CEE 6400 Homework#3
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All R code, plots reside here:

https://github.com/karunmj/usu-coursework/tree/master/cee6400phyhydro/hw/hw3

1) Double mass curve analysis
R software has been used (function lm()) to create best fit lines for cumulative precipitation at gage C vs cumulative precipitation at gages A, B, D, E for the time period 1970-1974 and 1975-1986. The slopes for these lines, pre and post gage C relocation, has been calculated and found to be 0.943 and 0.865 respectively.

Adjustment factor $k = \frac{slope\ for\ period\ after\ slope\ change}{slope\ for\ period\ before\ slope\ change} = \frac{0.865}{0.943} = 0.92$

Adjusted gage C values are then calculated by multiplying 1970-1974 data with the adjustment factor k, assuming it's statistically significant, and keeping 1975-1986 the same. They are tabulated in table 1.

Table 1: Adjusted gage C rainfall values

Year	C (in)
1970	**715.9**
1971	**955.4**
1972	**942.6**
1973	**757.2**
1974	**856.3**
1975	1584
1976	1215
1977	832
1978	918
1979	781
1980	782
1981	865
1982	956
1983	1102
1984	1058
1985	710
1986	1158

The measured and adjusted gage values have been plotted in figure 1.

2) Variance reduction, uncertainty analysis
   a) (Please refer to attached handwritten notes)
   b) (Please refer to attached handwritten notes)
   c) (Please refer to attached handwritten notes)

3) Intensity-duration-frequency analysis

From example 4.6 (Dingman), Table 4-12 has been modified to include intensity columns instead of depth. The following formula has been used:

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$$\text{Intensity} = \frac{Depth}{Duration}$$

Intensity versus exceedance probability percentage is plotted in log scale both x and y axis in R. Function lm() in R is then used to estimate best fit lines through them. Predict() function in R is then used to estimate 25-yr, 10-yr, 5-yr, 2-yr events' intensities which correspond to 4, 10, 20 and 50 exceedance probability percentages respectively. Figure 2, 3 and 4 shows logarithmic plots for 1-h, 6-h and 24-h respectively and figure 5, the intensity-duration-frequency plot. The intensity-duration-frequency values are tabulated in table 2.

Table 2: 2, 5, 10, 25 yr rainfalls

Return period (yr)	Duration (hr)		
	1	6	24
2	1.41	0.43	0.13
5	1.86	0.6	0.18
10	2.02	0.65	0.2
25	2.11	0.68	0.21

