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Cyclones and depressions of 1971—Bay of Bengal and Arabian Sea

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1. Introduction

Seven cyclonic storms and six depressions formed in the Bay of Bengal and the Arabian Sea during the year 1971. Two depressions also developed over land areas, one over Gangetic West Bengal and the other over east Madhya Pradesh. Of the seven cyclonic storms, five formed in the Bay of Bengal (four of them of severe intensity) and two in the Arabian Sea (both of severe intensity). The tracks of these storms and depressions are shown in Fig. 1 and their monthly distribution in Table 1.

The main features of this year's cyclonic disturbances were :

(*i*) No cyclonic storm struck the coast of Andhra Pradesh, Tamil Nadu or the west coast of India.

(*ii*) A severe cyclonic storm struck Orissa coast towards the end of October near Paradeep, causing considerable damage to life and property. About 10,000 persons and 50,000 heads of cattle were reported perished and 8,00,000 houses were reported damaged. The loss of life and property was mainly due to tidal waves 2 to 6 metres high between Paradeep and Balasore. Cuttack and Balasore districts were the worst affected areas.

(*iii*) Another severe cyclonic storm struck coastal West Bengal near Calcutta towards the end of September, causing some loss of life and damage to property.

(*iv*) The depressions and some low pressure areas which moved westwards across the central and northern parts of the country during the monsoon, led to serious floods in many parts of north India. The worst affected States were Bihar, Uttar Pradesh, West Bengal and Orissa. The loss on account of floods were emphasised in the following report published by the *'Times of India'* on 16th November 1971 —

"1023 lives lost in floods : Rs. 596 crores damage. New Delhi, November 15 : The Irrigation and Power Minister Dr. K. L. Rao, disclosed in Parliament today that 1,023 human lives were lost and property worth Rs. 596 crores was damaged in the floods this year — the severest since 1954.

In a statement laid on the table of both Houses of Parliament, he said the total population affected was 57 million and altogether an area of 12·5 million hectares, including a cropped area of 5·87 million hectares was affected in the entire country. The bulk of the damage (98 per cent), occurred in Bihar, Orissa, Uttar Pradesh and West Bengal".

A brief history of the cyclones and depressions, together with important features associated with them, is enumerated in the following paragraphs in chronological order.

2. Bay of Bengal

1. *Cyclonic storm — 4-8 May 1971*

A low pressure area moved from the east into the Andaman Sea on 2 May and concentrated into a depression by the evening of 3rd, with its centre near 9·5°N, 92·5°E. Moving slowly north-northwestwards, it intensified into a cyclonic storm on the morning of 5th near 11°N, 92°E. Continuing to move northnorthwestwards upto the 7th and later recurving northeastwards, it crossed the Chittagong coast on the morning of 8th between Chittagong and Cox Bazar. Thereafter, it

TABLE 1

Monthly distribution of cyclones and depressions in the Bay of Bengal and Arabian Sea (1971)

	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec		Annual total	
	D	C	D	C	D	C	D	C	D	C	D	C	D	C	D	C	D	C	D	C	D	C	D	C	D	C
Bay of Bengal									1		1	1(1)	1		1		1	1(1)	1	1(1)		1(1)			5	5(4)
Arabian Sea											1									1(1)				1(1)	1	2(2)
Land depression													1		1										2	
Total									1		2	1(1)	2		2		1	1(1)	1	2(2)	1(1)		1(1)		8	7(6)

D—Depression C—Cyclonic storm Figures in bracket indicate the cyclonic storm which had become severe

TABLE 2

Date	Name of ship/ station	Location		Time	Wind		Pressure
		Lat. (°N)	Long. (°E)	(GMT)	Direction	Speed (kt)	(mb)
4 May 71	VWDG	11·2	92·1	2000	E	25	999·2
5 May 71	VWDG	11·3	91·5	0000	NNE	25	997·8
	VWDG	11·4	91·0	0300	NNE	35	1000·2
	VWDG	11·5	90·6	0600	NNE	37	1002·0
	Car Nicobar AP			0300	SW	40	1002·1
	VWDG	11·5	90·0	0900	NNW	38	1002·8
	JMTW	12·5	94·5	0900	S	30	1001·5
	Port Blair			1200	SSW	20	996·7
	Coco Island			1200	SSE	30	1000·5
6 May 71	VWDG	11·8	87·6	0000	W	30	1002·5
	VWPT	14·4	92·4	1200	SSW	25	1000·0
	VWPT	14·4	91·8	1600	SSW	25	1003·6
7 May 71	VWSG	17·2	86·5	0000	N	5	999·5
	GSWX	18·6	87·1	0300	NNE	20	1003·7
	VWLG	18·2	87·2	1200	NNW	18	1001·6
	GSWX	18·1	87·4	1200	NW	23	1002·3
	Sandheads			1200	N	40	999·3
	Akyab			1200	SSE	25	1001·9

