

CE EN 431
Engineering Hydrology
Winter 1994
Section 1

Lab 4: Precipitation Intensity

Submitted to:
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Introduction

The purpose of this report is to show the storm pattern for Austin, Texas. In this lab, I produced the depth-duration-frequency (DDF) curves and the frequency-intensity-duration (FID) curve for Austin.

For this report, I used information from the 1940 *US Meteorological Yearbook*. In the yearbook, I found tables of excessive rainfall for many cities and towns in the United States. After I found my data, I combined my data with the CE 431 class to make 71 years of data for Austin. I then developed the DDF and FID curves from the 71 years of data.

Using the FID curve, an engineer can determine the intensity of rainfall in a particular area for a given duration and frequency. Sometimes, an engineer may need to design a highway culvert or another hydraulic structure using the 100-year storm. After determining the properties of the watershed surrounding the culvert, an engineer can use the FID curve to determine the flow through the culvert.

Objectives/Procedure

For the objectives and procedure, I have included the lab handout. You can find the lab handout in the appendix.

Results

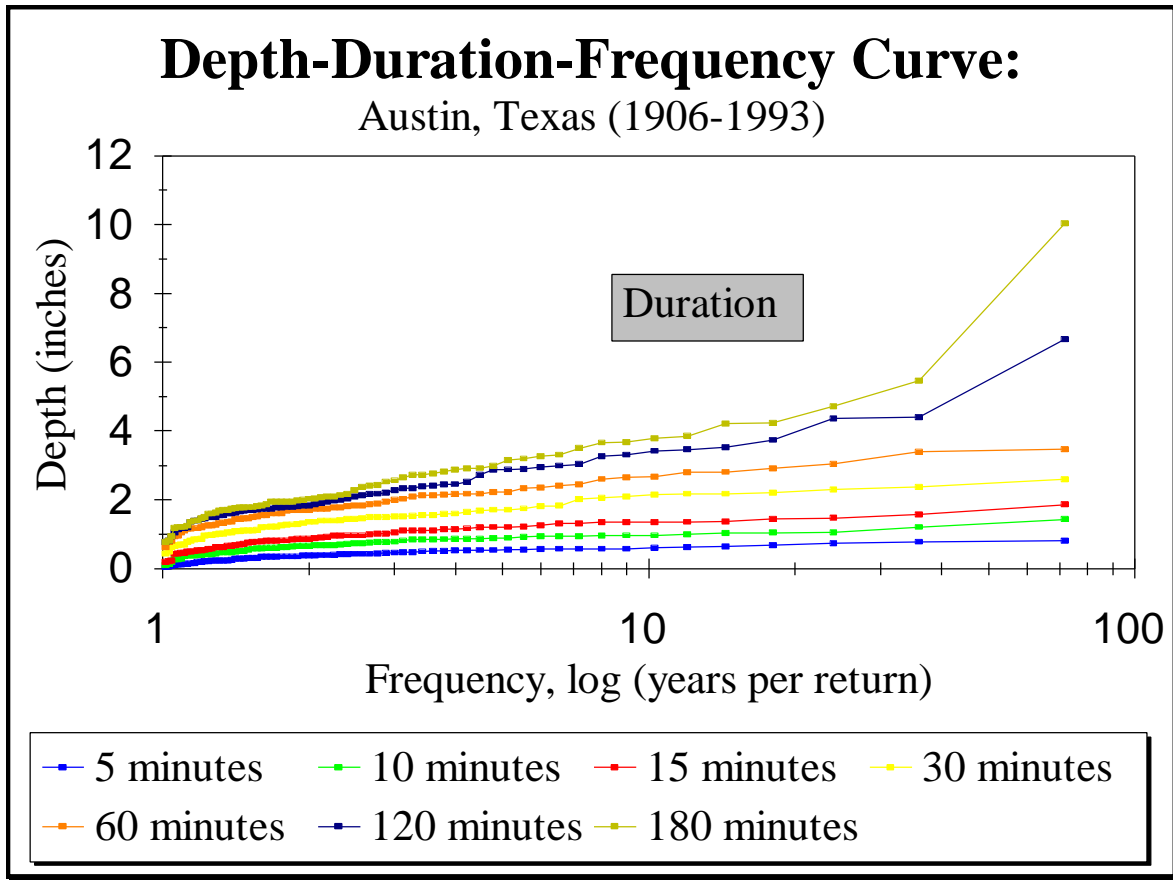


Figure 1: Depth-Duration-Frequency curve for Austin, Texas. Semilog scale. The graph has been created for durations of 5, 10, 15, 30, 60, 120, and 180 minutes.

