556.12 : 556.1

RAINFALL NETWORK FOR HYDROLOGICAL PURPOSES

For the computation of water balance, long term mean areal rainfall during a particular interval of time (season or year) and variability of rainfall are required. The economy could be the only criteria to achieve the optimum design for the estimation of areal rainfall. The problem of network design here is one of determining the minimum number of raingauge stations to the area of interest, the minimum length of data and accuracy in the measurements. In this study, the authors have applied three different statistical techniques, namely,

(*a*) Multiple correlation coefficient (MCC) method (India Met. Dep. 1972),

(*b*) Kagan's approach (Shaw and O'Connell 1974) and

(*c*) Polynomical surface fitting technique (Shaw and O'Connell 1974).

The annual rainfall data from 1901 to 1960 of 20 stations in Pen Ganga Basin have been utilized to obtain an optimum network design for the purpose of computation of areal rainfall of the basin. It is seen that all the three methods give the similar optimum network design.

The stepwise multiple regression technique was applied to 20 stations of Pen Ganga Basin (Table 1). It yielded the following regression equation :

$$Y = 0.629 + 0.210X_{17} + 0.191X_{16} + 0.155X_{11} + 0.118X_8 + 0.109X_4 + 0.108X_3 + 0.067X_{10}$$

The MCC between the variables was 0.996 which explained 97% of total variance in the computation of areal rainfall. The correlations worked out were subjected to *t*-test and were found to be statistically significant at 5% level of significance. The values of MCC were plotted against the number of variables (Fig. 1). The optimum design of network of raingauges for the computation of areal rainfall for water balance computations can be picked up from (Fig. 1) corresponding to desired accuracy. Kagan's method when applied to the basin's data gave the following correlation data :

TABLE 1

List of stations with their coordinates used in the study

Variable No.	Stations	Coordinates
1	Mehkar	(1.6, 3.2)
2	Donegaon	(2.4, 3.4)
3	Chikhli	(0.0, 4.5)
4	Washim	(4.6, 2.9)
5	Mangrulpur	(5.8, 3.9)
6	Risod	(2.7, 2.0)
7	Chandur Railway	(9.1, 6.5)
8	Barud	(10.7, 10.1)
9	Talegaon	(9.8, 5.8)
10	Yeotmal	(10.0, 4.3)
11	Darwha	(8.0, 3.7)
12	Pandherkawara	(12.0, 2.2)
13	Digras	(7.6, 2.6)
14	Ner	(8.5, 4.[illegible])
15	Umerkhed	(7.5, 0.[illegible])
16	Pusad	(6.9, 1.8)
17	Wardha	(12.3, 6.2)
18	Hinganghat	(13.5, 5.1)
19	Arvi	(10.5, 7.5)
20	Katol	(12.3, 9.0)

Annual rainfall = 953.5 mm

Overall annual variance = 267.2 mm

Coefficient of variation (c_v) = 0.28

Area of basin (A) = 48.790 sq. km.

The value of ρ_0=0.99 obtained by extrapolating the curve between ρ_d (mean correlation) and mean distance upto zero distance. The value of d_0=196 km obtained from the curve corresponding to $\rho=\rho_0/e$ (=0.37). The relative error of mean areal rainfall (Z_1) and relative error of spatial interpolation (Z_3) calculated as a function of n are depicted in (Fig. 2a). Obviously the accuracy of

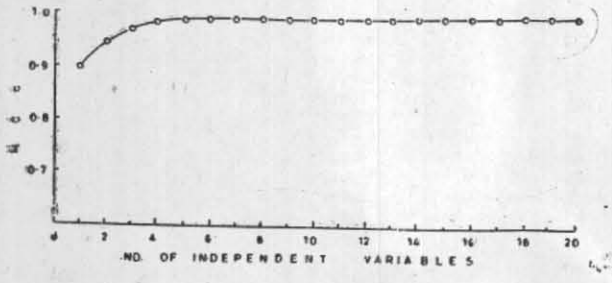

Fig. 1. Graph between MCC and No. of independent variables

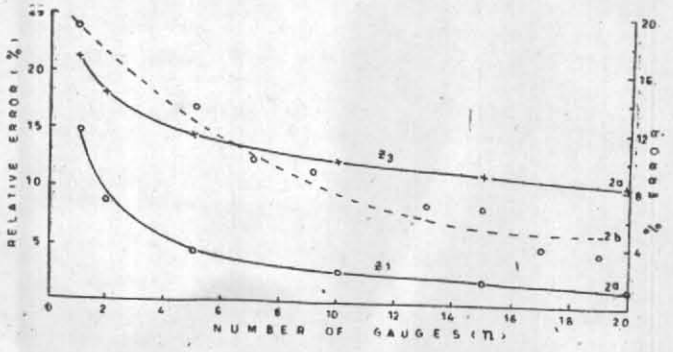

Fig. 2. (a) Relative error of mean areal rainfall (Z_1 and spatial interpolation Z_3) as functions of number of raingauges

(b) Areal rainfall by polynomial surface method

spatial interpolation is in this instance a more stringent criterion than the accuracy with which the average areal rainfall over the area may be obtained.

The polynomial surface fitting method was applied to annual rainfall of 20 stations in the basin. The basin was enclosed by rectangle with $a=13.5$ and $b=10.1$. The coordinates of each station are given in Table 1. The weight of each station were computed using second degree polynomial and method of least squares. The weighted areal rainfall was computed and its error from arithmetic mean was worked out. This procedure was repeated with randomly selected number of raingauge stations in the basin. The percentage error of the weighted areal rainfall was plotted with randomly selected number of raingauges (Fig. 2b). From Fig. 2(b), the network of raingauges may be designed according to the required accuracy. It will be seen that only 8 selected raingauges are needed to give a 10% error in the evaluation of the annual areal rainfall for water balance computations and it would give virtually the same results as using the data of 20 gauges available. But, the density of network of measuring stations is very much dependent upon the time interval (or duration) over which sampling is required.

References

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SURENDRA KUMAR
S. N. KATHURIA

Meteorological Office, New Delhi
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