7.4.4 Spatial distribution of rainfall map

Spatial distribution of rainfall is the process of moving the isohyetal map of the transposed storm to the design watershed.

Specific operations begin by analysis of the spatial distribution of actual storms. Existing data on storms in the design watershed (observed, surveyed or recorded in literature) are used to find general rules regarding the locations of centres and axials of storms that are similar, in terms of weather causes, to the transposed storm. These are then adjusted to fit the project.

Transposition of isohyetals should fit into the large-scale terrain of the design watershed. The storm centre should fit into small-scale terrains (such as river mouths).

7.4.5 Transposition adjustment

Transposition adjustment is the quantitative estimation of rainfall changes caused by differences between the design watershed and the transposed storm region, in terms of conditions such as regional shapes, geographical locations and terrains. Methods of orographic adjustment vary with orographic conditions.

7.4.5.1 Common methods

Transposition adjustments can be performed with methods introduced earlier in the manual. in this section, the comprehensive orographic correction method applicable to storm transpositions in orographic regions (Wang G., 1999) is the focus.

7.4.5.2 Comprehensive orographic correction method

In this method, storms in orographic regions are represented in two parts – weather system rains (weather system convergence components) and orographic rains (orographic convergence components).

Given that the weather system rain remains the same before and after the transposition, and the post-transposition efficiency increment is the difference between the orographic rains in the two regions, then the post-transposition rainfall equals the original storm weather system rain with moisture correction plus the orographic rain in the design region, that is:

$$R_B = \frac{W_B}{W_A}(R_A - R_{Ad}) + R_{Bd} \tag{7.4}$$

where R_A and R_B are the total rainfall of the transposition source region and the design region, respectively; W_A and W_B are the precipitable water of the transposition source region and the design region, respectively; R_{Ad} and R_{Bd} are the orographic rains of the transposition source region and the design region, respectively.

R_{Ad} and R_{Bd} are based on a full analysis of the regions' topographic effects on precipitations. They should be estimated using proper methods selected according to meteorological, topographic and rainfall data conditions. Existing methods for determining orographic rains may be conducted through either of two approaches – empirical comparison and theoretical computation – in order to make mutual comparisons and reasonable selections.

The empirical comparison approach involves comparing the rainfalls in the plains and the mountainous regions, respectively, and comparing the topographic profile and the rainfall profile.

7.4.5.2.1 *Comparing the rainfalls in the plains and the mountainous regions*

Rainfalls are different in plains and mountainous regions covered by the same weather system. The difference in the mean rainfalls between the regions can be viewed as caused by topography.

Let the mean rainfall of the stations in the plain be $\overline{R}_p$ and the mean rainfall of the stations in the mountainous region be $\overline{R}_s$, then the orographic rain $\overline{R}_d = \overline{R}_s - \overline{R}_p$. Note that the selected groups of stations must be representative of the regions.

This method typically applies to the separation of orographic rains for windward slopes.

7.4.5.2.2 *Comparing the topographic profile and the rainfall profile*

As is shown in Figure 7.5, the rainfall profile curve rises along the real line to point *a* past the sharp growth point *c*, which is not far from the turning point of the topographic profile. The imagined plain rainfall profile is extended along the broken line according to the trend (gentle slope) of the plain rainfall distribution. It is assumed that the separated plain rainfall centre can be superposed with the observed rainfall centre. Hence, section *ab* in Figure 7.5 can be viewed as the value of the separated orographic rain. In this method, the assumption that the two centres can be superposed often brings errors.