

## Rainfall and floods in India during 1973 southwest monsoon period

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### 1. Introduction

Rainfall during the 1973 southwest monsoon period was more or less normal over the country. It was in excess in Punjab, Jammu & Kashmir, Rajasthan, west Madhya Pradesh and Gujarat Region and deficient only over coastal Andhra Pradesh where it was -27 per cent. The characteristic feature of this year's monsoon was the occurrence of excessive rainfall in west Rajasthan and west Madhya Pradesh in August, leading to serious floods.

The southwest monsoon advanced into south Kerala as a feeble current on 23 May 1973 but retreated from there by 27th. It then revived and covered Kerala by 5 June and Karnataka on 7th. Advancing further it extended into Konkan Madhya Maharashtra, Marathwada and north Madhya Pradesh by 11 June. Simultaneously, the Bay of Bengal branch of monsoon advanced into Orissa, Gangetic West Bengal, Nagaland, Manipur, Mizoram and Tripura by the same date. Both the monsoon currents extended further into Gujarat, Vidarbha, Madhya Pradesh, Assam & Meghalaya, Arunachal Pradesh, Bihar, Sub-Himalayan West Bengal and south Rajasthan on 14th. Thereafter, the monsoon weakened and revived in the beginning of July and covered the entire country by 6 July. Its onset over the Peninsula and Madhya Pradesh was almost normal but over Assam and adjacent States it was delayed by about a week and over Uttar Pradesh by 10 to 15 days.

The southwest monsoon withdrew from Jammu & Kashmir on 14 September; from Punjab, Haryana, Himachal Pradesh, west Uttar Pradesh Rajasthan on 28 September; from northwest Madhya Pradesh and Gujarat State on 3 October; from Madhya Pradesh, Maharashtra State and east Uttar Pradesh on 10 October; from West Bengal, Bihar, Assam and adjacent States, Orissa

and Andhra Pradesh on 16 October 1973. The withdrawal of the southwest monsoon from north India was about 8-10 days later than the normal date whereas from the north Peninsula it was normal.

### 2. Weekly and cumulative rainfall

The percentage departures of the southwest monsoon rainfall week by week in the 35 meteorological sub-divisions of India are given in Table 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 Table 2. The salient features of the rainfall distribution are as follows.

*June* — The southwest monsoon advanced into Kerala in the beginning of June and covered Peninsula, Gujarat State, northeast India, Madhya Pradesh, Rajasthan and Bihar Plains on 14 June. This resulted in heavy to very heavy rainfall over Gujarat State, Rajasthan, Madhya Pradesh, Konkan, Vidarbha and Telangana during the week ending on 13 June. Significant excesses being 197 per cent in west Rajasthan, 157 per cent in west Madhya Pradesh, 423 per cent in Gujarat Region, 342 per cent in Saurashtra & Kutch, 102 per cent in Vidarbha and 121 per cent in Telangana. By this time 4 disturbances moved across Himalayas from west and excessive rainfall was also recorded over hills of west Uttar Pradesh (+98 per cent) and Haryana (+81 per cent) during the week ending on 13 June. Thereafter, there was lull in the monsoon activity over the country till the end of the month. However, 5 more western disturbances moved across north India during the second fortnight of June and caused excessive precipitation over Sub-Himalayan West Bengal, Bihar Plains, Uttar Pradesh, Haryana, Punjab, Himachal Pradesh and Jammu & Kashmir. Significant excesses being 108 per