Fig 1: Double mass curve for Station C

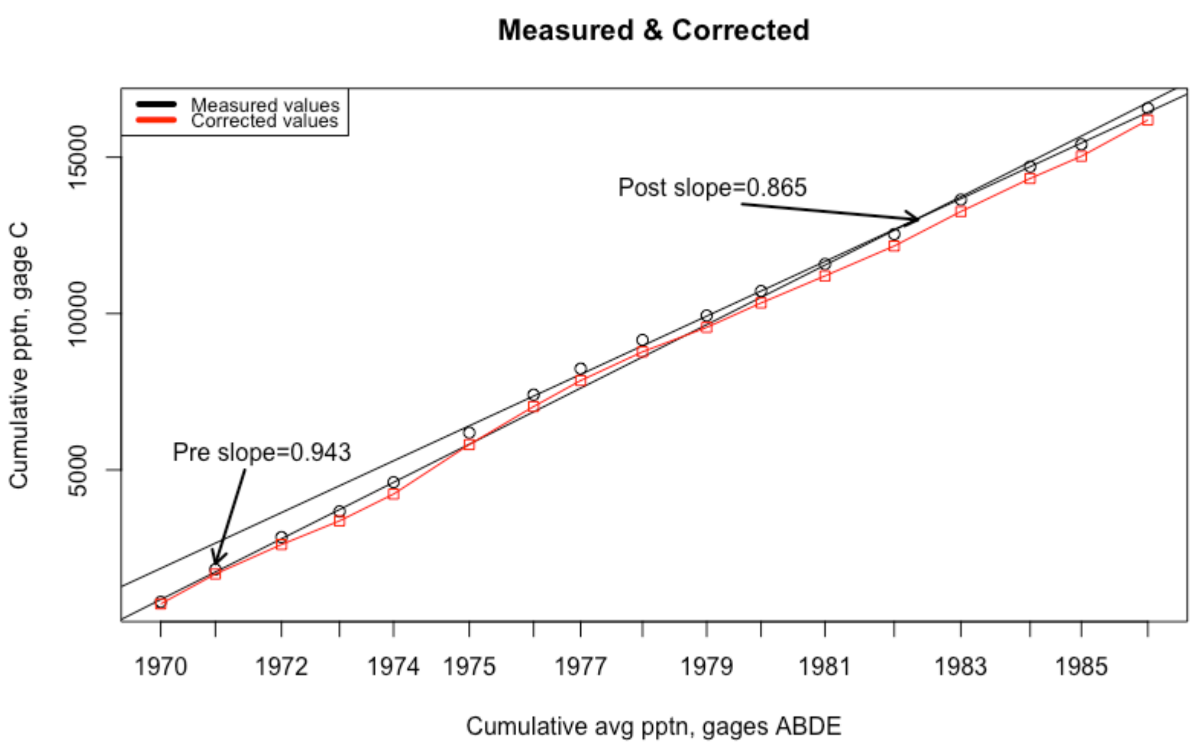

Fig 2: Logarithmic probability plot of intensity of 1-h rainfall

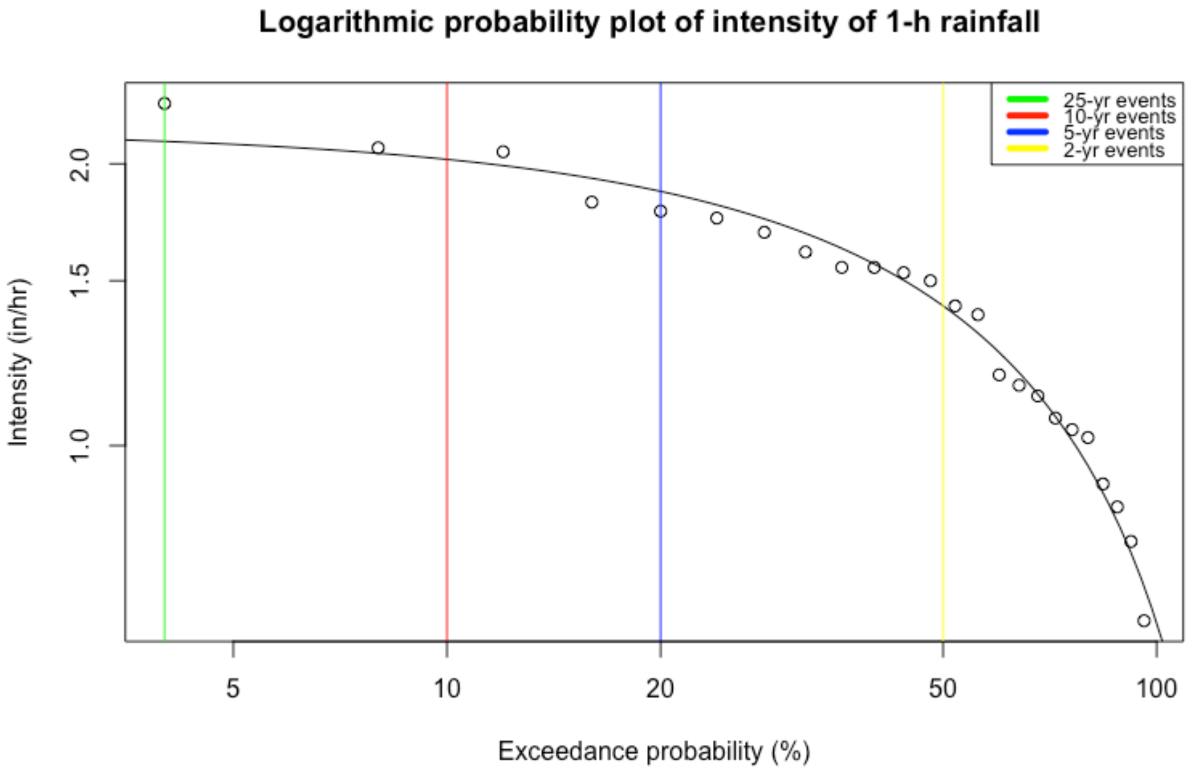

