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Rainfall and floods during 1970 southwest monsoon period

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1. Introduction

The southwest monsoon advanced into Kerala on 26 May. By 3 June it has extended into Mysore State, Maharashtra (outside Vidarbha) in the west and Assam, West Bengal and the parts of Orissa in the east. By 10 June, monsoon set in over the remaining parts of Orissa, Vidarbha, southwest Madhya Pradesh and Bihar and by 17 June it extended into the rest of Madhya Pradesh, east and central Uttar Pradesh, southeast Rajasthan and eastern parts of Gujarat. There was no further extension of the monsoon during the next two weeks. However, it became active again and by about 3 July it established itself over the entire country.

During the monsoon season 1970, concentrated spells of heavy rain were recorded in Assam, West Bengal, Gujarat State and Madhya Pradesh. Taking the season as a whole, the monsoon rainfall during 1970 was normal over the entire country except Gujarat State, Marathwada, Telangana, Rayalaseema, Coastal and North Interior Mysore where it was above normal.

2. Weekly and cumulative rainfall

The percentage departure of the monsoon rainfall, week by week and for the season (June to September) as a whole in the 31 meteorological subdivisions of India is shown in Fig. 1. The progress of the monsoon from 1 June depicting the percentage departures from normal of the cumulative rainfall for the successive weeks is given in Fig. 2. The salient features of the rainfall distribution as seen from Figs. 1 and 2 are described below —

June — The monsoon was generally active over the country during the month resulting in normal or appreciably above normal rainfall over most of the country. Monsoon was vigorous over Saurashtra and Kutch during the weeks ending 3rd, 10th and 17th June when the actual rainfall was in excess of the normal by 1100 per cent, 660 per cent and 246 per cent respectively. Vigorous monsoon conditions prevailed also over Himachal Pradesh, Jammu & Kashmir, Gujarat region and Madhya Maharashtra during the week ending 17 June. Rainfall was also in excess over Orissa, Uttar Pradesh, Haryana, Punjab, Himachal Pradesh, Madhya Pradesh, Maharashtra and Andhra Pradesh outside Rayalaseema during the month.

Rainfall activity decreased over almost the entire country during the week ending 24 June.

The rainfall during June was normal in Assam Sub-Himalayan West Bengal, Bihar State, west Uttar Pradesh, Rayalaseema, Tamil Nadu, Mysore State and Kerala. South Interior Mysore was the only sub-division where it was below normal.

July — The monsoon was active in west Uttar Pradesh, Punjab, Jammu and Kashmir, Rajasthan, Madhya Pradesh and Gujarat State during the first week of July. It was also more

