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Rainfall and floods during 1969 southwest monsoon period*

1. Introduction

During 1969 southwest monsoon season, concentrated spells of heavy rain occurred in Kerala, Madhya Pradesh, Madhya Maharashtra, Uttar Pradesh and East Rajasthan, causing floods in these parts, but parts of West Rajasthan and adjoining districts of Gujarat experienced drought conditions during the season. Rainfall during the southwest monsoon period was in excess in Madhya Maharashtra, deficient in Gujarat and Saurashtra and Kutch, Coastal Andhra Pradesh and Tamil Nadu and scanty in West Rajasthan. The rainfall was normal (± 24 per cent) over the rest of the country.

The sustained monsoon rainfall activity this year was due to and associated with movement of one cyclonic storm and 7 depressions (6 in Bay of Bengal and 1 in Arabian Sea), and a well marked low pressure area that formed in the central Arabian Sea, and moved northwards.

2. Weekly rainfall distribution

The distribution of the monsoon rainfall week-by-week in 31 meteorological sub-divisions on the basis of its percentage departures from normal rainfall is shown in Fig. 1.

The following salient features may be noted from this figure.

June — The monsoon activity was vigorous in Saurashtra and Kutch during the first fortnight of the month, the weekly rainfall being 158 per cent and 838 per cent above normal for the weeks ending 4 and 11 June respectively. Over Gujarat region, the rainfall was 464 per cent above normal during the week ending 11 June. It was also active over Bihar with percentage departure 121 per cent above normal over Bihar Plateau during the first week of June and 187 per cent above normal over Bihar Plains during the week ending 11 June. Monsoon was active in Coastal Mysore, Konkan, Madhya Maharashtra during the last week of June where the weekly rainfall was 59, 97 and 171 per cent above normal respectively.

July — During the first two weeks of the month the rainfall continued to be in deficit in Rajasthan. So far as other sub-divisions were concerned, the monsoon was active over sub-Himalayan West Bengal, Bihar Plains, East Uttar Pradesh Haryana, Punjab, Jammu & Kashmir, Konkan, Marathwada, Coastal Andhra Pradesh, Telengana, Rayalaseema, Tamil Nadu, Coastal Mysore and Kerala resulting in above normal rainfall during the week ending 16 July. In the third week of July East Rajasthan received 68 per cent excess rainfall, thus ending the dry spell in this region. Besides West Madhya Pradesh, Gujarat Region and Saurashtra & Kutch, received 56 per cent, 134 per cent and 210 per cent excess rainfall respectively. In the last week ending on 30 July, excess rainfall occurred over Haryana, Punjab, East Madhya Pradesh Andhra Pradesh and Kerala.

August — An important feature of August rainfall distribution was that the rainfall in West Rajasthan became normal and above normal during the weeks ending 13 and 20 August, the percentage departures being +15 and +71 per cent respectively.

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Note — Flood accounts and damage reports given in the article are taken from the *Flood News Letters* issued by the Central Water and Power Commission, New Delhi

