551.509.3 : 551.578.1(548.2)

## AN OBJECTIVE METHOD OF FORECASTING PENTAD RAINFALL AT BANGALORE DURING MONSOON SEASON

On the lines of Lund and Wahl (1955), Jagannathan and Ramamurthi (1961) and Sajnani (1964) developed technique for forecasting pentad rainfall utilising 700 and 500-mb contour heights at selected points as predictors. A technique on similar lines has been developed to forecast pentad rainfall at Bangalore during the monsoon season.

The character of pentad rainfall was classified in to three categories — abnormal (A), normal (N) and subnormal (S) utilising 30 years (1921-50) pentad rainfall data to determine the numerical limits (Table 1) which define these classifications. 13 years (1950-62) pentad rainfall data classified as above were used for developing the technique and subsequent three years data (1963-65) were utilised for testing it and assessing skill score.

The predictors used were the 5-day mean and 1-day contour heights of radiosonde stations over Indian region for the 5-day and 1-day periods antecedent to rainfall pentad. As done by earlier workers, preliminary selection of predictors was made by examining the contrasting features of contour height patterns and height anomaly patterns of composite charts based on six abnormal and six subnormal rainfall pentads for each month. Method of graphical correlation followed by relevant statistical tests (Jagannathan and Ramamurthi 1961) was used for final selection of three sets of predictors for each month. No such predictors were available for the month of June. Suitable predictors for months July, August and September are chosen and prediction diagrams based on them are presented in Figs. 1 (a) to 3 (c). Areas $\alpha$, $\beta$ and $\gamma$ in these prediction diagrams are the areas having predominantly A, N and S points respectively.

From the contingency tables between $\alpha$, $\beta$, $\gamma$, and A, N, S based on these diagrams, contingency

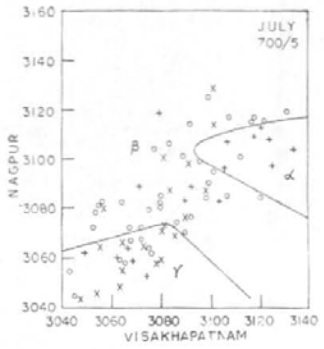


Fig. 1(a)

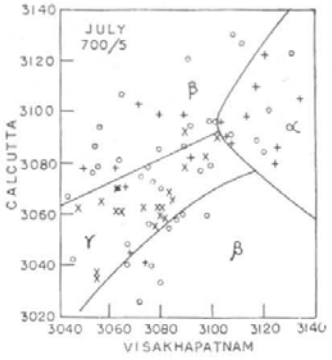


Fig. 1(b)

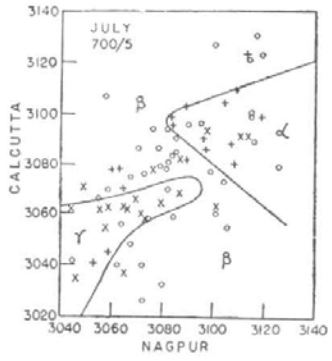


Fig. 1(c)

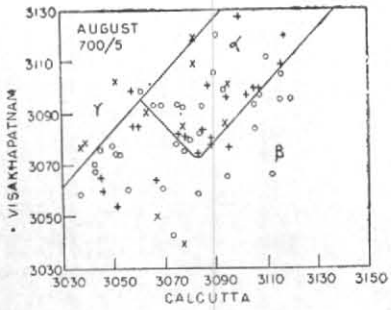


Fig. 2(a)

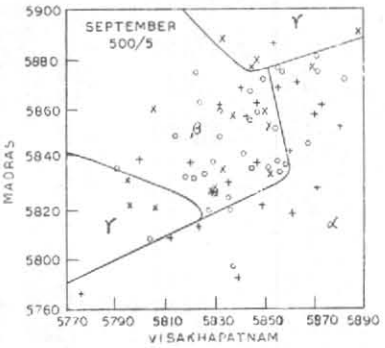


Fig. 3(a)

