

# Weather

## MONSOON SEASON (JUNE-SEPTEMBER 1987)\*

### 1. Introduction

The summer monsoon rainfall during 1987 was excess (departure from normal +11% and more) or normal (departure +10% to -10%) in only 10 sub-divisions of which 6 sub-divisions were from northeast India, three from the Peninsula and the tenth was Lakshadweep. Areawise, these 10 sub-divisions constitute about 20 per cent of the country. During the last five decades the 1987 monsoon rainfall is comparable with the 1972 monsoon rainfall, when the excess or normal rainfall covered around 20 per cent of the country comprising of eight meteorological sub-divisions, namely, Andaman & Nicobar Islands, Assam & Meghalaya, Gangetic West Bengal, Orissa, hills of west Uttar Pradesh, Haryana, Tamil Nadu and south Interior Karnataka. Monthly and seasonal rainfall and percentage departures from normal are given in Table 1. Seasonal rainfall departures analysed on the basis of individual station rainfall data are shown in Fig. 1.

The seasonal trough at 0.9 km a.s.l. appeared over north India to the east of Long. 80°E in the third week of June. It became well established over the plains of north India during the second week of July. Though it became weak towards the end of this month, it became active again in the second fortnight of August. During September it was seen mostly to the east of Long. 80°E.

During July it lay around its normal position, while in August the western end (west of Long. 80°E) of it mainly lay to southern latitudes with respect to its normal position.

For classification of rainfall distribution two norms have been used, one for describing the seasonal and the other for describing the monthly rainfall. This is because the limits for describing normal rainfall are generally decided on the basis of the variability or the standard deviation of the rainfall. As the period increases the standard deviation decreases and *vice-versa*. Thus, in the case of seasonal rainfall, where the period is larger, the limit of  $\pm 10$  per cent departure from normal has been adopted for defining normal rainfall, whereas in describing the monthly rainfall the limits of  $\pm 19$  per cent departure from the normal has been taken for defining the normal rainfall.

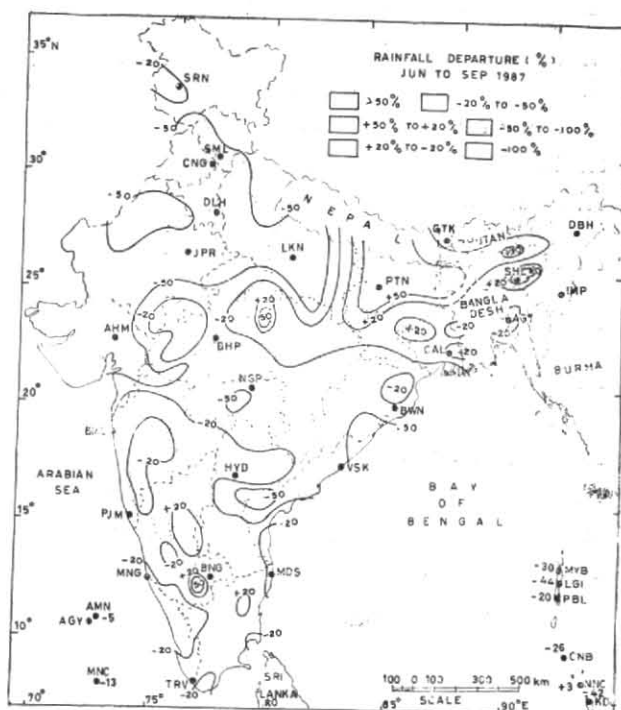


Fig. 1. Rainfall departure (per cent), June-September 1987

### 2. Chief features of the season

#### 2.1. Advance of monsoon

Southwest monsoon set in over south Kerala on 2 June. Thereafter, it steadily progressed northwards along the west coast and covered up to south Gujarat by 13 June. The Bay branch of the monsoon covered Andaman & Nicobar Islands on 30 May and set in over Tripura, Mizoram & Manipur on 4 June. It continued to advance westwards and covered northeast India outside Orissa and western parts of Bihar by 8 June. Monsoon covered the interior parts of Peninsula and south Madhya Pradesh by 16 June. After 16th, its further advance over the sub-continent halted for about

\*Prepared by S/Shri Nootan Das, M.R.M. Rao and N.C. Biswas, Meteorological Office, Pune

TABLE 1

Statement showing sub-divisional means of rainfall (mm) in each month (June-September 1987) and during the season as a whole

Sub-divisions	June		July		August		September		June to September			
	Actual (mm)	% dep. from normal	Actual (mm)	% dep. from normal	Actual (mm)	% dep. from normal	Actual (mm)	% dep. from normal	Actual (mm)	Normal	Dep. from normal	% dep. from normal
1. Andaman & Nicobar Islands	338	-24	70	-82	510	31	288	-34	1206	1652	-446	-27
2. Arunachal Pradesh	433	-36	1350	89	907	45	613	63	3302	2392	911	38
3. Assam & Meghalaya	359	-24	509	32	291	-14	389	55	1548	1447	101	7
4. Nagaland, Manipur, Mizoram & Tripura	279	-32	285	-26	322	-9	290	35	1176	1366	-190	-14
5. Sub-Himalayan West Bengal & Sikkim	567	-6	727	12	1000	84	529	15	2823	2255	568	25
6. Gangetic West Bengal	174	-29	462	52	440	47	294	23	1370	1089	281	26
7. Orissa	93	-55	306	-12	182	-46	135	-48	717	1148	-432	-38
8. Bihar Plateau	84	-55	381	12	389	17	283	27	1137	1084	53	5
9. Bihar Plains	149	-19	469	48	568	86	369	64	1555	1030	525	51
10. East Uttar Pradesh	12	-88	206	-32	144	-54	217	12	579	915	-336	-37
11. Plains of West Uttar Pradesh	27	-68	120	-57	135	-52	127	-24	409	814	-404	-50
12. Hills of West Uttar Pradesh	63	-71	329	-40	346	-34	179	-36	918	1572	-654	-42
13. Haryana, Chandigarh & Delhi	47	-10	27	-85	110	-39	15	-88	200	535	-336	-63
14. Punjab	32	-20	32	-81	99	-38	8	-93	171	492	-321	-65
15. Himachal Pradesh	105	-11	158	-69	247	-48	83	-61	593	1312	-719	-55
16. Jammu & Kashmir	131	133	56	-59	69	-45	35	-58	291	400	-110	-27
17. West Rajasthan	45	69	31	-69	40	-63	1	-99	117	290	-173	-60
18. East Rajasthan	33	-44	51	-79	227	-5	15	-87	327	655	-328	-50
19. West Madhya Pradesh	73	-34	191	-42	368	22	115	-40	747	937	-190	-20
20. East Madhya Pradesh	63	-62	289	-28	281	-29	291	30	924	1190	-266	-22
21. Gujarat Region, Daman, Dadra & Nagar Haveli	81	-21	80	-74	160	-23	2	-98	324	773	-449	-58
22. Saurashtra, Kutch & Diu	22	-69	39	-83	40	-68	1	-99	101	513	-411	-80
23. Konkan & Goa	694	1	916	-9	913	51	171	-47	2695	2613	82	3
24. Madhya Maharashtra	96	-6	81	-54	180	50	47	-66	404	537	-133	-25
25. Marathwada	172	27	139	-30	236	30	35	-81	582	698	-116	-17
26. Vidarbha	118	-27	195	-41	266	-3	44	-79	623	975	-352	-36
27. Coastal Andhra Pradesh	57	-41	76	-53	133	-8	60	-61	327	558	-231	-41
28. Telangana	81	-42	244	-6	243	17	85	-57	653	805	-152	-19
29. Rayalaseema	43	-42	30	-72	210	92	108	-26	392	437	-45	-10
30. Tamil Nadu & Pondicherry	53	24	21	-67	63	-30	107	19	244	284	-40	-14
31. Coastal Karnataka	1143	17	610	-48	801	20	127	-63	2681	3164	-482	-15
32. North Interior Karnataka	102	-9	81	-57	196	37	113	-31	492	609	-116	-19
33. South Interior Karnataka	95	36	55	-45	114	22	147	24	411	381	30	
34. Kerala	551	-7	187	-68	429	30	148	-38	1315	1754	-439	-25
35. Lakshadweep	356	16	29	-90	276	44	193	20	853	940	-87	-9