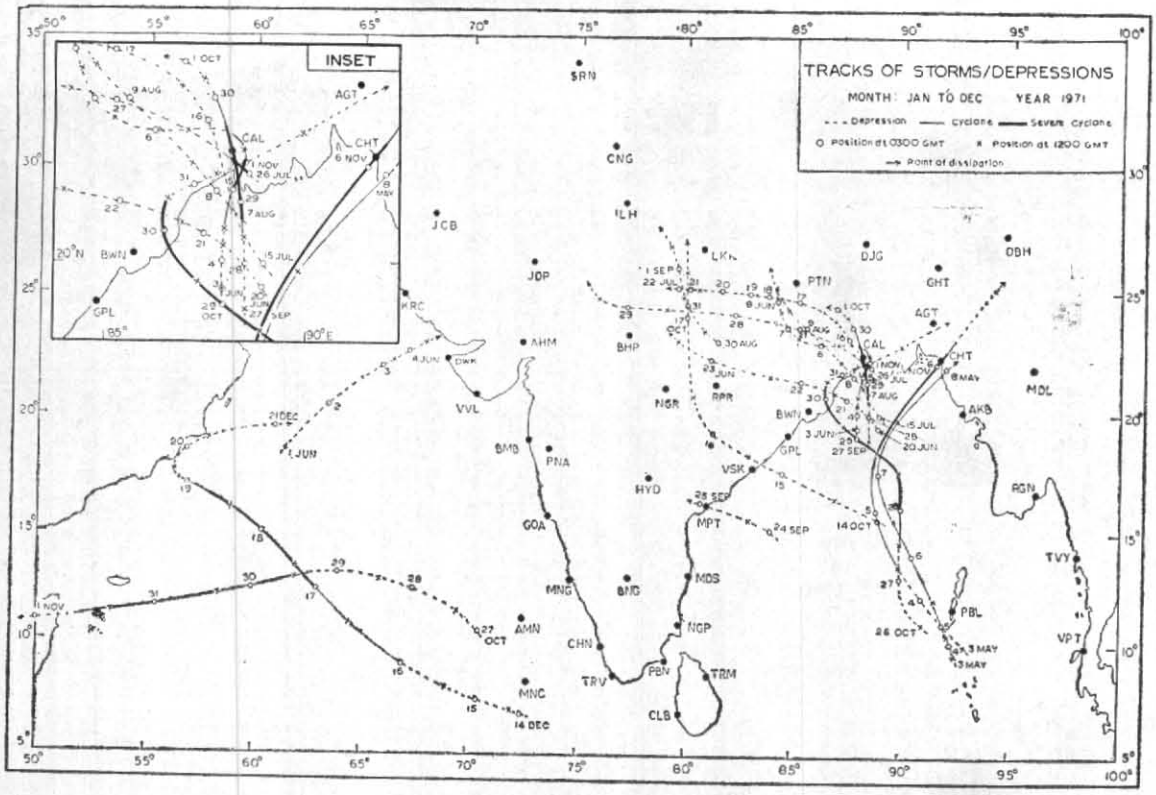

Fig. 1

weakened rapidly into a low pressure area and moved away northeastwards across Tripura, Mizoram and Manipur by the 9th.

This system caused widespread rain with a few very heavy falls in the Bay Islands from the 3rd to 5th, and in south Assam from the 8th to 10th. The notable rainfall amounts were :

Date	Station	Rainfall (cm)	Date	Station	Rainfall (cm)
3	Kondul	25	8	Agartala	14
4	Car Nicobar (AP)	20		Kailashahar	12
5	Long Island	12	10	Tura	14
8	Haflong	17		Kailashahar	13

The ships' and Island observatory reports in the vicinity of the storm field which were of interest are given in Table 2.

The Bay Islands reported a pressure departure of about —10 mb from the normal on the evening of 5th; otherwise, there was nothing of significance on the pressure change and departure charts. A trough in the upper tropospheric westerlies lay between 80-85° E, north of 20° N on the 7th. It persisted near 85°E on the 8th. The storm was

Fig. 2
ESSA-8—View of the storm at about 0330 GMT on 6 May 1971

then located on the western periphery of an anticyclone above 300 mb, with strong winds from the south/southsouthwest. These two factors could have helped the recurvature of the storm northeastwards.

The satellite pictures showed that this disturbance was generally in stage C or C+ on the 6th and possibly in X-1 category on the 7th. The estimated central pressure was about 993 mb.

TABLE 3

Date	Name of ship/ station	Location		Time (GMT)	Wind		Pressure (mb)
		Lat. (°N)	Long. (°E)		Direction	Speed (kt)	
3 Jun 71	JNHV	18·9	88·3	1200	NE	16	990·4
4 Jun 71	Sandheads			0000	NE	30	990·4
	JNHV	17·3	90·6	0000	SW	30	996·4
	GSHY	16·3	86·0	0000	WSW	40	998·7
	Sandheads			1200	SE	22	985·3
	Paradeep			1200	WNW	30	988·1
5 Jun 71	Sagar Island			0000	NNW	45	980·0
	Sandheads (Near Sagar Island)			0000	N	45	978·8
	GFHY	20·5	88·3	0000	SW	40	988·4
	Sandheads			0300	N	46	983·9
	Sagar Island			0300	NNW	37	983·3
	Sandheads			1200	WSW	40	989·5
	Sagar Island			1200	WSW	28	989·3
	Calcutta			1200	WSW	09	984·8

2. *Severe cyclonic storm — 3-8 June 1971*

A depression formed in the Bay of Bengal near 19·5° N and 88°E on the morning of 3rd. Moving practically northwards, it intensified into a cyclonic storm by the evening of 4th. It became severe by the morning of 5th close to Sagar Island. It crossed the West Bengal coast near Sagar Island on that afternoon, and lay as a cyclonic storm near Calcutta by the evening of the same day. Subsequently, moving initially west and then northnorthwest, it gradually weakened into a low pressure area over northwest Bihar by the evening of 8th.

This system helped the monsoon to advance into Orissa, Bihar State, Madhya Pradesh and east Uttar Pradesh. The monsoon was vigorous in Gangetic West Bengal, Orissa and Bihar Plateau on the 6th and active to vigorous in Madhya Pradesh from the 6th to 9th. The notable amounts of rainfall were :

Date	Station	Rainfall (cm)	Date	Station	Rainfall (cm)
6	Jamshedpur	15	8	Jabalpur	17
	Ranchi	11		Sidhi	17
	Baripada	11		Umaria	12
	Jharsuguda	10		Sagar	11
7	Ambikapur	16	9	Panna	11
	Jashpurnagar	16		Rewa	10

The reports from ships and observatories which were useful for locating the storm centre and in assessing its intensity are given in Table 3.