TABLE 1  
SOUTHWEST MONSOON 1973

PERCENTAGE DEPARTURES FROM NORMAL RAINFALL FOR THE WEEK ENDING

MONTH	JUNE				JULY				AUGUST				SEPTEMBER				OCT	
	6	13	20	27	4	11	18	25	1	8	15	22	29	5	12	19	26	3
METEOROLOGICAL SUB-DIVISIONS																		
BAY ISLANDS	-37	-32	-50	+20	+31	+39	-46	-88	-59	-20	+13	-51	-64	-17	-22	+25	-74	+3
ARUNACHAL PRADESH	+63	-42	-9	0	-37	-97	-70	-26	+30	+105	-33	-99	-90	-51	-30	+100	-91	-95
ASSAM AND MEGHALAYA	+8	-74	-25	-27	-33	-85	-83	-10	+45	+48	-42	-8	-82	-47	+3	+39	-13	-48
NAGALAND, MANIPUR, MIZORAM & TRIPURA	-51	-90	+44	+29	+61	-26	-71	-44	+60	+62	-33	-73	-84	-62	-72	+14	+49	-3
SUB-HIMALAYAN WEST BENGAL	-9	+1	+59	-21	-29	-77	-82	-62	+86	+93	+11	-91	-79	-67	-34	+32	-12	-39
GANGETIC WEST BENGAL	-29	-19	-31	-53	-31	-19	-56	+3	+7	-52	-1	-34	+36	+14	-8	-1	+153	+26
ORISSA	-85	-51	-79	-72	-35	+34	-13	+22	-58	-72	-37	+35	+19	+42	-54	-46	+80	+17
BIHAR PLATEAU	-21	-83	+6	-32	+1	-36	-54	-57	-15	-47	-24	-1	-65	+100	-17	+16	+228	+34
BIHAR PLAINS	-45	-11	+97	-41	-48	-75	-93	-50	+66	-35	-31	+1	-99	-49	-15	+31	+69	-11
UTTAR PRADESH, EAST	-85	-55	+58	-36	-25	-77	-89	-42	+103	-12	+25	-48	-79	-57	-37	+6	+56	+21
PLAINS OF WEST UTTAR PRADESH	-100	+17	+73	-10	-29	-71	-1	-50	-1	-17	-14	-52	-73	-41	-24	-62	-11	-99
HILLS OF WEST UTTAR PRADESH	-89	+98	+108	+23	-28	-67	-16	+23	-30	-24	-33	-23	-47	-32	-42	+28	-36	-57
HARYANA, CHANDIGARH & DELHI	-99	+81	+983	+51	-9	-60	-6	-15	+16	+60	+33	-31	+257	-73	-45	-55	-45	-91
PUNJAB	-99	-99	+501	+107	+64	-75	-14	+52	+4	+75	+61	+14	-64	-21	-73	-70	-88	-63
HIMACHAL PRADESH	-73	+45	+418	+10	-57	-80	-51	-27	-71	-16	+4	-82	-6	-8	-56	+75	-32	-89
JAMMU & KASHMIR	-38	-99	-99	+66	+1	+22	-25	-14	+43	+136	+791	-40	+54	-98	-99	-40	-69	
RAJASTHAN, WEST	+82	+197	-76	-100	-62	+35	-21	-38	-99	+142	+116	+397	+134	+7	+6	-92	-99	-98
RAJASTHAN, EAST	-45	+94	-99	-100	-72	-4	+8	+74	-93	+7	+56	+11	+19	+192	+47	-51	+4	-78
MADHYA PRADESH, WEST	-82	+157	-73	-98	+23	+77	+54	+110	-83	-36	+57	-15	+174	+143	+61	-38	+68	+45
MADHYA PRADESH, EAST	-72	+72	-78	-73	-31	+48	+7	-30	-71	-47	-36	+58	+119	-4	-57	-35	+21	+81
GUJARAT REGION, DAMAN, DADRA & NAGAR HAVELI	-99	+423	+6	-99	-64	+12	+24	-49	-89	-73	+26	+45	+93	+381	+124	-90	+461	+51
SAURASHTRA, KUTCH & DIU	+25	+342	-53	-99	-77	+156	+2	-78	-87	-93	-10	-82	-7	-52	-69	-81	+438	-14
KONKAN & GOA	-89	+97	-70	-88	+17	+78	-39	-64	-74	+66	+158	-30	+11	+11	+12	-80	+88	+17
MADHYA MAHARASHTRA	-23	+28	-45	-88	+114	+95	+26	-60	-75	+52	+45	+4	+17	-19	-61	-53	+111	+2
MARATHWADA	-49	+33	-91	-93	+193	+65	-17	-84	-87	+147	+83	+203	+180	-77	-87	-41	+74	+51
VIDARBHA	-65	+102	-98	-94	-34	+182	+61	-71	-95	-16	+11	+13	+74	-42	-79	-54	+66	+60
COASTAL ANDHRA PRADESH	+30	-24	-99	-53	-47	-14	-13	-86	-70	-12	+62	-27	-65	-75	-47	+16	-51	+9
TELANGANA	+13	+121	-66	-74	+2	+3	-2	-75	-74	+63	+35	+119	-52	-87	-86	-62	-19	+74
RAYALASEEMA	+119	+60	-90	-66	-14	-81	-86	-96	+35	+174	+212	-41	-83	-100	-91	+161	-85	+109
TAMILNADU & PONDICHERRY	+54	-60	-51	-46	-35	-49	-89	+25	+126	+66	+87	-58	-74	-68	+58	+193	+66	+8
COASTAL KARNATAKA	-67	+61	-46	-42	-1	0	-45	-69	-59	+51	+153	-4	-7	+1	-25	-94	-65	-34
INTERIOR KARNATAKA, NORTH	+58	+31	-17	-41	+43	+19	-33	-89	-62	+181	+19	+26	-71	-97	-96	-7	-37	+6
INTERIOR KARNATAKA, SOUTH	+98	+31	+200	-39	-70	+151	-36	-69	-67	+174	+39	-28	-57	-78	-62	+167	-67	-27
KERALA	-61	+5	+50	-55	+20	+45	-51	-75	-80	-27	+33	+30	+106	-66	-62	-87	-59	-47
LAKSHADWEEP	+34	-59	-57	-1	+129	+9	-67	-84	+123	+141	+129	+13	-50	-45	-18	-90	-73	-79

cent in the hills of west Uttar Pradesh, 983 per cent in Haryana, 501 per cent in Punjab and 418 per cent in Himachal Pradesh during the week ending on 20 June and 107 per cent in Punjab during the week ending on 27 June.

