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SEMI-QUANTITATIVE PRECIPITATION FORECAST FOR RAPTI CATCHMENT BY SYNOPTIC ANALOGUE METHOD

1. The dominant factor in forecasting quantitative precipitation amount is the synoptic meteorological situation. The technique of synoptic analogue is the most convenient method from the view of operational forecasting. Dhar *et al.* (1966) have studied floods and the associated meteorological conditions causing some heavy spells of rain in Assam. Lal *et al.* (1983) used synoptic analogue method for prediction of quantitative rainfall in Gomti river catchment in Uttar Pradesh using five years of data. Here an attempt has been made for the prediction of quantitative rainfall amount in Rapti catchment by utilising synoptic meteorological situations prevailing over Uttar Pradesh and neighbouring areas and rainfall data during the monsoon period from 1986-1992.

1.1. The river *Rapti* (Fig. 1) rises in the Himalayas in Nepal at an elevation of about *10,000* ft in the Daregaunra range. It has a total catchment area of 23906 sq km of which about 4688 sq km lies in Nepal and remaining in Uttar Pradesh state.

2. Seven years' rainfall data from, 1986 to 1992, for four monsoon months in respect of 18 stations scattered over the catchment areas, as shown in Fig. 1 and Table 1, has been collected and daily areal average actual rainfall computed. Synoptic situations in relation to different categories of rainfall ranges have been categorised using *Daily Weather Reports* and *Indian Daily Weather Reports*. The rainstorms less than 11 mm have been ignored and higher ranges of rainfall, *viz.*, 11-25 mm, 26-50 mm, 51-100 mm and above have been considered for matching with different categories of synoptic situations.

2.1. Total number of 220 rainstorms in association with different types of synoptic situations as specified below are shown in Table 3.

S1, 1 — A low pressure area/upper air cyclonic circulation located outside the catchment over north Bay and adjoining Bangladesh.

S1, 2 — A low pressure area/upper air cyclonic circulation located outside the catchment over Bihar plains and adjoining northeast Madhya Pradesh.

S1, 3 — A low pressure area/upper air cyclonic circulation located outside the catchment over

TABLE 1

List of raingauge stations in Rapti catchment

S. No.	Raingauge station	S. No.	Raingauge station
1	Balrampur	10	Kakrahi
2	Barhani	11	Khalilabad
3	Bansi	12	Mahrajganj
4	Bansgaon	13	Nengarh
5	Birdghat	14	Nautanwa
6	Bhinga	15	Pharenda
7	Domariaganj	16	Regauli
8	Gorakhpur	17	Siddharthnagar
9	Kakerdharighat	18	Utraula

TABLE 2

Testing of synoptic analogues of QPF for Rapti catchment during 1993 flood season

S. No.	Date (1993)	Actual average areal rainfall (mm)	Associated synoptic situations categorised (Type)	QPF range as per the analogue (mm)
1	21 Jun	17	S1, 2	11-25
2	24 Jun	88	S2, 1	51-100
3	25 Jun	67	S2, 2	51-100
4	26 Jun	58	S2, 2	26-50
5	27 Jun	38	S1, 2	26-50
6	28 Jun	23	S2, 1	11-25
7	1 Jul	15	S2, 1	11-25
8	6 Jul	16	S1, 3	11-25
9	14 Jul	12	S1, 1	11-25
10	16 Jul	23	S1, 2	11-25
11	24 Jul	19	S1, 2	11-25
12	30 Jul	16	S1, 3	11-25
13	5 Aug	17	S1, 3	11-25
14	6 Aug	28	S1, 3	26-50
15	8 Aug	29	S3, 2	26-50
16	10 Aug	58	S3, 3	51-100
17	11 Aug	55	S3, 3	51-100
18	18 Aug	18	S1, 3	11-25
19	21 Aug	23	S1, 2	11-25
20	22 Aug	24	S1, 2	11-25
21	23 Aug	28	S2, 1	26-50
22	24 Aug	55	S2, 2	51-100
23	25 Aug	41	S3, 1	11-25
24	28 Aug	51	S2, 2	51-100
25	29 Aug	22	S2, 1	11-25
26	31 Aug	13	S2, 2	11-25
27	1 Sep	24	S2, 1	11-25
28	3 Sep	18	S1, 3	11-25
29	4 Sep	14	S1, 3	11-25
30	5 Sep	49	S2, 1	11-25
31	6 Sep	47	S2, 2	26-50
32	10 Sep	28	S1, 3	26-50
33	24 Sep	16	S3, 1	11-25

