

Studies of thousands of station-years of rainfall data indicate that multiplying the results of a frequency analysis of annual maximum rainfall amounts for a single fixed time interval of any duration from 1 to 24 hours by 1.13 will yield values closely approximating those to be obtained from an analysis based on true maxima (Hershfield, 1961a). Hence, the PMP values yielded by the statistical procedure should be multiplied by 1.13 if data for single fixed time intervals are used in compiling the annual series. Lesser adjustments (Weiss, 1964; Miller, 1964) are required when maximum observed amounts for various durations are determined from two or more fixed time intervals (Figure 4.5). Thus, for example, maximum amounts for 6- and 24-hour periods determined from 6 and 24 consecutive 1-hour rainfall increments require adjustment by factors of only 1.02 and 1.01, respectively.

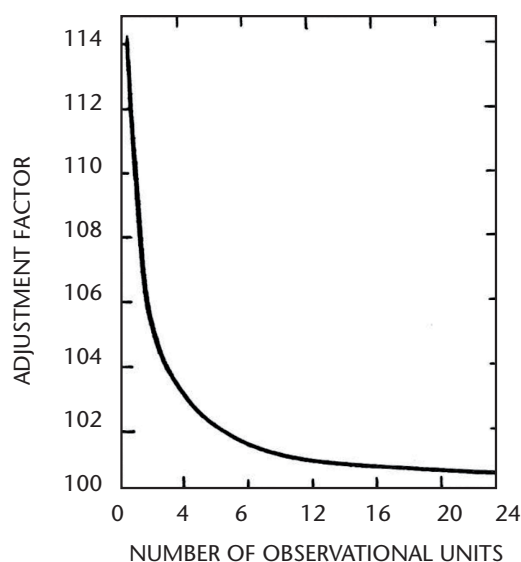
#### 4.2.5 Area-reduction curves

The procedure described here was developed for point rainfall data. Hence, its use requires some method for reducing the point values it yields to some required areal rainfall averages.

There are two types of depth–area relations (Miller and others, 1973). The first is the storm-centred relation, that is, the maximum precipitation occurring when the storm is centred on the area affected (Figure 4.6A). The second type is the

geographically fixed area relation where the area is fixed and the storm is either centred on it or displaced so only a portion of the storm affects the area (Figure 4.6B). Storm-centred depth–area curves represent profiles of discrete storms, whereas the fixed-area data are statistical averages in which the maximum point values frequently come from different storms. The storm-centred curves are appropriate for use with PMP studies.

There are many variations of the two basic depth–area relations (Court, 1961; United States Weather Bureau, 1960). Those for use with any PMP studies should be based on the depth–area–duration (DAD) characteristics of the storms types capable of producing the PMP in the region. The curves of Figure 4.7 are based on average values obtained from DAD analyses of important general storms over the western United States. The relation of Figure 4.7 is presented only as an idealized example and curves should be developed for the specific location of the project. For example, this relation does not show as much decrease with increasing area as would curves based on localized cloudbursts, and is therefore inappropriate for use where such storms would cause the PMP. They do not extend beyond 1 000 km<sup>2</sup> because extrapolation of point rainfall values becomes more unreliable as size of area increases. Necessity, however, has led to relations (McKay, 1965) relating point values to areas in excess of 100 000 km<sup>2</sup>. Point values are often assumed to be applicable to areas up to 25 km<sup>2</sup> without reduction.



**Figure 4.5. Adjustment of fixed-interval precipitation amounts for number of observational units within the interval (Weiss, 1964)**

#### 4.2.6 Depth–duration relationships

Only daily measurements of precipitation are available for many regions. Various types of depth–duration relationships have been developed to show rainfall distribution within storms. Such relationships vary a great deal depending on storm type. For example, orographic rainfall will show a much more gradual accumulation of rainfall with time than will thunderstorm rainfall.

The maximum depth–duration relation of Figure 4.8 is based on rainfall amounts in heavy storms averaged over areas ranging up to 1 000 km<sup>2</sup> in Illinois, United States (Huff, 1967). This relation arranges the rainfall increments for various time intervals in decreasing order of magnitude and not in chronological order. In other words, the curve, a depth–duration curve, shows the greatest 3-hour amount in the first 3 hours, the second greatest 3-hour amount in the second 3-hour period, and so forth. This arrangement is not intended to represent the order in which the rainfall increments occurred, nor does it do so, except perhaps