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

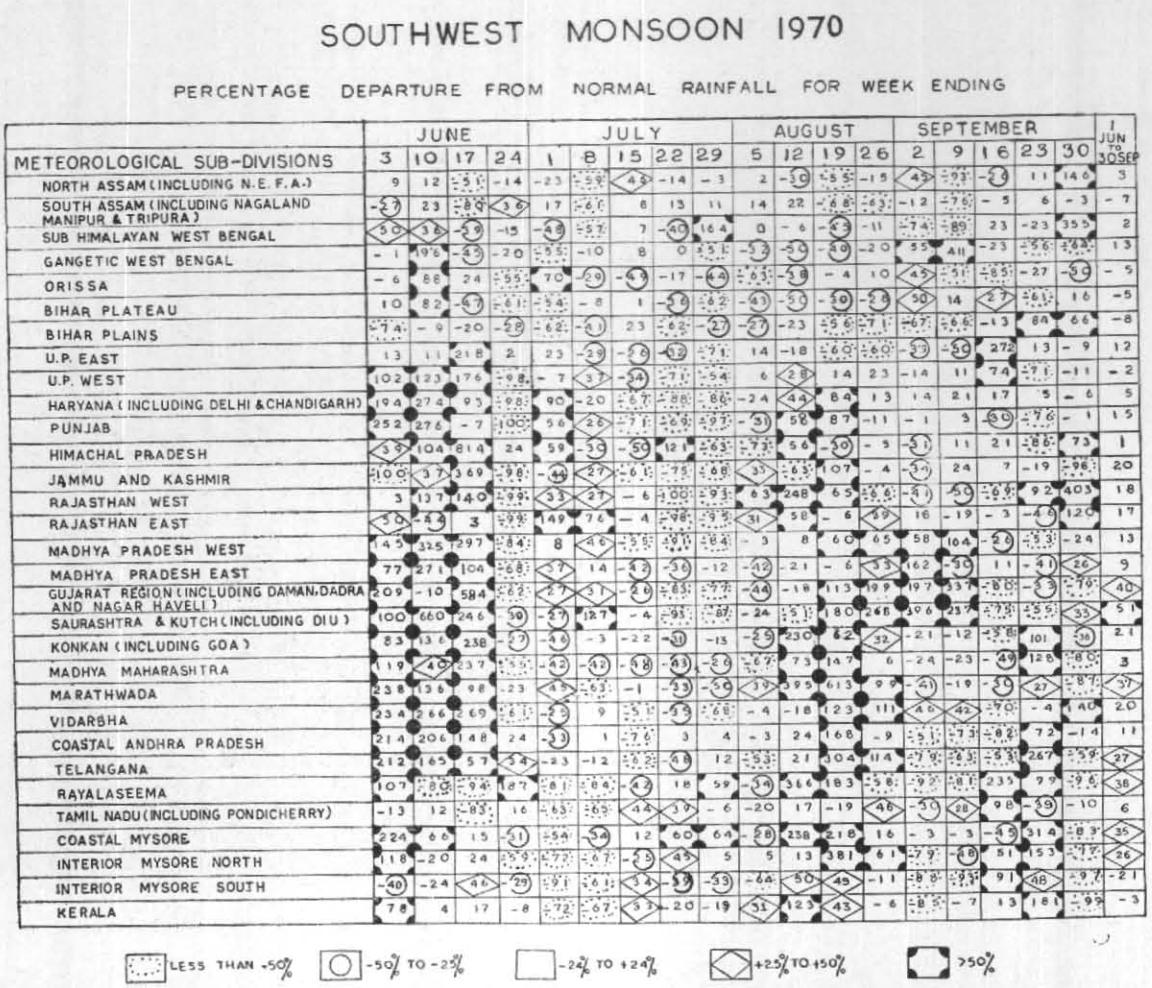

Fig. 1. Percentage departure of SW monsoon rainfall week by week and for the season (June to September) as a whole in 31 Met. Div. of India

or less normal in coastal and north Interior Mysore during the month except the first week and the Tamil Nadu during the fortnight ending 22nd. But for this, the monsoon was weak over the country during July. The cumulative rainfall during the season upto the end of July was more or less normal over the country except over south Interior Mysore where it was below normal.

August — The monsoon revived over most of the country outside northeast India during the second week of August. Significant excesses of rainfall during August were 248 per cent in west Rajasthan, 230 per cent in Konkan, 395 per cent in Marathwada, 366 per cent in Rayalaseema and 238 per cent in coastal Mysore during the week ending 12 August; 613 per cent in Marathwada, 304 per cent in Telangana and 381 per cent in north Interior Mysore during the week ending 19 August and 268 per cent and 396 per cent in Saurashtra & Kutch during the weeks ending 26 August and 2 September respectively. Over northeast India also the monsoon revived towards the end of August and early September.

The cumulative rainfall continued to be normal over the country except in Gujarat State, Konkan, Marathwada, Andhra Pradesh and coastal Mysore, where it was above normal. In Interior Mysore South, where rainfall was below normal till the first week of August it became normal by the end of August.

