Mausam, (1985), **36**, 3, 393-402

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Weather

MONSOON SEASON (JUNE-SEPTEMBER 1984)*

1. Introduction

The summer monsoon rainfall of 1984 was normal or excess over about 85 per cent and deficient over about 15 per cent of the land areas of the Indian sub-continent.

During the monsoon, the seasonal trough at 0.5 km a.s.l. established itself from the second week of June, to the east of long. 80° E and over the entire country by the 1st week of July. However, it was not prominent in the second fortnight of July and first week of August but was re-established in the second week of August which continued to be so throughout this month and upto mid-September. After this the trough shifted abruptly to Peninsula by 7-10 degrees south of its normal position and did not return to its normal position. Regular periodical northward progressions of the trough were observed during July and August.

A number of lower and middle tropospheric cyclonic circulations formed over the Bay of Bengal, a few of these developed into low pressure areas or depressions.

Percentage departure of monthly and seasonal rainfall sub-divisionwise is given in Table 2. The seasonal departures computed from individual station data is shown in Fig. 4.

2. Chief features of the season

2.1. *Advance of monsoon*

Southwest monsoon advanced over south Kerala on 31 May. Thereafter the Arabian Sea branch advanced northwards slowly but steadily along the west coast and covered most parts of Gujarat State by 18th. The Bay branch of the monsoon also marched westwards and advanced into Uttar Pradesh by 18th. By this time monsoon covered the entire Peninsula, northeast India, most parts of Uttar Pradesh, Madhya Pradesh and Gujarat State. The advance upto this date was nearly normal. Thereafter its further march towards northwest India was arrested till 1 July. By seven July it covered the remaining parts of north Gujarat State, west Madhya Pradesh and west Uttar Pradesh and northwest India outside western parts of Kashmir. It covered the western parts of Kashmir on 18 July.

The advance of monsoon over northern parts of Gujarat State, east Rajasthan and northwest Madhya Pradesh was delayed by 1 to 2 weeks and was nearly normal over the rest parts of northwest India. Fig. 1 shows the dates of onset of monsoon over the country and Table 1 the progress of it week by week, prepared from the weekly rainfall data available at the time of its preparation.

2.2. *Activity of monsoon*

The rainfall during June was largely deficient in Gujarat region (—53%), moderately deficient (—26% to —50%) over west Madhya Pradesh, interior Maharashtra, Andhra Pradesh and north interior Karnataka. However, the monsoon activity in July wiped out the rainfall deficiency from Madhya Maharashtra, Andhra Pradesh and north interior Karnataka and brought down the deficiency in Gujarat region to moderate category while no significant improvement was noticed in west Madhya Pradesh, Marathwada and Vidarbha. The activity of monsoon during August was rather weak over the Peninsula leading to deficiency in the seasonal rainfall in Andhra Pradesh and Kerala. At the end of the monsoon the seasonal rainfall was excess or normal over the country outside Himachal Pradesh, Marathwada, Vidarbha and Andhra Pradesh and Andaman & Nicobar Islands, where it was deficient.

2.3. *Withdrawal of monsoon*

The withdrawal phase of monsoon commenced on 12 September, when it withdrew from Jammu & Kashmir. Withdrawal from northwest India and west

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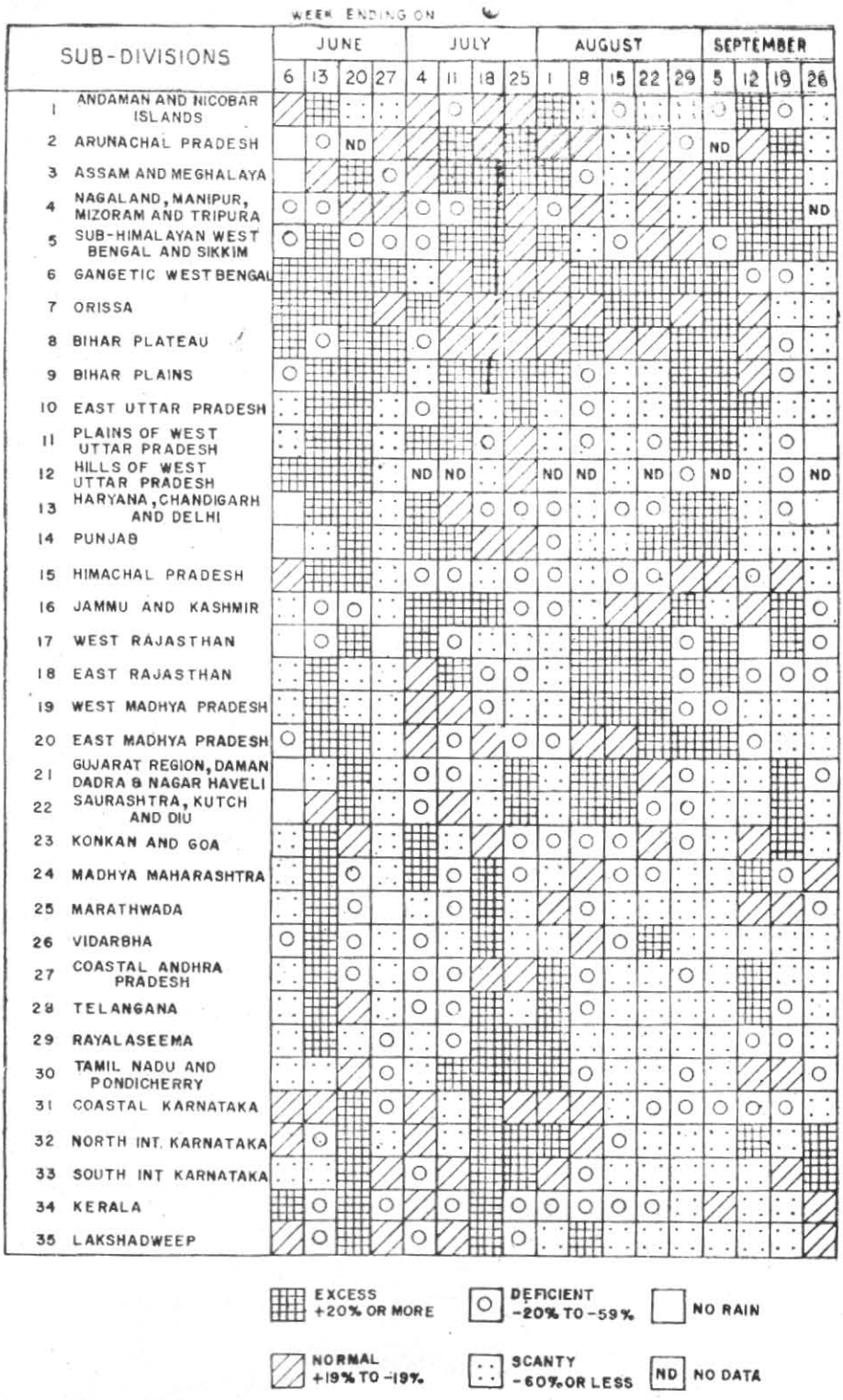
TABLE 1

