970	36.8	5-Apr	23.3	6-Apr	1984	126	2	10
1971	62.9	25-Oct	29.4	26-Jan	1983	124	3	6.67
1972	103	12-Jul	58.3	12-Jul	1980	118	4	5
1973	64.3	13-Oct	39.6	28-Oct	1979	107	5	4
1974	53.8	21-Dec	39.9	3-Feb	1981	107	6	3.33
1975	92	3-Nov	45.6	2-Dec	1972	103	7	2.86
1976	51	17-Nov	26.9	26-Dec	1975	92	8	2.5
1977	71.4	17-Jan	39.4	18-Jan	1982	80.4	9	2.22
1978	77	7-Nov	31.1	7-Nov	1978	77	10	2
1979	107	17-Dec	57.8	14-Dec	1977	71.4	11	1.82
1980	118	26-Dec	64.6	26-Dec	1985	70.6	12	1.67
1981	107	31-Oct	73.1	31-Oct	1973	64.3	13	1.54
1982	80.4	3-Dec	40	3-Dec	1971	62.9	14	1.43
1983	124	11-Jul	40.8	15-Nov	1969	60.6	15	1.33
1984	126	4-Jan	66.9	4-Jan	1974	53.8	16	1.25
1985	70.6	1-Nov	29.8	1-Nov	1976	51	17	1.18
1986	162	24-Feb	86	24-Feb	1970	36.8	18	1.11
1987	31.2	3-Mar	23.7	3-Mar	1987	31.2	19	1.05