September – During the week ending on 9 September monsoon continued to be active over Gangetic West Bengal, Bihar Plateau, west Madhya Pradesh and Gujarat State, marked excesses being 411 per cent in Gangetic West Bengal, 337 per cent in Gujarat region and 237 per cent in Saurashtra & Kutch. During the week ending on 16 September, the monsoon activity was weak over the country except in Uttar Pradesh, Rayalaseema, Tamil Nadu and Interior Mysore where the weekly rainfall was in excess. During the week ending 23 September,

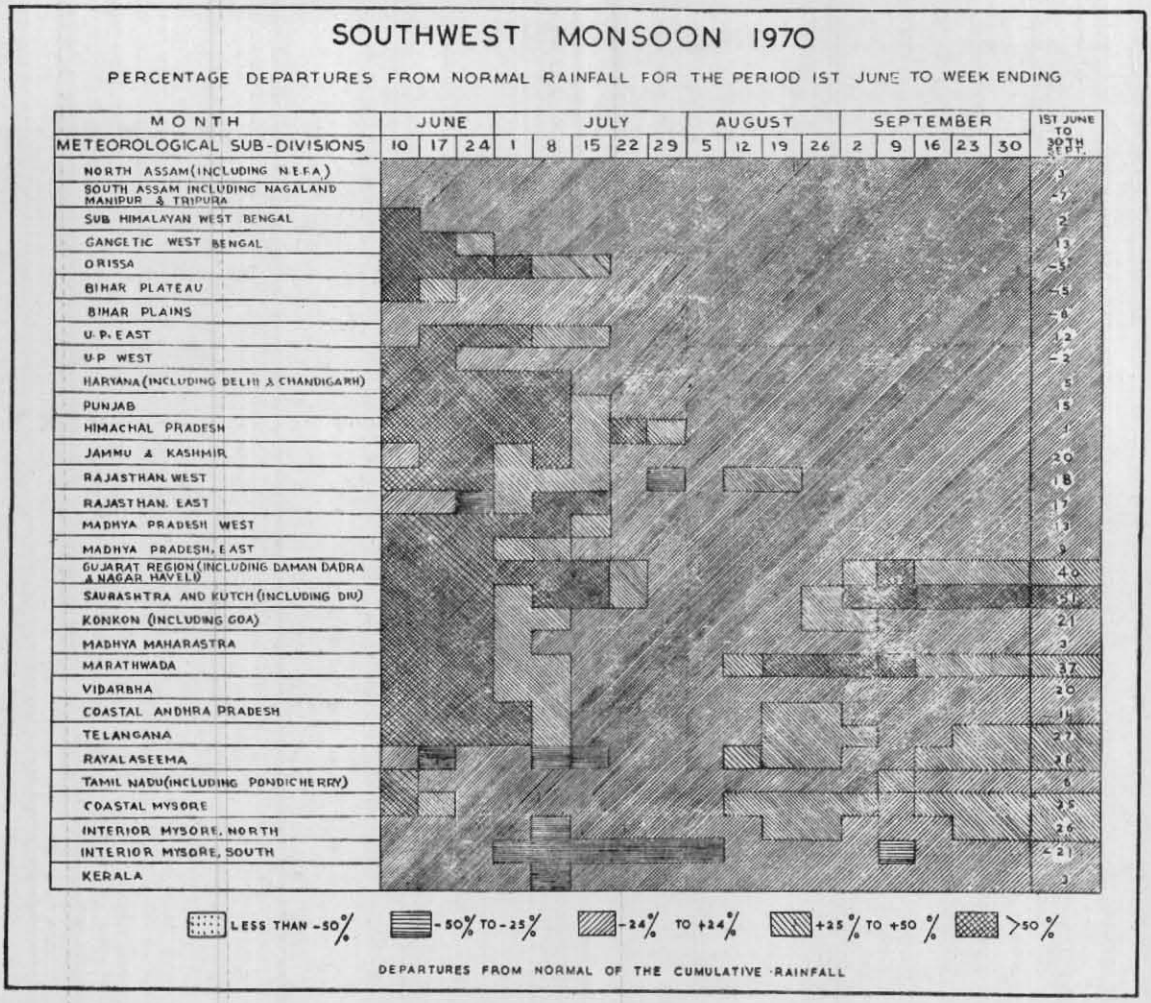

Fig. 2. Progress of monsoon from 1 June depicting the percentage departures from normal of the cumulative rainfall for the successive weeks

