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**Rainfall and floods during 1961 southwest monsoon period\***

**1. Chief features of the rainfall**

The floods during the southwest monsoon period of 1961 perhaps attracted more widespread attention than in any one year since 1955. The States of Madras and Andhra Pradesh also experienced heavy floods this year. The miseries and losses of life and property due to the floods caused by bursting of protective dams meant for controlling floods or other projects were so alarmingly high that the economics of flood control measures had to be reviewed by bodies like Central and State Flood Control Boards, Central Water and Power Commission, Ministry of Irrigation and Power etc. A detailed account of floods and damage† caused by them, are given as far as available in the following paragraphs.

The Arabian Sea branch of the monsoon was ushered in over Kerala about 10 days in advance of the normal date due to a trough of low in southeast Arabian Sea. The low concentrated to become a severe cyclonic storm on 24 May 1961 and later moved inland crossing the western coast between Devgad

and the Ratnagiri on the 24th night. Consequently monsoon was established over Konkan and Madhya Maharashtra. Simultaneously the development of a severe cyclonic storm in central Bay of Bengal towards close of May, resulted in the advance of the Bay branch of monsoon also. The monsoon established itself over Peninsular India south of 18°N and in Assam by the end of May and over whole of Peninsula, Orissa, Bihar, West Bengal and east Uttar Pradesh by first week of June 1961. Though further advance was halted, its fury continued unrelented over Kerala. The monsoon established itself over the entire country by the end of June. During its retreat, it seemed to have withdrawn from most of northwest India by the end of September, but a revival ensued between 3 and 14 October caused by the passage of a low over the Peninsula from where it recurved northeastwards before breaking up in Uttar Pradesh Himalayas on 15th. Finally the monsoon withdrew from north and central India by 20th, about 15 days after the normal dates. During October, south Bihar, south U.P.,

\*This article has been prepared in the Hydrology Section of the Headquarters Office of the India Meteorological Department by S. Banerji, Meteorologist, with the collaboration of the members of the staff of the section

†The account of damage has been taken from the flood reports submitted to the Central Flood Control Board meeting of 17 November 1961



and west Madhya Pradesh recorded severe floods.

Rainfall week by week for the period 7 June to 18 October 1961 for all the 28 meteorological sub-divisions of India is given in Table 1. The table also indicates the percentage departure (deficit or excess) of actual seasonal rainfall recorded (during the monsoon months June to September) from the normal rainfall for the same period. It may be noticed that 13 divisions out of 28 had 25 per cent or more excess rainfall, and only one division had deficit of more than 25 per cent; none had a large deficit. A close study of the table reveals the following characteristics —

- (i) Excess rainfall in 14 weeks out of 17 during June to September in Kerala,
- (ii) Deficient rain in Assam and Sub-Himalayan West Bengal in most weeks during June, July and September,
- (iii) Comparatively less rainfall during August which is usually the rainiest month, as compared to September over most parts of north and central India,
- (iv) Continuous spell of heavy rain in west Madhya Pradesh and adjoining Rajasthan during 6 September to 18 October, and
- (v) Unusual rainfall activity during first half of October in U.P., Bihar, M.P. and the West Coast.

From the observation made in (i) to (v) one could expect the following synoptic situations as causes for (i) Weak development of the anticyclone over south Arabian Sea or unusual activity in the formation and movement of depression in southeast or east central Arabian Sea, (ii) Absence of breaks in monsoon, (iii) Passage of fewer depressions during August than in September/October, and (iv) The axis of the seasonal trough lying south of normal position.

On a study of the synoptic charts for the monsoon months, the following information is gathered—

- (a) During the period June/July, four depressions formed in the region of the Arabian Sea two of which concentrated into severe cyclonic storms.
- (b) There were no periods of breaks; in fact the seasonal trough lay on most occasions south of its normal position. This explains the deficit rain in sub-montane West Bengal. This also would explain the cause of frequent floods of the central India rivers like Mahanadi, Nerbada and Tapti.
- (c) There were no depressions that traversed the country between the first week of July and 5 September 1961 although during the period 5 depressions are normally expected. The activity of the monsoon was, therefore, restricted to the central parts of the country as the seasonal trough lay south of its normal position.

## 2. Chief floods of 1961

Most of the rivers in Central and Peninsular India had floods this year. The rivers of Punjab and northeast India except Brahmaputra did not figure so prominently this year as far as the major floods are concerned during the onset of monsoon.

