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Semi-quantitative precipitation forecasts for Gomti catchment by synoptic analogue method

J. LAL*, J. S. DAY and K. K. KAPOOR

Meteorological Office, Lucknow

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सार – उत्तर प्रदेश में गोमती नदी के जल ग्रहण क्षेत्र की क्षेत्रीय वर्षा के अर्धमात्रात्मक पूर्वाभास के लिए एक सरल विधि विकसित करने का प्रयास किया गया है। क्षेत्रीय वर्षा की पूर्वानुमान परिसीमा के सिनाप्टिक अनुरूप तैयार करने क लिए विभिन्न प्रकार की सिनाप्टिक स्थितियों तथा उनसे उत्पन्न जलग्रहण क्षेत्र की तूफानी वर्षा में सहसंबंध स्थापित किया गया है। इस विधि के प्रयोग से पर्याप्त परिशुद्धता के साथ दैनिक पूर्वानुमान जारी किए जा सकते हैं।

ABSTRACT. An attempt has been made to evolve a simple method for advance assessment of areal rainfall semiquantitatively for Gomti river catchment in Uttar Pradesh. Different types of synoptic situations are correlated with their resulting rainstorms over the catchment to prepare synoptic analogues for forecast range of areal rainfall. The method can be used in day to day forecasting with reasonable accuracy.

1. Introduction

At present, reasonably accurate qualitative rainfall forecasts for areas of interest can be given 24 to 28 hrs in advance, though for hydrological forecasting, these do not serve the real purpose since quantitative precipitation forecasts (QPF) are required for rainfall run-off relationships.

One of the earliest attempts at computing precipitation rates was made by Fulks (1935). The dynamical methods based on computations of vertical velocity and moisture distribution in the vertical were not found feasible for small catchment areas for which QPF is required to be issued on operational basis to various flood forecasting centres of Central Water Commission. As such the simpler synoptic methods based on classification of synoptic situations into different types each associated with certain rainfall distribution were applied during the last decade by a few workers. Rao *et al.* (1970) classified four broad synoptic types associated with heavy rainfall over Ganga barrage catchment. Holgate (1973) related different sets of synoptic conditions, mainly the frontal systems, to rainfall amounts likely to cause flooding in various river valley areas. Abbi *et al.* (1979) identified the movement of cyclonic storms/depressions with respect to Bhagirathi catchment and prepared analogue maps depicting the associated rainfall distribution. In this paper, an attempt has been made to evolve the synoptic analogues for specified ranges of forecast areal rainfall (being used operationally by India Meteorological Department) in respect of Gomti catchment. The topography of the catchment is resonably flat and has evenly spaced raingauges with uniform rainfall pattern.

2. Description of the catchment

The river *Gomti* (Fig. 1) rises in the Gangetic plains near Mainket about 30 km east of Pillibhit town in Pillibhit district of Uttar Pradesh at an elevation of 200 m and drains the area lying between the water sheds of *Ramganga* and the *Sarda* in the upper reaches and between the *Ganga* and the *Ghaghra* lower down. From origin to its confluence with *Ganga,* the river flows in a northwest to southeast direction draining the total catchment area of 30433 sq km along a course of 940 km.

3. Data used and method of analysis

The data in respect of departmental/state raingauge stations listed in Table 1 for 4 months of

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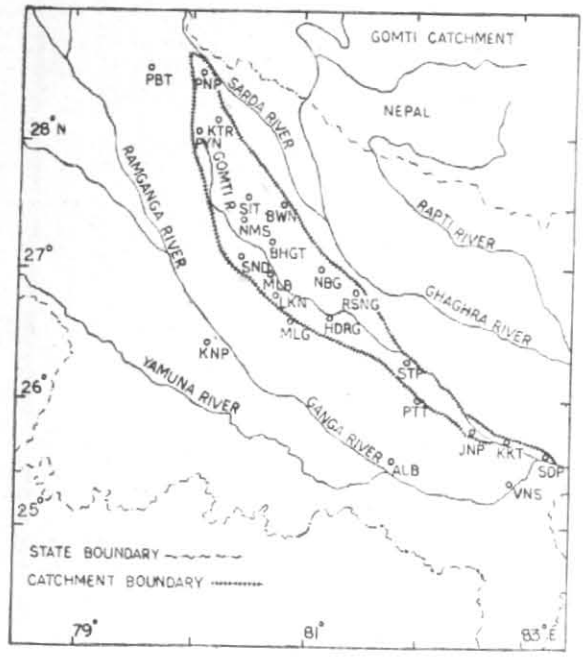

Fig. 1

flood season from June to September for the year 1976 to 1980 have been used. The daily average areal rainfall over the catchment was derived by the method of arithmetic means using the above data.

For synoptic situations corresponding to rainstorms, the daily weather charts available in the Meteorological Office, Lucknow have been utilised. It is observed that only weather systems within a range of about 500 km from the central area of the catchment contribute appreciably to the average rainfall over the catchment and the systems beyond that range have very little contribution. As such the synoptic situations have been identified accordingly.

The rainstorms with 10 mm or more of average areal rainfall in the catchment have been considered and their grouping for synoptic typing has been done as per the rainfall ranges, *viz.*, 11-25 mm, 26-50 mm and 51-100 mm or more, the usual ranges adopted by the department for issuing semi-QPF.