the rainfall was in excess over the Bihar Plateau, west Rajasthan, Maharashtra, Andhra Pradesh, Mysore State and Kerala, the marked excesses being 101 per cent in the Konkan, 128 per cent in Madhya Maharashtra, 267 per cent in Telangana, 314 per cent in coastal Mysore, 153 per cent in north Interior Mysore and 181 per cent in Kerala. Monsoon activity considerably decreased over most of the sub-divisions of the country during the last week of September except in north Assam, Sub-Himalayan West Bengal, Bihar Plains, Himachal Pradesh, Rajasthan, east Madhya Pradesh, Saurashtra & Kutch and Vidarbha where active monsoon conditions prevailed. Significant excesses being 403 per cent over west Rajasthan, and 355 per cent over Sub-Himayalan West Bengal. The total rainfall of the monsoon season, 1 June to 30 September 1970 was normal or above normal over the entire country.

3. Major flood producing rainspells during southwest monsoon season

The major floods and spells of heavy rainfall that affected various parts of the country during the southwest monsoon season of 1970 are the following —

(*i*) Flood in the Brahmaputra valley during the 3rd week of June,

(*ii*) Heavy rainfall and floods in the Brahmaputra valley and north Bihar rivers during the 2nd and 3rd weeks of July,

(*iii*) High floods in *Alaknanda* river during the 3rd week of July,

(*iv*) Heavy rains and floods in Sub-Himalayan West Bengal during the last week of July,

(*v*) Heavy rains and floods in Gangetic

West Bengal during the 1st week of September,

(*vi*) Heavy rains and floods in Madhya Pradesh and Gujarat State during the first week of September,

(*vii*) Floods in Andhra Pradesh during the third week of September and

(*viii*) Heavy rains and floods in Uttar Pradesh during the second and third weeks of September.

3.1. *Flood in Brahmaputra valley during the third week of June*

The severe floods in the Brahmaputra valley during the third week of June was in association with the shifting of the monsoon trough close to the foot of the Himalayas over Uttar Pradesh and northeast India from the 17 to 21 June 1970.

The chief amounts of rainfall recorded during the period were —

Tura 15 cm and Pasighat 14 cm on 18th, Pasighat and Jalpaiguri 7 cm each on 20th.

3.2. *Heavy rains and floods in the Brahmaputra valley and the north Bihar rivers during second and third weeks of July*

Under the influence of a cyclonic circulation in the lower troposphere which persisted over northwest India between 8th and 10th and moved eastwards across the hills of west Uttar Pradesh by 11th, the axis of the monsoon trough shifted north and was lying close to the foot of the Himalayas on the 12th and persisted there till 17th. In association with this, heavy rainfall occurred in Assam, Sub-Himalayan West Bengal and Bihar State on the 12th and 13th. The eastern end of the axis of monsoon trough shifted southward on the 18th under the influence of a low pressure area situated over Orissa and adjoining Gangetic West Bengal. The axis was again shifted northwards on 22nd when low pressure moved over to Sub-Himalayan West Bengal and adjoining Bihar Plains.

In association with these, fairly widespread rains occurred in northeast India and adjoining east Uttar Pradesh. Active monsoon conditions prevailed in Bihar Plateau on 20th and in Gangetic West Bengal on 21st and 22nd. According to the Press Reports, consequent to heavy rains in Nepal-Himayalan region and north Assam, the *Kosi* and other rivers in north Bihar flooded crop lands in Muzzafarpur, Darbhanga and Saharsa districts. The floods in the *Brahmaputra* and its tributaries also caused heavy damage to crops and other property particularly in north Kamrup district.