PERCENTAGE DEPARTURE FROM NORMAL RAINFALL FOR WEEK ENDING

METEOROLOGICAL SUBDIVISIONS	JUNE				JULY					AUGUST				SEPTEMBER				OCT	1ST JUNE TO 30TH SEPT
	4	11	18	25	2	9	16	23	30	6	13	20	27	3	10	17	24	1	
NORTH ASSAM (INCLUDING NEFA)	-67	69	-29	-17	-12	4	0	-5	-49	-24	-45	98	-25	-29	-54	-57	-66	-51	-4
SOUTH ASSAM (INCLUDING NAGALAND, MANIPUR AND TRIPURA)	-15	69	-32	-64	-57	15	-4	-55	-7	-26	-41	97	4	-41	-67	-34	-63	-29	-3
SUB HIMALAYAN WEST BENGAL	-90	42	33	-10	-5	-17	31	-23	-18	-72	-64	5	78	28	-37	-52	-52	14	-7
GANGETIC WEST BENGAL	-19	20	-79	-66	-39	-12	-39	19	-83	-9	72	50	-32	-65	8	-17	7	33	-2
ORISSA	16	41	-52	-50	-62	-34	-39	6	83	16	-23	31	-57	-66	293	-33	89	-58	-5
BIHAR PLATEAU	121	8	-56	-78	-18	1	-52	84	-57	48	72	2	-9	-58	17	88	3	-38	-6
BIHAR PLAINS	-28	187	-5	-20	-58	3	31	64	-61	-64	9	139	35	15	-55	64	17	42	11
UP EAST	-39	-30	-51	-32	-68	53	13	24	5	-67	-12	104	11	-2	-47	-38	201	-59	8
U.P. WEST	13	-99	-95	-76	-63	15	-12	-43	6	56	43	31	-13	-33	42	22	185	-99	4
HARYANA (INCLUDING DELHI & CHANDIGARH)	-38	-76	-70	-51	-69	-35	52	-84	84	20	97	84	-95	100	113	305	-94	100	15
PUNJAB	-99	-100	-100	-77	-69	-46	17	496	187	-88	-31	68	-71	-100	-34	406	100	-100	-4
HIMACHAL PRADESH	-42	-99	-98	-23	-57	-28	-5	-32	-8	60	-18	7	-50	-48	-38	84	-25	-92	7
JAMMU AND KASHMIR	4	-84	-78	-43	-58	1	70	-3	-10	-19	30	-39	-69	-100	-93	-73	-58	100	-24
RAJASTHAN, WEST	-93	-78	-44	-80	-59	-94	-60	-41	-54	-97	15	71	-100	-92	-70	-15	100	100	-58
RAJASTHAN, EAST	-70	-39	-42	-90	-87	-43	-38	68	25	30	17	105	-93	-95	4	93	-63	100	-5
MADHYA PRADESH, WEST	-27	40	-84	-90	-85	-10	-27	56	-18	130	24	20	-51	-74	14	-9	82	100	5
MADHYA PRADESH, EAST	-53	-43	-48	-50	-51	10	-28	3	59	60	-22	1	-65	-79	4	-56	104	-93	-8
GUJARAT REGION (INCLUDING DAMAN, DADRA & NAGAR HAVELI)	-63	464	-57	-91	-98	-86	-42	134	-33	-65	-13	-16	-92	-76	135	56	-99	100	-25
SAURASHTRA & KUTCH (INCLUDING DIU)	-58	838	-81	-89	-98	-99	9	210	-96	-94	-82	-17	-75	-47	-61	-71	-100	-100	-35
KONKAN (INCLUDING GOA)	-46	-23	-51	11	97	-17	72	47	-14	-3	-19	-52	-61	50	351	-58	-75	-99	11
MADHYA MAHARASHTRA	38	-33	17	-53	171	49	-63	14	-6	103	-28	-71	120	77	349	-89	-82	-99	32
MARATHWADA	-66	-48	-63	-11	4	74	84	-58	-74	127	-49	-60	116	74	251	-68	-33	100	11
VIDARBHA	-82	38	-57	-64	-31	23	-37	19	26	4	-28	-51	-4	-67	133	-66	178	-83	-8
COASTAL ANDHRA PRADESH	-17	64	-24	-74	0	-65	55	-54	68	-56	-63	81	-2	-43	40	-89	-43	-90	-52
TELANGANA	-25	-52	-37	-88	-27	28	-29	-82	123	-7	-47	-35	31	38	106	-95	175	-99	9
RAYALA SEEMA	-37	-76	242	-41	17	-75	62	-89	168	-89	-88	-17	346	79	-66	100	-77	499	-4
TAMIL NADU (INCLUDING PONDICHERRY)	3	-69	-43	-17	-82	-35	36	-25	-60	-93	-53	47	28	17	-91	-96	-94	-44	-32
COASTAL MYSORE	5	-24	-66	10	59	-17	51	-41	-9	-7	-58	-97	-12	94	276	-17	1	100	-2
INTERIOR MYSORE, NORTH	-34	-78	58	-23	26	39	23	-4	21	69	-12	-50	87	195	54	-83	4	-83	18
INTERIOR MYSORE, SOUTH	23	-56	-59	-52	-50	-26	-17	-12	-39	6	-90	13	89	91	17	-73	-67	-79	-17
KERALA	12	-7	-68	21	-30	-20	41	17	80	-20	-72	-79	19	62	59	-39	-90	-64	-10