The cumulative rainfall during the month was in excess over hills and plains of west Uttar Pradesh, Haryana, Punjab, Himachal Pradesh and Interior Karnataka and it was deficient over Assam & Meghalaya, Orissa, Bihar Plateau, Rajasthan, Jammu & Kashmir, Madhya Pradesh, Saurashtra & Kutch, Marathwada, Vidarbha, coastal Andhra Pradesh, Telangana and Lakshadweep. The rainfall was normal over the rest of the country. Significant excesses being 337 per cent in Haryana, 127 per cent in Punjab, 113 per cent in Himachal Pradesh. Jammu & Kashmir was

the only state where the June rainfall was scanty (-60 per cent).

*July*—The monsoon after its revival in the beginning of July covered the entire country by the 6th and was active to vigorous in Maharashtra, north Interior Karnataka, Kerala and Bay Islands and Lakshadweep during the week ending on 4 July. It continued to be so during the subsequent week and Orissa, Jammu & Kashmir, west Rajasthan, Madhya Pradesh, Gujarat State, Maharashtra State and south Interior Karnataka also had heavy rainfall. The significant excesses being 114 per cent in Madhya Maharashtra and 183 per cent in Marathwada during the week ending on 4 July and 156 per cent in Saurashtra & Kutch, 182 per cent in Vidarbha and 151 per cent in south Interior Karnataka during the week ending on 11