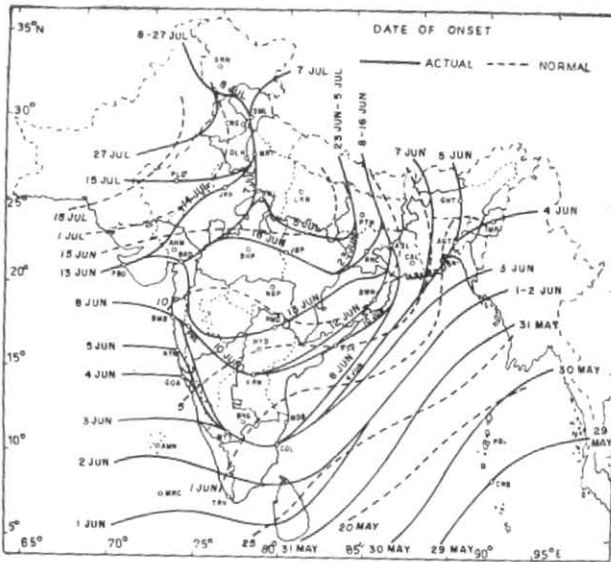


Fig. 2. Advance of southwest monsoon, 1987

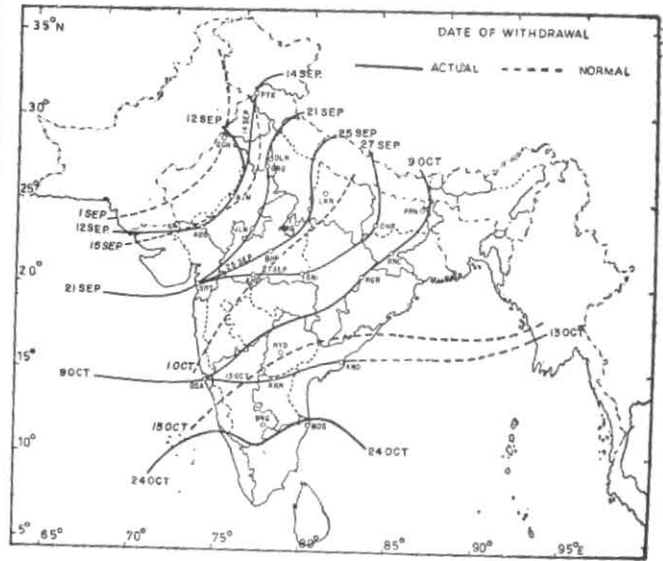


Fig. 3. Withdrawal of southwest monsoon, 1987

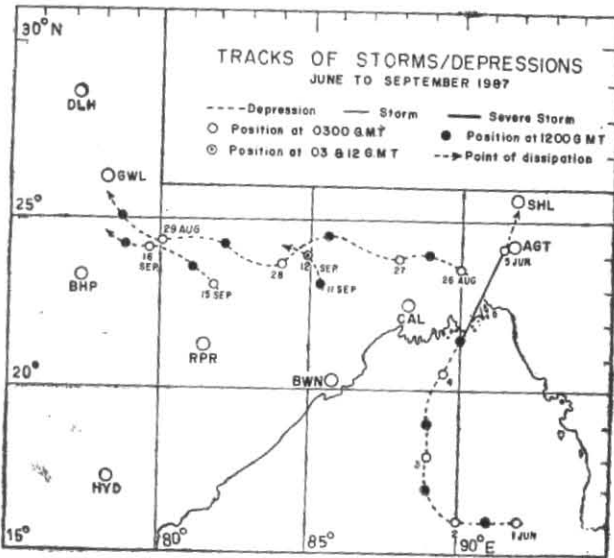


Fig. 14. Tracks of storms/depressions, Jun-Sep 1987

3 weeks. In the second phase of advance, which commenced on 5 July and ended on 15 July monsoon covered the rest of the country outside Haryana, Punjab and northwest Rajasthan. It advanced over those areas on 27 July.

Monsoon advanced around normal dates in Kerala, Karnataka, Konkan & Goa, Rayalaseema, coastal Andhra Pradesh, Orissa, south Madhya Pradesh, Assam & adjacent States and Sub-Himalayan West Bengal & Sikkim. It advanced by about 4 to 5 days earlier than the normal dates over south Gujarat and eastern parts of Bihar plains. The advance of monsoon over the rest of the country was delayed. It was delayed by 4 to 7 days over Madhya Maharashtra, Marathwada, Vidarbha, Bihar Plateau and Jammu & Kashmir; by 10

to 15 days over western parts of Bihar plains, Uttar Pradesh, southwest Rajasthan and Himachal Pradesh and by about 20 days over north Madhya Pradesh and east Rajasthan. Its advance over Haryana including Delhi, Punjab and northwest Rajasthan was delayed as much as 25 to 27 days.

Fig. 2 shows the dates of advance of southwest monsoon over the country and Fig. 5, the progress of monsoon week by week.

### 2.2. Activity of the monsoon

Though monsoon did not advance over Uttar Pradesh and northwest India in June, the rainfall during the month was excess (+20 per cent and more) or normal (+19 to -19 per cent) in most of the sub-divisions of northwest India. However, it was scanty (-60 per cent or less) in Uttar Pradesh. In the rest of India, where the monsoon advanced during the month, the activities were quite subdued except for Sub-Himalayan West Bengal & Sikkim, Bihar plains, Maharashtra excluding Vidarbha, Tamil Nadu, Karnataka and Kerala. In other areas it was deficient (-20 to -59 per cent) or scanty (-60 per cent and less).

Rainfall during July was much below normal over the country outside the States of northeast India and Konkan & Goa and Telangana. This situation made the combined rainfall of June and July in most of the remaining sub-divisions deficient. Defect became large (-51 per cent and less) in plains of west Uttar Pradesh, Haryana, Punjab, Himachal Pradesh, east Rajasthan Gujarat and Rayalaseema.

Rainfall during the month of August was normal or above normal in the States of northeast India outside Orissa, east Rajasthan, west Madhya Pradesh and the Peninsular India but continued to be below normal in rest of the country. August rainfall lowered the negative cumulative percentage departure for these three months in east Rajasthan (departure became -42% from

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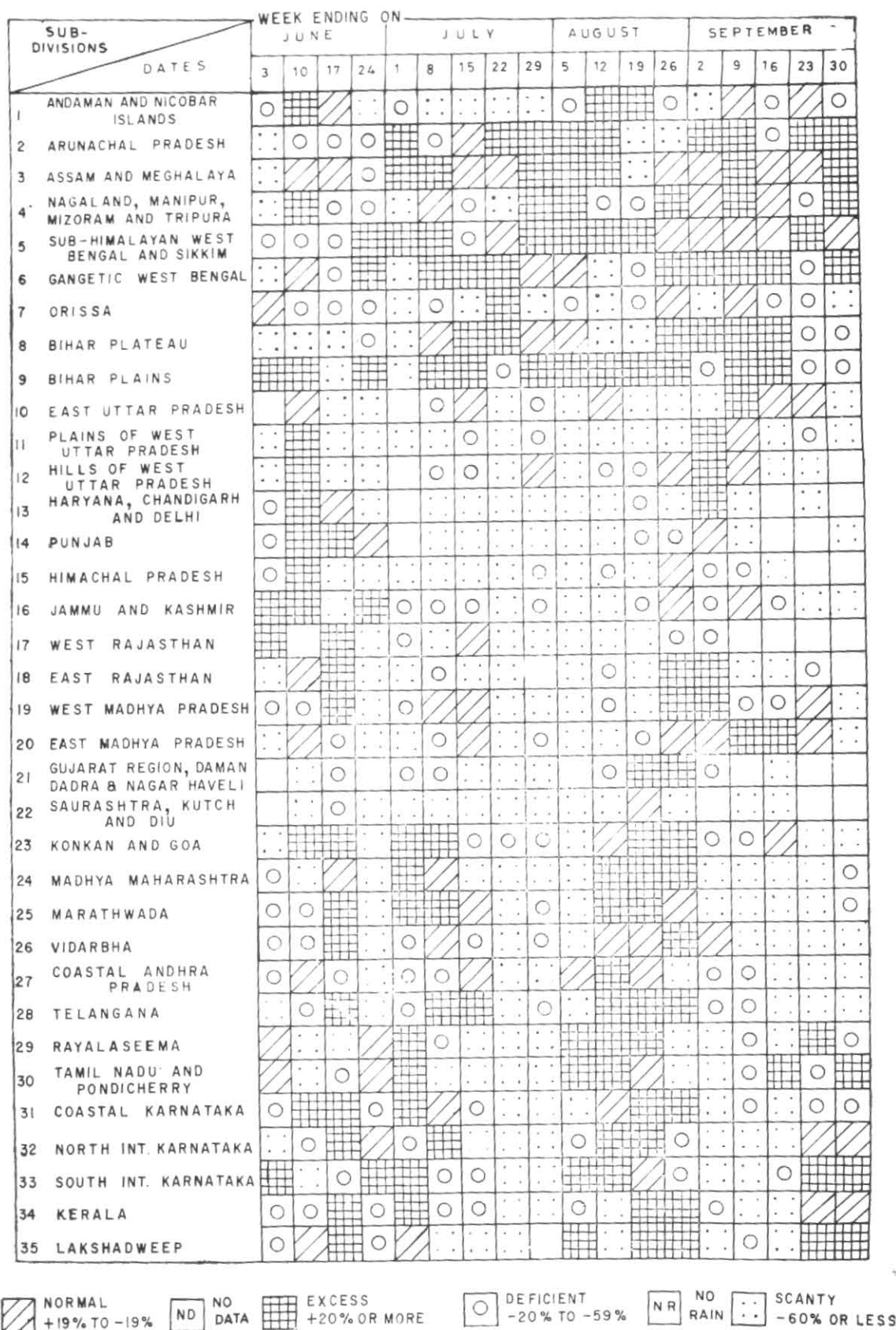


Fig. 5. Progress of the monsoon week by week, 1 June to 30 September 1987

—72%), Gujarat region (—48% from —61%) and Rayalaseema (—2% from —59%). For these three months the cumulative rainfall continued to remain largely deficient in plains of west Uttar Pradesh, Haryana, Punjab, Himachal Pradesh, west Rajasthan and Saurashtra & Kutch. During the month of September rainfall was normal or above normal in the States of northeast India outside Orissa, east Uttar Pradesh, east Madhya Pradesh, Tamil Nadu and south interior Karnataka. There was very little rain in Haryana, Punjab, Rajasthan and Gujarat during this month. At the end of the season Haryana, Punjab, Himachal Pradesh, west Rajasthan and Gujarat had largely deficient monsoon rainfall.