Fig 3: Logarithmic probability plot of intensity of 6-h rainfall

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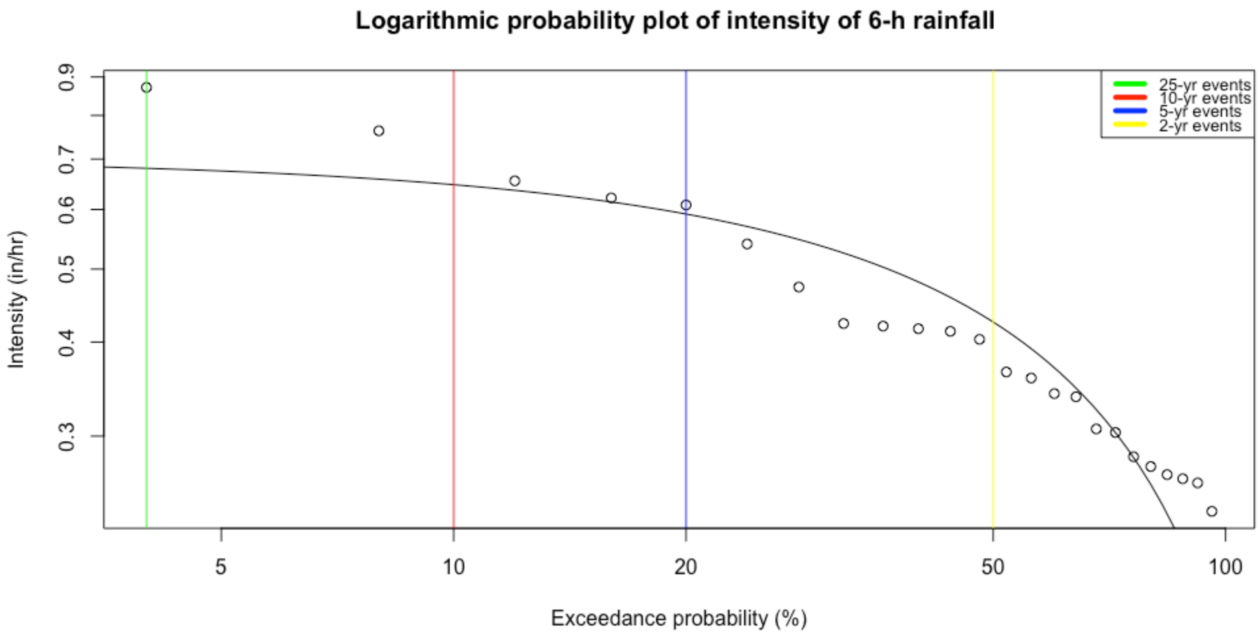