TABLE 2

SOUTHWEST MONSOON 1973

PERCENTAGE DEPARTURES FROM NORMAL RAINFALL FOR THE PERIOD 1ST JUNE TO WEEK ENDING

MONTH	JUNE				JULY				AUGUST					SEPTEMBER				1st June TO 30th SEPT
	6	13	20	27	4	11	18	25	1	8	15	22	29	5	12	19	26	
METEOROLOGICAL SUB-DIVISIONS	-37	-28	-32	-9	-1	+10	+3	-4	-10	-9	-7	-10	-12	-12	-13	-8	-13	-11
BAY ISLANDS	+63	-4	+25	+8	+24	-13	-21	-16	-9	+13	+10	-1	-5	-7	-7	+17	-1	-3
ARUNACHAL PRADESH	+8	-30	-25	-24	-24	-10	-19	-19	-13	-3	-6	-6	-11	-12	-14	-6	-6	-6
ASSAM AND MEGHALAYA	-51	-72	-29	-15	-3	-8	-18	-21	-14	-6	-7	-13	-17	-19	-22	-20	-18	-18
NAGALAND, MANIPUR, MIZORAM & TRIPURA	-9	+3	+34	+18	+7	-13	-22	-27	-17	-9	-7	-13	-16	-20	-21	-12	-12	-13
SUB-HIMALAYAN WEST BENGAL	-29	-14	-7	-18	-20	-19	-20	-16	-13	-11	-11	-11	-7	+3	+3	+6	+13	+13
GANGETIC, WEST BENGAL	-85	-54	-45	-53	-46	-21	-14	-2	-10	-11	-12	-7	-4	-1	-4	-1	+3	+2
ORISSA	-21	-59	-17	-22	-15	-12	-13	-24	-22	-23	-24	-21	-25	-15	-15	-9	+2	+2
BIHAR PLATEAU	-45	-43	+27	+7	-7	-14	-29	-33	-19	-15	-15	-12	-17	-20	-19	-12	-9	-8
BIHAR PLAINS	-85	-73	-7	-12	-16	-36	-49	-47	-23	-14	-7	-9	-15	-17	-19	-16	-12	-11
UTTAR PRADESH, EAST	-100	-33	+17	+38	+12	0	-1	-10	-6	+6	+6	+1	-6	-8	-9	+5	+4	+2
PLAINS OF WEST UTTAR PRADESH	-89	+38	+86	+81	+43	+21	+12	+15	+7	+2	-2	-4	-7	-9	-11	-2	-2	-3
HILLS OF WEST UTTAR PRADESH	-99	-5	+406	+337	+180	+89	+63	+46	+41	+45	+45	+37	+36	+29	+24	+19	+16	+12
HARYANA, CHANDIGARH & DELHI	-99	-99	+139	+127	+109	+47	+26	+33	+29	+55	+56	+53	+45	+39	+32	+29	+24	+21
PUNJAB	-73	-11	+71	+113	+41	-2	-18	-19	-29	-13	-11	-18	-16	-16	-17	-13	-13	-14
HIMACHAL PRADESH	-38	-86	-88	-60	-50	-39	-36	-31	-18	-5	+86	+77	+74	+73	+58	+39	+33	+30
JAMMU & KASHMIR	+82	+72	+8	-27	-40	-12	-15	-23	-37	-5	+10	+60	+71	+65	+63	+54	+51	+49
RAJASTHAN, WEST	-45	+32	-27	-53	-61	-31	-16	+11	-9	-7	+3	+5	+6	+23	+25	+37	+37	+35
RAJASTHAN, EAST	-82	+79	+8	-31	-34	+1	+16	+40	+18	+13	+18	+16	+29	+38	+40	+39	+40	+42
MADHYA PRADESH, WEST	-72	+33	-23	-44	-38	-11	-6	-9	-19	-25	-26	-17	-6	-0	-9	-9	-5	-5
MADHYA PRADESH, EAST	-99	+242	+112	+11	-24	-12	-2	-9	-23	-26	-22	-17	-9	+19	+27	+20	+38	+39
GUJARAT REGION, DAMAN, DADRA & NAGAR HAVELI	+25	+238	+83	-21	-49	+33	+25	+8	-7	-17	-16	-21	-20	-22	-25	-25	-17	-15
SAURASHTRA, KUTCH & DIU	-89	+48	+5	-29	-16	+6	0	-8	-17	-8	+3	+1	+2	+2	+3	+1	+4	+4
KONKAN & GOA	-23	+59	+23	-15	+21	+33	+34	+20	+8	+15	+19	+19	+19	+16	+11	+6	+14	+13
MADHYA MAHARASHTRA	-49	+20	-30	-55	+15	+27	+22	+3	-10	+3	+10	+27	+41	+29	+18	+15	+19	+19
MARATHWADA	-65	+54	-27	-57	-49	+3	+14	+1	-15	-17	-14	-11	-5	-7	-11	-4	-1	-1
VIDARBHA	+30	+8	-41	-46	-46	-31	-24	-33	-39	-35	-23	-21	-25	-29	-30	-23	-25	-27
COASTAL ANDHRA PRADESH	+13	+86	+10	-26	-9	+6	+5	-3	-13	+1	+8	+19	+14	+6	0	0	-1	-3
TELANGANA	+119	+64	+21	+1	-3	-17	-30	-40	-30	+2	+24	+15	+4	-5	-10	+9	-2	-5
RAYALASEEMA	+54	+10	-12	-19	-17	-19	-32	-23	-2	+17	+27	+15	+4	-3	+2	+21	+13	+15
TAMIL NADU & PONDICHERRY	-67	+18	-8	-17	-11	-3	-9	-11	-16	-7	+6	+5	+5	+5	+4	+2	+1	0
COASTAL KARNATAKA	+58	+156	+90	+53	+51	+46	+31	+14	+4	+22	+22	+23	+16	+8	+1	+1	-2	-3
INTERIOR KARNATAKA, NORTH	+98	+90	+123	+79	+38	+65	+49	+29	+17	+33	+34	+28	+21	+15	+10	+24	+16	+16
INTERIOR KARNATAKA, SOUTH	-61	-13	+8	-8	-1	+9	+3	-5	-10	-11	-9	-7	-2	-4	-6	-7	-9	-10
KERALA	+34	-22	-32	-25	+8	+14	+3	-5	+3	+15	+23	+23	+19	+15	+14	+16	+13	+10
LAKSHADWEEP																		

July. During the second fortnight of July, the monsoon activity was generally weak except in Madhya Pradesh, Punjab and east Rajasthan; west Madhya Pradesh received rainfall 110 per cent above normal during the week ending on 25 July.

The cumulative rainfall during the period from 1 June to 25 July was normal over most parts of the country except Nagaland, Manipur, Mizoram and Tripura, Sub-Himalayan West Bengal, Bihar, east Uttar Pradesh, Jammu & Kashmir, west Rajasthan, coastal Andhra Pradesh, Rayalaseema and Tamil Nadu where it was deficient. Rainfall was in excess over Haryana, Punjab, west Madhya Pradesh, Madhya Maharashtra and south Interior Karnataka.