The major floods that attracted greatest attention this year and were responsible for great human sufferings and loss of life and property were —

- (1) Kerala floods in first week of July.
- (2) Cauvery floods on 6 July in upper catchment followed by one in Madras five days later.
- (3) Orissa floods of 10 July and 6 September.

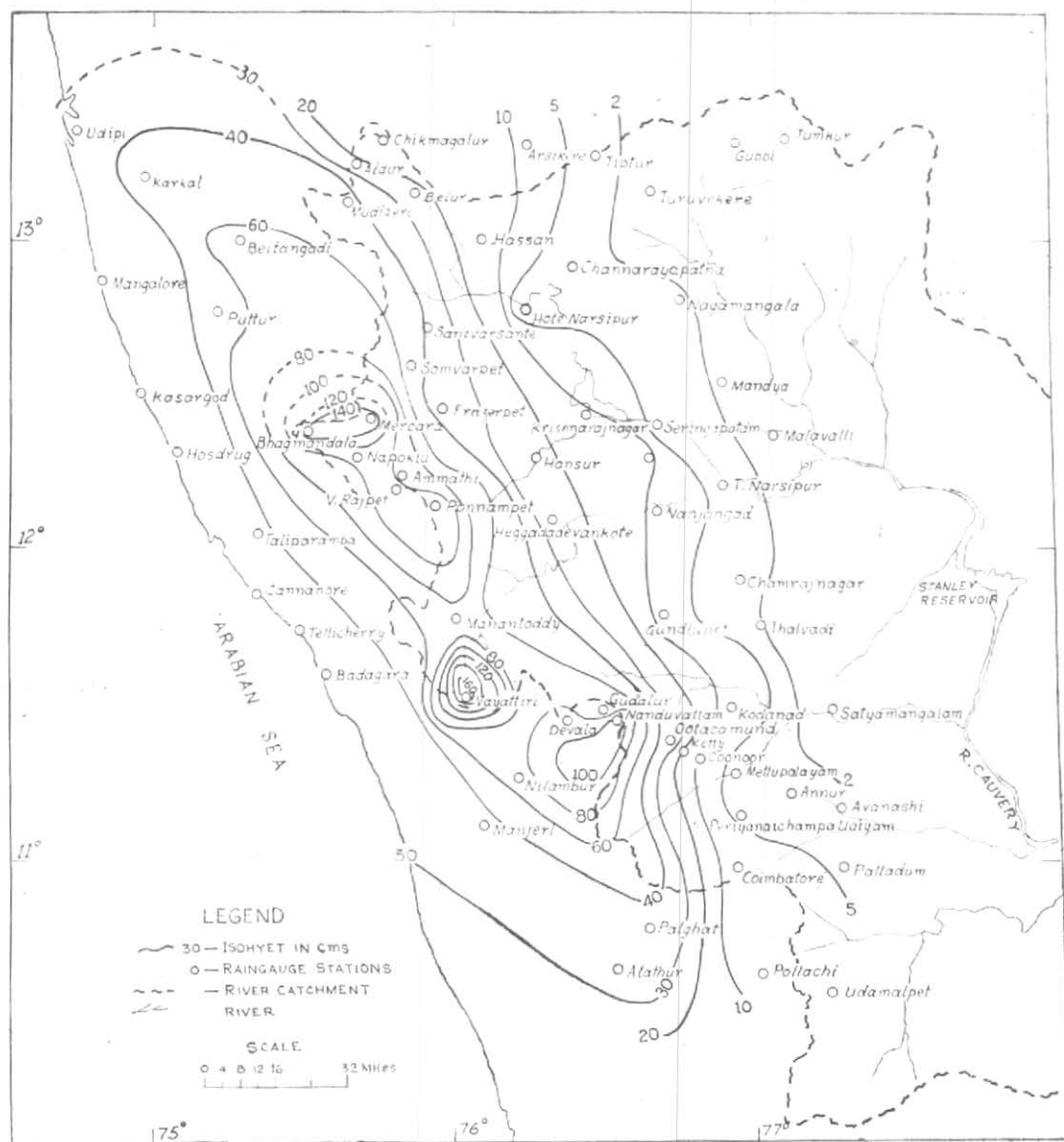


Fig. 1. Upper Cauvery catchment storm of 30 June to 5 July 1961  
Isohyets are in cm

TABLE 2  
DDA statistics of Upper Cauvery Storm of 30 June to 5 July 1961

Area (sq. miles)	50	100	500	1000	5000	10,000
Rainfall (cm)	165.0	131.0	123.0	110.0	81.5	63.0

- (4) Floods in Mutha river (Poona city) on 12 July.
- (5) U.P. floods in 3rd week of August.
- (6) Narbada floods of 25 August, 9 September and 13 October; river Tapti was in floods near Surat on 11 September.
- (7) Godavari floods of 24 August and 20 September.
- (8) Lower Bihar flood (Sone, Bagmati and Kamala) of 1-3 October.
- (9) Gomati flood near Lucknow on 14 October.