Progress of the monsoon week by week, 1 June to 30 September 1984



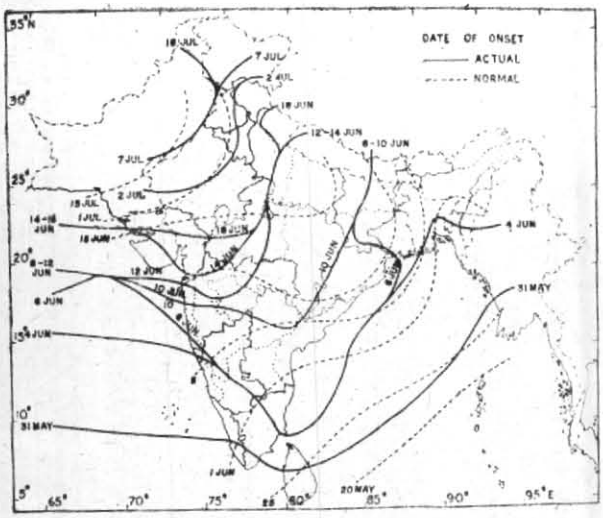


Fig. 1. Advance of southwest monsoon 1984

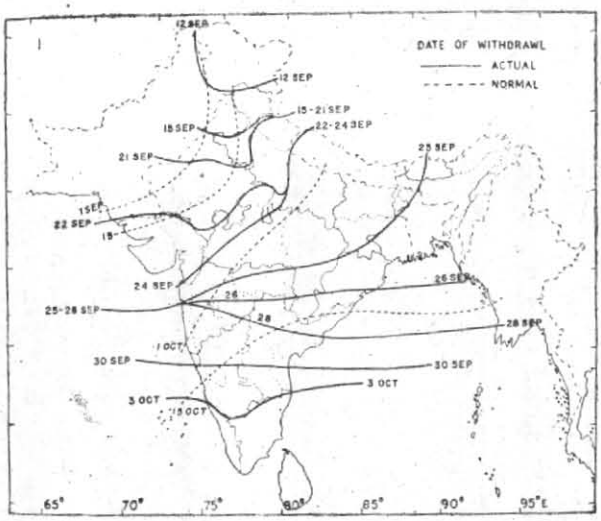


Fig. 2. Withdrawal of southwest monsoon 1984

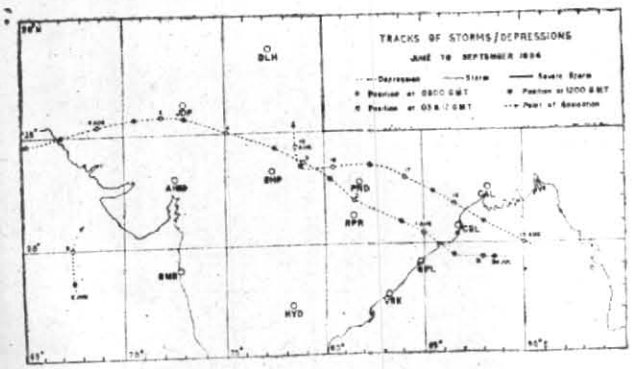


Fig. 3. Tracks of depressions during June-September 1984

Uttar Pradesh was complete by 22 September. The withdrawal from Rajasthan took place about two weeks later than the normal. Thereafter, southwest monsoon started retreating from the country rather fast. The withdrawal was complete from the country roughly to the north of Lat. 19° N by 26 September and that from over the entire country outside Tamil Nadu and Kerala by 3 October. Normally, the withdrawal phase of southwest monsoon takes about $1\frac{1}{2}$ months (beginning on 1 September from the westernmost parts of the country and completing by 15 October). In 1984 the withdrawal phase was complete in about three weeks time. As a result, though the withdrawal commenced late from Rajasthan, it was early by about one to two weeks from central, northeast and Peninsular India outside Kerala and Tamil Nadu. Fig. 2 showed the dates of withdrawal of the southwest monsoon from the Indian sub-continent.

2.4. *Depressions*

During monsoon season only two deep depressions in the Bay of Bengal and one depression in the Arabian Sea had formed. The average number of depressions/storms during the monsoon season worked out from the data set covering the period from 1981 to 1984 is 9. This season's total number is, therefore, very small and also is lowest for the last 94 years. The earlier lowest number was 4 in 1983. Tracks of these depressions are given in Fig. 3.

3. Significant monthly features

3.1. *June*

3.1.1. *Depressions*

During this month only one depression formed over east central Arabian Sea.

3.1.2. *Features heralding the advance of monsoon during June*

(*i*) A cyclonic circulation in the middle and upper tropospheric levels developed over Lakshadweep and neighbourhood on 31 May. It moved northnorthwestwards and under its influence a well marked low pressure area developed over east central Arabian Sea on 5th, which concentrated into a depression by the same evening centred near 18.5°N, 67.5°E. Moving northwards it became less marked over northeast Arabian Sea off north Gujarat coast by 7th.

(*ii*) A low level cyclonic circulation, which developed over northeast and adjoining east central Bay on 31 May moved over to northeast Bay and adjoining land areas on 1 June extending upto mid-tropospheric levels. Under its influence a well marked low pressure area formed over the northwest Bay and adjoining land areas on 3rd. Moving westnorthwestwards it lay over Bihar plateau and adjoining northeast Madhya Pradesh on 5th and persisted there till 8th, when it became a low pressure area. By next day the system moved over to northwest Madhya Pradesh and became less marked on 11th over the same area.