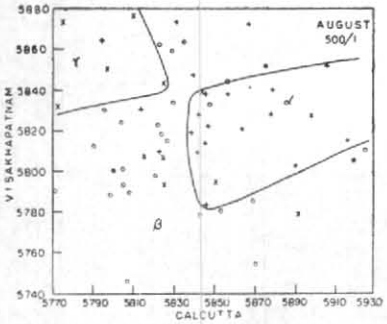


Fig. 2(b)

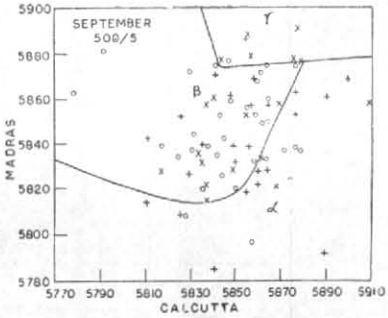


Fig. 3(b)

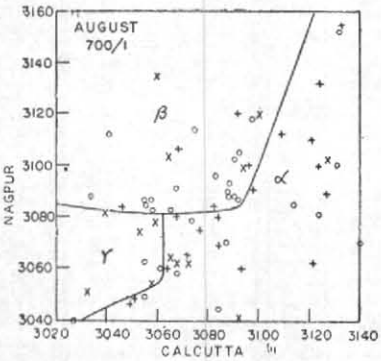


Fig. 2(c)

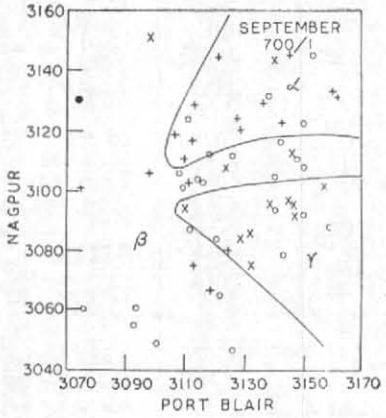


Fig. 3 (c)

**TABLE 1**

**The upper limit ($U$) of subnormal rainfall and lower limit ($L$) of abnormal rainfall at Bangalore for each pentad during monsoon season**

| Pentad No. | Pentad period | $U$ (mm) | $L$ (mm) | Pentad No. | Pentad period | $U$ (mm) | $L$ (mm) |
|---|---|---|---|---|---|---|---|
| 31 | 31 May-4 Jun | 1·8 | 27·4 | 43 | 30 Jul-3 Aug | 7·9 | 17·0 |
| 32 | 5—9 Jun | 4·1 | 16·5 | 44 | 4—8 Aug | 4·3 | 19·8 |
| 33 | 10—14 Jun | 0·5 | 9·9 | 45 | 9—13 Aug | 4·8 | 27·4 |
| 34 | 15—19 Jun | 1·8 | 6·6 | 46 | 14—18 Aug | 4·3 | 24·1 |
| 35 | 20—24 Jun | 2·8 | 7·9 | 47 | 19—23 Aug | 7·1 | 27·2 |
| 36 | 25—29 Jun | 3·1 | 12·2 | 48 | 24—28 Aug | 4·8 | 12·2 |
| 37 | 30 Jun-4 Jul | 4·1 | 19·8 | 49 | 29 Aug-2 Sep | 4·3 | 23·1 |
| 38 | 5—9 Jul | 4·3 | 16·3 | 50 | 3—7 Sep | 1·3 | 25·4 |
| 39 | 10—14 Jul | 4·3 | 16·8 | 51 | 8—12 Sep | 1·8 | 26·4 |
| 40 | 15—19 Jul | 2·5 | 17·3 | 52 | 13—17 Sep | 1·8 | 43·7 |
| 41 | 20—24 Jul | 9·4 | 29·5 | 53 | 18—22 Sep | 2·5 | 20·8 |
| 42 | 25—29 Jul | 2·0 | 17·5 | 54 | 23—27 Sep | 2·5 | 16·8 |

