551.509.324.2 : 551.509.21 : 556.51

SEMI QPF MODEL FOR RIVER NARMADA BY SYNOPTIC ANALOGUE METHOD

1. River Narmada is about 1300 km long winding its way through the ranges of Satpura and Vindhya running nearly parallel to each other in an east-west orientation. It drains a catchment area nearly 94000 sq km above Gardeshwar and experiences a mean annual rainfall of about 123 cm of which about 90% occurs during SW monsoon season (Abbi 1972). The region of upper catchment lies to the south of normal position of monsoon trough. The basin is exposed to the monsoon storms and depression moving NW or WNW. The river originates in Amarkantak Plateau of Maikal ranges in Madhya Pradesh and flowing westwards it empties near Gulf of Cambay in Arabian Sea. The eastern portion of the basin starts receiving heavy rainfall under the influence of storms even when they are over Orissa. The rainfall increases and covers the entire catchment as the system travels in NW or WNW directions.

1.1. To arrive at a conclusive result as to which synoptic systems and what places along the catchment or outside the catchment were significant for an average

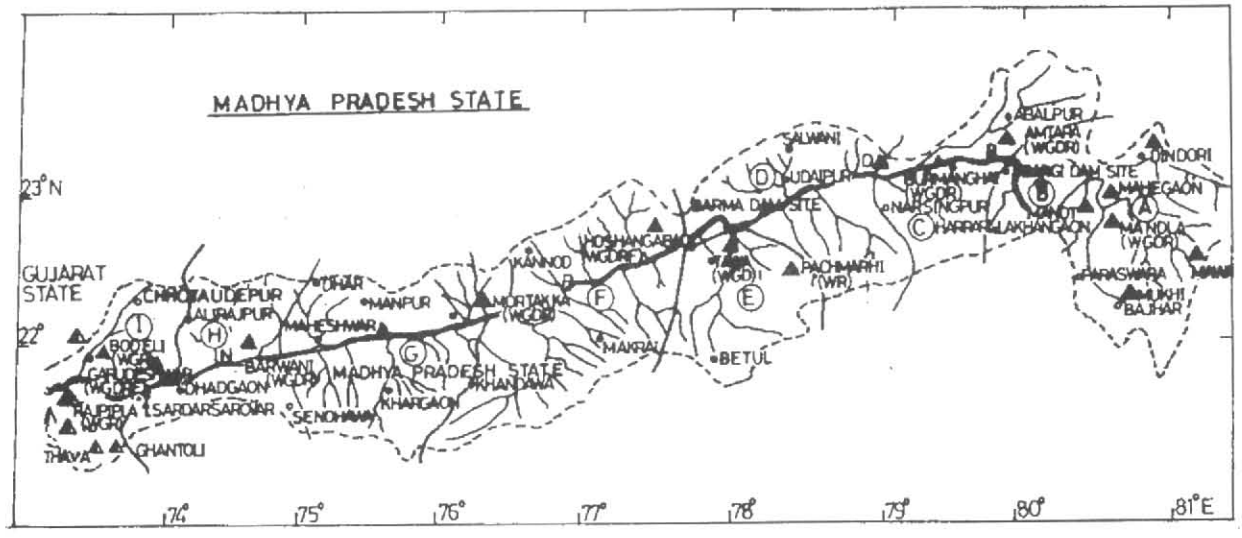

Fig.1. Narmada catchment

TABLE 1

Different synoptic situations with location and frequency of occurrence of daily rainfall

Sub basin/ Locations	Synoptic conditions: LOPAR													Synoptic conditions: DEPRESSIONS												Grand Total
	ABC				DEF				GHI				Total	ABC				DEF				GHI				Total	
	a	b	c	d	a	b	c	d	a	b	c	d		a	b	c	d	a	b	c	d	a	b	c	d	
NW Bay	12	17	6	-	11	11	6	-	3	1	-	-	67	4	4	1	-	6	1	1	-	-	-	1	-	18	85
Orissa	9	4	2	1	7	9	-	-	2	5	-	-	39	5	4	-	-	1	3	-	-	-	-	-	-	13	52
Bihar Plateau	13	9	7	-	4	10	5	-	3	-	-	-	51	-	3	-	-	1	1	-	-	-	-	-	-	5	56
East M.P.	13	19	-	-	13	21	6	1	16	5	3	-	98	7	5	8	-	2	3	14	1	-	6	3	-	49	147
West M.P.	3	-	-	-	-	3	-	-	-	2	-	2	10	-	-	-	-	-	-	-	-	-	-	-	3	3	13
	50	49	15	1	35	54	17	1	25	13	3	2	265	16	6	9	-	10	8	15	1	-	6	4	3	88	353

a-11-25mm, b-26-50mm, c-51-100mm, d->100mm rainfall

rainfall more than 11 mm per day, following study was initiated taking into consideration 10 years data from 1986-95.