August — The monsoon was generally active over most parts of the country throughout the month except Bihar, hills of west Uttar Pradesh, east Madhya Pradesh and Saurashtra & Kutch, where the rainfall was below normal. During the week ending on 1 August, the rainfall was in excess over northeast India, Bihar Plains, east Uttar Pradesh, Jammu & Kashmir, Rayalaseema, Tamil Nadu and Lakshadweep. The rainfall continued to be in excess during the subsequent week over these States except Bihar Plains and east Uttar Pradesh. The States of Haryana, Punjab, West Rajasthan, Konkan, Madhya Maharashtra and Marathwada, Telangana, Karnataka also received excessive rainfall during the week ending on 8 August and continued during the week

ending on 15 August. The significant excesses being 103 per cent in east Uttar Pradesh, 126 per cent in Tamil Nadu and 123 per cent in Lakshadweep during the week ending on 1 August and 105 per cent in Arunachal Pradesh, 136 per cent in Jammu & Kashmir, 142 per cent in west Rajasthan, 147 per cent in Marathwada, 174 per cent in Rayalaseema, 181 and 174 per cents in north and south Interior Karnataka respectively, and 141 per cent in Lakshadweep during the week ending on 8 August; and 791 per cent in Jammu & Kashmir, 116 per cent in west Rajasthan, 158 per cent in Konkan and Goa, 212 per cent in Rayalaseema, 153 per cent in coastal Karnataka, 129 per cent in Lakshadweep during the week ending on 15 August. During the second fortnight of August the monsoon continued to be active to vigorous over Jammu & Kashmir, Punjab, west Madhya Pradesh, west Rajasthan, Gujarat, Marathwada and Vidarbha. Significant excesses being 397 per cent in west Rajasthan, 203 per cent in Marathwada and 119 per cent in Telangana during the week ending on 22 August and 134 per cent in west Rajasthan, 174 per cent in west Madhya Pradesh, 119 per cent in east Madhya Pradesh, 93 per cent in Gujarat Region and 180 per cent in Marathwada during the week ending on 29 August.

The cumulative rainfall during the period from 1 June upto 29 August was normal over the country except Bihar Plateau, Saurashtra & Kutch and coastal Andhra Pradesh where it was just below normal. The rainfall was in excess, in Haryana, Punjab, Jammu & Kashmir, west Rajasthan, west Madhya Pradesh, Marathwada and south Interior Karnataka, the significant excess being 74 per cent in Jammu & Kashmir and 71 per cent in west Rajasthan.

*September*—The monsoon was active in many parts of northeast India, Uttar Pradesh and the central parts of the country during the month of September. The rainfall was generally deficient in south Peninsula and northwest India. During the week ending on 5 September, active to vigorous monsoon condition prevailed over Gangetic West Bengal, Orissa, Bihar Plateau, Jammu & Kashmir, east Rajasthan, west Madhya Pradesh and Gujarat Region and continued during subsequent week over east Rajasthan, west Madhya Pradesh and Gujarat Region. Rainfall was also excessive over Tamil Nadu during this week. Significant excesses being 140 per cent in Gangetic West Bengal 100 per cent in Bihar Plateau, 192 per cent in east Rajasthan, 143 per cent in west Madhya Pradesh and 381 per cent in Gujarat Region during the week ending on 5 September and 124

per cent in Gujarat Region during the week ending on 12 September. During the week ending on 19 September, the monsoon was active to vigorous over northeast India, Himachal Pradesh and hills of west Uttar Pradesh. Monsoon, however, withdrew from Jammu & Kashmir on 14 September. Significant excesses being 100 per cent in Arunachal Pradesh, 132 per cent in Sub-Himalayan West Bengal, 161 per cent in Rayalaseema, 193 per cent in Tamil Nadu and 167 per cent in south Interior Karnataka. Active to vigorous monsoon conditions again prevailed over northeast India, east Uttar Pradesh, Madhya Pradesh and Maharashtra during the week ending on 26 September. Significant excesses being 153 per cent in Gangetic West Bengal, 228 per cent in Bihar Plateau, 121 per cent in east Madhya Pradesh 460 per cent in Gujarat Region, 438 per cent in Saurashtra & Kutch, 88 per cent in Konkan and 111 per cent in Madhya Maharashtra. During the last week of September the monsoon withdrew from Punjab, Haryana, Himachal Pradesh and northeast Rajasthan on 27 September and from west Uttar Pradesh, southeast Rajasthan on 28 September.

The sub-divisionwise percentage departures of rainfall for the season as a whole (1 June to 30 September) are given in the last column of Table 2. It is seen from this figure that the seasonal rainfall was more or less normal over most parts of the country. The only sub-division, which received deficient rainfall (-27 per cent) was coastal Andhra Pradesh. The rainfall was, however, in excess in Punjab (21 per cent), Jammu & Kashmir (30 per cent), west Rajasthan (49 per cent), east Rajasthan (35 per cent), west Madhya Pradesh (42 per cent) and Gujarat Region (39 per cent).