### 2.3. Withdrawal of monsoon

The withdrawal phase of the southwest monsoon commenced from 12 September, when it withdrew from west Rajasthan. By 21 September it retreated from northwest India and most parts of Gujarat. By 27 September it further retreated from Uttar Pradesh and west and adjoining northeast Madhya Pradesh. Thereafter by 9 October, it withdrew from Bihar, most parts of east Madhya Pradesh and Maharashtra. By 13 October the withdrawal was complete from the rest of the country outside south Andhra Pradesh, Tamil Nadu and Kerala. On 24 October southwest monsoon withdrew completely. The retreat of the southwest monsoon from different parts of the country was around normal dates and it has been shown in Fig. 3.

### 2.4. Storms and depressions

At the very beginning of the season a storm developed over the Bay of Bengal and crossed Bangla Desh coast ushering in monsoon over Assam & adjacent States. Besides the storm, three depressions developed, all of them over the land during the season, of which one was in the month of August and two in September. The tracks of these systems are shown in Fig. 4.

## 3. Significant monthly features

### 3.1. June

On the first day of June a depression developed over east central Bay, which intensifying into a cyclonic storm entered Bangla Desh and ushered in monsoon over Assam & adjacent States. Besides the storm, a low pressure area and a number of upper air cyclonic circulations developed in the region during the month, but most of them dissipated *in situ* or moved eastwards and so the southwest monsoon could not advance into Uttar Pradesh and northwest India during June.

#### 3.1.1. Features heralding the advance of monsoon during June

Monsoon set in over south Kerala on 2 June. The synoptic features, which were responsible for the advance of monsoon over the country during the month of June and July are given in Table 2.

#### 3.1.2. Other synoptic features

From 1 to 3 June a trough in the lower levels was observed along and off Maharashtra, Goa, Karnataka coast and Laskhadweep area. Another trough on sea level chart extended from south Gujarat-Maharashtra

coast to Karnataka-Kerala coast from 12 to 17 June. Western Himalayas and neighbourhood were affected by six western disturbances during the month. The other synoptic features of the month are given in Table 3.

After the advance of southwest monsoon it was vigorous on one to two days in Assam & Meghalaya, Nagaland, Manipur, Mizoram & Tripura, Gangetic West Bengal, Bihar plains, Marathwada and coastal Karnataka. It was active on 8 to 11 days in Sub-Himalayan West Bengal & Sikkim, Konkan & Goa, coastal Karnataka and Kerala and on 1 to 4 days in Arunachal Pradesh, Assam & Meghalaya, Gangetic West Bengal, Madhya Maharashtra, Marathwada, Vidarbha, Telangana and interior Karnataka. Monsoon, though, advanced over Madhya Pradesh in the middle of June, its activity over the region remain quite weak. The other sub-divisions, where the monsoon activity during the month was weak, were Bihar Plateau, coastal Andhra Pradesh and Rayalaseema, Uttar Pradesh, north Gujarat and northwest India, where the monsoon did not advance during the month, had mainly subdued thundershower activity except on a couple of days. Rain or thundershowers were generally widespread in Himachal Pradesh and Jammu & Kashmir between 3rd and 4th; in west Uttar Pradesh, Haryana, Punjab, Himachal Pradesh and Jammu & Kashmir between 9th and 11th. They were generally widespread on 13th in west Rajasthan and on 21st and 22nd in Jammu & Kashmir and on 29th in Gujarat region.

### 3.1.3. Rainfall

It was excess in Jammu & Kashmir, west Rajasthan, Marathwada, Tamil Nadu and south interior Karnataka; normal in Sub-Himalayan West Bengal & Sikkim, Bihar plains, Haryana, Himachal Pradesh, Konkan & Goa, Madhya Maharashtra, coastal and north interior Karnataka, Kerala & Lakshadweep; deficient in Andaman & Nicobar Islands, Punjab, east Rajasthan, west Madhya Pradesh, Gujarat region, Vidarbha and Andhra Pradesh and rest of northeast India. It was scanty over the remaining parts of the country.

The significant amounts (cm) of rainfall were :

- 1st : Chickmagalur & Mancompu 8 each, Kayamkulam 7
- 2nd : Kayamkulam 17, Mancompu 10, Alleppey 9
- 3rd : Bentwal 19, Trichur 15, Manjeri 13, Tellicherry 11, Mangalore AP 9, Calcutta AP 8, Belthangadi & Kozhikode 7 each
- 4th : Shirali 21, Bhatkal 18, Honavar 8
- 5th : Shirali 25, Sonamura 14, Bhatkal 11, Agartala AP 10, Karwar 9, Amni Divi & Cherrapunji 8 each, Kailashahar 7
- 6th : Silchar AP 22, Cherrapunji 16, Arundhutinagar 14, Panjim 13, Shillong 12, Karwar 10, Lumding & Vengurla 9 each
- 7th : Cherrapunji & Silchar AP 11 each, Chalisgaon & Goalpara 10 each, Ratnagiri 9, Kokrajhar 7

TABLE 2

Weather systems responsible for the advance of southwest monsoon over the Indian sub-continent

Weather system (Period)	Place of first location	Direction of movement	Place of dissipation	Special remarks
<b>June</b>				
(i) Trough in the lower levels (1-3 Jun)	Along and off Maharashtra-Goa-Karnataka coast and Lakshadweep	—	<i>In situ</i>	—
(ii) C.S. (1-5 Jun)	Central Bay	NNE'ly	Meghalaya & neighbourhood	Appeared as a low pressure area over north Andaman Sea & neighbourhood on 30 May
(iii) Trough on S.L.C. (12-17 Jun)	Gujarat coast to Kerala-Karnataka coast	—	<i>In situ</i>	
(iv) Well marked low pressure area (7-10 Jun)	East central Arabian Sea	Westerly	Arabian Peninsula	Appeared as a cyclonic circulation over east central Arabian Sea off Maharashtra-Goa-Karnataka coast in mid-trop. levels on 5th
<b>Cyclonic circulations</b>				
(i) Mid and upper trop. levels (5-11 Jun)	Southwest Bay	Northerly	Central and adjoining northwest Bay	—
(ii) Lower and mid-trop. levels (9-12 Jun)	Off north Maharashtra-Gujarat coast	Do.	East central and adjoining northeast Arabian Sea	—
(iii) Mid-trop. levels (12-13 Jun evening)	Gujarat and neighbourhood	—	<i>In situ</i>	—
(iv) Lower/mid-trop. levels (13-24 Jun)	Bihar plains and neighbourhood	Easterly and then westerly	Bihar Plateau and neighbourhood	Moving eastwards it lay over Bangla Desh on 17th. Thereafter took a westerly course from 20th
(v) Mid and upper trop. levels (14-18 Jun)	West central Bay off Andhra coast	—	<i>In situ</i>	—
(vi) Do. (14-16 Jun)	East central Arabian Sea off Maharashtra coast	Northerly	East central and adjoining northeast Arabian Sea and south Gujarat and north Maharashtra	—
<b>July</b>				
(i) Low pressure area (12-15th)	Gangetic West Bengal and adjoining Orissa and north Bay	Northwesterly	Southern parts of Uttar Pradesh and adjoining north Madhya Pradesh. Associated cyclonic circulation in lower trop. levels became unimportant over northwest Uttar Pradesh on 17th	First observed on 8th as a cyclonic circulation between 7.6 and 9.5 km a.s.l. over north coastal Andhra Pradesh and neighbourhood
<b>Cyclonic circulations</b>				
(i) Lower and mid-trop. levels* (1st-10th)	West central and adjoining northwest Bay off north Andhra south Orissa coast	Northwesterly	East Uttar Pradesh	*Lay over west central Bay on 30 June
(ii) Lower trop. levels (25th evening-27th)	North Pakistan and neighbourhood	Easterly	Punjab and neighbourhood	—