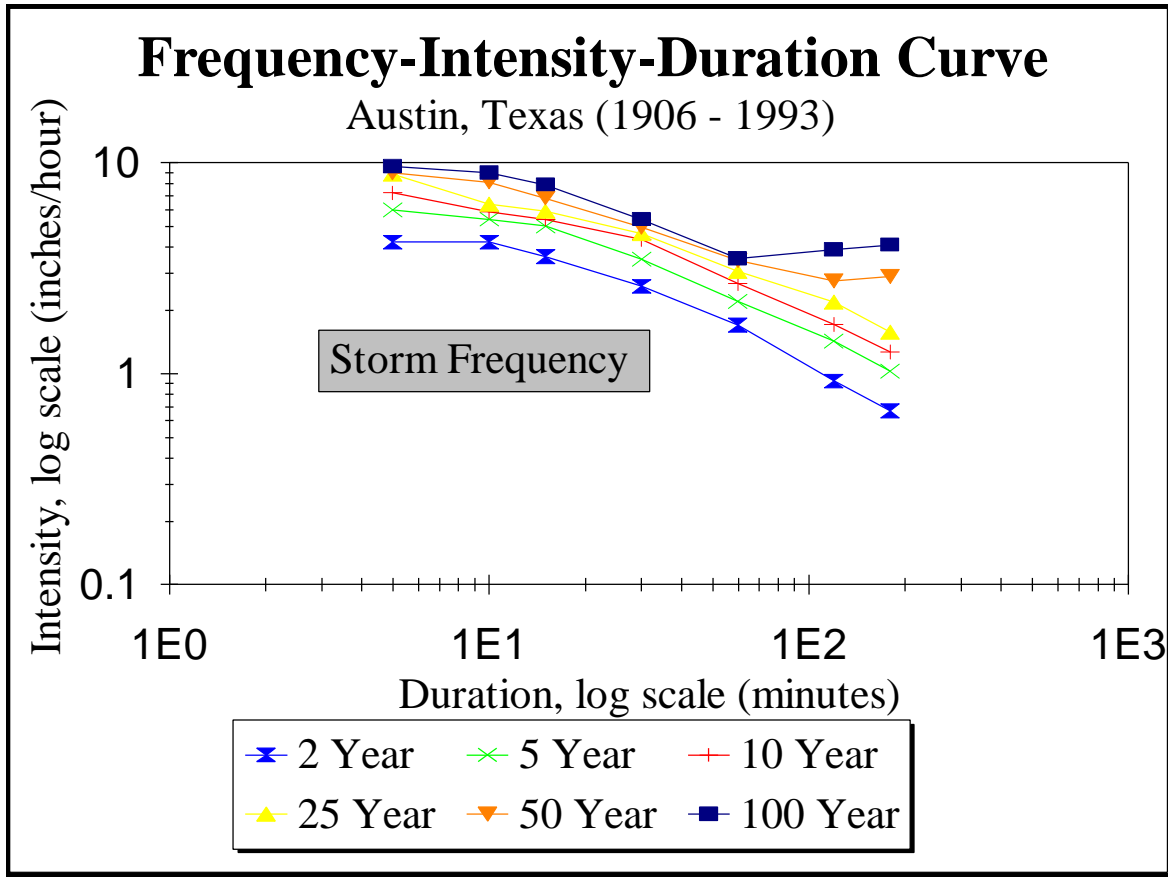


Figure 2: Frequency-Intensity-Duration curve for Austin, Texas. Log-log scale. The graph has been created for frequencies of 2, 5, 10, 25, 50, and 100 years.