The chief amounts of rainfall recorded during the period were —

Pasighat 15 cm and Krishnanagar 13 cm on 10th; Gauhati 13 cm on 12th ; Dhubri 18 cm and Darjeeling 14 cm on 13th; Pasighat 10 cm on 14 th; Kalimpong 20 cm on 20th; Pasighat 17 cm on 21st.

3.3. *High floods in Alaknanda river during the third week of July*

The western end of the axis of the monsoon trough continued to remain close to the foot of the Himalayas throughout the third week of July. An upper air trough in the middle and upper troposphere also moved across the western Himalayas in the second half of the week. These caused widespread rain with isolated heavy rainfalls in Himachal Pradesh and the hills of West Uttar Pradesh on most of the days of the week. This lead to high flood in the *Alaknanda* river. According to Press Reports, the road between Rishikesh and Joshimath had been washed away at several places due to slips in the mountain. The district of Chamoli was the worst affected and at Belakuchi alone several houses were washed away. More than 100 human lives were reported to have been lost and several hundred cattle got perished. There was complete dislocation of transport and communication in the area and according to Press Reports thousands of people got stranded including about 500 pilgrims in the Badrinath region.

The chief amounts of rainfall recorded during the period were —

Simla 12 cm on 18th, Nautanwa and Varanasi City 15 cm each on 20th; Joshimath 23 cm, Marwari 21 cm and Charmi 10 cm on 21st.

3.4. *Heavy rains and floods in Sub-Himalayan West Bengal during the last week of July*

The eastern end of the axis of the monsoon trough, which had shifted northward on 22 July under the influence of a low pressure area moving across Orissa and Gangetic West Bengal and then Sub-Himalayan West Bengal, remained close to the foot of the Himalayas upto 25th causing widespread rain with isolated heavy falls in Sub-Himalayan West Bengal. Rainfall in this subdivision was 164 per cent above normal during the week ending on 29th. As a consequence, the river *Teesta* was in high floods. According to the *Flood News Letter* issued by the Central Water and Power Commission, the river touched the extreme warning stage of 81·53 m at Kingsghat on 25th. Several

wooden bridges were washed away. Landslides and breaches were also reported from Darjeeling and Jalpaiguri districts. As a consequence of these over 20,000 persons are reported to have been affected.

The chief amounts of the rainfall recorded were— Jalpaiguri 19 cm and 25 cm on 24th and 25th respectively ; Cooch Behar 9 cm on 26th.

3.5. *Heavy rains and floods in Gangetic West Bengal during the first week of September*

A low pressure area developed over Gangetic West Bengal and adjoining Bihar Plateau and north Orissa on the morning of 31 August which concentrated into a depression on the morning of 2 September. It intensified into a deep depression on the morning of 3rd and lay with its centre near Ranchi. It then moved away practically westward across Madhya Pradesh. Under its influence the monsoon was vigorous in Gangetic West Bengal and consequently the rivers were in floods during the first week of September. According to Press Reports the heavy rains in West Bengal flooded vast areas in the districts of Midnapore, Burdwan, 24-Parganas, Howrah and Hooghly resulting in some loss of life and rendering thousands of people homeless. The heavy rains are reported to have caused acute drainage congestion in Calcutta, its suburbs and parts of Howrah district. Communications in the area were also reported to have been disrupted.

Significant amounts of rainfall recorded during the period were—

Sriniketan 14 cm, Burdwan, Calcutta City and Airport 13 cm on 3rd ; Burdwan 26 cm, Krishnanagar 22 cm, Dum Dum 13 cm, Sriniketan 12 cm and Calcutta 11 cm on 4th.