LESS THAN -50% | -50% TO -25% | -24% TO +24% | +25% TO +50% | >50%

[Fig. 1. Southwest monsoon 1969

During the third week ending 20 August, the monsoon activity increased considerably over northeast and northwest India as well as central parts of the country, resulting in moderate to large excess of weekly rainfall. In Bihar Plains, East Uttar Pradesh, East Rajasthan, the weekly rainfall was more than 100 per cent above normal. During the last week of this month, 346 per cent above normal rainfall occurred over Rayalaseema and more than 100 per cent excess in Madhya Maharashtra, Marathwada, Tamil Nadu and North Interior Mysore.

September — During the week ending 10 September, monsoon was active in Gangetic West Bengal, Orissa, West Uttar Pradesh, Haryana, East Rajasthan, West Madhya Pradesh, Gujarat Region, Maharashtra State, Coastal Andhra Pradesh, Telengana, Coastal and North Interior Mysore and Kerala where the week's rainfall was in excess. Significant excesses being 351 per cent in Konkan, 349 per cent in Madhya Maharashtra, 276 per cent in Coastal Mysore and 251 per cent in Marathwada and more than 100 per cent in Haryana, Gujarat Region, Vidarbha, Telengana and North Interior Mysore. During the succeeding week ending 17 September heavy rainfall occurred over Punjab and Haryana when the weekly rainfall was 406 per cent and 305 per cent above normal respectively. During the week ending 24 September, the rainfall was in deficit in Punjab, West Rajasthan, Gujarat State, whereas Uttar Pradesh, Madhya Pradesh Vidarbha and Telengana recorded more than twice the ususal rainfall during the week. In the last week of this month generally widespread rains occurred in northeast India in the first half of the week and isolated in the second half resulting in excess weekly rainfall in Gangetic West Bengal and Bihar Plains.

3. Devastating floods in Andhra Pradesh before the onset of southwest monsoon

In the month of May, before the onset of monsoon, devastating floods occurred in lower reaches of *Krishna* and *Godavari* rivers consequent to incessant heavy rains in their catchment areas adjoining Coastal Andhra Pradesh during the

Fig. 2. The cyclonic storm of 17 May as seen by ESSA-8. Orbit No. 1914, (0949 IST) while it was crossing Andhra coast

period 16-21 May 1969, in association with a cyclonic storm. It originated in the Bay of Bengal and was located near Lat. 15·5°N and Long. 83°E on the morning of 16th. It crossed the south Andhra coast between Ongole and Masulipatnam near Chinnaganjam in Guntur district on 17 May. Its movement slowed down considerably on crossing the coast but there was no significant change in its intensity. Later it moved very slowly northeastwards and was located east of Gannavaram on 19th morning. Thereafter it moved rather rapidly and weakened into a marked low pressure area over northeast Andhra Pradesh and neighbourhood on 20 May. The satellite picture of the cyclonic storm as seen by ESSA-8, while it was crossing Andhra coast on 17 May 1969 is shown at Fig. 2.

According to the press reports standing paddy and sugarcane crops were destroyed and communications were disrupted in Andhra Pradesh. The principal amounts of rainfall were — Ongole and Nidadavole 8 cm each, Vijayawada and Kakinada 7 cm each, and Masulipatnam and Gannavaram 6 cm each on 17th; Ongole 20 cm, Vijayawada 12 cm, Gannavaram 11 cm, and Rentachintala 8 cm on 18th; Gannavaram 13 cm, Khammam 9 cm, Rentachintala 8 cm and Ongole 5 cm on 19th; Bhadrachalam 7 cm on 20th and Khammam and Vijayawada 8 cm each on 21st. Gales of the order 60-70 kmph were reported from Gannavaram and Ongole which aggravated the situation.

Isohyetal analysis of this rainspell has been carried out for the Coastal Andhra Pradesh region for the period 16-21 May. The total isohyetal pattern of the 3-day storm is shown in Fig. 3. On the basis of this study, the weighted rainfall depths for the Coastal Andhra Pradesh region for the storm of 17-19 May 1969 are as follows:

Storm period	Rainfall depths (cm)
1-day (19 May)	5·5
2-day (18-19 May)	10·4
3-day (17-19 May)	15·0

The above rainfall depths were the highest so far for the Coastal Andhra Pradesh storms that have ever occurred in the month of May.

