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L E T T E R S

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SEMI - QUANTITATIVE PRECIPITATION FORECAST FOR RIVER SAI CATCHMENT BY SYNOPTIC ANALOGUE METHOD

1. Flood Meteorological Offices (FMOs) are established to provide meteorological support to Central Flood Forecasting Division (CFFDs) of Central Water Commission (CWC). In addition to the surface and upper air weather charts, FMOs prepare the rainfall analysis charts for catchments and sub-catchments as the case may be on map-scale 1 cm = 10 kms.

The technique of synoptic analogue is the most convenient method and gives significant input of day to day operational forecasting. The dominant factor in forecasting qualitative precipitation amount is the synoptic meteorological situation. The Quantitative Precipitation Forecast (QPF), required for the determination of run-off, floods is, how ever, difficult for small catchment's areas by evaluating vertical velocity and moisture distribution in the upper atmosphere because of sparse upper air network. Abbi *et al.* (1979) identified the movements of cyclonic storms/depressions with respect to Bhagirathi catchment and prepared analogue maps depicting the associated rainfall distribution. Lal *et al*. (1983) studied different types of synoptic situations and correlated them with their resulting rainstorms over Gomti Catchment and prepared synoptic analogue of forecast range of areal rainfall. Ram and Pangasa (1999) attempted to predict quantitative rainfall in Ghaghara catchment by utilizing synoptic situations prevailing over Uttar Pradesh and neighbouring areas and rainfall data for the south-west monsoon period from 1991-98. Statement showing by Middle Ganga Division-II, Central Water Commission, Lucknow U. P. in "Flood Appraisal Report, Monsoon Season-2006". The details of maximum River level in meters at all forecasting site of River SAI.

A method to issue semi-quantitative precipitation forecast for SAI catchment by synoptic analogue method has been discussed based on analysis of 10 years data (1996 to 2005) and the results were cross checked with the realized Average Areal Precipitation of 2006 and 2007 flood season.

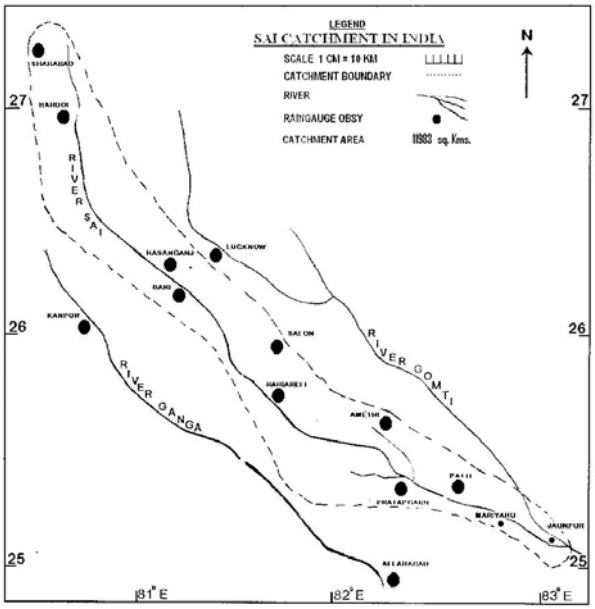

Fig. 1. Locator map of river Sai

2. The river Sai is the main tributary of river Gomti. It originates from Pilibhit and it passes through Shahjahanpur, Hardoi, Raibareli, Pratapgarh and Jaunpur between the river Gomti and river Ganga. In Jaunpur it joins the lower catchment of Gomti River. The catchment area of this river up to Raibareli is 7530 sq. kms. It is the main river of Raibareli and Pratapgarh district. It flows through Jaunpur district in the direction of 60 kms. Upstream from the Sangam of Ganga & Gomti in the downstream of Jaunpur, at the right direction upstream near Gaighat, it joins the river Gomti. The total length of the river Sai is 564 kms and the catchment area is 11,983 sq. kms (Table 1).

3. The two important parameters here are the synoptic situation and the corresponding average areal precipitation. The cases, which resulted in AAP of 10.5 mm (Rounded to 11 mm) and above only during the flood season for the year 1996 to 2005 have been used. The available 11 stations rainfall data of departmental and state raingauge, *viz*., Amethi, Bani, Hardoi, Hasanganj, Mariyahu, Patti, Pratapgarh Raibareli (T), Raibareli (FM), Shahabad**,** Solon distributed over the catchment, area as shown in Fig. 1 have been used for determination of

TABLE 1

Statement showing the details of main sites of river Sai for flood forecasting purposes