2. The methodology followed was same as followed by Ray *et al.*,(1998) for the Sabarmati basin. After going through the synoptic systems and associated rainfall over the Narmada catchment for a period of 10 years, two important systems responsible for active/ vigorous monsoon were identified.

S1 - depression/ deep depression.

S2 - low/ well marked low pressure.

3. It was observed that the eastern region of the catchment starts getting rain as soon as a depression or a low pressure area develops over NW Bay and it covers the entire catchment as it moves NW or WNW direction. Thus, systems when present over following five area/ meteorological sub-divisions were considered influential in causing active/ vigorous monsoon condition over the basin.

(*i*) NW Bay of Bengal

(*ii*) Orissa

(*iii*) Bihar Plateau

(*iv*) East M.P. and

(*v*) West M.P.

This route was mostly taken by the LOPAR's or depression that formed in NW Bay and yielded heavy to very heavy rainfall over the catchment, at times leading to floods. Data for the study has been used for the period from 15 June to 15 October for the years 1986-95. Synoptic conditions based upon 0300 UTC surface and 0000 UTC upper air charts have been collected.

4. It was observed that Narmada catchment receives rain mainly due to movement of systems over M.P. (from east M.P. to west M.P). Mid-tropospheric circulations over Gujarat cause heavy rain over H & I zones of Narmada as indicated in Fig.1, but since the frequency of occurrence of MTC was quite low, it was not included in the model. Table 1 depicts that statistically 75% of the occasions of average rainfall more than 11 mm per day were due to well marked LOPAR or a LOPAR and out of these 37% of the occasions, rainfall occurred when the system was over east M.P. Similarly the remaining 25% of occasions of rainfall were because of a depression or deep depression formed in NW Bay and their movement in WNW direction. Except for very few cases most of the depression or deep depression which formed in NW Bay and moved in WNW direction, weaken into a well marked LOPAR by the time they reach east M.P. 45% of the occasion of average rainfall more than 11 mm per day were due to either of these two system over M.P. and most of the cases of rainfall more than 100 mm were due to either of these systems over central to west M.P.

TABLE 2

Quantitative precipitation forecast model for Narmada basin

	Synoptic conditions					
	Depression			LOPAR		
Sub basin / Locations	ABC	DEF	GHI	ABC	DEF	GHI
NW Bay	11-25	11-25	-	11-25	11-25	-
Orissa	11-25	25-50	-	11-25	11-25	-
Bihar Plateau	25-50	11-25	-	11-25	25-50	-
East M.P.	25-50	50-100	25-50	25-50	25-50	11-25
West M.P.	11-25	50-100	>100	-	25-50	50-100

Table 2 gives the semi quantitative model. It was observed that most of the cases of active or vigorous monsoon condition over the basin were due to following synoptic conditions.

4.1. For zone ABC, a well marked LOPAR or a depression over Orissa or Bihar Plateau.

4.2. For zone DEF, it gets heavy rain when the depression or a well marked LOPAR weakened out of a depression lies over east M.P.

4.3. Zone GHI gets heavy rain as the above system travels and comes to eastern or central west M.P.

5. The study was mainly done to identify active and vigorous monsoon condition, leading to flood, as this is also the criteria for issue of quantitative precipitation forecast during monsoon. Since the simple cyclonic circulations over the area of study were responsible for less than 25 mm of rainfall, they have not been considered important for the study. The cases of rainfall where we could not find the associated synoptic condition due to non-availability of IDWR or WWR, have not been considered for the study. Therefore, the 353 occasions considered in the study are not the total number of occasions which might have occurred during ten years. Each occasion defines each day average rainfall more than 11 mm.

The model was verified for the years 1996 & 1997. For both the years it was observed that 50-55% of QPFs issued on the basis of the model were correct, 15-20% were out by one stage. The remaining about 30% were out by two stages, mostly due to following reasons.

5.1 If the system movement is very slow that is slower than normal expected.

5.2 Abrupt change in the direction of the system.

The Narmada basin being spread over M.P., Maharashtra and Gujarat, starts getting rain as soon as a LOPAR is formed in NW Bay and is affected by it till it strengthens and travels upto west M.P. and then further weakens. It is expected that the results can be further improved by increasing the density of the network of raingauges over the basin.

6. The authors are grateful to Shri R.K.Kankane, Director, Met. Centre, Ahmedabad for encouragement and providing necessary facilities for carrying out the present study and Ms Geeta Manjal for typing this manuscript.

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KAMALJIT RAY
D.M. PATEL

Flood Meteorological Office,
Ahmedabad-380003, India
13 August 1998, Modified 17 August 1999