Sandheads reported a negative pressure departure of 13 mb on the evening of 4th and 17·5 mb on the morning of 5th. Sagar Island reported a negative departure of 18 mb on the morning of 5th while Calcutta reported a negative pressure departure of 13·5 mb on the evening of 5th. At 0000 Z on 5 June when the centre of the storm was very close to Sagar Island and Sandheads, these places reported pressure of 980 and 979 mb respectively. The pressure at the centre of the system was estimated at about 976 mb. There were no significant upper air features, which could be associated with the intensification and movement of the storm.

This system could not be clearly identified in the satellite pictures, because of the cloudiness associated with the monsoon.

3. *Deep depression — 20-23 June 1971*

A depression formed in the north Bay of Bengal on the morning of 20th with its centre near 19·5°N, 89°E. Moving northwestwards, it became deep on the morning of 21st near 21°N, 87·5°E. Moving westnorthwest later it crossed the Orissa coast on the same night between Balasore and Chandbali. Continuing to move westnorthwestwards, it weakened into a low over west Madhya Pradesh by the 24th.

This system was responsible for active to vigorous monsoon conditions in Orissa on the 21st and 22nd, and active monsoon conditions in Vidarbha on 22nd and 23rd and in Madhya Pradesh from the 21st to 24th. The notable amounts of rainfall were :

Date	Station	Rainfall (cm)	Date	Station	Rainfall (cm)
21	Bhavani Patna	23	22	Phulbani	15
22	Bhubaneshwar	28		Titlagarh	12
	Puri	19	23	Wardha	16
	Bolangir	18			

Sandheads (position near lower Gasper) reported a southeasterly 25 kt wind and a pressure of 991·7 mb on the evening of 20th, with a pressure defect of 6 mb. Bhubaneshwar reported northerly 25 kt wind at 0000 Z of the 21st. The maximum pressure defect near the centre of the disturbance was 8 mb on the 21st. Sandheads reported a surface wind of 30 kt from the south and a pressure of 991·1 mb, while Chandbali reported the lowest pressure of 989·8 mb at 1200 Z of 21st. The largest pressure defect of 10 mb was reported by Keonjhargarh; while the lowest pressure was 990 mb close to the centre of the system on the morning of 22nd.

This system could be classified in stage C on the basis of satellite pictures on the 21st.

4. *Depression — 15-22 July 1971*

Under the influence of a low pressure wave moving westwards across the Arakan coast into north Bay, a depression formed on the morning of 15th near 20°N, 89°E. Moving northnorthwestwards, it crossed the coast near Contai on the same night, and was centred near Burdwan on the morning of 16th. Subsequently, it moved westwards and weakened into a low pressure area over south Uttar Pradesh and adjoining north Madhya Pradesh by the evening of 22nd.

This system caused generally widespread rain in northeast India and Madhya Pradesh on many days and in Uttar Pradesh and Rajasthan on a few days during this period. The monsoon was active to vigorous in Gangetic West Bengal on the 16th and 17th, and active in Orissa on the 16th, in Bihar Plateau from the 16th to 18th, in Madhya Pradesh from the 17th to 23rd and in Rajasthan on the 23rd. Floods were reported in some parts of Madhya Pradesh, Gangetic West Bengal and Bihar. The notable amounts of rainfall were —

Date	Station	Rainfall (cm)	Date	Station	Rainfall (cm)
			20	Satna	22
16	Chandbali	11		Tikamgarh	11
17	Asansol	18		Panna	11
	Bankura	14	21	Nowgong	10
18	Daltonganj	11	22	Shivpuri	16
19	Umaria	24		Vidisha	13
	Satna	15	23	Shivpuri	20
	Sidhi	12		Guna	10

The largest pressure defect near the centre of the depression was of the order of 4-6 mb on most of the days. Sandheads reported a surface wind WSW/30 kt and Sagar Island WSW/25 kt at 0300 Z of the 16th.

5. *Deep depression — 7-9 August 1971*

A depression formed in northwest Bay close to Sandheads on the evening of 7th. It became deep on the morning of 8th, and was centred close to Sagar Island. Moving northwestwards, it crossed the West Bengal coast near Contai on that afternoon. Continuing to move northwestwards, it gradually weakened into a low pressure area by the morning of 10th over west Bihar and adjoining east Uttar Pradesh.

This system caused vigorous monsoon conditions in Orissa on the 8th and active monsoon conditions in Gangetic West Bengal on the 7th and 8th, in Orissa on the 9th, in Bihar State on the 8th and 9th, in coastal Andhra Pradesh on the 8th, in east Madhya Pradesh on the 9th and in east Uttar Pradesh on the 9th and 10th. Heavy rains associated with this system worsened the flood situation in many parts of West Bengal, Bihar State and east Uttar Pradesh. Floods were also reported from Cuttack and Balasore districts in Orissa. The notable rainfall amounts were —

Date	Station	Rainfall (cm)	Date	Station	Rainfall (cm)
8	Chandbali	22	10	Chaparmukh	17
	Baripada	16		Dehri	16
	Balasore	13		Varanasi City	14
	Sambalpur	12		Varanasi AP	13
9	Rourkela	13		Allahabad	12
	Allahabad	12			