Name of River/Site	District in which situated	Catchment area up to site in (sq. km)	Co-ordinate		Type of site	River length (km)	Danger Level (m)	HFL(m)/Year
Sai			Latitude	Longitude				
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Bani	Lucknow	3105	26° 40′ 00″ N	80° 48′ 00″ E	G (Gauge)	150	115.500	116.500/1985
Raibareli	Raibareli	7530	26° 15′ 00″ N	81° 15′ 00″ E	GDSQ	240	101.000	104.810/1982

TABLE 2

Synoptic situation and rainstorm of total flood period affecting river SAI catchment during 1996 to 2005 flood season/month

Type of synoptic situation	Range of AAP (mm)	No. of rainstorms along with their probabilities in months					Total no. during flood season (probability)
		June	July	August	September	October	
A	11-25	-	-	2 (100%)	-	-	2 (100%)
	26-50	-	-	-	-	-	-
	51-100	-	-	-	-	-	-
B	11-25	1 (100%)	-	2 (100%)	2 (100%)	-	5 (100%)
	26-50	-	-	-	-	-	-
	51-100	-	-	-	-	-	-
C	11-25	-	6 (86%)	1 (100%)	8 (73%)	1 (50%)	16 (76%)
	26-50	-	1 (14%)	-	2 (18%)	1 (50%)	4 (19%)
	51-100	-	-	-	1 (9%)	-	1 (5%)
D	11-25	6 (67%)	13 (93%)	10 (83%)	10 (77%)	1 (100%)	40 (82%)
	26-50	2 (22%)	1 (7%)	2 (17%)	1 (8%)	-	6 (12%)
	51-100	1 (11%)	-	-	2 (15%)	-	3 (6%)
E^1	11-25	3 (100%)	18 100%)	15 (100%)	14 (100%)	1 (100%)	51 (100%)
E^2	26-50	1 (100%)	4 (100%)	5 (100%)	3 (100%)	2 (100%)	15 (100%)
E^3	51-100	-	2 (100%)	3 (100%)	1 (100%)	1 (100%)	7 (100%)
F	11-25	2 (100%)	3 (100%)	3 (100%)	4 (100%)	-	12 (100%)
	26-50	-	-	-	-	-	-
	51-100	-	-	-	-	-	-
G	11-25	-	-	2 (100%)	-	-	2 (100%)
	26-50	-	-	-	-	-	-
	51-100	-	-	-	-	-	-
H	11-25	-	1 (100%)	3 (100%)	1 (100%)	-	5 (100%)
	26-50	-	-	-	-	-	-
	51-100	-	-	-	-	-	-

average areal rainfall over the catchment which has been derived by the method of arithmetic means to the catchment under study. The cases in which AAP was lower than 10.5 mm are neglected, since during monsoon, light rainfall can occur on any day even without significant synoptic system in this reason.

For synoptic situation corresponding to rain storms, the daily weathers charts available in the Meteorological Center. Lucknow have been utilized after plotting of important missing data where ever necessary. It is observed that weather systems within a range of about 500 kms from the central area of the catchments contribute good rainfall over the catchment and the systems beyond that range have very little effect. As such the synoptic situation has been identified accordingly. Generally the rainstorms of greater than 11 mm lead to floods in the catchment. The rainfall amount for higher

TABLE 3

Testing of synoptic analogue of QPF for river SAI catchment for 2006 monsoon seasons

S. No.	Date	Synoptic situation (Type)	QPF range as per analogue (mm)	AAP (mm)	Verification	
					Correct	Out by one range over/under estimation
1	28 Jun 2006	E^1	11-25	16	Yes	-
2	30 Jun 2006	E^2	26-50	17	-	Over
3	09 Jul 2006	B	11-25	42	-	Under
4	11 Jul 2006	H	11-25	17	Yes	-
5	23 Jul 2006	C	11-25	11	Yes	-
6	28 Jul 2006	E^2	26-50	11	-	Over
7	29 Jul 2006	E^3	51-100	60	Yes	-
8	23 Aug 2006	B	11-25	15	Yes	-
9	26 Aug 2006	D	26-50	28	Yes	-

Percentage of correct forecast = (6/9) × 100 = 67%

ranges *viz*., 11-25 mm, 26-50 mm, 51-100 mm and more than 100 mm have been considered for matching with different categories of synoptic situations.

3.1. *The synoptic situations which gave rainfall over the catchment are classified into following categories :*

A. A low pressure area/upper air cyclonic circulation located out side the catchments over Gangetic West Bengal and adjoining areas.

B. A low pressure area/upper air cyclonic circulation located out side the catchment over Bihar planes and adjoining areas.