Discussion

As you can see, the results are located in figures one and two above.

Depth-duration-frequency curve. The depth-duration-frequency curve was created using the following steps:

- First, our class found and tabulated the maximum rainfall depths for several different storm durations in Austin. Our table was in the following format:

frequency	Rank	Year	inches of Precipitation, 5 minutes	Year	inches of Precipitation, 10 minutes	Year	inches of Precipitation, 15 minutes
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...and so forth.

- After I obtained all the data, I ranked the precipitation at the different time intervals by the largest amount of precipitation during that interval.
- Then, I calculated the storm frequency (or the return period, t_p) by the following equation:

$$t_p = \frac{(N + 1)}{m},$$

where m = the rank and N = the total number of years of data.

- Finally, I graphed the storm frequency versus the depth of precipitation for several precipitation durations. The final curve is located in figure 1.

In Austin, there were some years that had very high flooding. The depth of precipitation in a short time period in 1921 was particularly high. In a period of 3 hours, it rained over 10 inches in Austin. This heavy rainfall in 1921 may have been the 100-year storm and may have thrown the 100-year storm values I obtained off.

Frequency-intensity-duration curve. The frequency-intensity-duration curve was created using the following steps:

- First, I created the depth-duration-frequency graph. I have just explained the process of making this graph.
- Second, I picked the depths at different frequencies and durations off the depth-duration-frequency graph. I have included the graph I used in appendix C: calculations.
- After getting several depths of rainfall at different frequencies and durations, I calculated the intensity of rainfall using the following equation:

$$i = \frac{D}{t} \times 60.$$

In this equation, D = the depth of rainfall (inches) in a particular time period, t . If the time, t , is in minutes, the intensity, i , will be in inches per hour. 60 is the conversion factor.

- Then, I made the following table:

Duration (minutes)	2 Year Intensity (inches/hr)	5 Year Intensity (inches/hr)	10 Year Intensity (inches/hr)	25 Year Intensity (inches/hr)	50 Year Intensity (inches/hr)	100 Year Intensity (inches/hr)
5	4.20	6.00	7.20	8.88	9.00	9.60
10	4.20	5.40	5.88	6.36	8.10	9.00
15	3.60	5.00	5.40	5.92	6.80	7.88
30	2.60	3.50	4.32	4.62	4.96	5.40
60	1.70	2.20	2.67	3.05	3.45	3.51
120	0.93	1.43	1.72	2.19	2.75	3.88
180	0.67	1.03	1.27	1.58	2.90	4.08

- After making this table, I was able to create the FID graph--a graph of the intensity of precipitation for specific durations and frequencies.

Calculations

The calculations were fairly straightforward and involved finding the return period and intensity of precipitation. I have described these calculations in the last section (*discussion*). The data and calculations I used for the lab are located in Appendix C.

Conclusions/Applications

In conclusion, a hydrologist can obtain data for FID curves from many sources. Sometimes, however, data for a particular area where there is no record may need to be recorded.

The FID curve can be a very useful tool for a hydrologist. The FID curve relates precipitation depth and intensity to the frequency of occurrence. Among the applications of the FID curve are the following:

- Often, engineers may want to design a channel to support the runoff from a 100-year storm. As I have said in the introduction, if engineers have data for the watershed surrounding the channel, they can calculate the flow in the channel from a 100-year storm. Then, a hydraulic engineer can design the channel to carry the flow from this 100-year storm.
- FID curves can also be used to design dams, spillways, culverts, and other hydraulic structures in the same way.
- Finally, the FID curve can be used to determine where flooding will happen in a proposed residential area.

Appendix

Appendix A: References

- Wanielista, Martin. **Hydrology and Water Quantity Control**. John Wiley and Sons, Inc. 1990.
- United States Department of Commerce, Weather Bureau. **United States Meteorological Yearbook, 1940**. Printed by the United States Government Printing Office in 1942.

The lab handout and my calculations are located on the following pages.

Appendix B: Lab Handout

Appendix C: Calculations