CHAPTER 5

PRECIPITATION FREQUENCY ANALYSIS

5-1. General Procedures. The computation of frequency curves of station precipitation can be done by procedures similar to those for streamflow analysis described in the preceding sections. Both graphical and analytical methods may be used. In precipitation studies, however, instantaneous peak intensities are ordinarily not analyzed since they are virtually impossible to measure and are of little practical value. Cumulative precipitation amounts for specified durations are commonly analyzed, mostly for durations of less than 3 or 4 days. The National Weather Service has traditionally used the Fisher-Tippett Type I frequency distribution with Gumbel's fitting procedure. The logarithmic normal, Pearson Type III and log-Pearson Type III (Figure 5-1) distributions, have also been used with success. Station precipitation alone is not adequate for most hydrologic studies, and some method of evaluating the frequency of simultaneous or near-simultaneous precipitation over an area is necessary. Procedures for obtaining depth-area frequency curves are usually available from National Weather Service publications (references are given in subsequent paragraphs).

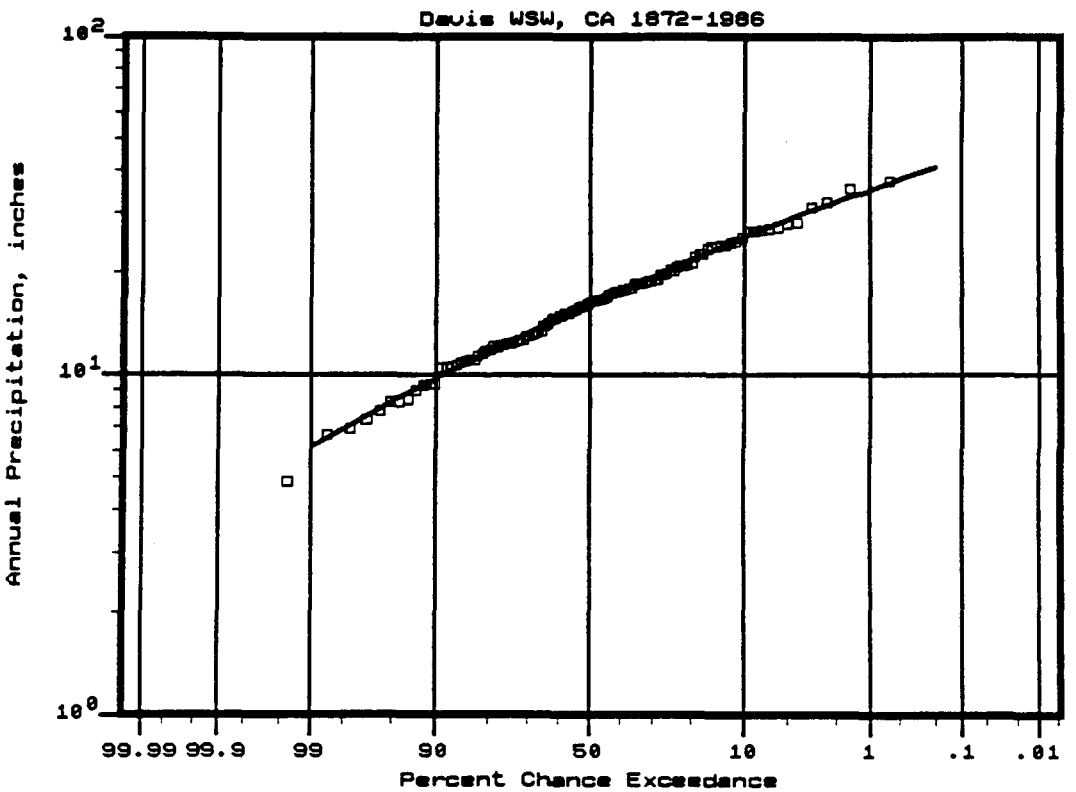

Figure 5-1. Frequency Curve, Annual Precipitation.

5-2. Available Regional Information. Where practical, use should be made of previous precipitation-frequency-duration studies that have incorporated regional information. For durations of 5 to 60 minutes in an area generally east of 105th meridian, see Hydro-35 (9). For durations of 2 to 24 hours in the same area see Technical Paper 40 (10). Because of the orographic effect, individual reports have been prepared for each of the 11 western states (24). These reports have maps for 6- and 24-hour durations with extrapolation procedures to obtain durations less than 6 hours. Longer duration events (2- to 10-days) are presented in references (21), (22) and (23).

5-3. Derivation of Flood-Frequency Relations from Precipitation.

a. Application. Precipitation-frequency relations are often used to derive flood-frequency relations where inadequate flow data are available or where existing (or proposed) watershed changes have modified (or will modify) the rainfall-runoff relationships. Guidelines for developing runoff frequencies from precipitation frequencies are presented in references (10) and (44). Flood-frequency curves developed by rainfall-runoff procedures often have less variance (lower standard deviation) than those developed from annual flood peaks. This results because not all the possible loss rates for a given magnitude of precipitation are modeled. If extensive use will be made of frequency curves derived by rainfall-runoff modeling, an appropriate ratio adjustment for the standard deviation should be developed for the region.

b. Calibration. Reference (44) describes the procedures involved in calibrating a HEC-1 model to a flow-frequency curve based either on gaged data from a portion of the basin or on regional flood-frequency relations. The coefficients from the calibrated model must be consistent with those from nearby basins that have also been modeled. It must be remembered that a frequency curve computed from observed flood peaks is based on a relatively small sample. It is possible that the flow-frequency curve derived from precipitation-frequency data is more representative of the population flow-frequency curve than the one computed from the statistics of the observed flood peaks. But, there are also errors in calibrating the model and establishing loss rates approximate with the different frequency events. Therefore, the derivation of frequency relations by rainfall-runoff modeling requires careful checking for consistency at every step.

c. Partial Duration. The precipitation-frequency relations presented in the National Weather Service publications represent all the events above a given magnitude; therefore, these relations are from a partial-duration series. The resulting flood frequency relations must be adjusted if an annual peak flood frequency relationship is desired. Or, more typically, the partial-duration series precipitation estimates are adjusted to represent annual series estimates prior to use.