551.509.324.2 : 551.509.335 : 556.51

SEMI - QUANTITATIVE PRECIPITATION FORECASTS FOR RIVER SHARDA CATCHMENT BY SYNOPTIC ANALOGUE METHOD

1. The technique of synoptic analogue is the most convenient method from the view of day-to-day operational forecasting. The dominant factor in forecasting qualitative precipitation amount is the synoptic meteorological situation. Out of all the aspects of Meteorology and Climatology of river basin, the most important for flood forecasting are the conditions under which flood producing heavy rains are possible in the basin. The Quantitative Precipitation Forecast (QPF) required for the determination of run-off floods is, however, difficult for small catchment areas by evaluating vertical velocity and moisture distribution in the upper atmosphere. Abbi *et al*. (1979) identified the movements of cyclonic storms/depression/monsoon troughs for a period of 1960-76 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 for areal rainfall. Ram *et al.* (1999) also studied similar type of synoptic situation for semi quantitative precipitation forecast in Ghaghara catchment.

Table 1 shows the details of all gauge sites of Sharda River for flood forecasting purposes. Statement showing by middle Ganga division-1 Central water commission Lucknow in “Flood Appraisal Report, Monsoon season, 2005”.

The present paper also attempts to predict the quantitative rainfall amount in Sharda river catchment in Uttarakhand and U.P by utilizing synoptic situation prevailing over the state and neighboring areas and rainfall data for the south-west monsoon season 1992 to 2005 has been used. The basic methodology is the same as in all the synoptic analogue methods and the results thus achieved have been tested for the monsoon data 2006.

2. The River Sharda is most important right bank tributary of the river Ghaghara; it is formed by a

TABLE 1

Detail of all gauge sites of river Sharda for flood forecasting purposes

Name of River/Site	Bank of site situated	District in which situated	Catchment area up to the site (sq. km)	Co-ordinate		Type of site	River length in km	Danger Level	HFL (Year)
Sharda				Lat.	Long.				
Banbasa	Right	Champawat	15820	28° 49′ 00″	80° 09′ 00″	G (Gauge)	230	223.50	222.60 (1999)
Palliakalan	Left	Kheri	17676	28° 23′ 00″	80° 33′ 00″	GDSQ	290	153.62	155.15 (1972)
Sharda Nagar	Right	Kheri	18553	28° 09′ 00″	80° 48′ 00″	G (Gauge)	350	135.49	136.55 (1993)

combination of number of tributaries near Barmadao Mandi in Nepal. It enters the plains near Sarkhana village.

Its tributaries are the Kali, Khoprang, Sarju, Ladiya, all on the right bank and the Chamalia on the left. It flows entirely in Uttarakhand and Uttar Pradesh through the districts of Almora, Pithoragarh and Champawat in Uttarakhand and Pilibhit, Kheri and Sitapur in U.P. It joins the river Ghaghara at upstream of Elgin bridge .The total catchment areas is about 20,720 sq. kms. of which only one-fourth lies in the plains.

There are main three river gauges network in Sharda river and their information given in Table 1.

3. The data of four months of principal flood season from June to September for the year 1992-2005 have been used, the available 13 stations rainfall data of departmental and state Raingauge, *viz*., Ascot, Champawat, Berinag, Dharchula, Lakhimpur-kheri, Nighasan, Pancheswar, Pithoragarh, Tanakpur, Tizzim, Tikonia, Banbasa, Palliakalan distributed over the catchment area as shown in Fig. 1 have been used for determination of average areal rainfall over the catchment which has been derived by the method of arithmetic mean.

For synoptic situations corresponding to rainstorms, the daily weather charts available in the Meteorological Centre, Lucknow have been utilized. It is observed that only weather systems within a range of about 500 kms 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 effect. As such the synoptic situations have been identified accordingly. For preparation of analogues, rainfall in the range 01-10 mm has not been considered. The higher ranges of rainfall *viz*., 11-25 mm; 26-50 mm, 51-100 mm and even more than 100 mm have been considered because these are important for the occurrences of floods.

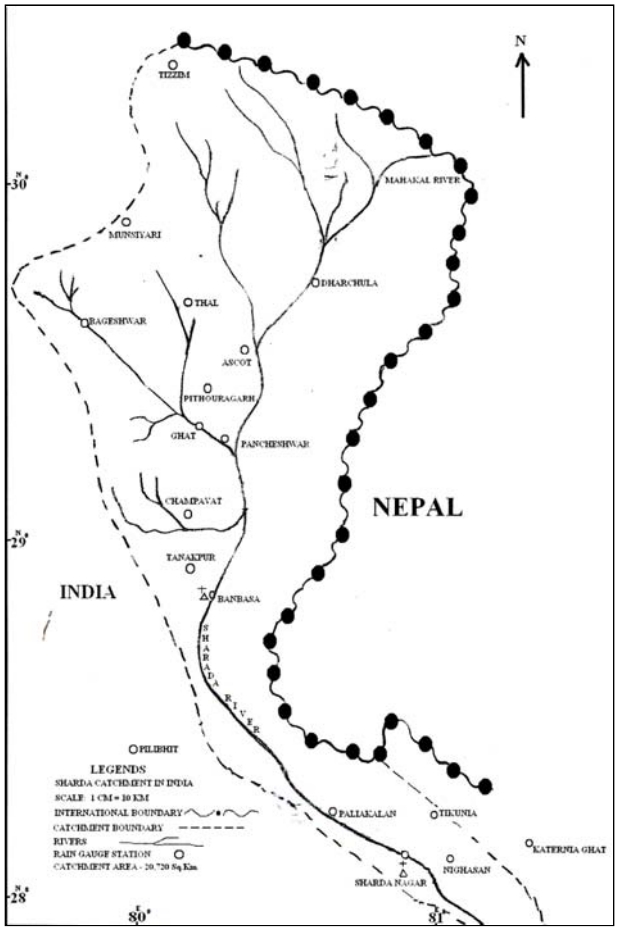

Fig. 1. Locator map of river Sharda

TABLE 2

Synoptic situation and rainstorm of total monsoon period affecting Sharda catchment, during 1992 to 2005 monsoon season/month