TABLE 3  
Details of weather systems during June 1987

Weather system (Period)	Place of first location	Dir. of movement	Place of dissipation	Special remarks
(i) Low pressure area (9th-11th)	Central Bay	—	<i>In situ</i>	First observed as cyclonic circulation in the mid and upper trop. levels over south-west and adjoining west central Bay on 5th
<b>Cyclonic circulations</b>				
(i) Lower trop. levels* (1st-2nd)	—	—	Bihar plains and neighbourhood	*System lay over Bihar plains and neighbourhood on 30 May evening
(ii) Do. (1st-2nd evening)	Western parts of Assam & neighbourhood	Easterly	Eastern parts of Assam & neighbourhood	
(iii) Do. (2nd-4th evening)	North Madhya Pradesh and adjoining Uttar Pradesh	Quasi-stationary	Northeast Madhya Pradesh and neighbourhood	
(iv) Mid and upper trop. levels (16th-18th)	North Madhya Maharashtra and neighbourhood	—	<i>In situ</i>	
(v) Lower and mid-trop. levels (19th-21st)	South Maharashtra and adjoining east central Arabian Sea	Westerly	East central Arabian Sea off south Maharashtra-Goa coast	
(vi) Mid-trop. levels/lower trop. levels (20th-30th)**	West central Bay off Andhra coast	Stationary	—	**Persisted over west central Bay off Andhra coast
(vii) Lower trop. levels (24th-30th)	East central Arabian Sea and adjoining south Konkan and Goa and Karnataka	Meandered over east central and adjoining south-east Arabian Sea	East central Arabian Sea off Goa-south Maharashtra coast	
(viii) Lower levels (24th evening-29th)	East Uttar Pradesh	Easterly	Bihar and neighbourhood	
(ix) Lower trop. levels (29th-30th)	Gujarat region and neighbourhood	Northerly	—	Lay over west Rajasthan and neighbourhood in the lower trop. levels

8th : Karwar 19, Harnai & Shirali 13 each, Rajapur 12, Ratnagiri 11, Thakurganj 8, Car Nicobar, Sriniketan, Supaul & Uluberia 7 each	& Pasighat 8 each, Bardoli, Bhira, Karimganj, Kayamkulam & Silchar AP 7 each
9th : Sabour 16, Shirali 11, Bhagalpur & Kasargode 9 each, Jagadhari & Panambur 8 each, Roorkee 7	14th : Karwar 12, Panjim & Ratnagiri 9 each, Honavar & Shirali 8 each, Indore 7
10th : Mukteshwar 23, Kundapur 14, Kasargode 13, Chamoli & Dharmasala 10 each, Bhira & Karkala 9 each, Calcutta AP & Fazilka 8 each, Kandaghat, Mangalore AP & Najibabad 7 each	15th : Bombay AP & Jalpaiguri 12 each, Cooch Behar & Kayamkulam 11 each, Kozhikode 9, Bhira & Panbari 8 each, Alibag & Shirali 7 each
11th : Hingoli 11, Karwar 10, Udipi 9, Amarghat, Dungeregarh, Pakal & Shirali 8 each, Churu & Mahabubabad 7 each	16th : Nanded 13, Kayamkulam & Purnea 12 each, Aijal 10, Pathri 9, Murtizapur, Parbhani & Peermade 8 each, Birpur, Chalisgaon & Gangtok 7 each
12th : Dharavi 13, Mathanguri 11, Panjim & Shirali 10 each, Bhira & Harnai 9 each, Peermade 7	17th : Ratnagiri 22, Bhira 13, Dhule and Songadh 10 each, Khamgaon & Quilandy 9 each, Bombay, Karkala, Mandsaur, Mangalore AP & Telli-cherry 8 each, Akola AP, Bagamandala, Calcutta, Khandwa & Peermade 7 each
13th : Surat 16, Matizeri 11, Bulsad, Harnai, Kunnankulam, Sarera & Shirali 10 each, Nawarangpur	18th : Aheri & Bhalki 10 each, Peermade 9, Murtizapur & Zaheerabad 7 each
	19th : Peermade 7

- 20th : Cooch Behar 19, Shirali 16, Bhatkal 14, Panbari 13, Honavar 12, Rangia & Udipi 8 each, Goalpara 7
- 21st : Mercapur 8, Navalgund 7
- 22nd : Sagar Island 11, Durgachak 9, Chouldghat, Imphal & Tezu 8 each, Madhupur & Mulke 7 each
- 23rd : Kannara 27, Kumarakom 17, Trichur 13, Mancompu 11, Kottayam 9, Darbhanga 8, Cooch Behar & Midnapore 7 each
- 24th : Chorgharia, Holalagundi & Pandavapura 11 each, Shillong 10, Panbari & Supaul 9 each, Namakkal, Purnea & Triveni 7 each
- 25th : Cherrapunji 74, Dahiwadi 10, Cooch Behar & Karimganj 9 each, Balurghat, Goalpara, Jalpaiguri & Melur 8 each, Hungund 7
- 26th : Cherrapunji 27, Mathanguri 25, Dahiwadi & Kumarakom 16 each, Alleppey & Armori 15 each, Kokrajhar 14, Kottayam 13, Quilon 11, Godchiroli & Tadong 10 each, Songadh 9
- 27th : Cherrapunji 51, Trichur 16, Panbari 14, Kunnamkulam 13, Mathanguri 12, Thakurganj 11, Cochin AP 10, Gevrai 8, Jalpaiguri, Nanded & Sivaganga 7 each
- 28th : Cannanore 16, Mangalore AP 13, Udipi 10, Kasargode & Gingee 9 each, Bahadurganj 8, Anantapur, Mathanguri & Shirali 7 each
- 29th : Panbari 17, Vengurla 14, Panjim 12, Mellabazar 11, Hansot, Jainagar & Mathanguri 10 each, Karwar & Silchar AP 9 each, Jalna, Malegaon & Surat 8 each, Cooch Behar, Jalgaon, Sangarredy & V. V. Nagar 7 each
- 30th : Vengurla 20, Chouldghat & Kankavali 18 each, Mathanguri & Taibpur 17 each, Koyana and Panbari 16 each, Luxshettipet 13, Panjim 12, Itanagar & Karwar 11 each, Jalpaiguri 8, Dhubri, Gad-Chiroli & Pasighat 7 each

#### 3.1.4. Floods and damages

As per the Press reports heavy rain from 6th to 8th caused floods in the river *Jhelum*, its tributaries and in Dal Lake near Srinagar city inundating low lying areas of Kashmir valley. The flood situation continued up to 13th. It took a toll of 62 human lives and damaged crops, houses and public utilities worth Rs. 73 crores.

#### 3.1.5. Temperature

The day temperatures were quite high over Uttar Pradesh in the last week of the month. Moderate heat wave conditions (temperature 6°C to 7°C above normal) prevailed on most days in east Uttar Pradesh, hills of west Uttar Pradesh and Jammu and on 1 to 2 days in plains of west Uttar Pradesh, east Rajasthan and Gujarat region between 25th and 30th of this month. Day temperatures were generally above (dep. +2°C to +3°C) or appreciably (+4°C to +5°C) above normal in Maharashtra outside Konkan and Goa, Andhra Pradesh, interior Karnataka and Kerala between 20th and 30th and were so in Tamil Nadu throughout the month.

Day temperatures fell by as much as 7°C to 17°C below normal in Haryana, Punjab, Himachal Pradesh and Jammu on 10th and 11th of the month.

### 3.2. July

#### 3.2.1. Advance of monsoon

Monsoon advanced over Uttar Pradesh on 7 July and thereafter stalled for a week before it advanced into Rajasthan. It covered the entire country as late as 27th of the month (Fig. 2). The synoptic features responsible for the advance of monsoon during the month are given in Table 2.

#### 3.2.2. Monsoon activity and associated synoptic features

The synoptic features of the month, other than those, which caused the advance of monsoon, are given in Table 4.

Besides those systems, extreme north India was affected by five western disturbances during the month. Also two troughs in mid and upper tropospheric westerlies affected northwest India between 6th & 8th, 10th & 12th respectively.

In the Peninsular India monsoon activities were mostly confined to the first fortnight of the month. It was active to vigorous on 4 to 6 days in Konkan & Goa, Telangana and coastal Karnataka and on 1 to 2 days in Madhya Maharashtra, Marathwada and Kerala during this period. However, in the second fortnight active to vigorous monsoon conditions prevailed over Marathwada on 23rd, over Vidarbha on 29th and over south interior Karnataka on 31st. Active to vigorous monsoon conditions prevailed on 6 to 11 days in Arunachal Pradesh, Assam & Meghalaya, West Bengal & Sikkim, Bihar and on 2 to 4 days in Nagaland, Manipur, Mizoram & Tripura, Orissa, Uttar Pradesh and east Madhya Pradesh during the month. Monsoon was active on 26th in Himachal Pradesh and Jammu & Kashmir and on 27th in Punjab. It was generally weak over east Rajasthan, Gujarat, coastal Andhra Pradesh, Rayalseema and north interior Karnataka during the month.