4. Major flood producing rainspells during southwest monsoon season

The major floods and heavy rainfall that affected various parts of the country during the southwest monsoon season of 1969 are the following:—

(*i*) Floods in Assam rivers during the second fortnight of June 1969.

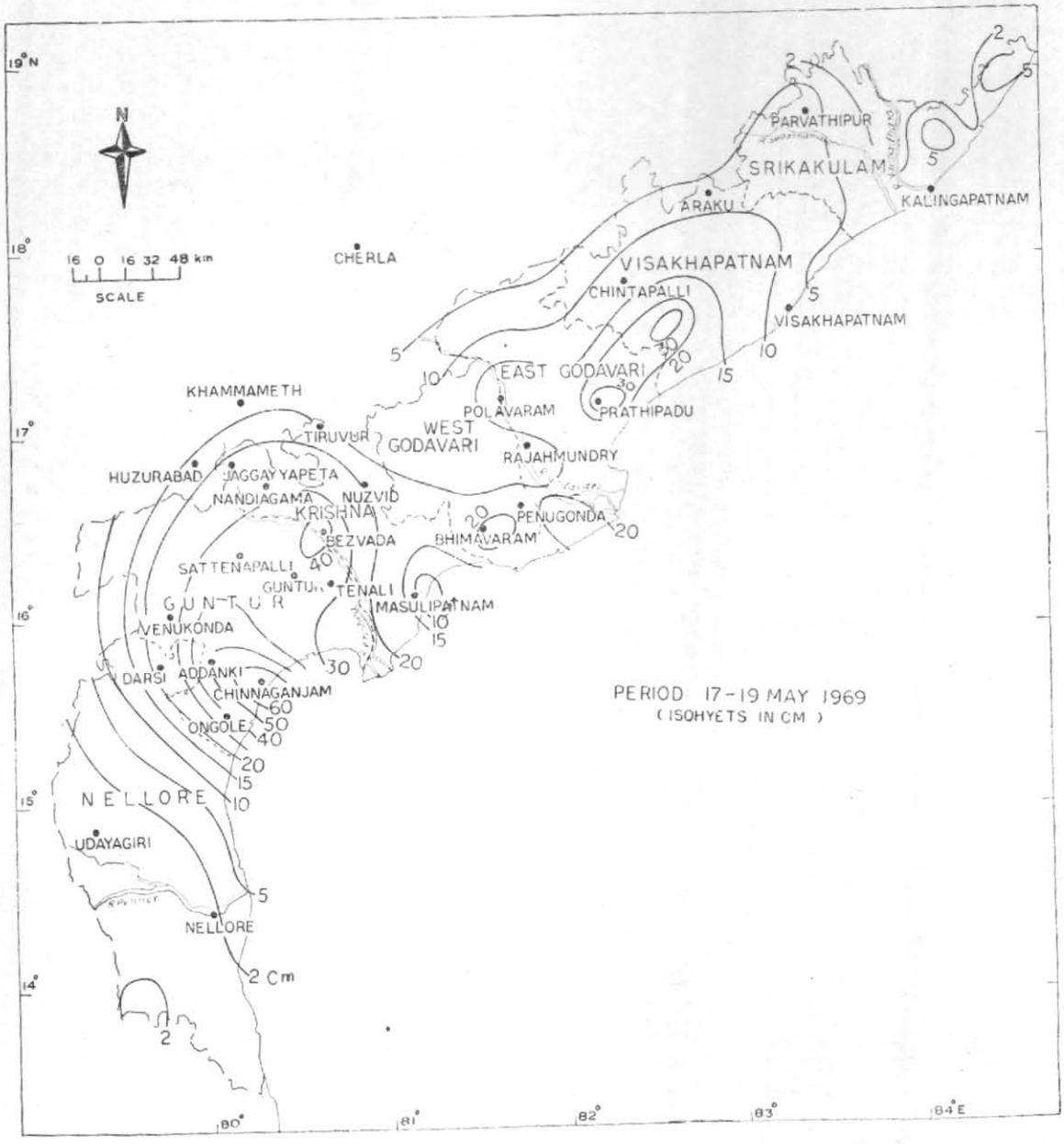

Fig. 3.