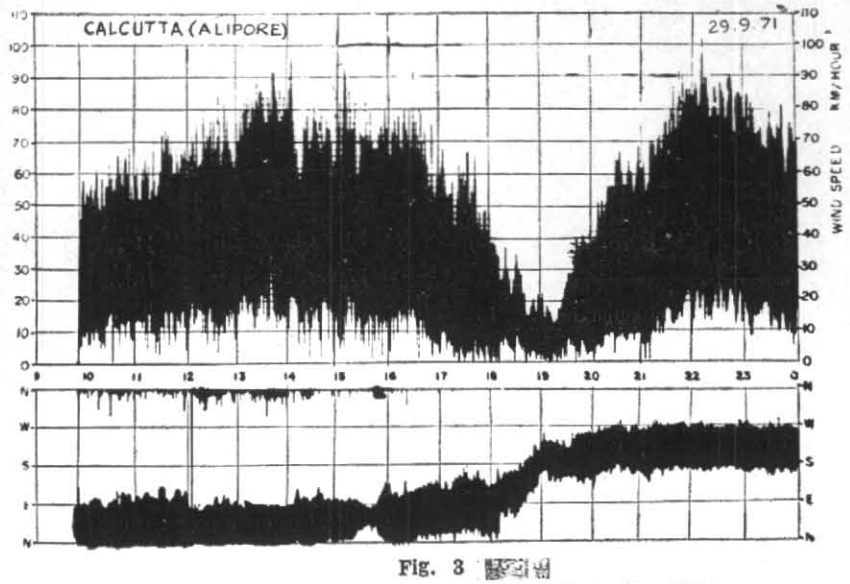

Fig. 3

Dines P.T. anemogram of Calcutta on 29 September 1971

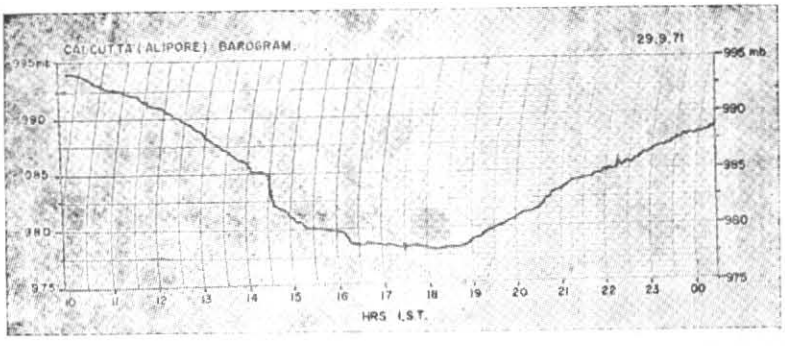

Fig. 4

Barograph record of Calcutta on 29 September 1971

TABLE 4

Date	Name of ship/ station	Location		Time	Wind		Pressure
		Lat. (°N)	Long. (°E)	(GMT)	Direction	Speed (kt)	(mb)
28 Sep 71	Sandheads			0300	NE	30	1001·7
	Sandheads (21·41° N, 88°E)			1200	NNE	25	997·3
	Sagar Island			1200	NNE	17	996·5
	GZKP	18·5	88·2	1200	W	40	—
29 Sep 71	PFGY	20·2	88·0	0000	SW	33	980·8
	Sandheads (21·41° N, 88°E)			0000	NNE	40	990·9
	Sagar Island			0000	NNE	30	991·0
	PFGY	19·8	88·8	0300	SW	40	991·3
	Sandheads (21·41° N 88°E)			0300	NNE	38	990·8
	Sagar Island			0300	NNE	30	989·9
	Sandheads			1200	WNW	55	988·6
	Sagar Island			1200	WSW	40	986·3
	Dum Dum			1200	E	30	980·2
	Calcutta			1200	NE	15	978·5

The surface wind at Sandheads was SW/40 kt and at Sagar Island ENE/14 kt on the evening of 7th. At 00Z of 8th the surface wind at Sandheads was SW/30 kt and at 0300Z SW/20 kt. The largest pressure defect near the centre of the system was about 8 mb on the 8th. The upper wind at Chittagong upto 1500 m was SE/30-40 kt on the evening of 7th.

6. *Depression — 24-25 September 1971*

A low developed over south and adjoining central Bay on the 23rd. It concentrated into a depression over west central Bay on the morning of 24th, near 15°N, 84°E. Moving westnorthwest, it crossed the coast near Masulipatam towards the early morning of 25th and weakened into a well marked low by that forenoon over coastal Andhra Pradesh and adjoining Telangana. Subsequently, it moved away westnorthwestwards across Maharashtra State.

This system caused widespread rain, with scattered heavy falls in many parts of Andhra Pradesh on the 25th and in Maharashtra State on the 26th. The notable amounts of rainfall were—

Date	Station	Rainfall (cm)	Date	Station	Rainfall (cm)
25	Eluru	15	26	Paithan (Maharashtra)	20
	Bhimavaram	14		Ozar	15
	Rentachintala	13		Aurangabad	15
	Nalgonda	13		Bijapur	15
	Hyderabad			Bhir	12
				Poona	12

The surface wind at Kakinada was ENE/15-20 kt on the 24th and the upper wind at Visakhapatnam on the same day at 600 m and 900 m was ENE/30 kt. The pressure defect near the centre of the system was 6 to 7 mb.

7. *Severe cyclonic storm — 27 September to 1 October 1971*

A well marked low pressure area developed over the central Bay of Bengal on the morning of 27th. Moving northwards it concentrated into a depression on the same evening near 19°N, 88·5°E. Continuing to move northwards, it intensified into a cyclonic storm on the evening of 28th and into a severe cyclonic storm on the morning of 29th, when it was centred near 21·5°N, 88·5°E. It crossed the Sundarbans coast on the same afternoon. Moving close to Calcutta by the same evening, it weakened into a cyclonic storm on the morning of 30th about 75 km east of Asansol. Subsequently, moving northwestwards, it weakened into a low pressure area over east Bihar State by the evening of 1 October.

This system caused widespread rain in many parts of northeast India from 29 September to 1 October. Scattered very heavy falls occurred in Gangetic West Bengal and Bihar Plateau on the 30th, and isolated very heavy falls in Sub-Himalayan West Bengal and Bihar Plains on the next day. Many districts in West Bengal were badly affected by the cyclone. The cyclone is reported to have taken a toll of about 60 human lives and caused many thousands of houses to collapse. The notable amounts of rainfall were —

Date	Station	Rainfall (cm)	Date	Station	Rainfall (cm)
30 Sep	Bankura	18	1 Oct	Malda	24
	Midnapore	16		Patna AP	15
	Asansol	15		Jalpaiguri	13
	Contai, Dumka	14	2 Oct	Purnea	14
	Sagar Island	13		Darbhanga	12
	Burdwan	12		Muhammadabad	12

The reports from ships and observatories in and near the storm field which were of interest are given in Table 4.