#### 3.2.3. Rainfall

It was excess in Arunachal Pradesh, Assam & Meghalaya, Gangetic West Bengal and Bihar plains; normal in Sub-Himalayan West Bengal & Sikkim, Orissa, Bihar Plateau, Konkan & Goa and Telangana; deficient in Nagaland, Manipur, Mizoram & Tripura, Uttar Pradesh, Jammu & Kashmir, Madhya Pradesh, coastal Andhra Pradesh, Karnataka and rest of Maharashtra. It was scanty over the remaining parts of the country.

The significant amounts (cm) of rainfall were :

- 1st : Cherrapunji 50, Panjim 33, Panbari 32, Beki Road Bridge 29, Honavar 25, Karwar 21, Vengurla 20, Alibag 18, Goalpara 16, Bombay & Karkala 15 each, Hosdurg 11, Yellandu 9
- 2nd : Kokrajhar 23, Balod 18, Kankavali & Panbari 15 each, Ahwa 14, Cooch Behar, Ratnagiri, Shirali & Vengurla 13 each, Birpur, 11, Kunnamkulam, Mathanguri, Panjim & Udipi 10 each



TABLE 4  
Details of weather systems in July 1987

Weather systems (Period)	Place of first location	Dir. of movement	Place of dissipation	Special remarks
Low pressure area (17th-24th)	North Bay and neighbourhood	WNW'ly	Bihar*	First observed as a cyclonic circulation in lower levels over Bangla Desh on 16th
<b>Cyclonic circulations</b>				
(i) Lower levels (upto 1st evening)	West Rajasthan and neighbourhood	—	Merged with the cyclonic circulation under SN (ii)	†Last month's cyclonic circulation over Gujarat region and neighbourhood
(ii) Mid-trop. levels (30th Jun-9th evening)	EC & Adj NE Ar. Sea off north Maharashtra-south Gujarat coast	Quasi-stationary	South Gujarat and neighbourhood	
(iii) Lower trop. levels (6th-7th)	Bihar Plateau and neighbourhood	—	—	Merged with the circulation on 7th that moved from Bay
(iv) Lower trop. levels (9th evening-14th)	Bihar Plateau and neighbourhood	WNW'ly	Merged over east Uttar Pradesh with the circulation of the low pressure area	
(v) Mid-trop. levels (11th-14th)	Gujarat region and neighbourhood			
(vi) Lower and mid-trop. levels (16th-17th)	Gujarat and neighbourhood	—	<i>In situ</i>	
(vii) Lower levels (20th-22nd)	Northwest M.P. and adjoining south Uttar Pradesh]	Northeasterly	East Uttar Pradesh and neighbourhood	
(viii) Lower and mid-trop. levels (20th-26th)	North Gujarat and neighbourhood	Quasi-stationary	South Gujarat and neighbourhood	
(ix) Mid-trop. levels (23rd-26th)	Southwest Bay and adjoining Tamil Nadu	—	<i>In situ</i>	
(x) Lower and mid-trop. levels (26th-31st)	Bihar and neighbourhood	—	<i>In situ</i>	
(xi) Lower levels (27th-29th)	Southwest Uttar Pradesh and adjoining northwest Madhya Pradesh	—	<i>In situ</i>	
(xii) Mid-trop. levels (28th-29th)	East central Arabian Sea off Maharashtra-Goa coast	—	<i>In situ</i>	
(xvi) Do. (29th-31st)	Southeast Arabian Sea and adjoining Lakshadweep	—	<i>In situ</i>	
(xiii) Do. (29th evening-1 Aug)	South Gujarat and neighbourhood	—	<i>In situ</i>	

- 3rd : Balsad 19, Sandheads 17, Jainagar & Kundapur 15 each, Bhatkal, Honavar & Karimganj 14 each, Shirali 13, Rajghat 12, Canning Town 9
- 4th : Navsari 19, Bansaon 17, Anandpur 13, Perur 11, Balsad 10, Belthangadi & Kankavali 8 each, Chikhli, Gorakhpur, Guna & Jeypur 7 each
- 5th : Gad-chiroli 13, Kalyan & Khowang 12 each, Nawrangpur 11, Haldwani, Mangrol & Puranpur 8 each, Bhira, Purnea & Venkatapuram 7 each
- 6th : Vada 28, Nawrangpur 19, Kalyan 18, Jharsuguda AP 13, Purnea 11, Beki Road Bridge, Hansot & Sambalpur 10 each, Navasari & Peermade 9 each, Dahanu, Gauhati AP & Itanagar 8 each
- 7th : Bhira 30, Beki Road Bridge 26, Ahwa & Panbari 24 each, Dharampur 23, Poladpur 19, Gaya AP 18, Alibag 15, Bombay AP 13, Songadh 10, Gaighat 9, Pasighat 8
- 8th : Bhira 26, Mangaon 22, Ahwa & Indore 15 each, Gorakhpur 13, Bagamandala & Ittapalli 12 each, Shirali 10, Kozhikode & Shirpur 9 each, Gangtok & Satara 7 each
- 9th : Mulug 25, Bansi 18, Dundigal AP, Mahabubabad & Pharenda 16 each, Chorgharia 15, Medak 14, Sironcha 13, Sirsi 12, North Lakhimpur 11, Gad-chiroli & Ramgundam 10 each, Belthangadi & Songadh 9 each, Itanagar 8
- 10th : Malkangiri 16, Supaul 14, North Lakhimpur 13, Mahabubabad & Sonapur 12 each, Calcutta AP & Gyanpur 11 each, Golaghat & Sironcha 10 each, Itanagar & Majbat 8 each, Khammam 7
- 11th : Kakerdarighat 17, Harriya 16, Simdega 15, Chandbali, Karwar & Sukma 12 each, Karkala 11, Honavar & Mohania 9 each, Bahraich & Pederu 8 each, Ranchi AP 7
- 12th : Sandheads 30, Dhamtari 14, Dalhousie 13, Ambikapur, Midnapore & Panposh 12 each, Karkala 11, Bansaon & Bhira 10 each, Bagamandala & Puri 7 each
- 13th : Koyana 19, Bhira & Jenapur 13 each, Pathalgaon & Ghatshile 11 each, Nalbari 10, Jamshedpur & Puri 7 each
- 14th : Tikamgarh 16, Salempur 12, Pasighat 11, Sabour 10, Mandla 9, Chintapalli & Koyana 8 each, Bhira 7
- 15th : Bareilly 11, Mukteswar 9, Chalakudy & Farrukhabad 8 each, Ambone & Patna AP 7 each
- 16th : Dakor 22, Panbari 13, Pasighat 9, Cooch Behar & Sehore 8 each, Ambone & Rajkot AP 7 each
- 17th : Sandheads 15, Patna AP 13, Amraghat & Baroda 11 each, Jhumritilaiya 8, Dholka 7
- 18th : Balasore 40, Jeypur 21, Sandheads 19, Purulia 12, Pand 9, Bhira 8
- 19th : Dhankanal 18, Cuttack 17, Tezpur 16, Jharsuguda AP 12, Chiplun 11, Bansaon & Harnai 10 each, Ratnagiri 9, Silchar AP 8, Bombay & Dhanbad 7 each
- 20th : Koyna 21, Sonapur 13, Phulbani 9, Poladpur 8, Patna 7
- 21st : Tandur 10, Bhira & Pasighat 9 each, Bhimavaram 7
- 22nd : Pasighat & Tezu 16 each, Cooch Behar 15, Kantamal 11, Jalpaiguri 10, Dhamtari & Jharsuguda AP 9 each, Bahraich, Purnea & Sirgaon 7 each
- 23rd : Pasighat 23, Shillong 13, Cooch Behar & Sandheads 11 each, Bansaon & Dharavi 10 each, Tezu 9, Dibrugarh AP & Perur 8 each, Jogindernagar & Purnea 7 each
- 24th : Pasighat 24, Chorgharia 21, Nirmali 20, Goalpara 16, Dibrugarh AP 15, Jainagar 14, Bhatkal, Itanagar, Purnea & Shillong 9 each, Aheri 8, Balarampur & Bhira 7 each
- 25th : Jogindernagar 17, Shillong 15, Rajapur 13, Chapra & Goalpara 10 each, Sohella 9, Dharamsala & Motihari 8 each, Konta & Tezpur 7 each
- 26th : Balurghat 16, Koyna, Malda & Sabour 11 each, Luxshettipet 10, Bhagalpur, Songadh & Tikonia 9 each, Chamba & Gargoti 8 each, Jogindernagar, Kathua, Pantnagar, Panagarh AP & Pathankot 7 each
- 27th : Kamakhyanagar 20, Gad-Chiroli 13, Kokrajhar 12, Bijnor, Cooch Behar & Jabalpur 9 each, Khajuraho 7
- 28th : Patna AP 25, Chapra 15, Bhira 12, Gad-Chiroli 11, Bramhapuri & Hanamkonda 8 each, Jalpaiguri 7
- 29th : Nandgaon, Kazi & Sirpur 10 each, Kanpur AP & Narsinghpur 8 each, Adilabad, Gondia & Indrapuri 7 each
- 30th : Pasighat 12, Tirupattur 9, Calcutta, Mandla & Uthagamandalam 7 each
- 31st : Chorgharia 21, Malavalli 16, Arogyavaram & Katihar 12 each, Khowai 9, Malda, Pasighat & Tezu 8 each, Kokrajhar 7