(*ii*) Heavy rains and floods in Kerala during the second and third week of July 1969.

(*iii*) Floods in Uttar Pradesh and Punjab during the second fortnight of July.

(*iv*) Heavy rains and floods in Orissa and adjoining Madhya Pradesh during the second fortnight of July.

(*v*) Heavy rains and floods in Madhya Pradesh during the last week of July and first week of August.

(*vi*) Floods in Rajasthan and adjoining West Madhya Pradesh in the middle of August.

(*vii*) Floods in Madhya Pradesh, Maharashtra, Gujarat and East Rajasthan during the second week of September.

Account of major flood producing rainspells is described below.

4.1. *Floods in Brahmaputra and Barak rivers during the second fortnight of June*

A Bay of Bengal depression formed over Lat. 15°N, Long. 88°E on 16 June, moved north to

northeastwards and crossed East Pakistan coast on 19th and was centred near Aijal on 20th morning. Under the influence of this Bay depression which lay over south Assam by 20 June (near Aijal) and later merging with the seasonal trough and thus making it more marked, generally widespread rain occurred in *Brahmaputra* and *Barak* river catchments with isolated heavy to very heavy falls in these areas on one or two days from 21 to 23 June which resulted in floods in the two rivers. According to the press reports these swollen rivers flooded vast areas of crop-land and inhabited area in north Assam and Cachar districts in south Assam, thereby disrupting road and rail communications and damaging houses and rendering many people homeless.

The chief amounts of rainfall recorded during the spell are : Gauhati 7 cm on 19th; Haflong 16 cm, Silchar 11 cm, Pasighat 8 cm, Rangia 8 cm on 22nd; Majpat and Tangla 10 cm each on 23rd and Rangia 11 cm on 24th.

4.2. *Floods in Kerala during the second and third week of July*

A trough of low pressure formed in east central Arabian Sea off Kerala coast on 11 July, shifted gradually northwards and lay off north Maharashtra-south Gujarat coasts on 14th and became well marked on 15 July. The system caused active monsoon conditions in Kerala on 12th and thereafter active monsoon condition prevailed. Due to incessant and heavy rains at times in the State, local rivers were in heavy floods inundating vast areas. Malapuram, Kottayam, Cannanore, Kozhikode, Palghat, Alleppy and Quilon districts were severely affected. About 528 houses and huts collapsed and about 2000 were partially damaged. 27 people were reported to have lost their lives and more than 200 were injured. More than 35,000 families were affected and standing crop was damaged.

The chief amounts of rainfall recorded during the period were : Mangalore Airport 12 cm and Mangalore City 11 cm on 13th; Mangalore Airport 20 cm on 14th and Allepy 13 cm on 22nd July.

4.3. *Floods in Punjab and Uttar Pradesh during the second fortnight of July*

Active monsoon conditions prevailed in Uttar Pradesh and Punjab during the period 16 to 26 July. As per *Flood News Letter* issued by Central Water and Power Commission, 99 villages were affected in Sangrur district due to heavy rains and breaches in the drains. 61 houses were damaged and 4 human lives were lost. In Uttar Pradesh river *Ghagra* was in floods during the period affecting 180 villages and an area of about 15,000 acres including cropped area of about 4200 acres.

Chief amounts of rainfall were : Patiala 10 cm on 15th; Hardoi 14 cm, Nainital 13 cm on 16th; Azamgarh 17 cm, Gorakhpur 16 cm on 17th and Ferozepur Sadar 17 cm on 26th.

4.4. *Heavy rains and floods in Orissa and adjoining Madhya Pradesh during the second fortnight of July*

Heavy rains occurred in the catchment of *Indravati* in Madhya Pradesh in the last week of July and caused floods over there. Total rainfall of 26 cm was recorded at Jagdalpur from 28 to 31 July. The water level in the river rose to 4·11 m above the bridge at Jagadalpur on 30 July. Parts of Jagdalpur town were inundated. Orissa also received heavy rains during this period causing floods in *Mahanadi* river. The districts of Cuttack, Dhenakal, Koraput, Kalahindi, Ganjam and Puri were affected. A discharge of 11 lakh cusecs passed at Naraj downstream of Hirakud against a safe discharge of 9 lakh cusecs.