A detailed account of some of the floods and the synoptic situation associated with the same is given below—

(1) *Cauvery floods in July*—The principal cause of floods in river Cauvery was continuous heavy rain in the upper catchment (Coorg district, Coastal Mysore) between the period 26 June to 6 July. Mercara whose rainfall has a close correlation with the rainfall in the upper Cauvery catchment (3800 sq. miles) is the only departmental observatory in the area. Rainfall recorded at this station during the 11-day period was 193 cm. The previous highest record for Mercara was in July 1924, when 160 cm of rain was recorded at this station between 15 and 25 July 1924.

The spell of heavy rain commenced with the formation of severe cyclonic storms in the east central Arabian Sea. An easterly low from the Arakans travelled into the Arabian Sea and developed into a depression on the evening of 21 June about 200 km

westsouthwest of Bombay and further concentrated into a severe cyclonic storm on 23rd morning centred 150 km west of Porbander when it recurred northeastwards and crossed Kutch coast the same night. With the weakening of the cyclonic storm, heavy rain spell commenced in Konkan and Coastal Mysore. Development of depressions in Bay during last week of June and first week of July along with the development of depression over Kutch on 2 July resulted in a continuous rainspell. As a result of this continuous spell of heavy rain, in the upper Cauvery catchment, Krishnarajsagar anicut recorded the highest gauge level of 9.50 ft on 5 July, the previous highest being 9.25 ft reached in June 1911. The Cauvery and its tributaries Hemavati, Coleroon and Kabini crossed the danger level at many places and inundated vast areas. Besides, breaches in the discharge channels from the Mettur reservoir and other bunds added to the misery of the people by bringing large areas under water and causing damage to houses. Minor irrigation works, roads and bridges particularly came under the flood onslaught. The exact damage is not known fully but it is reported that 82 human lives were lost, thousands of heads of cattle perished and 11,000 houses were damaged or destroyed, rendering 5000 families homeless. 30,000 acres of cropped area was affected. According to a rough estimate loss to property was worth 9 crores of rupees in Mysore State and Rs. 38.6 lakhs in Madras State.

Isohyetal analysis of the storm in the area in and around Coorg district is given in Fig. 1. DDA statistics for the storm is given in Table 2. It will be noticed that average storm rainfall in 1000 sq. miles is 110 cm.

(2) *Orissa floods of 10 July*—Orissa was again visited by destructive flood this year. Very heavy rains occurred in the catchment area of Hirakud reservoir between 5-10 July. The accumulation in the reservoir was so heavy that for the safety of the Dam outflow beyond the capacity of the discharge channels had to be effected when the inflow increased to 15.4 lakhs cusecs on 10th afternoon. This resulted in breaches in the channel at Mirajapur, Gobindpur and Khavsua and flooding in the delta regions. A 100 feet wide breach also occurred in the canal embankment at Patamundai. The flow in the Mahanadi delta was augmented by the discharge from its tributaries joining it near the delta.

Luckily the damage to lives and livestock was negligible as sufficient time was gained by containing the flood in the Hirakud Dam. People were informed by radio and leaflets dropped from air with instructions to shift to higher regions. However, the damage to crops was on an area of 6.1 lakhs acres and the damage to public utility works was of the order of Rs. 1.7 lakhs.

Synoptic situation responsible for this flood was as follows —

A depression developed over the north-west angle of Bay on 1 July 1961. It crossed the coast near Balasore on 2nd evening and moved in a northwesterly direction. It weakened and lay as low pressure area over M. P. and became unimportant on the 5th. Subsequently a land low developed over Bihar and neighbourhood and shifted to U.P. on the 10th. Vigorous monsoon conditions obtained over M.P. Rainfall recorded during the storm period 5-10 July at some of the observatories in upper Mahanadi catchment were: Pendra 51.3, Raigarh 52.3, Campa 31.7 and Raipur 36.6 cm.