(*iii*) A low level cyclonic circulation was observed over south Uttar Pradesh and neighbourhood between

TABLE 2

Statement showing sub-divisional means of rainfall in each month and during the season as a whole June to September 1984

Sub-division	June		July		August		September		June to September			
	Actual	Percentage departure from normal	Actual	Percentage departure from normal	Actual	Percentage departure from normal	Actual	Percentage departure from normal	Actual	Normal	Departure from normal	Percentage departure from normal
	(mm)		(mm)		(mm)		(mm)		(mm)	(mm)	(mm)	(mm)
1. Andaman and Nicobar Islands	375	—21	353	—8	98	—72	293	—27	1119	1610	—491	—30
2. Arunachal Pradesh	435	—35	—	—	—	—	820	120	—	—	—	—
3. Assam and Meghalaya	381	—15	492	32	248	—32	369	46	1490	1437	53	4
4. Nagaland, Manipur, Mizoram and Tripura	383	—12	281	—10	257	—11	294	46	1215	1236	—22	—2
5. Sub-Himalayan West Bengal and Sikkim	522	—15	817	28	376	—22	609	34	2323	2184	139	6
6. Gangetic West Bengal	637	154	332	11	423	32	167	—27	1560	1102	458	42
7. Orissa	290	35	319	—8	448	34	136	—46	1193	1146	47	4
8. Bihar Plateau	558	176	338	—8	433	27	157	—29	1486	1133	353	31
9. Bihar Plains	382	115	445	66	241	—20	214	—7	1282	976	306	31
10. East Uttar Pradesh	206	124	347	13	229	—25	323	69	1105	894	211	24
11. Plains of West Uttar Pradesh	214	160	300	7	256	—2	110	—35	880	792	88	11
12. Hills of West Uttar Pradesh	285	68	339	—41	287	—52	207	—33	1119	1649	—531	—32
13. Haryana, Chandigarh and Delhi	68	23	169	—4	215	30	90	—28	541	520	21	4
14. Punjab	48	28	275	61	176	19	122	18	621	459	162	35
15. Himachal Pradesh	161	39	302	—41	305	—36	161	—29	929	1327	—398	—30
16. Jammu and Kashmir	30	—34	107	—19	60	—17	68	—15	266	330	—64	—19
17. West Rajasthan	12	—55	59	—44	115	1	59	1	244	304	—59	—20
18. East Rajasthan	37	—43	159	—35	237	1	127	8	559	661	—102	—15
19. West Madhya Pradesh	65	—48	166	—52	592	100	55	—71	878	954	—76	—8
20. East Madhya Pradesh	153	—2	285	—29	514	27	135	—40	1086	1186	—100	—8
21. Gujarat region, Daman, Dadra and Nagar Haveli	41	—53	229	—31	417	104	71	—50	758	765	—7	—1
22. Saurashtra, Kutch and Diu	72	7	125	—49	130	—8	142	57	470	547	—78	—14
23. Konkan and Goa	771	11	1011	0	436	—27	244	—30	2463	2649	—186	—7
24. Madhya Maharashtra	67	—36	183	4	85	—34	133	—3	469	546	—77	—14
25. Marathwada	72	—48	146	—18	121	—15	124	—35	464	648	—184	—28
26. Vidarbha	90	—50	229	—33	225	—19	56	—72	599	996	—397	—40
27. Coastal Andhra Pradesh	69	—32	139	—13	75	—48	112	—26	395	555	—160	—29
28. Telangana	99	—29	259	8	8	—59	152	—20	595	778	—183	—24
29. Rayalaseema	41	—39	165	69	16	—83	128	—11	351	405	—54	—13
30. Tamil Nadu and Pondicherry	21	—47	151	162	34	—60	131	47	337	271	66	24
31. Coastal Karnataka	1055	6	849	—18	484	—21	172	—43	2559	2945	—386	—13
32. North Interior Karnataka	80	—28	264	53	79	—42	123	—23	546	580	—34	—6
33. South Interior Karnataka	69	—11	115	—1	33	—67	146	26	363	410	—47	—11
34. Kerala	611	—2	465	—17	195	—41	143	—38	1414	1743	—329	—19
35. Lakshadweep	318	—8	262	—3	99	—51	80	—50	760	977	—217	—22

8th and 11th . These systems were responsible for the advance of monsoon over the country outside northwest India and western parts of plains of west Uttar Pradesh, northwest Madhya Pradesh and extreme northern parts of Gujarat State as shown in Fig. 1.

(*iv*) A cyclonic circulation in the middle tropospheric levels was observed over Saurashtra & Kutch and adjoining Gujarat region and east central Arabian Sea on 14th, where a low pressure area developed on 15th. It became less marked over Gujarat State by 16th. However, the upper air cyclonic circulation in the lower and middle tropospheric levels persisted there till 17th, which gradually became less marked by 19th.

(*v*) A low pressure area developed over south Uttar Pradesh and neighbourhood with associated cyclonic circulation upto mid-tropospheric levels on 14th. It became less marked over west Uttar Pradesh and adjoining Haryana on 17th.

These two systems further advanced the southwest monsoon by 18th over the most parts of Gujarat State and west Madhya Pradesh, rest of Maharashtra State and hills of west Uttar Pradesh. Further advance of monsoon was stalled till 2 July.

3.1.3. *Other synoptic features*

(*i*) Trough on sea level chart off west coast extended from south Maharashtra-Goa coast to Lakshadweep from 2nd to 6th and from 19th to 30th and from Gujarat coast to Lakshadweep on most of the remaining days. However, there was no embedded off shore onset vortex within this trough.

(*ii*) A cyclonic circulation in the lower and middle tropospheric levels which developed over south Andhra-north Tamil Nadu coasts and adjoining west central Bay on 7th, moved over coastal Andhra Pradesh and neighbourhood by 9th. Under its influence a low pressure area formed over west central Bay off north Andhra coast on 11th, which became well marked over northwest Bay and adjoining land areas on 13th. It moved over Bihar plateau and neighbourhood on 15th. Under the influence of a westerly trough in mid and upper tropospheric levels, it moved eastnortheastwards and lay over Assam and adjacent States as a low pressure area on 20th. Thereafter it again took westerly course and became less marked over Sub-Himalayan West Bengal on 22nd.

(*iii*) A low pressure area which developed over north and adjoining central Bay on 21st, moved over northwest Bay and adjoining land areas by 23rd when it became well marked. The associated cyclonic circulation extended upto mid tropospheric levels. It lay over east Madhya Pradesh and adjoining Bihar and Orissa as a low pressure area on 29th. It merged with another low pressure area on 30th which moved from east central and adjoining northeast Bay to over Gangetic West Bengal and adjoining Orissa and neighbourhood between 28th and 30th.

(*iv*) A cyclonic circulation/trough in the lower and mid-tropospheric levels developed off Andhra coast on 22nd. It became less marked there by 26th.