Average areal precipitation realized (range)(mm)	Associated synoptic situation	Total number of rainstorms occurring		
	Type	Number	Sub-Total	%
11-25	A	4		
	B	4	16	7.8
	C	8		
	D	113	174	84.4
	E	61		
	F	9		
	G	-	16	7.8
	H	7		
Total number of rainstorm		206	206	100
26-50	A	-	-	-
	B	-		
	C	-		
	D	14	54	63.5
	E	40		
	F	18		
	G	6	31	36.5
	H	7		
Total number of rainstorm		85	85	100
51-100	A	-	-	-
	B	-		
	C	-		
	D	3		
	E	10	13	72.2
	F	-		
	G	-		
	H	5	5	27.8
Total number of rainstorm		18	18	100
Grand Total number rainstorm		309	309	

3.1. The total Nos. of 309 rainstorms over Sharda catchment in association with different types of synoptic situations as specified below is shown in Table 2. There was no rainstorm which gave rainfall > 100 mm during the period under consideration.

(A) A low pressure area / upper air cyclonic circulation located outside the catchment over north Bay and adjoining Bangladesh.

(B) A low pressure area / upper air cyclonic circulation located outside the catchment over Bihar planes and adjoining northeast Madhya Pradesh.

(C) A low pressure area / upper air cyclonic circulation located outside the catchment over west Uttar Pradesh and adjoining area.

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

(E) A low pressure area / upper air cyclonic circulation located over the catchments.

(F) An elongated axis of monsoon trough with embedded upper air cyclonic circulation south of the catchments.

TABLE 3

Testing of Synoptic analogue of QPF for Sharda catchment for monsoon season, 2006

S. No.	Date	Actual average areal rainfall (mm)	Associated Synoptic situation categorized (type)	QPF range as per analogue (mm)
1.	09 July 2006	42	H	26-50
2.	10 July 2006	11	E	11-25
3.	12 July 2006	11	C	11-25
4.	13 July 2006	16	E	11-25
5.	15 July 2006	40	E*	26-50
6.	17 July 2006	11	E	11-25
7.	26 July 2006	14	E	11-25
8.	27 July 2006	14	E	11-25
9.	23 August 2006	11	E	11-25
10.	25 August 2006	11	D	11-25
11.	26 August 2006	23	E	11-25
12.	27 August 2006	19	E	11-25
13.	21 September 2006	15	E	11-25

*Along with G

(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 foot hills of Himalaya (Break monsoon)

4. The following results are found from Table 2.

4.1. Out of 206 occasions of rainstorms in the range of 11-25 mm the systems like (A, B, C), (D, E) & (F, G, H) have accounted for 7.8 %, 84.4 % and 7.8% respectively.

4.2. Out of 85 occasions of rainstorms in the range of 26-50 mm. The systems like (D, E) & (F, G, H) have been accounted for 63.5% & 36.5% respectively.

4.3. Out of 18 occasions of rainstorms in the range of 51-100 mm there were the occurrence of system (D, E) & (F, G, H) have been accounted for 72.2% & 27.8% respectively. There are no occasions of rainstorms in the range of >100 mm during the period.

4.4. Table 3 shows the rain storm of different categories during the monsoon season 2006 which was tested by synoptic analogue method. Though the test results are approximately matching with the analogue, it was observed that from 9th July 2006 to 21st September 2006. The synoptic situations are approximately same. Also on 15 July 2006 it was observed that synoptic situation 'E' has given different amount of rainfall because monsoon axis was also passing through the catchment.

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 systems like low pressure area / upper air cyclonic circulation located over the catchment area and neighborhood, located near or moving towards the catchment area and neighborhood and active monsoon trough over the catchment area with a tendency to move towards foothills of Himalayas produces the rainfall generally in the higher ranges. Thus on the basis of this study the synoptic analogue technique gives fairly accurate quantitative precipitation forecast in 24 hours advance for Sharda catchment. Further if a careful watch is kept on the weather situation and the more frequent observation are 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 which is the requirements for flood disaster preparedness and mitigation. Considering the various hazardless aspects of floods it is imperative to issued the

advance flood warning for various flood affected towns in order to provide timely relief and rescue operations to the flood victim.

6. The authors are thankful to Shri B. L. Verma DDGM, RMC New Delhi, Shri J. P. Gupta Scientist 'E' I/C M.C. Lucknow for encouragement and also thankful to Shri Rajendra Kumar, S.A. & Shri Ajay Shakti Mech. Gr.-I, M. C. Lucknow for collection of valuable data and typing of manuscript.

References

Abbi, S. D. S., Singh, Rajender and Katyal, K. N., 1979, "A case study of heavy rainfall in Bhagirathi catchment in association with September 1978 Bay depression", *Vayumandal*, **9**, 1&2, 16-22.

Lal, J., Day, J. S. and Kapoor, K. K., 1983, "Synoptic analogue method for issue of semi quantitative precipitation forecast for Gomti catchment", *Mausam*, **34**, 3, 309-312.

Ram, L. C. and Pangasa, N. K., 2009, "Semi quantitative precipitation forecast for Ghagra catchment by synoptic analogue method", *Mausam*, **51**, 1, 85-88.

MANNU RAM
MOTI LAL

Meteorological Centre, Lucknow
(*Received 8 August 2007, Modified 18 October 2010*)
e mail : mannu.ram@imd.gov.in