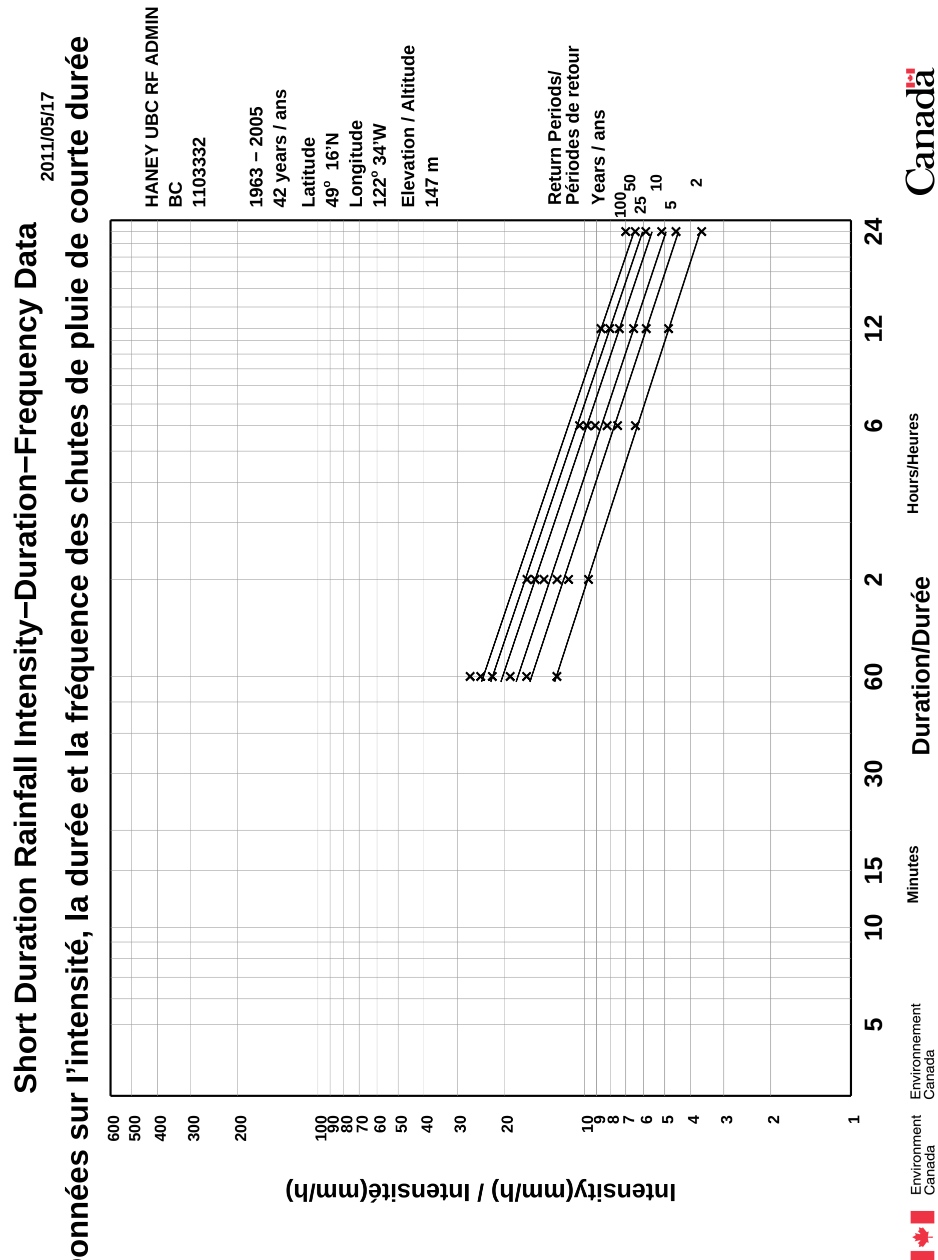
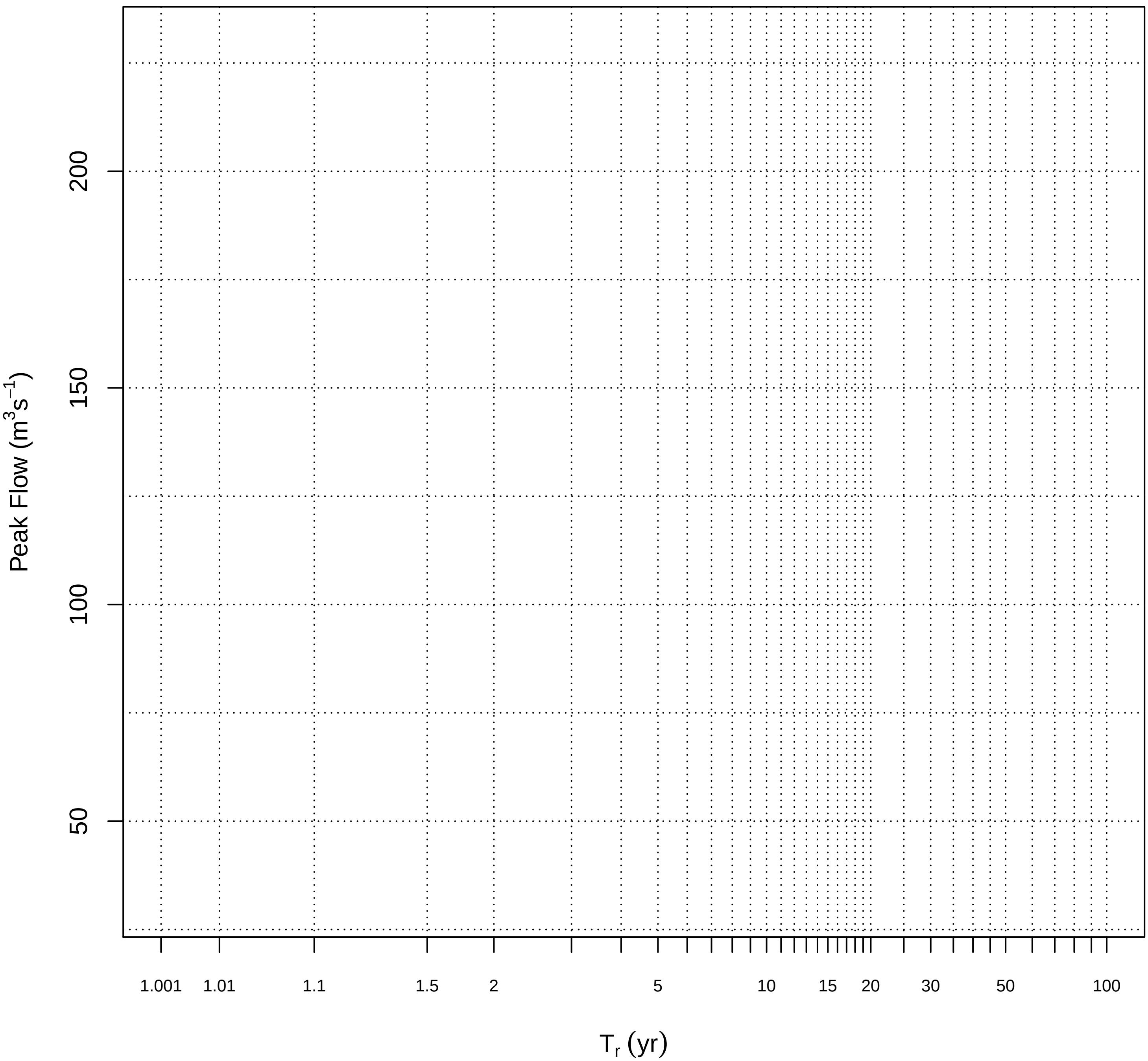


Figure 1: Intensity-duration-frequency (IDF) curves for the Haney UBC Research Forest Station, North Alouette.

Table 2: Design flood estimates. $Q_T(FFA)$ = estimate of Q_T from flood frequency analysis.
(Hand this page in with your writeup)

T_r(yr)	$Q_T(FFA)$
2	
5	
10	
25	
50	
100	


Peak Flow (m^3s^{-1})
50
100
150
200
1.001
1.01
1.1
1.5
2
5
10
15
20
30
50
100
T_r (yr)