(3) *Floods in Mutha River (Poona city) on 12 July 1961*—Poona city suffered extremely heavy damage due to breaches in

the Panshet and Khadakvasla dams resulting in unprecedented discharge in river Mutha. The earthen dam at Panshet had been built upstream of the older Khadakvasla dam in order to augment the water supply to Poona city. Heavy rain between 1-7 July in the catchment area of the river resulted in heavier inflow in the earthen dam than its designed capacity. The over-flowing water cut a 900 feet breach in Panshet dam whose rushing water had an enormous impact on the pucca Khadakvasla dam and caused a breach 200 feet wide at the top and 75 feet at the bottom. Water which came down from the breached reservoir like a big waterfall overflowed the banks of river Mutha, flooding considerable parts of the city. Four bridges downstream were overtopped and many buildings collapsed. In some parts of the city water entered into houses two to three storeys high. Being caught unawares people had very little time to remove their belongings. According to information available to date a total of 5000 houses were damaged and 31 human lives were lost, in addition to the loss of many heads of cattle. Damage to crops were of the order of Rs. 6.7 lakhs. According to rough estimate, damage to private property was of the order of Rs. 60.4 lakhs. The damage to life would have been much heavier if the breach which occurred in the afternoon, occurred at night.

Meteorological conditions responsible for this heavy rainfall were —

- (a) Development of a depression over Saurashtra and Kutch and the adjoining northeast Arabian Sea on 2 July 1961. It moved slowly first in an easterly direction for a day and then northwestwards for the next 2 days; it was centred near Bhuj on 5 July.
- (b) Depression in the northwest angle of Bay which crossed Balasore coast on 2 July. Its further movement has been described in the previous column.

Under the influence of these, vigorous monsoon conditions prevailed over Konkan and Madhya Maharashtra. Mahabaleshwar recorded 22 cm of rain on 6th and 13 cm on 7 July 1961.

(4) *Lower Bihar Floods on 1-3 October 1961*—Bihar was in the grip of floods in the month of August and October. In August, the Ganga, Bagmati and Kosi were in medium floods. This resulted from continuous spells of rain in the plains due to the seasonal trough lying over the area. There was spell of very heavy rain and as such damage was confined only to the low lying areas in and near the flooded river. An area of 17,500 sq. miles was affected.

South Bihar, however, got a severe storm towards the close of the monsoon season, when very heavy rain occurred between 1-3 October 1961 after an indication for a few days of the retreat of monsoon from the area. Floods during this part of the year are abnormal besides, the moderate storms at this time appear more severe when compared with what it would seem to be at other time of the monsoon season. This year's floods occurred in association with a depression that developed over the north Bay of Bengal on 27 September and which became deep on 28th morning with centre 100 km southeast of Calcutta. It moved in a westerly direction and crossed the coast near Contai on the morning of 29th and weakened into a depression, centred 100 km southwest of Jamshedpur. It was centered 100 km west of Ranchi on 30th and between Ambikapur and Daltonganj on the morning of 1 October 1961. It then curved northeastwards and apparently intensified with centre 75 km west of Naya Dumka on 2nd morning. Thereafter, it rapidly weakened and lay as a low pressure area over Bihar plains on the 3rd. It moved further north-northwestwards and filled up over the central parts of U.P. by the 6th. Unusually heavy rain occurred in association with this storm; some of the noteworthy amounts of rainfall

being—Nawada (Gaya) 41.8 cm and Barbigaha (Monghyr) 33.7 cm on 2 October, Sheikhpura (Monghyr) 37.4 cm, Monghyr 35.7 cm, Laukaha (Darbhanga) 34.5 cm and Simera (Patna) 30.0 cm on 3 October.

Some of the heaviest rainfall amounts for the storm period (1-3 October) were as follows—

Barbigaha 57.4 cm, Sheikhpura 55.9 cm, Monghyr 55.7 cm and Nawada 54.8 cm.

The damage to life and property due to the flood caused by this storm was exceptionally heavy. The storm was analysed for its water potential and a comparison was made with the previous major storms for which information was available. Table 3 gives comparative statement of all the major storms that occurred in the second half of September or later along with the heaviest storm on record for the area between the period 1923-1955.

From the depth duration area (DDA) statistics it should be apparent that although the rainfall at the storm centre was not the heaviest for this storm compared to most intense of all the storms analysed for the period 1923-1955, this storm was certainly the most intense amongst those occurring during the close of the monsoon season. Further the water yield for this storm is apparently the heaviest of all the storms that have been analysed. The centre of the storm was in district Monghyr and as such the maximum damage to life and property occurred in this district. The storm isohyets for the October 1961 storm are given in Fig. 2.