Fig 4: Logarithmic probability plot of intensity of 24-h rainfall

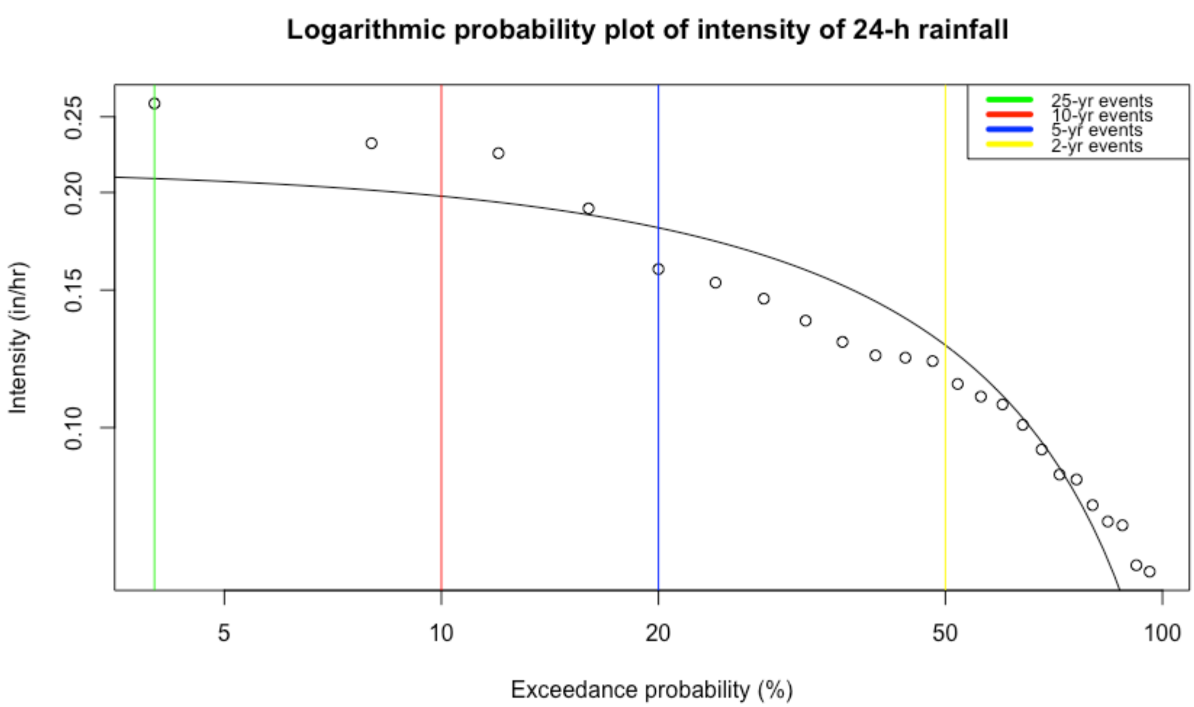

Fig 5: Intensity-duration-frequency plot

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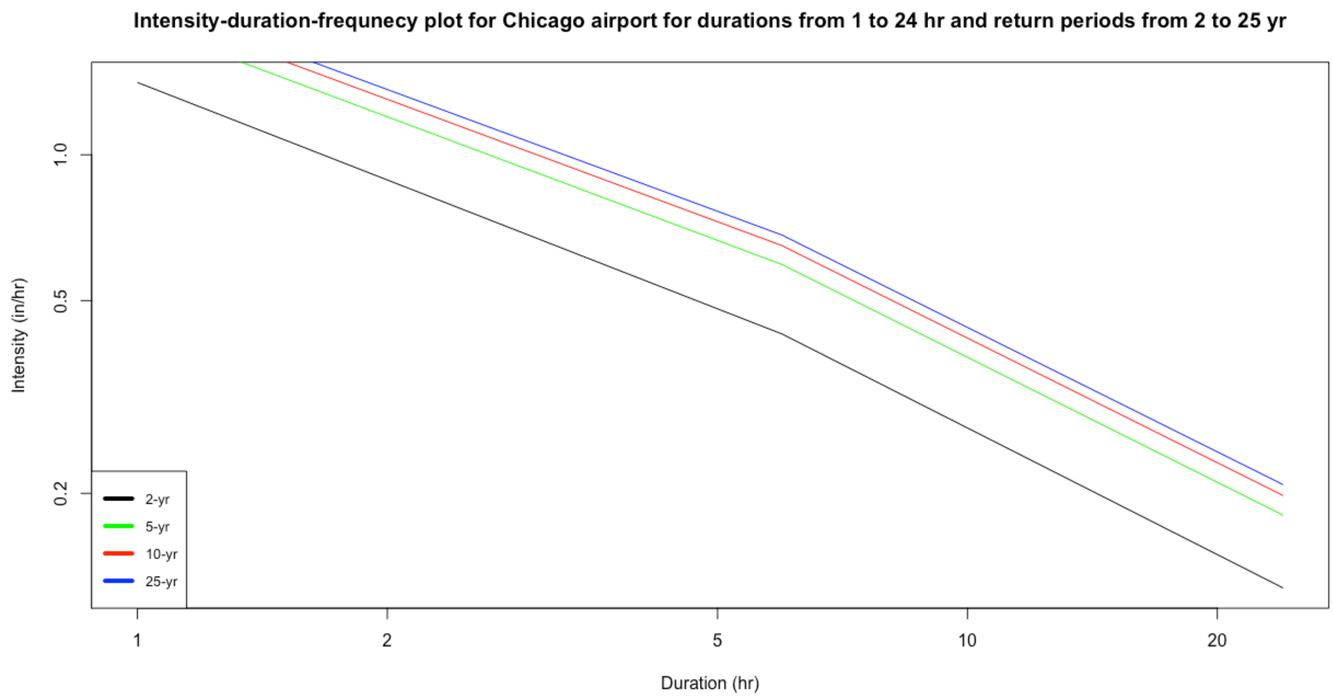


4) <u>ARCGIS rainfall analysis</u>
   a) Station identifier (staid), elevation and mean annual precipitation at the most northern and most southern rain gages in the dataset
      i) Northernmost
         (1) Station ID - p012
         (2) Elevation - 1581m
         (3) Mean annual precipitation - 558.62mm
      ii) Southernmost
         (1) Station ID – p17614
         (2) Elevation – 2098m
         (3) Mean annual precipitation - 763.62mm
   b) Find layout attached
   c)
      i) Find layout attached
      ii) Station identifier with largest Theissen polygon - p053
      iii) Theissen polygon basin average mean annual precipitation is found by the equation

$$\frac{\epsilon\ A_i P_i}{\varepsilon A i}$$

   From the ARCGIS generated dbf file, this is found out to be 476.31mm

   d)
      i) Find layout attached
      ii) I have used the Universal Kriging interpolation method
      iii)
         (1) Basin average mean annual precipitation (anntot) – 510.55mm