3.6. *Heavy rains and floods in Madhya Pradesh and Gujarat State during the first week of September*

The heavy rainfall over Madhya Pradesh and Gujarat State during the first week of September which caused severe floods in the river *Narmada* and its tributaries was in association with a depression that formed near Chakulia in Gangetic West Bengal on the morning of 2 September. This depression intensified into a deep depression on the 3rd morning and was centred near Ranchi. It then moved practically westwards across Madhya Pradesh and lay about 50 km southwest of Jabalpur on 5th morning and was centred 50 km west of Indore on 6th morning. It then weakened into a depression over north Gujarat State on the morning of 7 September with its centre near Ahmedabad. Thereafter, it moved northwestwards across southwest Rajasthan and adjoining West Pakistan by the morning of 8th.

Under its influence, widespread rain with isolated heavy falls occurred on 3rd and 4th and heavy to very heavy rain on 5th and 6th over west Madhya Pradesh. Gujarat State experienced widespread rain with scattered heavy to very heavy falls between 6 and 8 September.

As a consequence of these, the rivers *Narmada* and *Tapti* rose in floods. The flooded *Narmada* and *Tapti* were reported to have inundated many areas in southwest Madhya Pradesh and in Broach and Surat districts in south Gujarat disrupting all communications.

The chief amounts of rainfall recorded during this period were —

Betul 10 cm, Pachmarhi 13 cm on 3rd; Betul 14 cm on 4th; Hoshangabad 11 cm and Pachmarhi 16 cm on 5th; Bhopal 11 cm, Khandwa 10 cm, Surat 10 cm, Ahmedabad 11 cm, Broach 10 cm, Ballabh Vidyanagar 15 cm and Bhavnagar 13 cm on 6th; Surat 26 cm, Bhavnagar 26 cm, Baroda 13 cm, and Rajkot 11 cm on 7th and Naliya 13 cm on 8th.

A detailed study of this heavy rainspell over *Narmada* catchment 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 3-day period and the average maximum rainfall for 1-day, 2-day and 3-day durations occurred on 6th, 5th-6th and 5-7 September 1970 respectively. The corresponding depth values obtained for specific areas are given in Table 1. The total storm isohyetal pattern for the period 5 to 7 September 1970 is shown in Fig. 3.

3.7. *Floods in Andhra Pradesh during the 3rd week of September*

A well marked low pressure area formed over the west-central and adjoining northwest Bay to of Bengal on 20 September, concentrated into a depression on the morning of 21st about 100 km southeast of Visakhapatnam and moving west-northwestwards weakened into a well marked low pressure area over north Gujarat on the morning of 23rd. In association with this, widespread rain occurred in the Peninsula during the second half of the week. According to the Central Water & Power Commission *Flood News Letter*, river *Godavary* was in floods and the Hyderabad-Chanda road was submerged on 21 September. According to Press Reports, the heavy rains also affected the twin cities of Hyderabad and Secunderabad causing

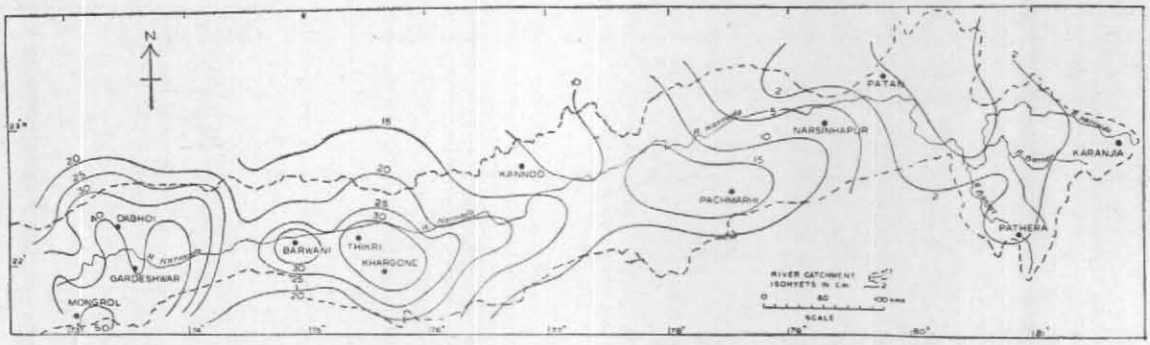

Fig. 3. Total storm isohyetal pattern for the period 5-7 September 1970 in *Narmada* catchment

TABLE 1

Depth-Duration statistics

Area (sq. km)	Average depth of precipitation (cm)		
	1-day	2-day	3-day
2,000	24·8	38·3	49·8
5,000	24·0	34·8	46·2
10,000	22·8	32·6	41·6
20,000	20·7	28·4	36·6
50,000	15·4	20·8	26·4
75,000	11·3	16·2	20·6
1,00,000	8·3	12·4	16·0

many house collapses and a toll of about 75 human lives.