(*v*) The last western disturbance of the previous month and eight others affected north Pakistan, Western Himalayas and neighbourhood during the month.

After the advance of the southwest monsoon it was vigorous on 3 to 4 days in Gangetic West Bengal and east Uttar Pradesh and on 1 to 2 days in Sub-Himalayan West Bengal & Sikkim, Orissa, Bihar, Saurashtra & Kutch, Vidarbha, coastal Andhra Pradesh, south interior Karnataka and Kerala and was active on 5 to 8 days over West Bengal & Sikkim, Bihar plains, coastal Karnataka and Kerala and so on 1 to 4 days over Assam and adjacent States, Orissa, Bihar plains, hills of west Uttar Pradesh, east Madhya Pradesh, Gujarat region and Konkan & Goa during the month. Monsoon was weak over Madhya Maharashtra, Marathwada, Telangana and Rayalaseema.

The rainfall over northwest India and the neighbourhood areas of west Uttar Pradesh, Rajasthan and west Madhya Pradesh, where monsoon current did not advance during this month, was mainly of scattered or isolated except in Haryana, Punjab, Himachal Pradesh and Jammu & Kashmir. Himachal Pradesh received generally widespread rainfall for 8 days with isolated heavy falls on a couple of days. The other three subdivisions received generally widespread rainfall on 1 to 2 days during the month.

3.1.4. *Rainfall during the month*

Rainfall during the month was excess in Gangetic West Bengal, Orissa, Bihar State, Uttar Pradesh, Haryana, Punjab and Himachal Pradesh; normal in Assam & Meghalaya, Nagaland, Manipur, Mizoram & Tripura, Sub-Himalayan West Bengal & Sikkim, east Madhya Pradesh, Suarashtra & Kutch, Konkan, & Goa, coastal and south interior Karnataka, Kerala and Lakshadweep and deficient over the rest of the country.

The significant amounts, 10 cm or more, of rainfall were :

2nd	Kayamkulam 10.
3rd	Cannanore 16, Mangalore, Kozhikode & Vayittiri 11 each.
4th	Uluberia 14.
5th	Canning Town 27, Digha 26, Diamond Harbour 24, Sandheads 22, Dum Dum & Dharchula 18 each, Contai 17, Calcutta 14.
6th	Dum Dum 38, Kasargode 35, Calcutta 29, Port Blair 18, Krishnagar 14.
7th	Devgarh 17, Karwar 16, Jalpaiguri 14, Vengurla 13, Darjeeling 12.
8th	Pune 10.
9th	Gorakhpur 27, Sagar Island 12, Shirali & Yanam 11 each.
10th	Gorakhpur 11.
12th	Bombay 13, Alibag 10.
13th	Gunupur (Orissa) 28, Kashinagar 17, Kalingapatnam 15, Kalaikundi, Alibag & Gudari 13 each.

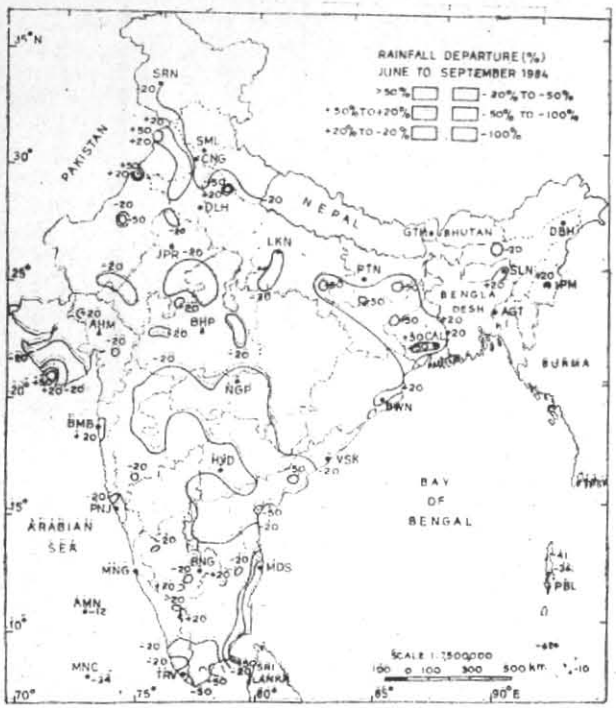


Fig. 4. Seasonal departure of rainfall

14th	Vengurla 21, Junagarh, Bagamandela 19 each, Paikmal 16, Bagati (Magra), Titlagarh & Agumbe 13 each.
15th	Panposh, Bagamandala 24 each, Beltangdi, Dum Dum & Tensa 18 each, Peermedu 16, Chakradharpur 14.
16th	Bagamandala 31, Bidiabaise & Nilambur 21 each, Mahabaleshwar & Manantoddy 19 each, Santacruz 18.
17th	Navsari 42, Bulsar 25, Cherrapunji, Vayittiri & Nilambur 24 each, Mahabaleshwar 20.
18th	Cherrapunji 45, Bagamandala 17, Shirali 16, Calcutta, Mangalore 15 each, Agartala 13.
19th	Cherrapunji 37, Mangalore 21, Kasargode 15.
21st	Jalpaiguri 22.
22nd	Rajghat 14, Digha 13.
23rd	Calcutta 14, Champa 13.
24th	Bankura 20, Dhanbad & Panagarh 17 each, Cherrapunji 16.
25th	Bankura & Bhagalpur 18 each.
26th	Bhagalpur & Sandheads 14 each.
27th	Bankura 27.
28th	Bilaspur (M.P.) 19.
30th	Mercara 20, Ratnagiri 19, Panjim 17, Kasargode 16, Alibag 15, Bombay & Agumbe 13 each.