C. A low pressure area/upper air cyclonic circulation located out side the catchment over south Uttar Pradesh and north Madhya Pradesh.

D. A low pressure area/upper air cyclonic circulation located near and moving towards the catchment.

E^1. Upper air cyclonic circulation (CYCIR) located over the catchment.

E^2. A low pressure area (LOPAR) located over the catchment.

E^3. A well marked LOPAR/DEPRESSION located over the catchment.

F. An elongated axis of monsoon trough with embedded upper air cyclonic circulation, South of the catchment.

G. An elongated axis of monsoon trough with embedded upper air cyclonic circulation, passing through the catchment.

H. An elongated active monsoon trough with embedded upper air cyclonic circulation, close to the foothills of Himalayas.

4. The total number of 169 rainstorms have been observed over the catchment with AAP falling in 11-25 mm and higher ranges and no rainstorm of rainfall > 100 mm observed during the period under consideration:

4.1. The detail analysis of synoptic situation and number of corresponding rainstorms in different months and the flood season alongwith probabilities are given in Table 2.

4.1.1. The synoptic situation A, B, F, G and H when the low pressure area/upper air cyclonic circulation lies out side the catchment and monsoon trough lies near or passes through the catchment, AAP is mostly in the range of 11-25 mm.

4.1.2. The synoptic situation C, D and E when the low pressure area/upper air cyclonic circulation is either over or near the catchment, AAP is observed in all the three ranges, *i.e*., 11-25 mm, 26-50 mm and 51-100 mm. Generally, the forecast is given corresponding to maximum probability.

4.1.3. The SAI Catchment received AAP in the range of 11-25 mm, 26-50 mm and 51-100 mm on 133 (79%), 25

TABLE 4

Testing of synoptic analogue of QPF for river SAI catchment for 2007 monsoon seasons

S. No.	Date	Synoptic situation (Type)	QPF range as per analogue (mm)	AAP (mm)	Verification	
					Correct	Out by one range over/under estimation
1	28 Jun 2006	E^1	11-25	14	Yes	-
2	02 Jul 2007	E^1	11-25	13	Yes	-
3	17 Jul 2007	E^1	11-25	26	-	Under
4	25 Jul 2007	E^1	11-25	11	Yes	-
5	26 Jul 2007	E^1	11-25	14	Yes	-
6	27 Jul 2007	E^1	11-25	12	Yes	-
7	28 Jul 2007	E^2	26-50	39	Yes	-
8	02 Aug 2007	E^1	11-25	25	Yes	-
9	25 Aug 2007	B	11-25	15	Yes	-
10	27 Aug 2007	E^1	11-25	23	Yes	-
11	05 Sep 2007	D	11-25	17	Yes	-
12	06 Sep 2007	G	11-25	13	Yes	-
13	25 Sep 2007	D	11-25	21	Yes	-
14	28 Sep 2007	B	11-25	11	Yes	-

Percentage of correct forecast = (13/14) × 100 = 92%

(15%) and 11 (6%) occasions respectively. This shows that the SAI catchment generally receives rainfall in the range of 11-25 mm and occasionally gets very heavy rainfall in the range of 51-100 mm which are associated with strong systems near or over the catchment.

4.2. The analogues have been verified for the year 2006 and 2007 flood season, the results are given in Table 3 and 4 respectively. It is mentioned here that no QPF was issued during flood season 2006 and 2007 as the river was flowing well below danger level and no flood alert was issued at any of the gauge points. It has been observed that QPF forecast based on only analogues gives 67% and 92% correct forecast for the year 2006 and 2007 respectively. For better results, the forecasters have to use his experience and detailed analysis of synoptic situation in addition to analogues for forecasting QPF.

5. The above study concludes that the synoptic systems which are far away from the river catchment generally produce rainfall in lower range of 11-25 mm. The system likes low pressure area/upper air cyclonic circulation located over the catchments area and neighbourhood, located near or moving towards the catchments area and neighbourhood and active monsoon trough over the catchment area with a tendency to move towards North produces the rainfall generally in the higher ranges. Thus, on the basis of this study the synoptic analogue technique is fairly accurate in issuing quantitative precipitation forecast by the forecaster in 24 hours advance for SAI catchment. Further if a careful watch is kept on the weather situation and the more frequent observation will be collected during the movement of low pressure area/cyclonic circulation a reasonable success can be achieved by the forecaster in issue of an advance warning necessary for flood disaster preparedness and mitigation. Considering the various hazardness aspects of floods. It is imperative to issue the advance flood warning for various flood affected towns and agricultural field in order to provide timely relief and rescue operations to the flood victim.

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