Chief amounts of rainfall recorded during the period were —

Khammam 13 cm, Honavar 12 cm, Karwar 10 cm and Bhadrachalam 10 cm on 17th; Honavar 10 cm on 18th; Kakinada 9 cm, Hanamkonda 8 cm on 19th and Begumpet 12 cm on 22nd.

3.8. *Heavy rains and floods in Uttar Pradesh during the second and third weeks of September*

A deep depression which was centred over the north Bay of Bengal on 9 September crossed West Bengal coast and moved across the Bihar Plateau into east Uttar Pradesh by 12th. It was then centred between Kanpur and Lucknow on the morning of 13th. After being more or less stationary near Lucknow upto the 14th morning it moved eastwards, weakened into a depression on 15th and was centred about 100 km north of Varanasi on 16th morning. This system caused fairly widespread rain in Uttar Pradesh with active to vigorous monsoon conditions in east Uttar Pradesh between the 10th and 15th.

According to Press Reports and the *Flood News Letter*, the heavy rains in Uttar Pradesh and adjoining Madhya Pradesh caused floods in the rivers *Ganga* and the *Sone*. The river *Yamuna* was also in medium floods and recorded a level of 85·82 metre at Pratappur on 17 September. The river *Ghagra* recorded a level of 105·35 metres on 15th at Chowkaghat and maintained the same level till 18 September. The concentrated rainfall is reported to have caused lot of inundation and house collapses. The districts of Chamoli, Uttar Kashi, Unnao, Jaunpur, Allahabad and Lucknow reported to have been badly affected. Cropped area of about 2·6 lakh hectares and over 30 thousand houses were reported damaged. About 80 persons were also reported to have lost their lives.

The chief amounts of rainfall recorded during the period were —

Dehradun 15 cm on 11th; Allahabad 16 cm on 13th, Lucknow 14 cm and Fatehpur 21 cm on

