Environmental Hydrology Chapter 2 Equations:

Average Rainfall, the Hazen Method, the Weibull Method, Probability

Average Rainfall

The average rainfall for the entire area is then assumed to be a weighted average of the observed rainfalls, calculated by Equation 2.1:

$$P = \frac{\sum_{i=1}^{n} A_i P_i}{\sum_{i=1}^{n} A_i} \tag{2.1}$$

where *P* represents the average depth of rainfall in the watershed with a total area of $\sum_{i=1}^{n} A_i$ and *Ai* is the area of the ith polygon with precipitation of *Pi* in that polygon.

Hazen Method

The first step in the Hazen method is to assemble as many years as possible of rainfall records for the duration of interest. The annual values are first listed in order from the highest to the lowest. A ranking number is then given each rainfall amount with 1 for the highest, 2 for the second, etc. From the ranking, a plotting position is determined from:

$$F_a = \frac{100(2n - 1)}{2y} = \frac{100}{\text{Return Period, T}} \tag{2.2}$$

where F_a is the plotting position or probability of occurrence (%) for each event, y is the total number of events, and n is the rank of each event. The precipitation amounts are plotted against the probability of recurrence on probability paper. A straight line is drawn through the plotted points. The line can be extended to obtain larger return periods. The size of event for a given return period can be estimated from the graph.

Weibull Method

An alternative plotting method that has seen widespread application is the Weibull method (Chen, 2000):

$$T = \frac{y+1}{n} \tag{2.3}$$

The Weibull and Hazen methods will give similar IDF curves to each other if the period or record for a particular application is long (at least 20 years).

Probability

Sometimes, hydrologists need to estimate the probability that a given return period storm will occur at least once within a given number of years, e.g., what is the probability that a 100 year storm will occur at least once during the next ten years. The relationship to determine that probability is:

$$P(\mathrm{T},\mathrm{n}) = 1 - \left[1 - \frac{1}{\mathrm{T}}\right]^{n} \tag{2.4}$$

where P(T,n) is the probability that a *T* year return period storm will occur at least once during *n* years (Barfield et al., 1983).