The pressure defect near the centre of the system was 18 mb at 0300 Z of 29th, 26 mb at 1200 Z of 29th and 16 mb at 0300 Z of 30th. Calcutta (Alipore) recorded the lowest pressure of 978.5 mb with a pressure defect of 26 mb on the evening of 29th. This pressure defect was a record for Calcutta. Calcutta experienced gales reaching about 100 km on the 29th.

The satellite cloud picture (not reproduced) showed that the system could be classified in stage X-2 on the morning of 29th with a central overcast region of 5° in diameter. The maximum wind speed estimated from the picture was 65-70 kt. This gave an estimated pressure of 979 mb at the centre of the system, which agreed well with the actual pressure (978·5) recorded at Calcutta, when the centre of the cyclone was close to that place.

8. *Deep depression — 14-17 October 1971*

A well marked low that lay over east central Bay on the 13th concentrated into a depression on the morning of the 14th near 15·5°N, 89°E. Moving westnorthwest it intensified into a deep

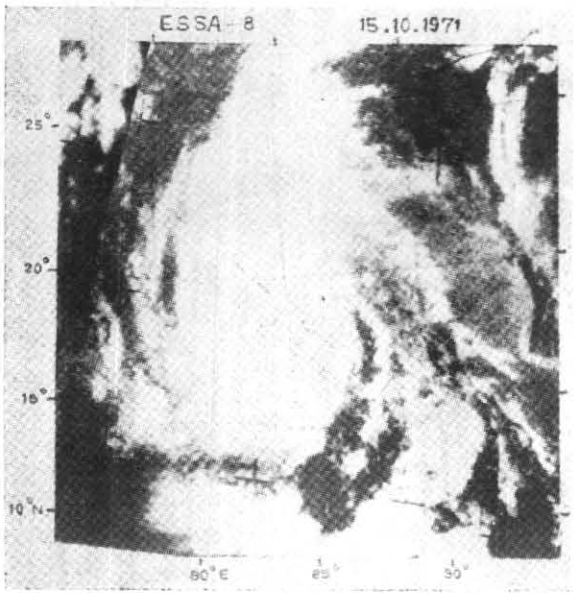

Fig. 5

ESSA-8 View of the deep depression at about 0400Z of 15 October showing the system in stage X-1. Cloudiness may be seen extending towards north through as many as 7 to 8 degrees of latitude from the centre of system.

depression by the morning of 15th, when it was centred near 17·5°N, 84·5°E. It crossed Andhra Pradesh coast a little to the north of Visakhapatnam by the same afternoon. Thereafter, moving initially northwestwards and later northwards, it gradually weakened into a trough of low pressure over central Uttar Pradesh by the evening of the 18th.

This system caused good rainfall in Orissa on the 15th and 16th, in Gangetic West Bengal on 15th, in Madhya Pradesh on the 16th and 17th and in Uttar Pradesh from the 16th to 18th. There were reports of gales that hit the southern districts of coastal Orissa (particularly Puri), uprooting trees, blowing away roofs and dislocating road traffic. The floods in the Burabalang and the Baitarni caused damage to paddy crops in Mayurbhanj, Keonjhar and Balasore districts in Orissa. The principal amounts of rainfall were —

Date	Station	Rainfall (cm)	Date	Station	Rainfall (cm)
15	Jajpur	17	16	Baripada	9
	Chandbali	12		Visakhapatnam	8
	Gopalpur	11	18	Gorakhpur	15
	Bhubaneshwar	11		Farrukhabad	13
	Puri	10		Nainital	12
	Paradeep	10		Deoria	10

No 'ships' reports were available near the centre of the depression. Ships PCYP and 9VMM located about 400 to 500 km to the northeast of the centre of this system, reported surface wind E/SE 30-35 kt both on the morning and evening of the 14th. The winds in the lower troposphere were N/NE 30-35 kt in coastal Orissa on the 14th evening and 15th morning. The surface wind at Puri was E/40 kt at 0300 Z of 15th. Visakhapatnam also had squally weather in the early morning of 15th. The maximum wind speed reached in one of the squalls was 87 kmph (47 kt) at about 0430 IST of 15th. Bhubaneshwar reported upper winds E/SE 40-50 kt at 0600 Z and 1200 Z at 0·9 km and 1·5 km. The winds in the lower troposphere were strongest (of the order of 30-40 kt) on the eastern and northeastern sectors of the system on the 16th and 17th.

The largest pressure defect was 10 mb at Visakhapatnam at 1200 Z of 15th. It was of the order of 8 mb near the centre of the system on the 16th and 17th. Visakhapatnam reported the lowest pressure of 995·8 mb at 0900 Z of 15th. A well marked trough in the middle and upper tropospheric westerlies which remained practically stationary along 75°E north of 20°N from the 15th to 17th, contributed to the northward movement of the depression from Telangana to Uttar Pradesh.

This system could be classified in stage C on the 14th and stage X-1 on the 15th morning. The satellite picture showed extensive cloudiness towards north, reaching as far north as 700-800 km from the centre of system between the 15th and 17th.

9. *Severe cyclonic storm — 26-31 October 1971*

Under the influence of a low pressure wave from the east, a depression formed over southeast Bay of Bengal on the evening of 26th with its centre near 11°N, 91°E. Moving practically northwards, it intensified into a cyclonic storm by the 27th evening, and into a severe cyclonic storm by the morning of 28th, when it was centred near 16°N, 90°E. It continued to move practically northwards upto the 28th evening. Subsequently, it took a northwestward course and crossed the Orissa coast close to Paradeep by the early morning of the 30th. Thereafter, moving northwards initially and later eastwards across northeast Orissa, it weakened into a depression and moved across Bangla Desh. It later weakened into a low over Tripura.