This rainspell occurred firstly in association with the monsoon trough which was running through this region between 16 to 25 July and was well marked with a low pressure area moving from north Bay of Bengal to the central parts of the country. Secondly, a depression formed on 28 July in northwest Bay of Bengal which deepened on 29th and crossed north Orissa coast near Balasore on 30th evening. It lay about 50 km northeast of Jharsuguda on the morning of 31 July. Chief rainfall figures recorded during the period were : Sambalpur 11 cm on 19th; Sagar 12 cm, Guna 11 cm, Jagdalpur 8 cm, Tikamgarh 10 cm on 20th ; Kaner 13 cm, Satna 7 cm, Tikamgarh 13 cm, Jagdalpur 10 cm and Bhira 11 cm on 29th; Bhubaneshwar 28 cm, Puri 17 cm on 30 July and Bhira 16 cm, Jarinjguda 14 cm on 31 July.

4.5. *Heavy rainfall and floods in Madhya Pradesh during the last week of July and first week of August*

Consequent on heavy rains in first week of August in the Balaghat area, river *Wainganga* was in floods submerging the Balaghat—Seoni road bridge. During last week of July and early August locally heavy rains also occurred in the Narmada catchment resulting in high discharge of the river at Hoshangabad where it rose to

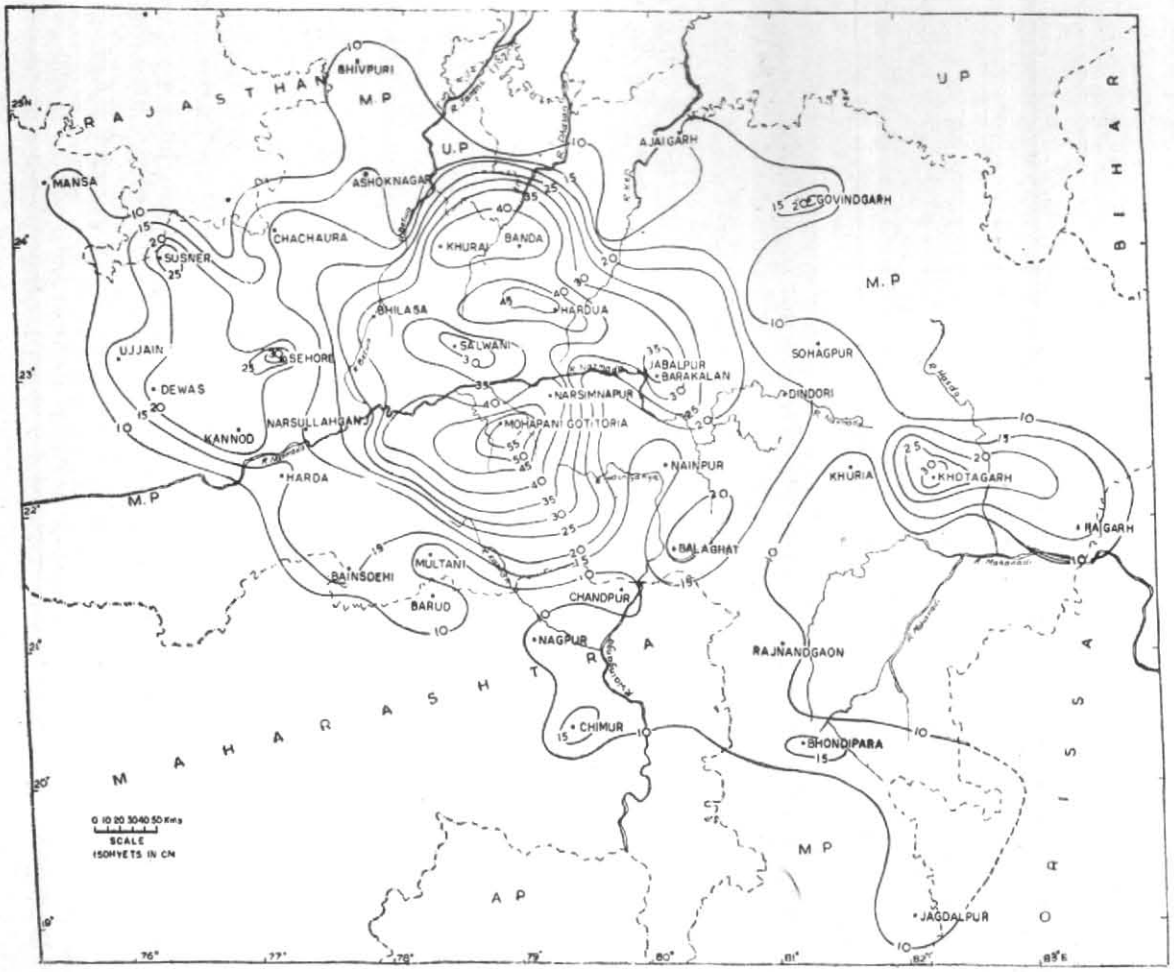

Fig. 4. Madhya Pradesh storm of 31 July — 3 Aug 1969

3·44 m above the warning stage on 2 August and crossed the danger level in the lower reaches. Hoshangabad town was partly inundated. River *Tapti* also crossed the warning stage on 2 August.

This rainspell occurred in association with the Bay depression which lay on 28th morning with centre about 400 km southsoutheast of Calcutta, moved northwest, became deep on 29th, crossed north Orissa coast near Balasore on 30th and lay 50 km northeast of Jharsuguda on 31 July. continuing to move northwest it lay close to Satna by evening of 1 August, weakened gradually into low pressure area on the morning of 2 August over northeast Madhya Pradesh and adjoining southeast Uttar Pradesh. Chief amounts of rainfall recorded during the period were : Bhira 16 cm, Jharsuguda 14 cm, Pachmarhi 13 cm and Narsinghpur 11 cm on 31 July; Jharsuguda 28 cm, Pachmarhi 14 cm; and Jabalpur 22 cm and Bhira 23 cm on 1 August and Hoshangabad 11 cm on 2 August.