3.1.5. *Floods and damages during June*

As per "*Weekly Flood News Letter*" from Central Water Commission (CWC) floods were reported from northeast India, Uttar Pradesh and Kerala during this month. Floods in river *Brahmaputra* in Assam continued throughout the month from 2nd week, which affected vast populated areas. Heavy rains virtually paralysed the life in Calcutta city on 5th and 6th and flooded large areas of 24 Parganas, Howrah, Hooghly, Midnapur and Nadia districts. They also caused lot of damage to Calcutta Metro Railway system. Another spell of heavy rain, during 15th to 17th, submerged vast areas of Gangetic West Bengal and low lying areas of west Dinajpur and Malda districts. There were breaches in the embankment of river *Ajoy*. Floods in the river *Mahananda* affected Katihar town and 25 villages in Kathihar district in Bihar, Heavy rains on 12th and 13th caused floods in the rivers *Vamsadhara*, *Nagavali* and *Indravati* and hill streams of Karaput district affecting 359 villages in Orissa. Loss of public properties estimated at about Rs. 1.91 crores. Unusual rain during 16th to 19th flooded rivers in Manipur and Tripura causing breaches in embankments. Due to land slides 12 persons were killed and 8 were injured in Tripura. Damages to paddy crops in Manipur estimated at about Rs. 185.35 lakhs. Heavy rains and floods in Uttar Pradesh during this month affecting 1101 villages in the district of Basti and Faizabad. Four human lives were also lost. Also heavy rain in Kerala, in the third week, caused flooding and severe sea erosion, especially in the northern parts of the State. Parts of National Highway No. 47 in Alleppey district were damaged.

As per press reports 32 deaths occurred in West Bengal due to house collapse, floods and electrocution during the month of June.

3.1.6. *Temperature*

Moderate to severe heat wave conditions prevailed in north coastal Andhra Pradesh on 1 and 2 June.

Day temperatures were generally above normal in Assam & adjacent States, northwest India, Madhya Pradesh and Andhra Pradesh during the first ten days of the month being appreciably so on a few days. They were also generally above normal in Madhya Maharashtra, Marathwada, Andhra Pradesh and Tamil Nadu in the last week of the month.

3.2. *July*

3.2.1. *Advance of monsoon in July*

After a respite of two weeks from 19 June monsoon started advancing over northwest India and neighbourhood from 2 July. The following features were responsible for further advance of monsoon over northwest India and neighbourhood during July as shown in Fig. 1.

(*i*) The low pressure area which lay over Gangetic West Bengal and adjoining Orissa and neighbourhood on the last day of June, moved westnorthwestwards and merged with the seasonal trough over northeast Rajasthan and adjoining Haryana on 5th.

(*ii*) A low level cyclonic circulation developed over Haryana and neighbourhood on 3rd and another over central Pakistan and adjoining Rajasthan on 5th. The later one merged with the former over Punjab and neighbourhood on 7th. The combined cyclonic circulation persisted over Punjab and neighbourhood till 17th and became less marked by next day.

3.2.2. *Depression*

On the evening of 30th a depression formed in the Bay of Bengal.

3.2.3. *Monsoon activity and associated synoptic features*

(*i*) A cyclonic circulation in the lower and mid-tropospheric levels lay over Gujarat State and neighbourhood from 2nd to 6th which weakened there by 7th.

(i) A cyclonic circulation in the mid-tropospheric levels, which developed over the northwest Bay and adjoining land areas on 3rd, moved over north Madhya Pradesh and adjoining Uttar Pradesh on 5th, where it became less marked by 7th.

(*iii*) In the north-south trough in the lower and mid-tropospheric levels which extended from Sub-Himalayan West Bengal & Sikkim to northwest Bay on 11th, a low pressure area formed over north and adjoining west central Bay on 16th. It moved over Orissa and neighbourhood on 18th. Thereafter it moved away rapidly across central India and Gujarat State by 20th.

(*iv*) A cyclonic circulation in the mid-tropospheric levels was observed over west central and adjoining southwest Bay and land areas on 25th. It moved northwards and under its influence a depression developed over west central and adjoining northwest Bay on 30th evening. Further concentrating into a deep depression by the evening, it crossed Orissa coast between Puri and Paradeep in the early hours of 1 August.

(*v*) A cyclonic circulation in the lower tropospheric levels which lay over southeast and adjoining southwest Bay on 21st, became less marked over Tamil Nadu and adjoining southwest Bay on 23rd.

(*vi*) A cyclonic circulation in the mid and upper tropospheric levels was seen over Kerala-Lakshadweep and adjoining sea areas on 23rd and 24th.

(*vii*) The trough on sea level chart off west coast generally extended from Maharashtra-Goa coast to Lakshadweep area during the second fortnight of the month.

(*viii*) A cyclonic circulation extending up to 1.5 km asl which developed on 13th over north Pakistan extended over Punjab on 16th. It became less marked on 18th.

(*ix*) The last western disturbance of the previous month and six others affected north Pakistan, Western Himalayas and neighbourhood during the month.

During the month, monsoon was vigorous on 1 to 2 days in Assam & Meghalaya, Sub-Himalayan West Bengal & Sikkim, Bihar plains, east Uttar Pradesh, Haryana, Punjab, east Rajasthan, Gujarat State, onkan & Goa, Madhya Maharashtra, Telangana, Rayalaseema and north interior Karnataka. It was active on 8 to 12 days in Assam & Meghalaya, Sub-Himalayan West Bengal & Sikkim, Bihar plains and Kerala ; on 3 to 7 days in Gangetic West Bengal, Orissa, west Uttar Pradesh, Punjab, east Rajasthan, Madhya Pradesh, Gujarat region, Maharashtra State, coastal Andhra Pradesh, Telangana, coastal and north interior Karnataka and on 1 to 2 days in the rest of the subdivisions outside Haryana and west Rajasthan where the number of active days were *nil*. Also generally widespread rain with isolated heavy to very heavy falls occurred on 4 to 8 days in Arunachal Pradesh, Himachal Pradesh, Konkan & Goa, coastal Karnataka and Kerala.

3.2.4. *Rainfall during the month*

The rainfall was excess in Assam & Meghalaya, Sub-Himalayan West Bengal & Sikkim, Bihar plains, Punjab, Rayalaseema and Tamil Nadu; normal in Andaman & Nicobar Islands, Nagaland, Manipur, Mizoram & Tripura, Gangetic West Bengal, Orissa, Bihar plateau, plains of Uttar Pradesh, Haryana, Jammu & Kashmir, Konkan & Goa, Madhya Maharashtra, Marathwada, coastal Andhra Pradesh, Telangana, coastal & south interior Karnataka, Kerala and Lakshadweep and deficient over the rest of the country outside Arunachal Pradesh, from where rainfall data were not available.

The significant amounts, 10 cm or more, of rainfall were :

1st Gaganbavada 37, Harnai 26, Bagamandala 22, Parola 20, Yellapur 18, Sirsi 14.

2nd Bombay 54, Bagamandala 53, Yellapur 24, Mahabaleshwar 23, Vayittiri 21, Chalisgaon 18.

3rd Bagamandala 53, Lonavala 38, Bhira 28, Mahabaleshwar 16, Bulsar 14.