### 3. Major flood producing rainfalls

Floods occurred in the rivers of Assam, Bihar, West Bengal, Jammu & Kashmir, Uttar Pradesh, Rajasthan, Madhya Pradesh and Gujarat State. The rivers of southern Peninsula were generally free from floods.

The major spells of heavy rainfall resulting in disastrous floods and consequently causing human sufferings and widespread loss of property and crops are enumerated here.

#### 3.1. *Floods in the rivers of North Bengal in the middle of June*

Under the influence of the shifting of the seasonal trough of low pressure northwards, the

monsoon was active to vigorous over Sub-Himalayan West Bengal. Heavy rainfall occurred in the catchment areas of north Bengal rivers. Jalpaiguri recorded 9 cm of rain on 14 June. As a result of this heavy rainfall, river *Teesta* crossed the warning stage on 17 June. The road from Jalpaiguri to Mainaguri and rail link were cut-off due to flood damage. Other north Bengal rivers like *Torsa*, *Jaldhaka* were also in floods during the same period. According to the *Flood News Letter* an area of 0.5 lakh hectare was affected by the floods and about three thousand houses were damaged.

### 3.2. River Narmada in floods during the second week of July

A low pressure area developed in north Bay of Bengal on 11 July. It concentrated into a depression on 12th about 300 km south of Calcutta. Moving westnorthwest it became a deep depression on the morning of 13th and crossed the coast near Chandbali on the same forenoon. Continuing to move in a westnorthwest direction it weakened and lay as a low over north Madhya Pradesh on the 14th and finally merged with the seasonal trough on 15th. Under its influence, widespread rain occurred in Madhya Pradesh and Orissa from 12 to 15 July.

Another low formed over northwest Bay of Bengal on 18 July and concentrated into a depression on the morning of 19th near Sandheads. It moved northnorthwest and intensified rapidly into a cyclonic storm and crossed coast near Contai on 19th night. It then lay near Midnapore on 20th morning. It further moved westnorthwestward and lay over north Madhya Pradesh on 22nd as a depression. Under its influence, the monsoon again became active to vigorous over Madhya Pradesh from 19 to 21 July 1973.

Due to these two disturbances which affected Madhya Pradesh in quick succession, the river *Narmada* remained in floods during 2nd and 3rd week of July. It crossed the warning stages at Garudeshwar and Broach gauge sites on 15 July. At Broach the river level receded temporarily but again crossed the warning stage on 20 July. The river *Narmada* also crossed the warning stage at Hoshangabad on 22 July. It recorded a level of 298.70 m a.s.l. against the warning stage of 296.46 m a.s.l. As a result of these floods in river *Narmada*, Khalghat bridge was submerged on 19 July when water level was reported to be about 5 m over the bridge. Road bridge at Mandla was also submerged and the water was about 3/4 m above it on 21 July.

Road bridge at Tilwaraghat near Jabalpur was flooded on 18 July thereby disrupting the road communication between Jabalpur and Nagpur. The city of Ujjain was also inundated due to heavy rainfall over these areas and thereby disrupting the road communications.

### 3.3. Flood in the rivers of Jammu & Kashmir during 1st half of August

A western disturbance moved eastwards across extreme north Jammu & Kashmir between 8 and 10 August and a low which moved from north Madhya Pradesh to southeast Rajasthan merged with the monsoon trough between 9th and 11th. In association with these systems, vigorous monsoon conditions prevailed in Jammu & Kashmir on 9th and 10th and heavy rainfall occurred resulting in floods in rivers *Jhelum*, *Chenab* and *Tawi*. As a result of these floods large areas were affected in Srinagar. About 80 people were rescued from an island of the river bed by helicopters. A breach also occurred upstream of Kandiza thereby causing heavy flooding on both sides of river *Jhelum* and the standing crops were damaged. According to the *Flood News Letter*, 973 villages with population of 3 lakhs were affected. 12,000 houses were damaged and 75 human lives and 10,000 cattle heads were reported to have been lost. The total damage was estimated to be of the order of Rs. 9.5 crores.

### 3.4. Heavy rainfall in Rajasthan resulting in floods during the second half of August

A low moved from central Uttar Pradesh to central Rajasthan from 12 to 14 August and concentrated into a depression on 14th evening which moved and persisted over west Rajasthan on 15th and 16th. It then moved slowly eastwards and lay as a deep depression over south Rajasthan on 18th. It weakened into a low over east Rajasthan on 19th and merged with the monsoon trough the next day. A western disturbance also moved eastwards across extreme north Jammu & Kashmir between 16 and 18 August. Under the influence of these systems, rain or thunder-showers were fairly widespread on many days in west Rajasthan. Very heavy rain was reported from many stations in Rajasthan. Jaisalmer had a record rainfall of 20 cm on 16th while Barmer recorded an exceptionally heavy fall of 23 cm on 18 August. The annual rainfall of these two place is 20 and 31 cm respectively. Tonk also had very heavy rainfall of 24 cm on 14 August. As a result of heavy rainfall the rivers *Luni*, *Sukri*, *Badi* and *Jawai* were in floods. The districts of Jaisalmer, Barmer and Pali were badly affected.