A detailed study of this heavy rainspell has been carried out by Depth-Area-Duration analysis. The daily rainfall data of Madhya Pradesh and the adjoining regions were examined and it was found that the rainstorm was of 4-day period and the average maximum rainfall for 1-day, 2-day, 3-day and 4-day duration occurred on 1 August, 1-2 August, 1-3 August and 31 July-3 August 1969 respectively. This storm has been analysed by isohyetal method and depth values obtained for standard areas for various durations are given in Table 1. The total storm isohyetal pattern for the period 31 July –3 August 1969 is also shown in Fig. 4.

4·6. *Floods in Rajasthan and adjoining West Madhya Pradesh in the middle of August*

In Madhya Pradesh, the *Sirna* river was in floods on 16 August and inundated nearly one-fourth of Mandsor town. Many rivers in Rajasthan were also in floods during the second and third week of August due to widespread rains in

their catchment areas. Several bridges in the area were submerged. Following heavy rain in catchment area of *Chambal*, the level of Ghandisagar Reservoir rose to 397·21 metres against the full reservoir level of 399·9 metres. Heavy rain in Jhalawar district flooded rivers *Abu*, *Banas* and *Parwan*.

A depression formed 200 km southeast of Calcutta on 13 August rapidly intensified into cyclonic storm by same evening close to Sandheads, crossed north Orissa coast on the morning of 14th near Balasore, weakened into a deep depression and moving westnorthwestwards and lay close to Sidhi on the morning of 15th. Continuing to move northwestwards it weakened into depression on 15th evening and then into low pressure area on the evening of 16th over northwest Madhya Pradesh and adjoining southwest Uttar Pradesh. It then moved over northern parts of central Uttar Pradesh on 17th and finally weakened on 18th. Under its influence monsoon became active in East Rajasthan and West Madhya Pradesh.