#### 3.2.4. Floods and damages

As per the reports of Central Water Commission, river *Brahmaputra* and its tributaries were in floods throughout July except in the second week. It affected about 93 villages in Kokrajhar district and Teck and Jorhat east circle during the first week. Floods badly affected the Kaziranga Game Sanctuary. In lower Assam, road communications were disrupted due to breaches at many places. In the last week high floods in the river *Siang* and its tributaries in Arunachal Pradesh cut-off road communications to east Siang district. In Bihar, floods in the rivers *Kamala Balan*, *Kosi*, *Gandak* and *Adhwara* group had affected a population of about 7 lakhs in 620 villages in eight districts. Estimated damages to crops and other properties were about rupees 54 lakhs. Floods took a toll of 26 human lives in Bihar, 12 in Assam and 4 in West Bengal during the month.

TABLE 5  
Details of weather systems during August 1987

Weather system (Period)	Place of first location	Direction of movement	Place of dissipation	Special remarks
(1)	(2)	(3)	(4)	(5)
(i) Low pressure area (3rd-8th evening)	Bihar and neighbour- hood	Westerly	East Rajasthan and adjoining Haryana and West Uttar Pra- desh	First seen as a cy- clonic circulation over Bangla Desh and neighbourhood in the lower trop. levels on 2nd
(ii) Do. (13th-17th)	West central Bay and adjoining coastal An- dhra Pradesh	NW'yly	Marathwada*  *Associated cyclonic circulation dissipa- ted over the same area by 18th evening	First seen as a cyclo- nic circulation in the mid-trop. levels over west central Bay and adjoining coastal An- dhra Pradesh on 9th
(iii) Do. (18th-27th)	Northeast and ad- joining east central Bay	WNW'yly	Northeast Rajasthan and adjoining Ma- dhya Pradesh, Uttar Pradesh and Har- yana	The remnants of Ty. <i>Betty</i> of Pacific
(iv) Depression (26th-30th evening)	Bangla Desh	Westerly	Northwest Madhya Pradesh and adjoining south Uttar Pra- desh†	First appeared as a low pressure area over north Bay and adjoining Bangla Desh on 24th  †Became unimportant over plains of west Uttar Pradesh on 1 Sep

## Cyclonic circulations

(i) Lower trop. levels (31 Jul-2 Aug)	Jammu & Kashmir and Himachal Pra- desh	Easterly	Moved away	
(ii) Lower trop. levels (1st-2nd)	Bangla Desh and neighbourhood	Easterly	Moved away east- wards across Assam & neighbourhood	
(iii) Do. (3rd-5th)	Northwest Bay and neighbourhood	NW'yly	—	Merged with the cir- culation of the low pressure area over northeast Madhya Pradesh and neigh- bourhood
(iv) Lower and mid- trop. levels (3rd evening-6th)	Punjab and neigh- bourhood	—	<i>In situ</i>	
(v) Mid-trop. levels (4th-5th)	Arabian Sea off Kar- nataka coast	—	<i>In situ</i>	
(vi) Lower/mid-trop. levels (5th-12th)	West central Bay off Andhra coast	Westerly	Marathwada and neighbourhood	Lay over Marath- wada and neighbour- hood on the last 3 days
(vii) Lower and mid- trop. levels (7th-13th)	Andaman Sea	WNW'yly	—	Merged with the cy- clonic circulation of the low pressure area over west central Bay and adjoining coastal Andhra Pra- desh
(viii) Do. (8th-9th even- ing)	Gujarat and neigh- bourhood	—	<i>In situ</i>	
(ix) Lower trop. levels (12th-13th)	Saurashtra & Kutch	—	Do.	

TABLE 5 (contd)

(1)	(2)	(3)	(4)	(5)
(x) Lower trop. levels (13th-15th)	Northeast Madhya Pradesh and neighbourhood	--		<i>In situ</i>
(xi) Do. (18th-20th)	Gujarat and neighbourhood	—		Do.
(xii) Do. (19th-20th)	Northwest Madhya Pradesh and neighbourhood	—		Do.
(xiii) Lower levels (19th-26th)	Northwest Rajasthan	Northerly		Punjab and neighbourhood
(xiv) Lower and mid-trop. levels (21st-25th)	Northeast Arabian Sea and adjoining land areas	Quasi-stationary		South Gujarat and neighbourhood
(xv) Lower trop. levels (20th-22nd)	Southeast Uttar Pradesh and adjoining Madhya Pradesh	Do.		South Uttar Pradesh and adjoining Madhya Pradesh
(xvi) Lower levels (28th-31st evening)	Southwest Rajasthan and neighbourhood	—		<i>In situ</i>

### 3.2.5. Temperature

Day temperatures in Uttar Pradesh, Haryana, Punjab and Jammu were 6° to 7° C above normal on most days between 1st and 5th. They were also 4° to 7° C above normal on most days in plains of Uttar Pradesh, Haryana, Punjab, Himachal Pradesh, Jammu, Rajasthan and Gujarat region during the second fortnight of the month.

### 3.3. August

#### 3.3.1. Monsoon activity and associated synoptic features

A land depression and three low pressure areas developed over the Indian sub-continent and adjoining sea areas during the month.

The synoptic features of the month are given in Table 5.

Besides those synoptic features, three western disturbances moved away eastwards across the extreme north India during the month.

During the month the monsoon was active to vigorous on 7 to 11 days in Assam & Meghalaya, West Bengal & Sikkim, Bihar, west Madhya Pradesh, Konkan & Goa, Marathwada, Telangana and coastal Karnataka; on 3 to 5 days in Arunachal Pradesh, Orissa, hills of west Uttar Pradesh, Punjab, east Rajasthan, Gujarat region, Madhya Maharashtra, Vidarbha, north interior Karnataka and Kerala and on 2 days each in plains of Uttar Pradesh, Haryana, Himachal Pradesh, east Madhya Pradesh, coastal Andhra Pradesh and south interior Karnataka. Rainfall was generally widespread on 16 to 22 days with isolated heavy to very heavy falls on a couple of days in Andaman & Nicobar Islands and Lakshadweep. They were generally widespread on 15 to 20 days in Nagaland, Manipur, Mizoram & Tripura, coastal Karnataka and Kerala and on 4 to 12 days in Arunachal Pradesh, Assam & Meghalaya, West Bengal & Sikkim, Orissa, Bihar Plateau, hills of west Uttar Pradesh, Jammu & Kashmir, Madhya Pradesh, Gujarat

region, Maharashtra, Andhra Pradesh and interior Karnataka.

#### 3.3.2. Rainfall

It was excess in Andaman & Nicobar Islands, Arunachal Pradesh, West Bengal & Sikkim, Bihar plains, west Madhya Pradesh, Konkan & Goa, Madhya Maharashtra, Marathwada, Rayalaseema, Karnataka, Kerala and Lakshadweep; normal in Assam & Meghalaya, Nagaland, Manipur, Mizoram & Tripura, Bihar Plateau, east Rajasthan, Vidarbha, coastal Andhra Pradesh and Telangana; deficient over the rest of the country outside west Rajasthan and Saurashtra & Kutch where it was scanty.