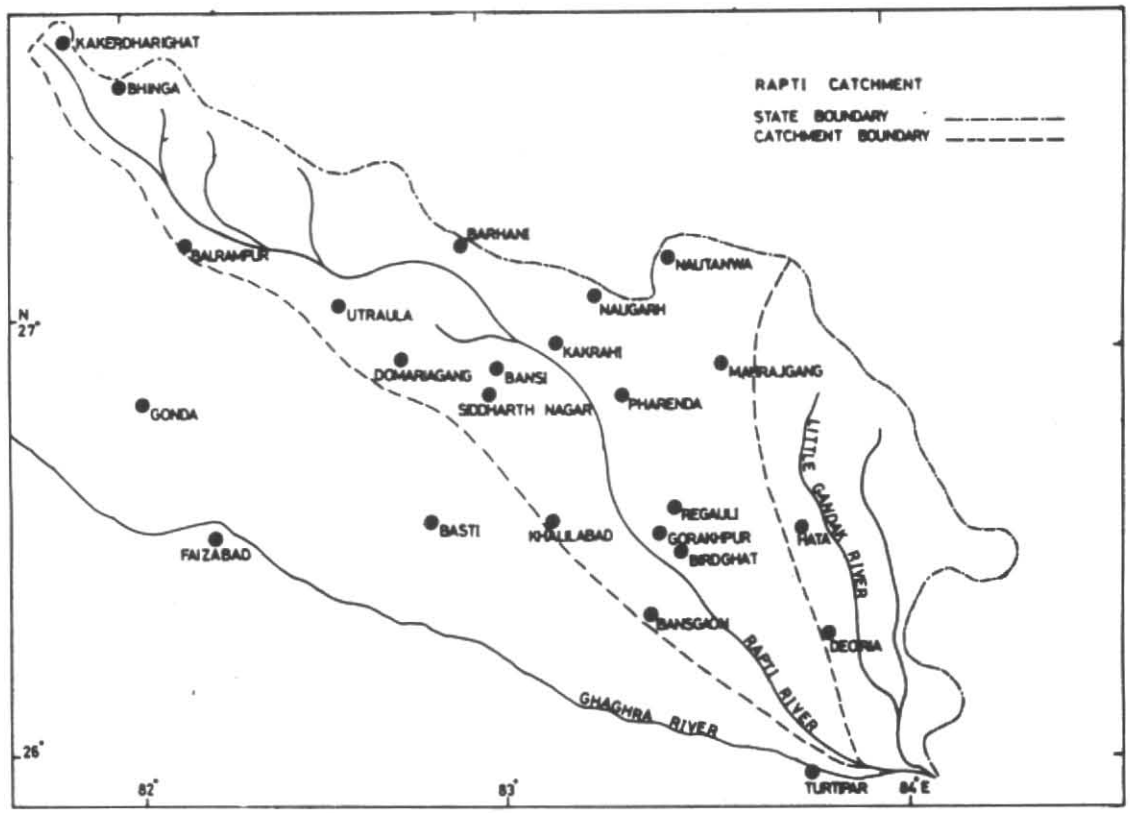

Fig. 1. Locator map of river Rapti

southwest Uttar Pradesh and adjoining north Madhya Pradesh.

S2, 1 — A low pressure area/upper air cyclonic circulation located near and moving towards the catchment.

S2, 2 — A low pressure area/upper air cyclonic circulation located over the catchment.

S3, 1 — An elongated axis of monsoon trough with embeded upper air cyclonic circulation south of the catchment.

S3, 2 — An elongated axis of monsoon trough with embeded upper air cyclonic circulation passing through the catchment.

S3, 3 — An elongated active monsoon trough with embeded upper air cyclonic circulation, close to the foothills of Himalayas.

3. It is seen that systems like, S1, 1; S1, 2; S1, 3 which are far away from the catchment area have accounted for 63% occasions when the realised rainfall was in 11-25 mm range. The contribution of systems like S2, 1 and S2, 2 is 18% considering the 126 occasions of rainfall range of 11-25 mm, whereas the contribution of systems S3, 1 to S3, 3 was found to be 19%.

3.1. Out of 73 occasions of rainstorms in the range of 26-50 mm, systems like S3, 1 to S3, 3 accounted for 41% whereas S2, 1 to S2, 2 and S1, 1 to S1, 3 account for 34% and 25% respectively.

3.2. Out of 21 occasions of rainstorms in the range of 51-100 mm and above categories S3, 2 and S3, 3 together accounted for 50% of the occasions whereas contribution of S2, 1 and S2, 2 was found to be 38% and contribution of S1, 2 to S1, 3 was about 10%.

3.3. Table 2 shows the rainstorms of different categories during the monsoon season 1993 which was tested by synoptic analogue method, it is seen that out of 33 rainstorms of all the categories the range 11-25 mm contribute almost 58% of which system S1, 1 and S1, 3 accounted for 68% of the occasions which matches well with the analogue. Out of seven cases of rainstorms in the category of 26-50 mm S2, 1 and S2, 2 accounted for 43% which is little higher than the analogue. Out of six cases in

TABLE 3

Synoptic situations and the rainstorms affecting Rapti catchment during 1986-1992 flood seasons

Average areal rainfall range (mm)	Associated synoptic situation (Type)	Total number of rainstorms occurring
11-25	S1, 1	24
	S1, 2	33
	S1, 3	22
	S2, 1	22
	S2, 2	1
	S3, 1	17
	S3, 2	4
	S3, 3	3
26-50	S1, 1	1
	S1, 2	10
	S1, 3	7
	S2, 1	18
	S2, 2	7
	S3, 1	7
	S3, 2	20
	S3, 3	3
51-100 or above	S1, 2	2
	S2, 1	5
	S2, 2	3
	S3, 2	2
	S3, 3	9
Total		220

the range of 51-100 mm and above S2, 1 and S2, 2 accounted for 67% and S3, 1 to S3, 3 accounted for 33% which shows that in the higher ranges the systems which are near the catchment play a dominant role in producing rainfall of higher ranges. Dates on which the analogue did not fit well was on 26 June, 25 August and 5 September when the estimation of precipitation forecast was a degree higher than the realised average rainfall.

4. It has been found that the systems which are far away from the catchment predominantly produce rainfall in the lower range 11-25 mm and the systems near the catchment areas or active monsoon trough with a tendency to move towards foothills produce rainfall generally in the higher ranges. On the basis of this information fairly accurate quantitative precipitation forecast can be issued by the forecaster in advance of 24 hrs for Rapti catchment.

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