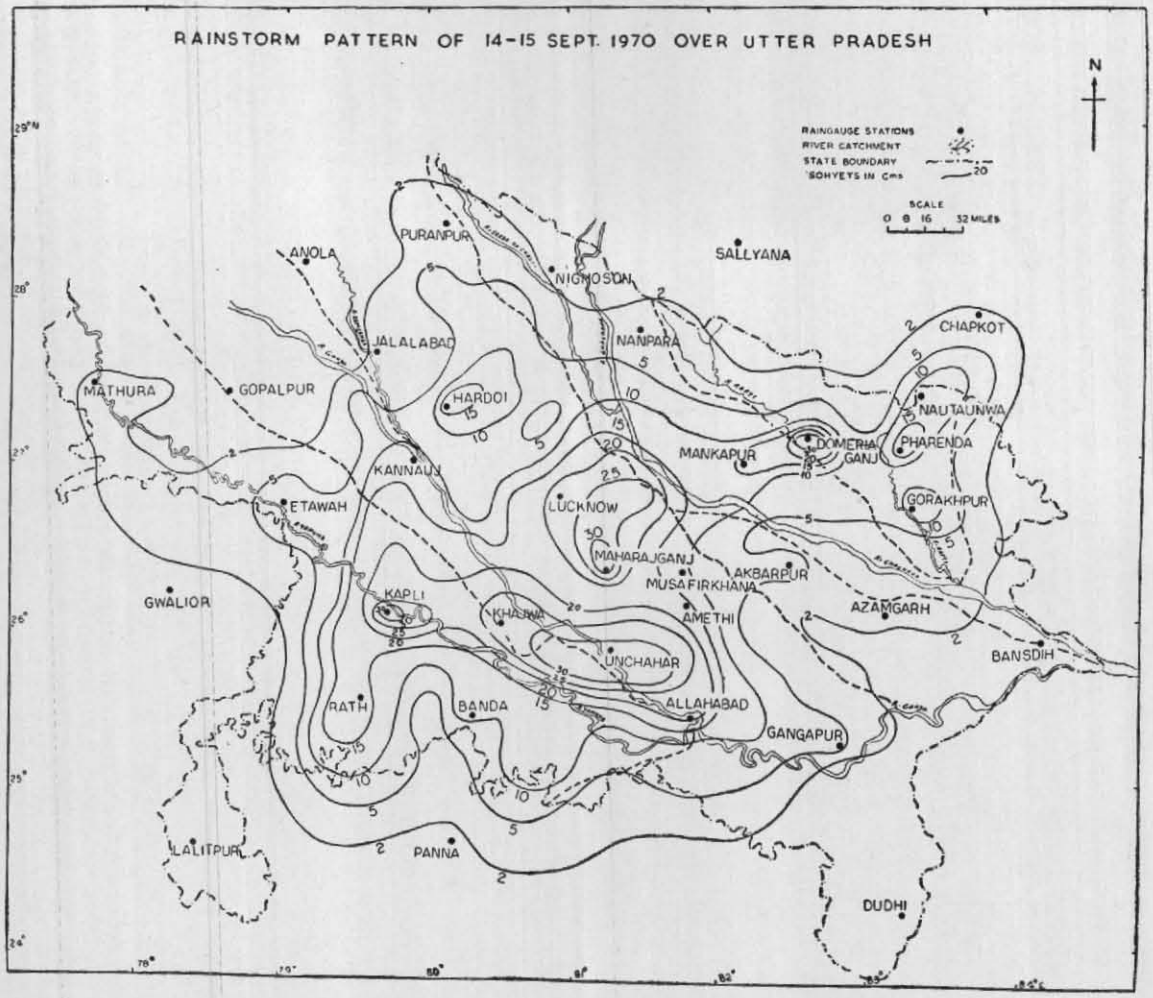

Fig. 4. Rainstorm pattern of 14-15 September 1970 over Uttar Pradesh

14th; Allahabad 23 cm, Banda 16 and Orai 15 cm on 15th; Kanpur (I.A.F.) 30 cm, Kanpur (Obsy) 24 cm, Lucknow City 11 cm on 16th, Varanasi 10 cm on 16th; Gorakhpur 11 cm and Lucknow 10 cm on 17th and Varanasi 10 cm on 20th.

A detailed study of this storm was also carried out by isohyetal methods. It was found that the rainstorm of 2-day period and the average maximum rainfall for 1-day and 2-day duration occurred on 15th and 14-15 September 1970 respectively. The total storm isohyetal pattern is shown in Fig. 4 and the depth values obtained for standard areas for 1-day and 2-day durations are given in Table 2.

TABLE 2

Depth-Area-Duration Statistics

Area (sq. km)	Average depth of precipitation (cm)	
	1-day	2-day
2,000	23·4	33·5
5,000	20·8	31·5
10,000	18·3	29·3
20,000	15·8	26·3
50,000	12·2	19·7
75,000	10·3	16·8
1,00,000	8·8	14·6
1,40,000	7·5	11·5
1,80,000	—	9·6

4. Summary

(*a*) The advance of the monsoon over the Peninsula was about 5 to 6 days before the normal dates. Over the rest of the country the dates of onset were more or less normal.

(*b*) The rainfall was normal or above normal over the entire country during the current southwest monsoon period. However, July was relatively dry and this defficiency was made during the subsequent period.

(*c*) The floods during this monsoon season are reported to be more devastating in nature than during the last season.