4th Mangaon 22, Santacruz 17, Mahabaleshwar & Rajgurunagar 16 each.

5th Mahabaleshwar 13.

6th Cherrapunji 14, Mahabaleshwar 13, Rawat Bhata 11.

7th Chaparmukh 17, Navasari 12, Amritsar & Mahabaleshwar 10 each.

8th Dhubri 38, Jalpaiguri & Bahraich 17 each.

9th Shillong 13, Pehowa 10, Chandigarh AP 9, Bilaspur (H.P.) 8.

10th Pasighat 12, Adirampattinam 11.

11th Cherrapunji 73, Supaul 13.

12th Dhubri 40, Cherrapunji 19, Darjeeling 10.

13th Cherrapunji 21, Alur & Ramannapet 18 each.

14th Raipur 22, Vayittiri & Agumbe 15 each, Kassargode 13.

15th Gaganbavada 20, Aguma 16, Sholapur 15, Bagamandala 13.

16th Mangaon 22, Lonavala 15, Bagamandala 14

17th Patan 19, Karwar 17, Mahabaleshwar 16, Gaganbavada 15.

18th Mahabaleshwar 35, Agumbe 27, Karkala & Lonavala 22 each, Belangadi 20, Vayittiri & Bagamandala 19 each, Honavar 16, Shajapur 14

19th Lonavala 30, Bhira 22, Agumbe 21, Veraval, Mahabaleshwar & Bulsar 20 each, Surat 16.

20th Cherrapunji 28, Ambone 21.

21st Cherrapunji 18.

22nd Podili 32, Cherrapunji 27, Panjim 16.

23rd Cherrapunji 43, Vayittiri 26, Coondapur 14, Karkala 13.

24th Cherrapunji 27.

25th Dhubri 29, Dehradun 13.

26th Cherrapunji 29, Dhubri 19, Chaparmukh 13.

27th Cherrapunji 20, Pasighat 13.

28th Cherrapunji 14.

29th Batala 14.

3.2.5. *Floods and damages during July*

The C.W.C., *'Floods News Letter'*, reported floods from Assam, West Bengal, Bihar, Uttar Pradesh, Gujarat and Karnataka. River *Brahmaputra* in Assam and *Burhi Gandak, Kamla, Balan, Kosi* and *Mahananda* in Bihar continued to be in floods throughout the month causing breaches in the embankments. Along *Jaidhal* river there was a breach of 20 m on 26th in Lakhimpur district and another of 50 m in the Kumotiya dyke in the last week. In Bihar about 4396 villages were affected by floods upto 1 August. Zamindari embankment at Sripalpur on *Punpun* river breached at 5 to 6 places on 30 July 1984. The floods in *Ganga* and *Raidok*, in the third week, affected vast areas and thousands of people were marooned in Malda district of West Bengal. Railway bridges Nos. 11 and 12 on broad-gauge between Malda and Kumedpur were affected disrupting train services between Katihar and Malda. Heavy rains/floods affected 3055 villages in 16 districts of Uttar Pradesh upto 30 July and 4396 villages in 16 districts of Bihar. Following heavy rain on 22nd and 23rd National High Way No. 9 in Karnataka was damaged at a number of places. Heavy rain in the first and third week of July caused floods in rivers *Purna*, *Ambica* and others in Gujarat. Estimated loss to public properties was about Rs. 1.50 crores.

3.3. *August*

3.3.1. *Monsoon activity and associated synoptic features*

(*i*) The deep depression which crossed north Orissa coast in the early hours of 1st moved westnorthwestwards and weakened into a depression over Madhya Pradesh by 3rd morning then it lay centred about 25 km southeast of Sagar. Thereafter it moved northwestwards between 3rd and 4th and then westwards across Rajasthan and entered southeast Pakistan on 6th. It moved away westward across south Pakistan and adjoining north Arabian Sea by 7th.

(*ii*) A mid-tropospheric cyclonic circulation developed over Bangla Desh and adjoining Gangetic West Bengal on 4th. Under its influence a low pressure area formed over north Bay and adjoining Bangla Desh and Gangetic West Bengal on 6th evening with associated cyclonic circulation extending upto mid-tropospheric levels. The low pressure area became well marked on 7th over coastal Orissa, Gangetic West Bengal and adjoining northwest Bay. Moving westnorthwestwards across central India, it became unimportant over south Pakistan on 15th.

(*iii*) A low pressure area with associated cyclonic circulation upto mid-tropospheric levels formed over north Bay and adjoining coastal areas of Bangla Desh on 11th. It concentrated into a depression on 15th centred near 20.0° N, 90.0° E. Further intensifying into a deep depression by the same evening it crossed north Orissa coast near Balasore around mid-night, the same day. Moving westnorthwestwards it weakened into a depression over northwest Madhya Pradesh and neighbourhood on 19th morning when it lay centred about 70 km northwest of Sagar. It weakened further and merged with the seasonal trough over west Uttar Pradesh and neighbourhood on 21st.

(*iv*) A cyclonic circulation in the lower and mid-tropospheric levels was observed over northeast Arabian Sea and adjoining Saurashtra & Kutch from 21st to 22nd.

(*v*) A low pressure area with associated cyclonic circulation extending upto mid-tropospheric level lay over east Uttar Pradesh and adjoining northeast Madhya Pradesh and Bihar on 23rd. It merged with the seasonal trough over plains of Uttar Pradesh on 26th.

(*vi*) A cyclonic circulation in the mid-tropospheric levels was observed over north Bay and adjoining land areas on 25th. Under its influence a well marked low pressure area formed there on 26th which moved inland and merged with the seasonal trough over Bihar on 31st. However, the cyclonic circulation upto mid-tropospheric levels persisted.

(*vii*) A cyclonic circulation in the lower tropospheric levels was observed over Haryana and adjoining areas from 26th to 28th.

(*viii*) The last western disturbance of the previous month and ten others affected north Pakistan and Western Himalayas during this month.

Under the influence of these systems monsoon was vigorous on 3 to 5 days in Punjab, Madhya Pradesh and Gujarat region and on 1 or 2 days in Arunachal Pradesh, Gangetic West Bengal, Orissa, Bihar plateau, plains of west Uttar Pradesh, Rajasthan, Saurashtra & Kutch, Vidarbha, coastal Andhra Pradesh and Telangana. It was active on 9 to 11 days in Gangetic West Bengal, Orissa, Bihar plateau, east Rajasthan and west Madhya Pradesh; on 3 to 6 days in Assam & Meghalaya, Sub-Himalayan West Bengal & Sikkim, Bihar plains, plains of Uttar Pradesh, Haryana, Punjab, Himachal Pradesh, east Madhya Pradesh, Gujarat region, Vidarbha, coastal Karnataka and Kerala and on 1 or 2 days in Nagaland, Manipur, Mizoram & Tripura, hills of west Uttar Pradesh, Jammu & Kashmir, Saurashtra & Kutch, Konkan & Goa, coastal Andhra Pradesh and north interior Karnataka.

