Appendix 8

WEIGHTING OF INDEPENDENT ESTIMATES

The following procedure is suggested for adjusting flow frequency estimates based upon short records to reflect flood experience in nearby hydrologically similar watersheds, using any one of the various *generalization methods mentioned in V.C.1. The procedure is based upon* the assumption that the estimates are independent, which for practical purposes is true in most situations.

If two independent estimates are weighted inversely proportional to their variance, the variance of the weighted average, z, is less than the variance of either estimate. According to Gilroy (30), if

$$z = \frac{x(V_y) + y(V_x)}{V_y + V_x} \tag{8-1}$$

then

$$V_z = \frac{V_x V_y}{(V_x + V_y)^2} \left[V_x + V_y + 2r\sqrt{V_x V_y}\right] \tag{8-2}$$

in which V_x, V_y, and V_z are the variances of x, y, and z respectively, and r is the cross correlation coefficient between values of x and values of y. Thus, if two estimates are independent, r is zero and

$$V_z = \frac{V_x V_y}{V_x + V_y} \tag{8-3}$$

As the variance of flood events at selected exceedance probabilities computed by the Pearson Type III procedure is inversely proportional to the number of annual events used to compute the statistics (25), equation (8-3) can be written

$$C/N_z = \frac{(C/N_x)\ (C/N_y)}{C/N_x + C/N_y} = \frac{C}{N_x + N_y} \tag{8-4}$$

in which C is a constant, N_x and N_y are the number of annual events used to compute x and y respectively, and N_z is the number of events that would be required to give a flood event at the selected exceedance probabilities with a variance equivalent to that of z computed by equation 8-1. Therefore,

$$N_z = N_x + N_y \tag{8-5}$$

From equation 8-1,

$$Z = \frac{xC/N_y + yC/N_x}{C/N_x + C/N_y} = \frac{x(N_x) + y(N_y)}{N_x + N_y} \tag{8-6}$$

Equation 8-6 can be used to weight independent estimates of the logarithms of flood discharges at selected probabilities and equation 8-5 can be used to appraise the accuracy of the weighted average. As a flood frequency discharge estimated by generalization tends to be independent of that obtained from the station data, such weighting is often justified particularly if the stations used in the generalization cover an area with a radius of over 100 miles or if their period of record is long in comparison with that at the station for which the estimate is being made. For generalizations based on stations covering a smaller area or with shorter records, the accuracy of the weighted average given by equation 8-6 is less than given by equation 8-5.

For cases where the estimates from the generalization and from the station data are not independent, the accuracy of the weighted estimate is reduced depending on the cross correlation of the estimates.

Given a peak discharge of 1,000 cfs with exceedance probability of 0.02 from a generalization with an accuracy equivalent to an estimate based on a 10-year record, for example, and an independent estimate of 2,000 cfs from 15 annual peaks observed at the site, the weighted average would be given by substitution in equation 8-6 as follows:

$$\text{Log } Q_{.02} = \frac{10(\log 1000) + 15(\log 2000)}{25} = 3.181$$

from which $Q_{.02}$ is 1,520 cfs. By equation 8-5 this estimate is as good as would be obtained from 25 annual peaks.

If an expected probability adjustment is to be applied to a weighted estimate, the adjustment to probability should be the same as that applicable to samples from normal distributions as described in Appendix 11, but N should be that for a sample size that gives equivalent accuracy. Thus, in the preceding example, the expected probability adjustment would be that for a sample of size 25 taken from a normal distribution.