This system caused widespread rain with scattered heavy to very heavy falls in north

Orissa and Gangetic West Bengal on the 30th and 31st. The notable amounts of rainfall were :

Date	Station	Rainfall (cm)	Date	Station	Rainfall (cm)
30	Balasore	10	31	Baripada	18
31	Midnapore	22		Sagar Island	17
	Contai	20		Sandheads	10
	Balasore	20		Calcutta	8

10 State raingauge stations in Balasore district and 6 in Cuttack district recorded 24 hour rainfalls ranging from 12 to 30 cm during the period 29 to 31 October.

Winds exceeding 40 kt (74 kmph) were reported by the Motor Vessel (*Dredger III*) and by a Japanese ship SS *Heiyo Maru* in Paradeep port between the 29th noon and 30th noon. The highest speed estimated by *Dredger III* in association with the storm was 160-180 kmph from the midnight of 29/30 October to 0900 IST of 30 October. Ships SS *Heiyo Maru* also recorded 170 kmph wind at midnight of 29-30 Oct. The observatory at Bhubaneshwar airfield recorded an average wind speed of about 65 kmph from about 0130 to 1130 IST on 30th, the maximum speed being about 100 kmph at 0430 IST. The wind speed at Bhadrak town was estimated by a touring officer to be about 150 kmph from the bending of an electric traction pole. The hourly observations of wind and pressure recorded by *Dredger III* are depicted in Fig. 6.

Fig. 6 shows that the centre of the cyclone passed over or very close to Paradeep between 0500 and 0600 IST of 30th. The lowest pressure as recorded by *Dredger III* at the centre of the system was 966 mb (the departure from the normal being about 45 mb). The eye of the cyclone was estimated to have been about 20 km in diameter with a ring of hurricane winds around it. Cuttack recorded a pressure defect of 20 mb at 0300 Z on the 30th. Other available reports from ships and observatories in and near the storm field are given in Table 5.

Tidal waves affected the coastal belt of Orissa from Paradeep to Balasore, the height of the waves increased from 2 to 6 metres as one proceeded northwards from Paradeep to Balasore. The maximum height of the sea waves as observed by *Dredger III* at Paradeep port was 1 to 2 metres between 2200 IST and 2400 IST on the 29th and between 0800 IST and 0900 IST on the 30th. From the flood water marks left by the tidal waves at different places the height

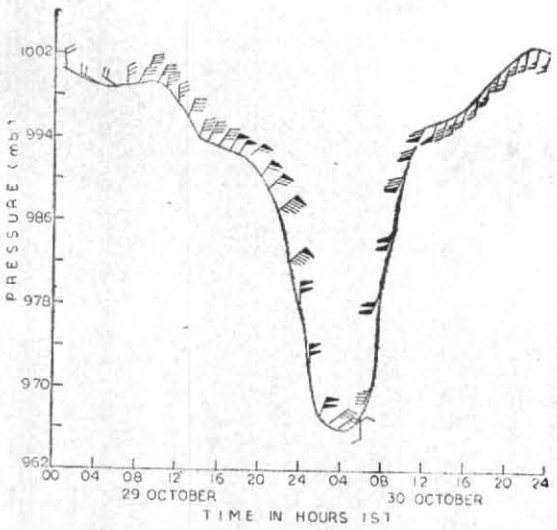

Fig. 6. Orissa Cyclone, October 1971

Hourly observations of wind and pressure recorded by Motor Vessel *Dredger III* at Paradeep Port

of the tidal waves were estimated to be about 2·5 metres at Bandpur village in Bhadrak, 3·5 metres at Basudevpur in Balasore district, 4 metres at Chandbali, 4·5 metres at Bansada in Chandbali block and in Jambu delta, 5 metres at Dhamra and 6 metres at Chandipur about 16 km southeast of Balasore. The saline water inundation due to the tidal waves extended inland to about 20 to 30 km. The maximum impact of the tidal waves was felt in the coastal stretch between the estuaries of the *Mahanadi* and the *Brahmani* and *Baitarni* rivers.

This cyclone caused very considerable damage to life and property in coastal Orissa, the worst affected being Jambu delta, Kendrapara, Mahakalpara, Rajnagar, Jajpur and Jagatsinghpur in Cuttack district and Chandbali, Basudevpur and Bansada areas in Balasore district. According to official estimates, about 10,000 people lost their lives, 50,000 heads of cattle perished and 8 lakhs houses were damaged. Rajnagar and Mahakalpara blocks of Kendrapara sub-division accounted for 9000 and odd deaths of which 5000 deaths occurred in Jambu delta alone. The loss to life and property was caused mainly by tidal waves associated with the cyclone.

This storm was in stage X-2 on the 28th and in stage X-4 on the 29th as seen from APT pictures. A large ragged eye was visible on the 29th. The maximum wind speed estimated from the satellite picture was about 100 kt. This gave an estimated pressure of 967 mb at the centre of the storm, which agreed well with the actual pressure of 966 mb recorded by *Dredger III* at Paradeep port.