The significant amounts (cm) of rainfall were :

1st : Sabour 25, Bhagalpur 24, Kamtaul 22, Malda 19, Darbhanga 12, Arundhutinagar 9

2nd : Purnea 29, Chatia 17, Cooch Behar 13, Bhagalpur 12, Kankavali 9, Berhampore & Malda 8 each, Gangtok 7

3rd : Bhagalpur 16, Cooch Behar & Kotaria 10 each, Hazaribagh & Minicoy 8 each, Palkot 7

4th : Kunnankulam 12, Goa AP & Sullurpet 9 each, Cikballapur, Hazaribagh & Panposh 8 each

5th : Tezpur 23, Pasighat & Siang 19 each, Korba 13, Ratnagiri & Visakhapatnam 12 each, Tumkur 11, Nandyal 7

6th : Chopda 16, Kalmeshwar 9, Ambejogai, Balurghat, Hungund & Ramgundam 8 each, Datia & Dehra Dun 7 each

7th : Baberu 10, Nandyal, Rajapur, Solapur & Vijayawada 8 each, Avanigadda, Dakor & Rawat Bhata 7 each

- 8th : Mathanguri 18, Songadh 12, Cotnour 11, Ambejogai, Maharajganj & Mahbubnagar 8 each, Bombay AP, Kokrajhar & Pusad 7 each
- 9th : Kokrajhar 14, Jalgaon 13, Pasighat 12, Hingoli 11, Koderu 9, Jalna 8, Cooch Behar & Gangtok 7 each
- 10th : Jalpaiguri 40, Cooch Behar 23, Chouldaghat 19, Sonbarse 18, Tezu 15, Itanagar, North Lakhimpur & Pasighat 13 each, Birpur & Udupi 12 each
- 11th : Jalpaiguri 30, Lalbegiaghat 22, Pasighat 19, Chouldaghat 16, Darbhanga & Chaparmukh 12 each, Pharenda & Talasari 11 each, Jogindernagar 10, Sakri 8, Gorakhpur, Karwar & Port Blair 7 each
- 12th : Pasighat 32, Gorakhpur 19, Varanasi 18, Jogindernagar 13, Patna AP 12, Bahraich & Jalpaiguri 11 each, Dharmasala & Shillong 10 each
- 13th : Jalpaiguri 25, Purnea 19, Gaganbavda, Kanpur & Patna AP 13 each, Cooch Behar 11, Gangtok & Machilipatnam 9 each, Madikeri 8
- 14th : Kumta 12, Ajnala, Hingoli & Khammam 10 each, Bombay & Honavar 9 each, Sahabad, Tirupati AP & Una 8 each, Amritsar AP, Belthangadi, Kasargode, Panjim & Purulia 7 each
- 15th : Honavar 13, Karimganj 11, Goa AP & Shirali 10 each, Bhadrawati, Gulbarga & Omerga 8 each, Akhuapada, Jejuri & Nandyal 7 each
- 16th : Nasik AP 19, Kallam 10, Honavar 9, Akola AP, Pandharpur & Vengurla 8 each, Buldhana & Latur 7 each
- 17th : Ratnagiri 15, Pune 14, Aligarh 12, Bhatkal & Bombay 10 each, Gangapur 9, Harnai 8, Panjim & Sindhi 7 each
- 18th : Gaganbavda 20, Maya Bandar 18, Alibag 17, Bhira 13, Trivandrum 9, Kathua 8, Kottayam & Port Blair 7 each
- 19th : Shirali 15, Gaganbavda 14, Alibag 13, Tarana 12, Bombay AP 11, Harnai & Khaira 10 each, Kayamkulam 9, Veraval & V. V. Nagar 7 each
- 20th : Bhira 35, Calcutta AP 18, Alibag 15, Shirpur 13, Amraoti & Ratnagiri 12 each, Bombay 9, Idikki, Shirali & Nagpur 8 each, Akola AP, Canning town, Dharampur, Imphal, Jogindernagar & Visakhapatnam 7 each
- 21st : Madhuban 17, Saswara AP 15, Dharampur 14, Bhograi 13, Bombay AP 12, Alibag, Champua & Sriniketan 10 each, Sakoli 9, Chaparmukh & Nizamabad 8 each, Calcutta AP 7
- 22nd : Bhira 18, Bhagalpur & Purnea 11 each, Daltonganj & Mansa 10 each, Bombay AP, Pathankot, Rairangpur & Silvassa 7 each
- 23rd : Daltonganj 13, Bankura 11, Hisua & Tamini 10 each, Aheri, Bhira, Dehra Dun & Sambalpur 9 each, Bisauli & Cuttack 8 each
- 24th : Umaria 24, Kangra 20, Dharamsala 16, Dharnagar, Duchi, Gaganbavda & Vidisha 10 each, Iddiki, Indore AP & Ponneri 9 each, Jabalpur, Jammu & Kottayam 8 each, Banbasa, Machilipatnam, Navsari & Nizamabad 7 each
- 25th : Sandheads 29, Bhira 21, Khurai 19, Sagar 18, Jhalwar 16, Nimach 13, Pratapgarh 12, Guna, Jabalpur, Kandaghat & Mahuva 10 each
- 26th : Sagwara 32, Banswara 30, Dharampur 25, Amboone & Calcutta AP 22 each, Kadana 21, Madhuban 15, Bhagamandala & Chittorgarh 12 each, Dhanbad & Midnapore 11 each, Ratlam 10
- 27th : Bankura 26, Berhampore & Sironj 18 each, Panagarh AP 16, Sonamura 15, Gadchiroli 13, Garhi 12, Banswara & Jhumritalaiya 11 each, Kasauli 9
- 28th : Morena & Simdega 18 each, Palkot 17, Bankura 16, Nazibabad 14, Chamorshi & Mangrol 13 each, Bangana 12, Goalpara, Raisen & Sonamura 11 each, Purulia 10
- 29th : Tikamgarh 24, Nowgong 23, Sagar 13, Gadchiroli 12, Sonepat 11, Dhanbad, Dharamsala, Jabalpur, Muzaffarpur & New Delhi (SFD) 9 each
- 30th : Guna 18, Bhimsagar 13, Kisanganj 11, Mangrol 10, Nimach & Panipat 7 each
- 31st : Tarana 14, Kisanganj & Mahesi 12 each, Chouldaghat, Nimach & Pratapgarh 9 each, Ranchi AP 7

### 3.3.3. Floods and damages

As per Central Water Commission Reports, during the month Assam, north Bengal and Bihar were under the grip of severe floods. In Assam *Brahmaputra* and its tributaries were in spate for the first three weeks of the month. Train services between Assam and the rest of the country was disrupted on 10th. Floods affected a population of about 47 lakhs in 3168 villages in the State. About 93 people lost their lives due to floods during the month in the State.

In West Bengal flood situations in West Dinajpur and Malda districts became grim in the first week, which continued to be so even during the third week of the month. Also rivers *Raidak*, *Torsa* and *Jaldhaka* were in spate during the second week affecting Cooch Behar, Jalpaiguri and parts of Darjeeling districts. 56 human lives reported to have been lost due to floods in the five districts of north Bengal during the month.

All the major rivers in Bihar were in spate during the month. In the second week Jhanjharpur town including the railway platform was inundated by the flood waters of the river *Burhi Gandak*. 5,269 villages in 20 districts of Bihar were affected by floods. 305 people reported to have lost their lives due to floods during the month.

As per press reports heavy danda pour on 12th/13th night around Sarhan-Jury-Dandaal area of Shimla district caused the collapse of a R.C.C. bridge. Kinnaur and Spiti valley were cut-off from Shimla district. Huge landslides on the Indo-Tibetan road disrupted the road traffic and telecommunication links in the interior districts of Himachal Pradesh.

TABLE 6  
Details of weather systems during September 1987

Weather systems (Period)	Place of first location	Direction of movement	Place of dissipation	Special remarks
(1)	(2)	(3)	(4)	(5)
(i) Depression (11th-12th evening)	Bihar Plateau and neighbourhood	Stationary	<i>In situ</i>	Seen as a mid-trop. cyclonic circulation over northwest and adjoining west central Bay on 31 Aug. Became low pressure area over northwest Bay and adjoining land areas on 4th
(ii) Depression* (15th AN-17th evening)	North Madhya Pradesh	NW'ly	Weakened into a well marked low pressure area over north Madhya Pradesh and adjoining south Uttar Pradesh. The remnant became less marked on 19th evening over the same area	*Remnant of the 1st depression, which persisted as a low pressure area, moved westwards and reintensified
(iii) Low pressure area (23rd-25th)	Northwest Bay off Orissa coast	NW'ly	Bihar Plateau and adjoining Gangetic West Bengal. However associated cyclonic circulation extending up to lower trop. levels persisted over Bihar plains on 30th	First located over north Andaman Sea and adjoining Gulf of Martaban as a cyclonic circulation extending up to mid-trop. levels on 18th
(iv) Low pressure area (25th-29th)	East central Arabian Sea off Karnataka-Goa-south Maharashtra coasts	Westerly	East central Arabian Sea	First located as a cyclonic circulation in the lower and mid-trop. levels over southwest Bay off Tamil Nadu coast on 15th
<b>Cyclonic circulations</b>				
(i) Lower trop. levels (31 Aug-3 evening)	Bihar and neighbourhood	—	<i>In situ</i>	
(ii) Mid-trop. levels (2nd-3rd)	Southwest Bay	—	Do.	
(iii) Lower trop. levels (4th-5th)	South Uttar Pradesh and adjoining Madhya Pradesh	Westerly	Southwest Uttar Pradesh and adjoining Madhya Pradesh	
(iv) Do. (4th-6th)	Haryana and neighbourhood	NW'ly	Punjab	
(v) Lower and mid-trop. level (5th-8th)	West Rajasthan	Southerly	Gujarat and neighbourhood	
(vi) Mid-trop. levels (7th evening-10th)	West central Bay off Andhra coast	—	<i>In situ</i>	
(vii) Lower trop. levels (9th-10th)	Haryana and adjoining north Rajasthan	Easterly	West Uttar Pradesh and neighbourhood	
(viii) Lower levels (9th-10th)	North Pakistan and adjoining Punjab	Easterly	Himachal Pradesh and neighbourhood	
(ix) Lower/mid-trop. levels (10th-11th)	Northwest and adjoining west central Bay	NW'ly	Merged with the circulation of the well marked low pressure area	
(x) Do. (10th-16th evening)	South Gujarat and adjoining northeast Arabian Sea	Northerly	West Rajasthan	
(xi) Lower and mid-trop. levels (20th-21st evening)	West central Bay off Andhra coast	WSW'ly	South Andhra and neighbourhood	