The damage to life and property due to this flood has been compared with that caused by the catastrophic earthquake of 1934. One of the reason for this was that a protective bund of lake on Kharagpur hills (Monghyr district) gave way when water started overflowing and roaring sheets of water descended over the sleeping villages submerging the area when it was still raining



TABLE 3

	1-3 Oct 1961	26-28 Sep 1953	28-30 Sep 1942	6-8 Oct 1929	17-19 Sep 1924	27-29 Aug 1940
1. Storm centre Lat.	25° 18'	24° 10'	26° 30'	24° 58'	26° 26'	24° 28'
Long.	85° 44'	85° 36'	85° 55'	88° 55'	85° 24'	84° 50'
2. Rainfall at storm centre (cm)	57.4	20.3	51.4	59.8	59.7	77.4
3. Extent in sq. miles Last enveloping isohyet (10 cm)	28,000 (10 cm)	19,068 (10 cm)	14,344 (10 cm)	30,052 (10 cm)	12,525 (10 cm)	34,916 (10 cm)
4. Average rainfall for (3) in cm	25.5	12.7	18.8	17.8	19.1	18.0

## DDA values

Area (sq. miles)	Rainfall (cm)					
	100	57.1	21.6	51.8	48.0	50.8
500	56.7	20.3	42.7	37.1	41.7	54.3
1000	56.0	19.3	37.6	34.5	37.1	43.7
5000	47.5	15.9	26.4	27.7	25.7	31.7
10,000	38.5	14.5	21.8	24.6	20.1	25.9
20,000	30.0	12.4	16.0	20.7	14.7	21.3
25,000	26.8	11.9		19.1	14.0	19.8
30,000	23.8	11.4		17.8	(22,000)	18.8

heavily. The flood is supposed to have taken a toll of several hundred of lives and thousands of heads of cattle. Six villages in Kharagpura Thana were completely wiped off. The Bihar Minister for Co-operation in his statement in the State Assembly on 11 October, stated that over 32,000 houses had collapsed in Monghyr and Patna districts alone. A total of 15,000 villages were affected by the flood. Almost all the roads in the districts of Patna, Gaya, Monghyr and Bhagalpur were severely damaged and communications was at stand still for nearly 10 days. Accurate information about the loss of property has not yet been available, but it is believed to be very heavy.

(5) *Uttar Pradesh floods in the 2nd week of October*—Floods in river Gomati again occupied the newspaper headlines this year towards the close of the monsoon season. Although peak flood level this year was not

as high as in 1960, the loss to life and property was nearly as great effecting an area of 12.09 lakhs acres. The number of houses destroyed were over 75,000 and it was feared that 86 human lives were also lost. The level of river Gomati was only 4.75 ft lower than the unprecedented level's record d in 1960. All the approach roads to Lucknow were inundated at several places.

The meteorological conditions that gave rise to the flood were as follows—

On 7 October 1961 a well-marked low pressure area from west central Bay of Bengal moved into Peninsula after crossing the Circars coast. It lay over Telengana on 8th and concentrated into a depression over Vidarbha on the 9th morning centred near Amravati. The depression remained practically stationary over Vidarbha for the next 48 hrs, i.e., till the morning of 11th and then started

moving northnorthwest. It was over west Madhya Pradesh on 12th morning with centre about 80 km west of Bhopal. Recurring thereafter northeastwards it was centred close to Guna on 12th evening and moved on to U.P. with centre near Kanpur on 13th. Thereafter it weakened rapidly and continued to move northwards and broke over the Himalayas on the 14th. Some of the notable amounts of rainfall recorded in association with the storm are as follows—

Orai 22 cm, Lucknow 14 cm on 13th, Balia 14 cm, Kheri Lakhimpur 12 cm and Lucknow 11 cm on 14th.

### 3. Conclusion

The broad features of the 1961 southwest monsoon rain and the associated floods over the country may be summarised as follows—

(1) Due to absence of 'break' monsoon conditions and the seasonal trough lying mostly south of its normal position, the catchment areas of central India and Peninsular rivers received heavy rain and all the rivers

like Mahanadi, Godavari, Nerbada and Tapti were in floods.

(2) Due to development of depressions in Arabian Sea during the period mid May-July monsoon was very active on the western coast and was particularly heavy over the Coastal Mysore.

(3) Abnormally heavy rainstorms occurred in south U.P. and south Bihar in the month of October. The Bihar storm can be regarded as the most intensive for this part of the season. The water yield of this storm is the heaviest for any previous storm recorded during 1923-1955.

(4) Some of the redeeming features of the rainfall distribution associated with the 1961 southwest monsoon season were—

- (a) Absence of floods in Punjab, Jammu and Kashmir; and
- (b) Absence of continuous period of draught during July/August in any one sub-division of south India.