4. Identification of analogues

The total number of rainstorms in different rainfall ranges as mentioned above and corresponding to each characteristic synoptic situation as detailed below are given in Table 2 :

A. The rainstorms in the lower rainfall range of 11-25 mm are associated with :

(a) A low pressure area (Lopar) and/or an upper air cyclonic circulation (Cycir)/trough located outside the catchment over northwest Uttar Pradesh/adjoining northeast Rajasthan or northeast Uttar Pradesh/adjoining Bihar or southwest Uttar Pradesh/adjoining northwest Madhya Pradesh.

(b) A feeble Lopar or an upper air Cycir/trough (over north Madhya Pradesh/adjoining south Uttar Pradesh) moving towards the catchment.

(c) A Lopar moving over the catchment.

(d) A well marked Lopar/depression moving away from the catchment.

TABLE 1

List of raingauge stations in Gomti catchment

1. Bhatpurwaghat	2. Biswan	3. Haidergarh
4. Jaunpur	5. Kerakat	6. Khutar
7. Lucknow	8. Malihabad	9. Mohanlalganj
10. Nawabganj	11. Neemsar	12. Patti
13. Pawayan	14. Puranpur	15. Ramsanehighat
16. Saidpur	17. Sandila	18. Sitapur
19. Sultanpur		

TABLE 2

Synoptic situations and the rainstorms affecting Gomti catchment during 1976 to 1980 flood seasons

Average areal rainfall range (mm)	Associated synoptic situation (type)	Total No. of rainstorms occurring
11-25	A(a)	29
	A(b)	13
	A(c)	12
	A(d)	10
26-50	B(a)	11
	B(b)	2
	B(c)	6
51-100 or above	C(a)	6
	C(b)	1
Total		90

TABLE 3

Testing of synoptic analogues of QPF for Gomti catchment during 1981 flood season

S. No.	Date (1981)	Actual average areal rainfall (mm)	Associated synoptic situation as categorised (type)	QPF range as per the analogue (mm)
1	2 Jul	45	B(c)	26–50
2	3 Jul	20	—	—
3	7 Jul	11	A(a)	11–25
4	14 Jul	19	A(a)	11–25
5	15 Jul	23	A(b)	11–25
6	16 Jul	19	A(b)	11–25
7	17 Jul	23	A(a)	11–25
8	18 Jul	14	A(b)	11–25
9	19 Jul	18	A(a)	11–25
10	21 Jul	11	A(a)	11–25
11	23 Jul	19	—	—
12	27 Jul	50	B(c)	26–50
13	1 Aug	13	A(a)	11–25
14	2 Aug	26	B(a)	26–50
15	22 Aug	31	B(c)	26–50
16	23 Aug	35	A(b)	11–25
17	24 Aug	20	A(b)	11–25
18	8 Sept	25	A(a)	11–25
19	9 Sept	60	C(a)	51–100 or more
20	10 Sept	52	C(a)	51–100 or more
21	28 Sept	54	C(a)	51–100 or more
22	29 Sept	123	C(a)	51–100 or more

B. The rainstorms in the higher rainfall range of 26-50 mm are associated with :

(a) A Lopar located near and moving towards the catchment.

(b) A well marked Lopar/Depression moving over the catchment.

(c) An elongated active monsoon trough over the catchment with its axis moving either north towards or south from the foothills of Himalayas.

C. The rainstorms in the highest rainfall range of 51-100 mm or more are associated with intense systems as :

(a) A well marked Lopar/depression moving towards the catchment.

(b) An elongated active monsoon trough over the catchment with its axis moving either north towards or south from the foothills of Himalayas with embedded lows/upper air Cycirs over it.

A significant synoptic situation described under the type C(b) is peculiar to this catchment, that is, the embedded vortices are very difficult to locate on the synoptic chart either due to their small size or short duration of their occurrence. But from the forecasting point of view, such systems are very important as they cause intense rainfall in the catchment.

5. Testing of analogues

The synoptic analogues of QPF so derived were tested during 1981 flood season for each rainstorm with actual average areal rainfall more than 10 mm and the results are given in Table 3.

It is seen that out of a total of 22 such rainstorms, the actual rainfall matched well with the QPF range based on synoptic analogues in 19 cases. Of the remaining 3 rainstorms, the associated synoptic situation could not be categorised in 2 cases, where the actual rainfall corresponded to the lower QPF range of 11-25 mm. The only occasion when the analogue did not fit was in case of the rainstorm occurring on 23 August 1981 when the actual rainfall was in excess by one stage of QPF range.

6. Concluding remarks

If the assessment of synoptic situation can be made correctly with the available data at the time of issue of forecast and the direction of movement of the rainstorm producing weather systems can be predicted on the basis of all available meteorological information, the semi-QPF can be issued fairly accurately 24 hrs in advance using the above analogues for Gomti catchment.

Similar analogues can also be determined in respect of other river catchments, which will help the field forecasters in operational Flood Meteorological Offices in rather quick formulation of QPF for respective catchment/subcatchment areas under flood alert conditions thus adding to the

efficiency of advance flood warning so necessary for flood disaster preparedness and mitigation.

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