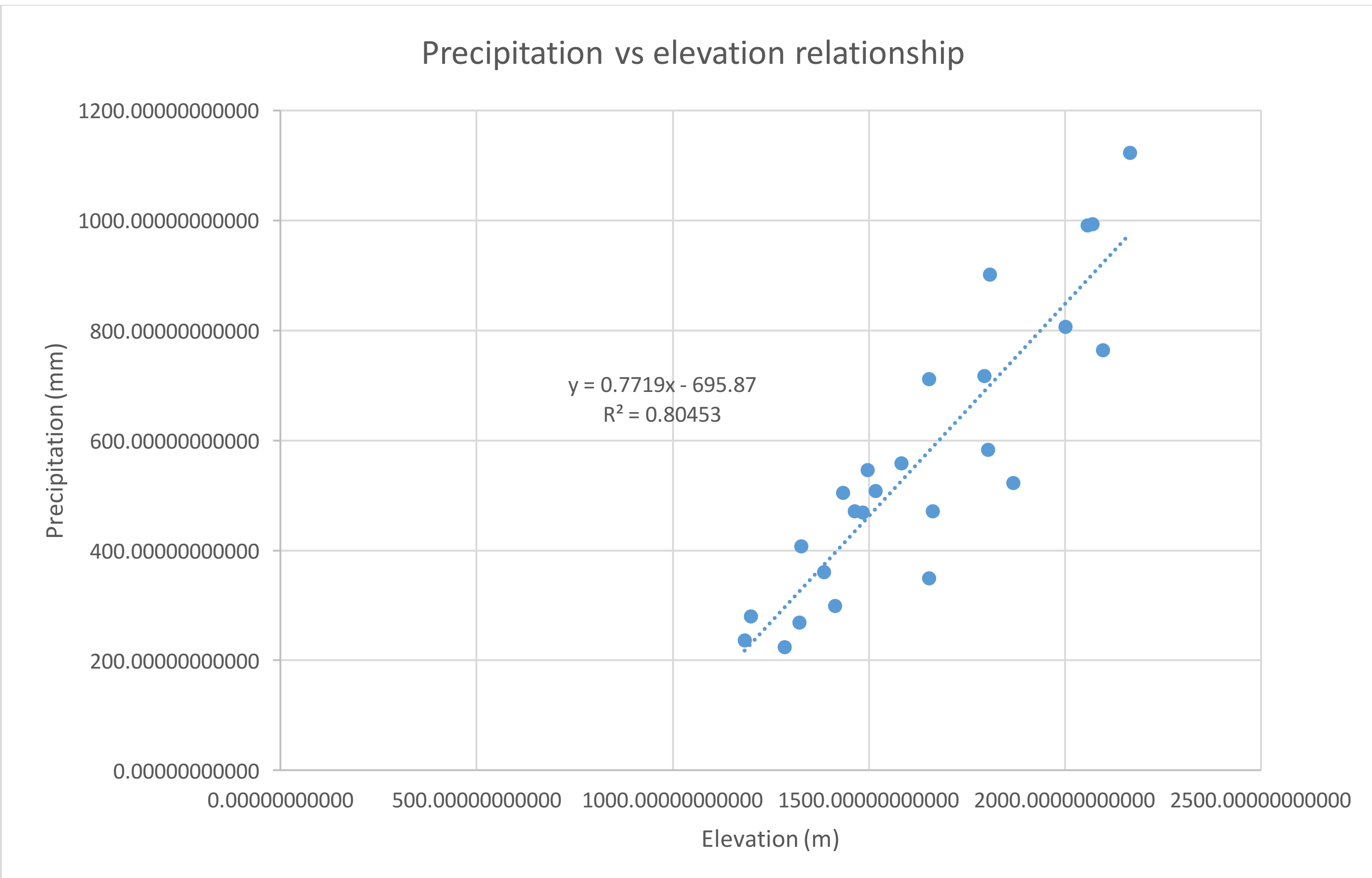
(2) Minimum precipitation - 135.32mm
(3) Maximum precipitation - 1113.95
(4) Standard deviation of precipitation - 194.48mm

e)

i) Find layout attached

ii)

(1) Basin average annual total precipitation – 484.7mm
(2) Minimum precipitation – 149.34mm
(3) Maximum precipitation - 1034.05mm
(4) Standard deviation precipitation - 198mm
(5) Precipitation versus elevation relationship



The relationship is as follows:

$$y = 0.772x - 695.87$$
$$R^2 = 0.8045$$

where y is precipitation in mm and x elevation in m