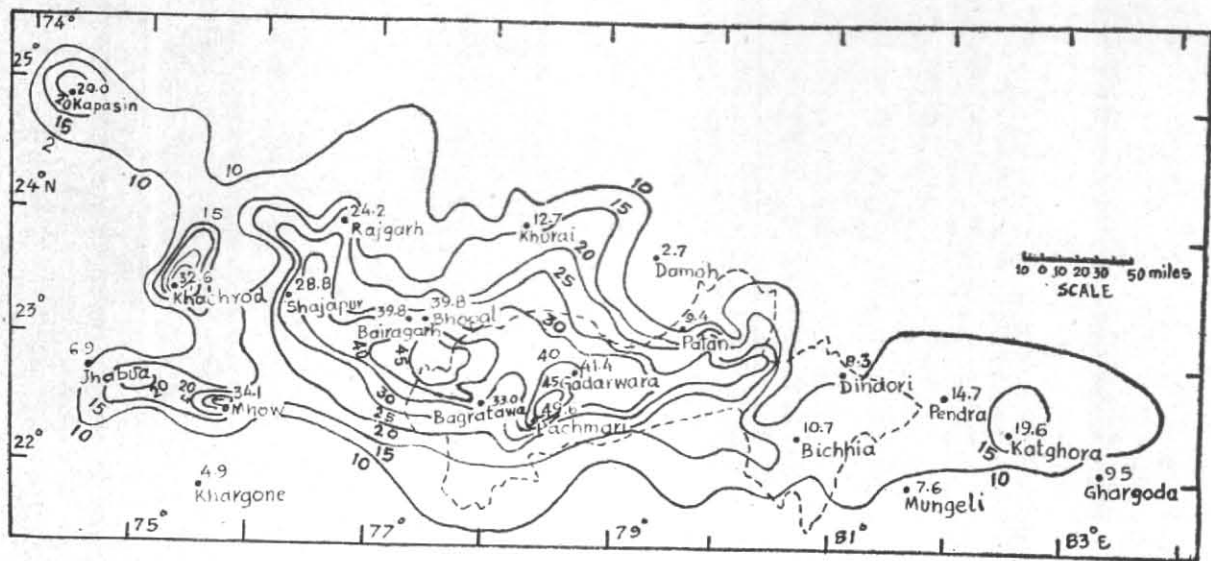


Fig. 1

Isohyetal pattern of 3-day rainstorm (28-30 August 1973) over Narmada catchment

Road and rail communications were completely disrupted. About 400 villages and a population of about 2 lakhs were affected by these floods. Food was air dropped to the marooned people. Meli Bund, a small irrigation project was over-topped and breached on 20 August resulting in the death of 4 persons. According to *Flood News Letter* 20,000 houses were damaged and 22 human lives were lost during these floods in Rajasthan.

Two more lows formed on 22nd and 23rd in quick succession and merged with the monsoon trough on 23rd and 24th respectively. Under the influence of these lows widespread rain occurred in Gangetic West Bengal, Orissa, Madhya Pradesh, Maharashtra State, Gujarat Region and east Rajasthan on 23 and 24 August. Pali, Barmer and Jalore districts remained marooned and food dropping by helicopters was continued.

Yet another spell of heavy rainfall was reported in the catchments of *Jawai* and *Banas* in Rajasthan in association with a deep depression which lay over north Madhya Pradesh on the morning of 19 August. It moved westnorthwest and lay over south Rajasthan on 31st evening and thereafter it weakened into a well marked low on 1 September. It persisted over southeast Rajasthan till 3 September and finally merged with the monsoon trough on the evening of 3rd. Significant amounts of rainfall recorded during this spell were: Erinpura Road 25 cm on 1 September and 36 cm on 2nd; Mount Abu 27 cm. on

31 August and 12 cm on 1 September. As a result of heavy rain, the west Banas dam was over-topped and breached in length of 100 m on the morning of 1 September. The Swarupganj dam was also breached on the same day.

Floods occurred in the river *Jawai*, *Luni* and its tributaries. Sirohi and Jalore districts were severely affected. Helicopters and boats were deployed for rescue operation. According to the State Government, about 560 villages with a population of 5 lakh people were affected and over 1.5 lakh houses were damaged due to floods in Rajasthan. 170 human lives were also reported to have been lost due to floods and house collapse.