TABLE 6 (contd)

(1)	(2)	(3)	(4)	(5)
(xii) Lower and mid-trop. levels (20th-23rd evening)	Northeast Madhya Pradesh and neighbourhood	Quasi-stationary	East Uttar Pradesh and neighbourhood	
(xiii) Lower/mid-trop. levels (22nd-24th)	Saurashtra & Kutch	—	<i>In situ</i>	
(xiv) Lower trop. levels (26th-30th)	Andaman Sea	Westwards	—	Lay over southwest Bay on 30th
(xv) Do. (26th-30th)	South Tamil Nadu and neighbourhood	Westwards	—]	Lay in the lower levels over Lakshadweep and neighbourhood on 30th

### 3.4. September

#### 3.4.1. Withdrawal of southwest monsoon

The withdrawal phase of the southwest monsoon commenced on 12 September, when it withdrew from west Rajasthan.

The withdrawal was complete from the Indian sub-continent outside Tamil Nadu and Kerala on 24 October. Details of withdrawal of southwest monsoon are given in Fig. 3.

#### 3.4.2. Monsoon activity associated synoptic features

Two depressions developed over the land areas of the sub-continent during the month. The synoptic features of the month are given in Table 6.

Besides those synoptic features two western disturbances moved away eastwards across extreme north of the country between 21st and 29th.

During the month active to vigorous monsoon conditions prevailed on 14 days in Assam & Meghalaya, on 5 to 7 days in West Bengal & Sikkim, Bihar plains and east Madhya Pradesh and on 2 to 3 days in Nagaland, Manipur, Mizoram & Tripura, Arunachal Pradesh and west Madhya Pradesh. It was active to vigorous on 4 to 5 days on Bihar Plateau and east Uttar Pradesh and on 1 to 2 days in Orissa, plains of west Uttar Pradesh, Himachal Pradesh, Konkan & Goa and Telangana during the first fortnight and was so on 1 to 3 days in Rayalaseema, south interior Karnataka and Kerala during the second fortnight of the month. Rainfall was generally widespread on 13 to 19 days in Arunachal Pradesh, Assam & Meghalaya and West Bengal & Sikkim; on 6 to 12 days in Andaman & Nicobar Islands, Nagaland, Manipur, Mizoram & Tripura, Bihar, east Uttar Pradesh, east Madhya Pradesh, Konkan & Goa, Karnataka and Kerala & Lakshadweep and on 1 to 5 days in Orissa, west Uttar Pradesh, west Madhya Pradesh, Vidarbha, Andhra Pradesh and Tamil Nadu during the month. Rainfall over Haryana, Punjab, Rajasthan and Gujarat was of isolated or scattered nature and that too on a few days only.

#### 3.4.3. Rainfall

It was excess in Assam & adjacent States, Gangetic West Bengal, Bihar, east Madhya Pradesh, south interior Karnataka and Lakshadweep; normal in Sub-Himalayan West Bengal & Sikkim, east Uttar Pradesh and Tamil Nadu; deficient in Andaman & Nicobar Islands, Orissa, west Uttar Pradesh, Jammu & Kashmir, west Madhya Pradesh, Konkan & Goa, Telangana, Rayalaseema, north interior Karnataka and Kerala and was scanty over the rest of the country.

The significant amounts (cm) of rainfall were :

- 1st : Shirgaon 14, Bhira 11, Chaparmukh & Harnai 7 each
- 2nd : Gangtok 12, Tadong 11, Koyana & Mahabaleswar 10 each, Cooch Behar & Gudivada 8 each, Harnai & Mathanguri 7 each
- 3rd : Sangareddy 12, Gorakhpur & Tataribazar 10 each, Gauhati AP & Panagarh AP 9 each, Gangtok & Rairakhal 7 each
- 4th : Daporijo & Sitapur 16 each, Bolangir, Mahabubabad & North Lakhimpur 11 each, Bhawanipatna, Sakti & Sonbarsa 10 each, Thakurdwara 9, Bareilly AP, Jamshedpur & Purulia 8 each, Gangtok, Raichur & Silchar AP 7 each
- 5th : Sambalpur 10, Patna AP 9, Dehra Dun, Jalaun, Khammam & Nowgong 8 each, Chhatarpur & Tezpur 7 each
- 6th : Akbarpur 9, Durgachak 8, Bhone, Imphal & Jammu 7 each
- 7th : Banda 22, Chhatarpur & Dibrugarh AP 11 each, Pasighat 9, Hindol 8, Jorhat, Narsinghpur, Pondicherry & Salempur 7 each
- 8th : Rosera 23, Varanasi AP 15, Dehra Dun 13, Muzaffarpur 10, Chapra & Kokrajhar 9 each, Bansgaon & Satna 7 each
- 9th : Rewa 13, Satna 11, Naharkatia & Sagar 8 each, Allahabad AP, Ferrukhabad, Jabalpur & Jhansi 7 each

- 10th : Varanasi AP 25, Baikunthpur 10, Sidhi 7
- 11th : Daltonganj 24, Varanasi 17, Ambikapur 12, Bhira & Dehri 8 each, Gorakhpur AP 7
- 12th : Duchi 16, Chapra 14, Darbhanga 11, Tensa 10, Malda 8, Chouldhaghat 7
- 13th : Dehri 18, Turtipar 15, Chapra, Gaganbavda & Uluberia 9 each, Dharmapuri & Tezpur 8 each, Daltonganj 7
- 14th : Sidhi 11, Parangipettai 10, Tiruvannamalai 9, Chidambaram 7
- 15th : Maihar 11, Jeypur, Naharkatia & Satna 9 each
- 16th : Bhind 18, Aryankava 17, Khajuraho 13, Bankura & Damoh 11 each, Cooch Behar, Jabalpur & Rajghat 9 each, Kayamkulam & Puri 8 each, Jhansi 7
- 17th : Shivpuri 13, Sironj 12, Akhuapada 11, Guna 9, Golaghat, Jhansi & Tikamgarh 7 each
- 18th : Kodaikanal 9, Tezu 8, Holenarsipur 7
- 19th : Jalpaiguri 19, Khanapur 12, Bijaipur 9, Ferozepur, Pandharpur & Tiruthuraipoondi 7 each
- 20th : Chalakkudy, K.R. Pet & Satna 9 each, Srinivaspur 8, Gangtok, Honavar, Hosur, Keonjhar & Polavaram 7 each
- 21st : Tezu 20, Hoskote 16, Rewa 11, Anantpur 10, Visakhapatnam & Yelhanka AP 9 each, Atmakur, Kashinagar & Nandyal 7 each
- 22nd : Jamkhed & Sulurpet 10 each, Kanakapura & Malda 7 each
- 23rd : Dholai 13, Pandavapura & Silchar AP 9 each, Madikeri, Paradip & Varanasi AP 8 each, Kallakurichi & Parvatipuram 7 each
- 24th : Peermade 16, Goalpara 13, Pasighat & Quilandy 10 each, Belthangadi, Malavalli & Panbari 8 each, Balumath, Kottayam & Sabroom 7 each
- 25th : Arundhutinagar 46, Cherrapunji 35, Khowai 21, Agartala AP 11, Lakhisarai 10, Chandgad & Shillong 9 each, Narsipatnam 8, Gauhati AP 7
- 26th : Cherrapunji 54, Shillong 13, Goalpara 11, Gangtok 8, Panagarh AP 7
- 27th : Cherrapunji 19, Goalghat & Karimganj 12 each
- 28th : Channapatna 11, Billoli & Usilampetti 9 each, Kanakapura 7
- 29th : Ma nargudi 15, Holenarsipur & Sirsi 7 each
- 30th : Tuticorin 12, Gangtok 8, Ghodegaon & North Lakhimpur 7 each

#### 3.4.4. Floods and damages

As per the reports of the Central Water Commission all the major rivers in Assam and Bihar were in floods during the second week of September. Floods in river *Ghaghra* and *Ganga* were reported from Uttar Pradesh between 10th and 15th. *Ganga* was in spate at Farakka almost throughout the month. In the last week of September rivers *Brahmaputra*, *Dhansiri*, *Burhi Dihing*, *Kopili*, *Katakhal* and *Manas* in Assam were again in floods, which affected 808 villages and about 5 lakhs population. Floods in Bihar interrupted rail traffic on Delhi-Howrah (both grand chord and main) lines as the flood waters submerged the track. Also flood waters entered Arah town and outskirts of Chapra town.