Generally widespread rain with isolated heavy falls occurred on 1 or 2 days in Assam & Meghalaya, Sub-Himalayan West Bengal & Sikkim, Bihar plains, hills of west Uttar Pradesh, east Madhya Pradesh and Konkan & Goa.

3.3.2. *Rainfall during the month*

The rainfall was excess in Gangetic West Bengal, Orissa, Bihar plateau, Haryana, Madhya Pradesh and Gujarat region; normal in Nagaland, Manipur, Mizoram & Tripura, plains of west Uttar Pradesh, Punjab, Jammu & Kashmir, Rajasthan, Saurashtra & Kutch, Marathwada and Vidarbha and scanty over Andaman & Nicobar Islands, Rayalaseema, Tamil Nadu and south interior Karnataka and deficient over the rest of the country outside Arunachal Pradesh, where from data for the month were not available.

The significant amounts, 10 cm or more, of rainfall during the month were :

1st Poladpur 31, Sangareddy 13, Kalingapatnam Mahabaleshwar & Jammu 10 each.

2nd Sindewahi 28, Agumbe 22, Balurghat 19.

3rd Seoni & Betul 18 each, Sawner & Shajapur 14 each, Ujjain 13.

4th Ratlam 18, Ahmadabad & Ujjain 14 each, Dohad 13.

5th Abu 24, Igatpuri 15, Idar 13.

6th Abu & Jashpurnagar 14 each.

7th Tensa (Orissa) 28, Deogarh (Orissa) 22, Kishorenagar (Orissa) 16, Nurpur 14.

8th Kakatpur, Tiring (Orissa) & Chaibasa 15 each, Balasore 13.

9th Kuchinda (Orissa) 13.

10th Betul 19, Raisen 15, Sehara 14, Mancompu 12.

11th Dohad & Dhar 16 each, Ratlam 15, Jhabua 14.

13th Bankura 17, Champa 13.

15th Pendra 13.

16th Chandbali 33, Naraj 20, Akhupada 19, Dhankanal 18, Paradip 17, Baijnath 13.

17th Sandheads 30, Rampur 28, Rajkishorenagar 23, Hirakund & Deogarh 22 each.

18th Jabalpur 16, Mandla & Raisen 15 each, Raigarh 14.

19th Tarana & Sandheads 24 each, Shajapur 18, Bhopal 15.

23rd Champa 16, Cherrapunji 13.

24th Panna 21, Jabalpur & Ajaigarh 18 each.

25th Barnala 19, Varanasi 12, Tibri 11.

26th Dum Dum 26, Tensa 16.

28th Taran Taran 12, Una (H.P.) & Jalandhar 11 each.

29th Gaya A.P. & Dehri 12 each.

30th Tarana 25, Chhatarpur & Dharmsala 12 each.

31st Bareilly AP 12 , Pathankot 8, Sidhi & Dhanbad 7 each.

3.3.3. *Floods and damages during August*

As per CWC floods were reported in August from Assam, West Bengal, Orissa, Bihar, Uttar Pradesh, Madhya Pradesh, Gujarat and Maharashtra of which the conditions were rather grave in West Bengal, Orissa, Bihar and Uttar Pradesh. Rivers *Ghagra* and *Rapti* were in floods in the first fortnight and river *Yamuna* was in flood in the fourth week. During the month about 6819 villages were affected in 32 districts of Uttar Pradesh. Rivers *Gandak, Burhi Gandak, Bagmati, Kamla, Balan, Kosi* and *Adwera* group in Bihar were in spate in the first two weeks. The second wave of floods in rivers *Gandak, Burhi Gandak* and *Kosi* in north Bihar and *Sone* and *Punpun* in south Bihar occurred in the fourth week. Total number of villages affected in Bihar upto 30 August were 7744. In West Bengal almost all major rivers and their tributaries were in spate in the 1st and 3rd week affecting parts of Hooghly, Midnapore, Howrah, Nadia, Murshidabad, Birbhum and Malda districts. Sunderban embankments were damaged at several location. In Orissa, river *Brahmani* at Jenapur and *Subarnarekha* at Rajghat were in floods on 9th and 10th affecting 185 villages in Balasore district. Following heavy rain from 15th to 17th floods affected 3260 villages in Cuttack, Balasore, Puri, Phulbani, Dhenkanal and Keonjargarh districts. 14 human lives were reported to have been lost and extensive cropped areas were submerged. In Assam river *Brahmaputra* was in floods in the first few days of the month. In the last week river *Dhansiri* was in spate flooding the valley. Heavy damage occurred in Goalpara district. In Madhya Pradesh floods in river *Indravati* in Bastar on 2nd disrupted road traffic from Jagdalpur and that in river *Narmada* affected 21 villages in Khargaon district in the 2nd week of the month. River *Narmada* was in floods at Broach from 12th to 14th. Heavy spell of rain in the first week breached many roads and cut off communications in north Gujarat State. Heavey rains/floods during the first week damaged crops and public properties in several districts of Maharashtra.

3.4. *September*

3.4.1. *Withdrawal of southwest monsoon*

The southwest monsoon withdrew from the country between 12 September and 3 October (Fig. 2).

3.4.2. *Weather and associated synoptic features*

The seasonal trough became active over the Peninsula and the south Bay and adjoining central Bay in the second fortnight of the month. It had not restored to its normal position thereafter. The following systems affected the weather over the country during this month.

(*i*) The cyclonic circulation extending upto mid-tropospheric levels, which lay over Bihar on 31 August, moved across Uttar Pradesh to Haryana and neighbourhood by 4th, where under its influence a low pressure area formed on 5th. It became less marked by next day.

(*ii*) Under the influence of a cyclonic circulation in the mid-tropospheric levels a low pressure area formed over north Bay and adjoining land areas on 1st, which became less marked over east Uttar Pradesh on 7th.