TABLE 5

Date	Name of ship/ station	Location		Time (GMT)	Wind		Pressure (mb)
		Lat. (°N)	Long. (°E)		Direction	Speed (kt)	
27 Oct 71	Car Nicobar			0000	SSW	25	1008·0
	Coco Island			0300	SE	30	1007·8
	Port Blair			1200	SW	32	1006·8
	Coco Island			1200	S	20	1005·0
28 Oct 71	VWQF	17·4	85·2	0900	NNW	30	1004·4
	VWQF	19·0	86·0	2200	NNE	45	1001·4
29 Oct 71	VWQF	19·1	86·2	0300	NNW	47	1001·7
	VWQF	18·6	86·0	0600	NNW	45	1003·0
	VWQF	18·3	86·0	0800	NW	45	1000·9
	Paradeep			0300	N	23	1006·7
	VWQF	18·0	85·8	1000	NNW	40	1001·5
	Paradeep			1200	N	45	997·0
	Sandheads (21·43° N, 88°E)			1200	ENE	35	1004·8
	Heiyo Maru (at Paradeep Port)			1430	N	59	995·0
	Do.			1830	N	91	984·0
	Do.			2230	N	8	969·0
30 Oct 71	Heiyo Maru (at Paradeep Port)			0230	SE	64	986·8
	VWQF	19·3	86·3	0000	WSW	40	999·6
	Charbatia			0000	NNE	35	994·0
	Bhubaneshwar			0000	NNW	30	994·9
	Charbatia			0300	NW	30	992·0
	VWQF	19·6	86·3	0300	SW	47	1001·0
	Bhubaneshwar			0300	WNW	36	995·1
	JHID	19·5	86·4	0600	SSW	55	1004·0
31 Oct 71	Sandheads			0300	S	24	1007·5

TABLE 6

Date	Name of ship/ station	Location		Time (GMT)	Wind		Pressure (mb)
		Lat. (°N)	Long. (°E)		Direction	Speed (kt)	
4 Nov 71	ATCH	14·3	93·0	0107	NE	40	—
	ATCH (near Table Island)			0600	SE	37-40	1008·0
	Coco Island			1200	SE	40	1008·3
5 Nov 71	9 VKQ	18·0	90·6	0000	ESE	17	1007·5
	PCPH	15·5	85·5	0600	N	15	1006·9
	9 VKQ	20·2	89·0	1200	NE	30	1005·0
6 Nov 71	Sandheads (Upper Gasper)			0000	NNW	25	1004·0
	Akyab			0000	S	40	1000·6
	Sandheads			0300	NNW	25	1007·2
	Chittagong			0300	NE	30	991·2
	Akyab			0300	SSW	25	1007·1

An aircraft reconnaissance probe into the storm by aircraft SWAN-37 showed that the centre of the storm was at 16°19′N, 89°44′E at 0301 GMT of 28th.

10. *Severe cyclonic storm — 3-6 November 1971*

A low pressure area moved from the east into Andaman Sea on the 2nd. It concentrated into a depression on the evening of the 3rd near 10°N, 93°E. Moving northwestwards, it intensified into a cyclonic storm by the evening of 4th, when it was centred near 13·5°N, 90·0°E. Subsequently, moving northnorthwest and then north, it became severe by the evening of 5th near 18·5°N, 89°E. Thereafter recurving and moving fast northnortheastwards, it crossed the coast close to Chittagong on the forenoon of 6th. It rapidly weakened later and moved northeastwards as a depression towards Nagaland and weakened further into a low pressure area later.

This system caused widespread rain in the Bay Islands from the 3rd to 5th and widespread rain with isolated heavy falls in Nagaland, Assam and Meghalaya. Cherrapunji recorded 10 cm of rain and Kohima 9 cm on the 7th. Heavy rain caused floods in the Manipur rivers and some damage to crops in Nagaland and Manipur. Heavy damage to other property was also reported from Mizoram.

The reports available from some ships and observatories in the storm field are enumerated in Table 6.

Chittagong reported the largest pressure defect of about 23 mb at 0300 GMT of 6th. At 0600 GMT of the same day, the wind at 600 m and 900 m a.s.l. over Chittagong was W/50-55 kt. A trough in the middle and upper tropospheric westerlies moved eastwards from Uttar Pradesh and Madhya Pradesh to northeast India between the 4th and 6th. This could have influenced the recurvature of the storm northeastwards.

A reconnaissance report by aircraft 'SWAN-56' at 1430 GMT of 5th located the centre of the cyclone near 18°57′ N, 89°30′E. Another aircraft 'SWAN-55' located the storm centre at 0230 GMT of 6th near 21°26′ N, 91°26′ E.

The satellite pictures (not reproduced) showed that this system was in stage C+ on the 4th and in stage X-2 on 5th and 6th. The maximum wind speed estimated from the satellite pictures was about 60-65 kt. This gave an estimated pressure of 992 mb at the centre of the storm.

3. Arabian Sea

1. *Deep depression — 1-4 June 1971*

A depression formed in the west central Arabian Sea near 18·5°N, 61·5°E on the evening of 1st.

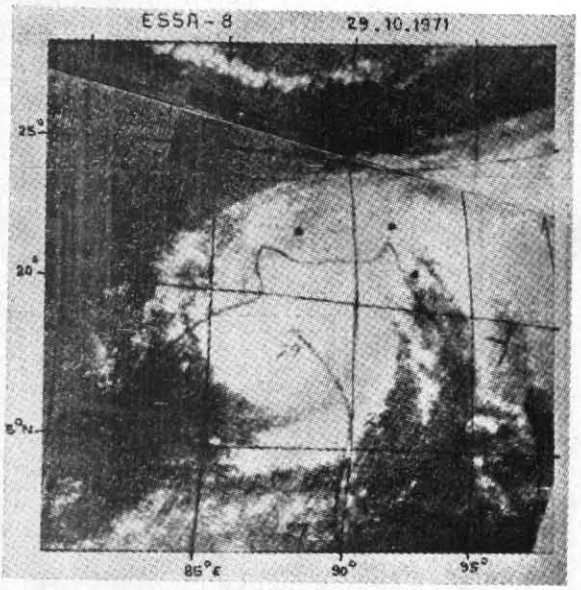

Fig. 7
ESSA-8 View of the severe cyclone at about 0400 Z of 29 October 1971. A large irregular eye may be seen at the centre of the cloud mass

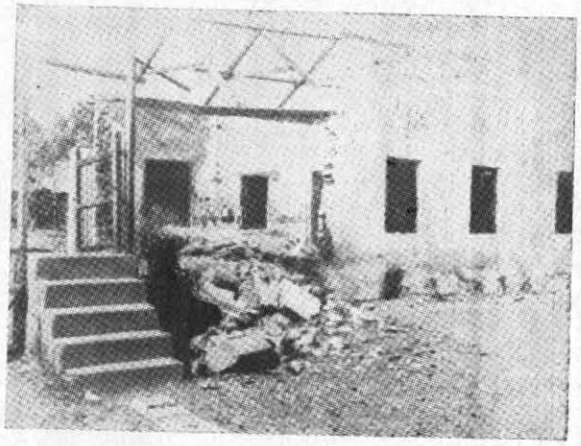

Fig. 8
High School building very badly damaged at Basudevpur (Balasore Dist.)