The chief amounts of rainfall were : Narsinghgarh 15 cm on 15th; Kota 10 cm, Jhalawar 8 cm, Shalshujalpur City 18 cm, Shajahpur 18 cm, Bhanpura 18 cm, Garoth 15 cm and Maemehidpur 14 cm on 16th and Jhalawar 35 cm on 17th.

4.7. *Floods in West Madhya Pradesh, Maharashtra and Gujarat and East Rajasthan in the second week of September 1969*

According to the press reports, the heavy rains in Maharashtra State caused floods in *Godavari* and three other rivers, inundating vast areas in Nander, Parbhani and Aurangabad districts of Marathwada. The water level of *Godavari* at Nanded town had reached a maximum level of 359·02 m against the warning stage of 357·84 m in the beginning of the second week. Consequent to heavy rainfall in the catchment areas of *Narmada* and *Tapti*, the rivers were in floods. The level of *Narmada* at Broach was 7·54 m on 9 September against the warning stage of 7·62 m and was reported to be rising. The river *Tapti* crossed the warning stage at Burhanpur on 7 September. The maximum level of the river rose to 29·33 m against the warning stage of 28·96 m at Surat on 9 September. This resulted in inundation of the vast areas of the south Gujarat and Dhulia and Jalgoan districts of Maharashtra. Further, heavy rain caused breaches in many dams and irrigation tanks in Alwar district and floods in Sawai Madhopur, Japur and Bharatpur districts of East Rajasthan. River *Gambhir*, *Banganga* and *Sahibi* were in floods.

TABLE 1

Depth-Area-Duration statistics of 31 July-3 August 1969 storm

Area (sq. km)	Average depth of precipitation (cm)			
	1-day	2-day	3-day	4-day
2,000	19·7	32·8	41·0	53·3
5,000	18·2	30·5	39·8	50·5
10,000	16·7	28·3	38·2	47·6
20,000	15·3	25·8	35·5	43·7
50,000	13·4	21·8	30·0	37·1
75,000	12·1	19·5	27·2	33·2
1,00,000	11·0	17·8	24·8	30·0
1,50,000	9·4	15·5	21·2	25·7
2,00,000	8·2	13·7	18·9	22·8
2,50,000	7·2	12·4	17·0	20·4

This heavy spell of rain occurred in association with a Bay depression centred about 400 km east of Visakhapatnam on 6th which moved northwest, crossed coast near Gopalpur on 7th morning and lay near Dohad in Gujarat State on 10th morning. Later it recurved northnortheastwards, to east Rajasthan on 11th where it weakened into a low pressure area and merged into the monsoon trough by 12th evening.

The significant amounts of rainfall were: Yeotmal 14 cm and Khandwa 7 cm on 6th; Wardha, Sironch and Bhira 7 cm each on 7th; Pachmarhi 7 cm and Broach, Jalgaon, Pusad and Mandla 6 cm each on 8th; Mahabaleshwar 9 cm Hoshangabad 7 cm, Baroda and Ujjain 5 cm each on 9th and Raipur 11 cm, Alwar 22 cm, Surat 15 cm, Bhira 10 cm, Broach 9 cm, Dohad 8 cm and Baroda 7 cm on 10 September 1969.

5. Summary

(1) Weekly rainfall pattern over the country during the southwest monsoon period was characterised by rather below normal rainfall in many parts of the country in June, above normal in July and August and again less than normal in September.

(2) The accumulated monsoon rainfall was almost normal over most parts of the country except West Rajasthan, Gujarat State, Coastal Andhra Pradesh and Tamil Nadu where it was below normal. The Madhya Maharashtra was the only sub-division which received excess seasonal rainfall.

(3) The floods during the monsoon season were not so devastating in nature as compared to those of 1968 but many rivers in north India, Maharashtra and Kerala were in floods during 1969.

(4) Apart from major floods, caused by the depressions/storms mentioned above, there were also floods in various parts of India in association with active monsoon conditions caused by low pressure areas and marked troughs, *e.g.*, floods in Assam and North Bengal in the first fortnight of June, first fortnight of July and last week of August.

(5) The monsoon rainfall was deficient in West Rajasthan and Gujarat State owing to the fact that the monsoon depressions did not move sufficiently west. This resulted in continued drought conditions in northwestern parts of Gujarat and West Rajasthan.