### 3.5. Floods in river Narmada due to heavy rainfall in Madhya Pradesh and Gujarat Region during the last week of August

A low formed over north Bay on 24th August and concentrated into a depression near Sandheads on the morning of 26th. It crossed coast near Contai on the evening of 26th, became deep and moving westnorthwest it lay near Jabalpur on 29th. Under its influence active to vigorous monsoon conditions prevailed over Madhya Pradesh and Gujarat Region during 28 to 30 August 1973. Heavy rainfall occurred over Narmada catchment area and the river *Narmada* was in high floods on 30 August. It attained the maximum level of 301.84 m at 1200 hr on 30

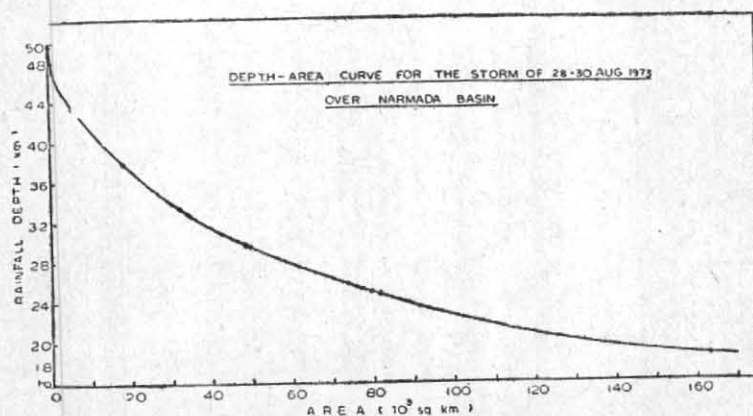


Fig. 2

Depth-area curve for the storm of 28-30 August 1973 over Narmada basin

August at Hoshangabad gauge site which exceeded the previous highest ever recorded level of 299.90 m in 1969. At Gurudeshwar it recorded a maximum level of 40.08 m on 31 August against the previous highest recorded level of 41.65 on 6 September 1970. According to *Flood News Letter* the road bridges at Mandla, Tilwaraghat, Burmanghat, Mortakka and Khalghat remained submerged from 27 August onwards. The water was flowing about 12.1 m above the Khalghat Bridge on 1 September. The water was 2.4 m above the road bridge at Mandla on 28 August. Tilwaraghat road bridge was also submerged and was under 8 m deep water on 29th. The road communications between Jabalpur and Nagpur were completely disrupted. Road communications were also disrupted between Narsinghpur and Gadarwara. The city of Hoshangabad was worst affected on 30 August and the city road bridge was not accessible.

Significant amounts of rainfall were recorded at Jabalpur and Vidisha 20 cm each; Budhni 17 cm, Narsinghpur 12 cm Pachmarhi 18 cm, Power Khedi 12 cm, Rajgarh 17 cm and Bhopal and Hoshangabad 10 cm each on 29 August 1973. Bhopal recorded 28 cm of rain, Pachmarhi 24 cm, Budhni 28 cm, Power Khedi 31 cm, Shajapur 21 cm, Raisen and Ujjain 13 cm each, Indore 12 cm and Narsinghpur 11 cm on 30 August. A detailed study of this heavy rainfall over Narmada catchment in Madhya Pradesh during the period from 28 to 30 August 1973 was carried out by depth-area-duration method. The isohyetal pattern is shown in Fig.1.

As can be seen from this figure that the heavy rainfall centres were located near Hoshangabad

and Pachmarhi. The concentration of heavy rainfall near Hoshangabad caused record flood level in river *Narmada* at Hoshangabad on 30 August at 1200 hr. Depth-area-curve of rainfall for the storm of 28-30 August 1973 is shown in Fig. 2.

The maximum depth of precipitation for various standard areas have been picked up from this curve and are given below :

Area (sq. km)	Average depth (cm)
500	47.3
1,000	46.7
5,000	43.9
10,000	41.3
20,000	37.2
50,000	29.4
1,00,000	22.6
1,20,000	20.8
1,50,000	19.0

A comparison of this rainstorm with the past heavy rainstorms which had occurred over the Narmada basin, reveals that the water potential yielded by the rainstorm of 28-30 August 1973 is more or less at par with the historical rainstorms of 4-6 August 1968 and 5-7 September 1970.

#### 4. Summary

The monsoon activity was generally normal in the country except in Punjab, Jammu & Kashmir, Rajasthan, west Madhya Pradesh and Gujarat Region where active to vigorous monsoon conditions prevailed resulting in excessive rainfall and floods in these states. The rainfall was however deficient in coastal Andhra Pradesh

where it was —27 per cent.

Devastating floods occurred in Jammu & Kashmir, Rajasthan, Madhya Pradesh and Gujarat Region. The floods in Jammu & Kashmir were reported as unprecedented. Southern districts of Rajasthan, west Madhya Pradesh and Gujarat Region also received a few spells with record rainfall this year.

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