(*iii*) A cyclonic circulation extending upto 3.1 km asl developed over northwest and adjoining land areas on 8th. Under its influence a low pressure area formed over west central and adjoining northewest Bay on 10th, which became well marked over west central Bay by next day. It moved across the northern parts of the Peninsula and weakened over southeast Pakistan and adjoining west Rajasthan on 16th.

(*iv*) A cyclonic circulation in the lower tropospheric levels lies over Tamil Nadu and adjoining southwest Bay on 14th. By 19th it moved over west central Bay off north Tamil Nadu-south Andhra coasts extending upto mid-tropospheric levels. Under its influence a low pressure area developed there on 27th, which became well marked on 29th and persisted on 30th.

(*v*) Two upper air cyclonic circulations in the lower and mid-tropospheric levels emerged into Andaman Sea from the east, one on 13th and the other on 21st evening. Both of these cyclonic circulations merged with the circulation over southwest and adjoining west central Bay, the former on 19th and the latter one on 27th.

(*vi*) A cyclonic circulation in the lower tropospheric levels lay over southeast Arabian Sea off north Kerala coast and Lakshadweep area on 25th. It became less marked off Karnataka-Goa coasts on 28th.

(*vii*) The last western disturbance of the previous month and seven others affected north Pakistan and Western Himalayas during the month.

(*viii*) A cyclonic circulation between 2.1 and 3.1 km a. s. l., which lay over central Pakistan on 21st, became less marked over hills of west Uttar Pradesh on 24th.

Under the influence of these systems monsoon was vigorous on 4 days in Arunachal Pradesh, Assam & Meghalaya ; on 1 to 2 days in Sub-Himalayan West Bengal & Sikkim, Punjab, Gujarat State, Konkan & Goa, Madhya Maharashtra, Andhra Pradesh and south interior Karnataka. It was active on 8 days in Sub-Himalayan West Bengal & Sikkim ; on 3 to 5 days in Assam & Meghalaya, plains of Uttar Pradesh, Himachal Pradesh, east Madhya Pradesh and interior Karnataka; on ene to two days in Arunachal Pradesh, Gangetic West Bengal, Orissa, Bihar plains, hills of west Uttar Pradesh, Haryana, Punjab, Jammu & Kashmir, east Rajasthan, west Madhya Pradesh, Saurashtra & Kutch, Konkan & Goa, Marathwada, Vidarbha, Telangana, coastal Karnataka and Kerala. Generally widespread rainfall occurred on 13 days in coastal Karnataka and on 5 to 10 days in northeast India, hills of west Uttar Pradesh, Himachal Pradesh, interior Karnataka and Kerala during the month.

3.4.2. *Rainfall during the month*

It was excess in Assam & adjacent States, Sub-Himalayan West Bengal & Sikkim, east Uttar Pradesh, Saurashtra & Kutch, Tamil Nadu and south interior Karnataka normal in Bihar plains, Punjab, Jammu & Kashmir, Rajasthan, Madhya Maharashtra and Rayalaseema ; deficient in rest of the sub-divisions outside west Madhya Pradesh and Vidarbha, where it was scanty.

The significant amounts of rainfall of 10 cm or more were :

1st Rewa 13, Satna & Dehradun 11 each, Midnapore 10.

2nd Kuchinda and Jamankhira (Orissa), Rewari (Haryana) 13 each, Agartala & Sabalgarh (M.P.) 10 each.

3rd Nakodar 18, Rewa 14, Jalandhar 13, Sikar & Raya 10 each.

4th Patti 18, Ferozepore 13, Gauhati AP 10.

5th Cherrapunji 22, Varanasi AP 21, Kota AP 14, Mirjapur & Patna AP 10 each.

6th Cherrapunji 33, Baghdogra, Deoria (E. U.P.), Dalhousie & Una 12 each, Bundi 11.

7th Bahraich 56, Jalpaiguri 12.

8th Cooch Behar 12, Kathua 10.

10th Jalpaiguri 12, Kondul 10.

11th Mulug (Telangana) 11, Sattenapalli (C.AP) 10.

12th Alibag 19, Bombay 15, Ahmedpur (Marathwada) & Venkatapuram (Telangana) 14 each.

13th Navsari 24, Santacruz 22, Alibag 18, Jaggayyapet 13.

14th Tezu 60, Cherrapunji 33, Rajkot AP 24, Pasighat 21, Porbandar & Gudivada 10 each.

15th Cherrapunji 70, Pasighat 25, Bhuj AP 18, Cooch Behar 17.

16th Cooch Behar 32, Cherrapunji 24, Dhubri 14, Jalpaiguri 12.

17th Jalpaiguri 23, Diamond Harbour 12.

18th Jalpaiguri 13, Cooch Behar 12.

19th Pasighat 14, Cherrapunji 11.

20th Jalpaiguri 12, Sangareddy 11, Srivilliputtur & Mannargudi 10 each.

26th Bangalore city 12.

29th Srivilliputtur 20, Kayamkulam 14.

30th Madras AP & Denkanikottai 20 each, Sullurpeta 19, Tirupati AP 14, Pakala (Rayalaseema) 13.

3.4.3. *Floods and damages during September*

According to press reports and Central Water Commission's *'Weekly Flood News Letter'* the flood situation in Brahamaputra valley of Assam, in north Bihar and Uttar Pradesh became critical during the first fortnight of the month. The critical situation continued in Assam in the third week too. Rivers *Brahmaputra, Puthimari, Manas, Beki* and *Dhansiri* in Assam, rivers *Ganga, Gandak, Burhi Gandak, Bagmati, Kamla, Balan, Kosi, Mahananda, Sone* and *Punpun* in Bihar and rivers *Ganga, Ghagra* and *Rapti* in Uttar Pradesh were in floods. On 12 September heavy rain/floods affected 10438 villages in 35 districts of Uttar Pradesh. In the first week, river *Subarnarekha* in Orissa, river *Manu* in Tripura and rivers *Ganga, Jalangi, Churni, Mundeswari, Kapaleswari, Bhagirathi, Ajoy* and *Damodar* in West Bengal were in floods affecting Rajghat district in Orissa, Kailashahar district in Tripura and Murshidabad, Hooghly, Malda, Nadia and Birbhum districts in West Bengal. On 12 September a number of human lives reported to have been lost due to floods/heavy rains : 161 in Uttar Pradesh, 54 in Tripura, 46 in West Bengal, 61 in Bihar and 38 in Assam. Total damages to crops and public utilities as on this date were reported to be approximately 7.67 crores in Assam, 98.73 crores in Bihar, 223.12 crores in West Bengal and 15.25 crores in Tripura.