yields only point values of PMP and thus requires area-reduction curves for adjusting the point values to areas of various size. A second problem is determining the appropriate value to use for K, a statistical variable that depends on the frequency distribution of extreme-value hydrological data. Different K values have been used by various investigators (Dhar and Damte, 1969; McKay, 1965).

4.2 DEVELOPMENT OF PROCEDURE

4.2.1 Basis

The procedure as developed by Hershfield (1961*a*, 1961*b*) and later modified (1965) is based on the general frequency equation (Chow, 1961):

$$X_t = \overline{X}_n + KS_n \tag{4.1}$$

where X_t is the rainfall for return period t, $\overline{X}_n$ and S_n, are, respectively, the mean and standard deviation of a series of n annual maxima, and K is a common statistical variable, which varies with the different frequency distributions fitting extreme-value hydrological data.

If the maximum observed rainfall X_m is substituted for X_t, and K_m for K, K_m is then the number of standard deviations to be added to to obtain X_m, or

$$X_t = \overline{X}_n + K_m S_n \tag{4.2}$$

The initial determination of an enveloping value of K_m was based on records of 24-hour rainfall for some 2 700 stations in the climatological observation programme. Values of $\overline{X}_n$ and S_n were computed by conventional procedures, but the maximum recorded rainfall at each station was omitted from the computations. The greatest value of K_m computed from the data for all stations was 15. It was first thought that K_m was independent of rainfall magnitude, but it was later found to vary inversely with rainfall: the value of 15 may be too high for areas of generally heavy rainfall and too low for arid areas. Values of K_m for other rainfall durations were later determined (Hershfield, 1965), and its variation with $\overline{X}_n$ for durations of 5 minutes, 1, 6 and 24 hours is shown in Figure 4.1, which indicates a maximum K_m of 20. Other investigators (Dhar and Damte, 1969; McKay 1965) have used other values for K to estimate PMP (see Section 4.5).

4.2.2 Adjustment of $\overline{X}_n$ and S_n for maximum observed event

Extreme rainfall amounts of rare magnitude or occurrence – for example, with return periods of 500 years or more – are often found to have occurred at some time during a much shorter period of record, such as 30 years. Such a rare event, called an outlier, may have an appreciable effect on the mean $\overline{X}_n$ and standard deviation S_n of the annual series. The magnitude of the effect is less for long records than for short, and it varies with the rarity of the event, or outlier. This has been studied by Hershfield (1961*b*) using hypothetical series of varying length, and Figures 4.2 and 4.3 show the adjustments to be made to $\overline{X}_n$ and S_n to compensate for outliers.

In these figures $\overline{X}_{n-m}$ and S_{n-m} refer to the mean and standard deviation of the annual series computed after excluding the maximum item in the series, respectively. It should be noted that these relationships consider only the effect of the maximum observed event. No consideration was given to other anomalous observations.

4.2.3 Adjustment of $\overline{X}_n$ and S_n for sample size

The mean $\overline{X}_n$ and standard deviation S_n of the annual series tend to increase with length of record, because the frequency distribution of rainfall extremes is skewed to the right so that there is a greater chance of getting a large than a small extreme as length of record increases. Figure 4.4 shows the adjustments to be made to $\overline{X}_n$ and S_n for length of record. There were relatively few precipitation records longer than 50 years available for evaluating the effect of sample size, but the few longer records available indicated adjustment only slightly different from that for the 50-year records.

4.2.4 Adjustment for fixed observational time intervals

Precipitation data are usually given for fixed time intervals, for example 8 a.m. to 8 a.m. (daily), 6 a.m. to noon (6-hourly), 3 a.m. to 4 a.m. (hourly). Such data rarely yield the true maximum rainfall amounts for the indicated durations. For example, the annual maximum observational day amount is very likely to be appreciably less than the annual maximum 24-hour amount determined from intervals of 1 440 consecutive minutes unrestricted by any particular observation time. Similarly, maxima from fixed 6-hour and hourly intervals tend to be less than maxima obtained from 360 and 60 consecutive 1-minute intervals, respectively, unrestricted by fixed beginning or ending times.