**TABLE 2**

**Values of (10·000+log $Rij$) based on data for 1950-1965**

| Predictor | | Predictand class: July | | | August | | | September | | |
|---|---|---|---|---|---|---|---|---|---|---|
| No. | Class | A | N | S | A | N | S | A | N | S |
| I | α | 10·3021 | 9·6098 | 9·8605 | 10·1883 | 9·7261 | 9·9528 | 9·9309 | 9·8371 | 9·7125 |
| | β | 9·8272 | 10·2166 | 9·6983 | 8·6604 | 10·2290 | 9·8800 | 9·7190 | 10·1847 | 10·3984 |
| | γ | 9·9013 | 9·7178 | 10·2410 | 9·1066 | 9·8446 | 10·2521 | 9·9022 | 9·6177 | 10·3032 |
| II | α | 10·1425 | 9·8803 | 9·6044 | 10·2860 | 9·3162 | 9·9090 | 10·1993 | 9·8431 | 9·8577 |
| | β | 9·9798 | 10·2175 | 9·3936 | 9·5737 | 10·2506 | 9·8969 | 9·8122 | 10·1436 | 9·9535 |
| | γ | 9·5521 | 9·7358 | 10·3243 | 9·9329 | 9·8227 | 10·2799 | 9·9658 | 9·7522 | 10·8842 |
| III | α | 10·3054 | 9·7286 | 9·8467 | 10·1587 | 9·8223 | 9·9409 | 10·3185 | 9·6117 | 9·7101 |
| | β | 9·7814 | 10·2500 | 9·6010 | 9·8510 | 10·1600 | 9·8890 | 9·6730 | 9·4942 | 8·8536 |
| | γ | 9·7249 | 9·6128 | 10·3216 | 9·7656 | 9·9508 | 10·2311 | 9·6990 | 9·8513 | 10·2943 |

**TABLE 3**

**Comparison of forecast with actual precipitation character**

| | | Forecast A | Forecast N | Forecast S | Total |
|---|---|---|---|---|---|
| Observed | A | 14 (67) | 1 (5) | 6 (28) | 21 (100) |
| | N | 6 (24) | 13 (52) | 6 (24) | 25 (100) |
| | S | 0 (0) | 1 (13) | 7 (87) | 8 (100) |
| Total | | 20 | 15 | 19 | 54 |

ratio $R_{ij}$ and normalised contingency ratio $R'_{ij}$ for each cell of contingency tables were calculated, where

$$R_{ij} = f_{ij} \; / \; \overset{\circ}{f}_{ij} \, ,$$

$$R'_{ij} = 1 + (R_{ij} - 1) \left[ \overset{\circ}{f}_{ij} \cdot \frac{k.l}{N_0} \right]^{\frac{1}{2}}$$

$l$, $k$ being number of predictor and predictant classes respectively (here 3 in each case); $f_{ij}$ , $f^{\circ}_{ij}$ , the frequency in $ij$ cell of actual contingency table and contingency table based on Null Hypothesis respectively, and $N_0$ the largest of the total values in the different contingency tables.

Instead of using product of normalised contingency ratio, the sum of $(10{\cdot}000 + \log R'_{ij})$ was used for the prediction scheme. Table 2 gives the values $(10{\cdot}000 + \log R'_{ij})$ for July, August and September based on data for period 1950–1965 and can be used for prediction of rainfall character by the operational forecaster (Sajnani 1964).

Table 3 gives the comparison of forecast by this technique with the observed character of pentad rainfall for 54 pentads of three monsoon months July, August and September for years 1963—65. Figures in brackets give the percentage accuracy of the forecast. It will be seen that on 67% of occasions abnormal rainfall and on 87% of occasions subnormal rainfalls was forecasted correctly.

Skill score in this case has been 0·45, which is of the same order as obtained by earlier workers.

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