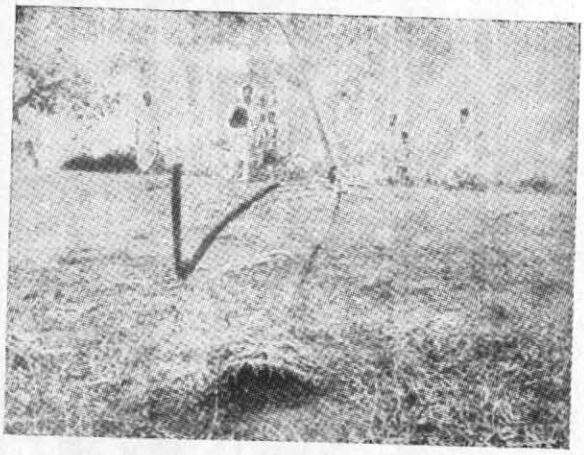

Fig. 9
Electric traction pole bent by the hurricane winds at Chandbali

TABLE 7

Date	Name of ship/ station	Location		Time (GMT)	Wind		Pressure (mb)
		Lat. (°N)	Long. (°E)		Direction	Speed (kt)	
2 Jun 71	JHBD	19·3	66·8	1200	W	25	997·0
	VWBK	18·6	65·3	1200	WSW	30	999·8
	PCUY	17·6	67·6	1200	WSW	50	998·2

TABLE 8

Date	Name of ship/ station	Location		Time (GMT)	Wind		Pressure (mb)
		Lat. (°N)	Long. (°E)		Direction	Speed (kt)	
27 Oct 71	Amini			1200	S	18	1007·5
	PCPY	14·1	67·7	1200	NNE	13	1009·0
28 Oct 71	PCPY	11·7	69·7	0600	S	14	1011·1
29 Oct 71	GGRA	15·0	67·0	0600	SE	15	1011·5
	ATDO	11·6	62·2	0900	W	20	1005·8
	ATDO	12·9	63·6	1700	SSE	18	1007·1
30 Oct 71	PTIB	13·2	55·5	1200	N	15	1009·7

TABLE 9

Date	Name of ship/ station	Location		Time (GMT)	Wind		Pressure (mb)
		Lat. (°N)	Long. (°E)		Direction	Speed (kt)	
14 Dec 71	PCYI	7·3	74·8	0600	ESE	22	1007·6
	FNIB	8·0	75·8	1200	ESE	25	—
15 Dec 71	GXBV	10·9	68·1	0000	NE	15	1007·5
	PHRD	9·9	71·5	0600	E	24	1008·2
21 Dec 71	PJOT	17·0	57·8	0600	NW	32	1013·0

Moving northeastwards it became deep on the morning of 3rd. Subsequently, it weakened into a trough of low pressure off the north Gujarat coast by the morning of 5th.

This system caused the advance of the monsoon into southeast Rajasthan by the 3rd. The monsoon was active in Konkan from the 3rd to 5th and in Gujarat State from the 4th to 6th. The principal amounts of rainfall were : Dahanu 14 cm on 3rd; Dahanu 10 cm, Surat 9 cm on 4th and Broach 8 cm on 5th.

The ships' reports as in Table 7 were available a little away from the depression field :

The largest pressure defect was 8·8 mb at Dwarka on the morning of 4th and 8·6 mb at Bhuj on the same evening.

The satellite pictures showed that this system was in stage C on the 3rd and 4 th.

2. *Severe cyclonic storm — 27 October to 1 November 1971*

A low pressure area developed over the Laccadive region on the 24th. It became well marked on the 25th. Moving westwards, it concentrated into a depression on the morning of 27th with its centre near 10·5°N, 70·5°E. Moving westnorthwestwards and later westwards, it intensified into a cyclonic storm by the evening of 29th near 13°N, 62°E. Subsequently moving westsouthwestwards, it became severe on the morning of 31st, when it was centred near 12°N, 55·5°E. Continuing to move westsouthwest it weakened into a depression over Somalia coast by the 1st of November.

This system caused good rainfall in Kerala and the Arabian Sea Islands between the 24th and 27th when it was a well marked low pressure area. Subsequently, it did not affect the weather in India. Palghat reported 10 cm of rain on the 24th. Trichur and Palghat recorded 8 cm of rain each on the 26th.

A few reports from ships and observatories near the field of the disturbance are given in Table 8.

The wind at 300 m. a.s.l. on the morning of 27th over Minicoy was WSW/25 kt and over Amini Divi was SE/20 kt. This system was tracked mainly with the help of satellite cloud pictures. This disturbance was in stage B or C upto the 29th morning and in stage X-2 on the 30th and 31st. The maximum wind speed estimated from the satellite cloud picture was about 60 kt. This gave an estimated pressure of about 992 mb at the centre of the system.

3. *Severe cyclonic storm — 14-21 December 1971*

A well-marked low pressure area that formed over Laccadive-Maldive region on the 13th, concentrated into a depression on the morning of 14th with its centre near 7°N, 72·5°E. Moving westnorthwestwards, it intensified into a cyclonic storm on the morning of the 16th near 9°N, 67°E. Subsequently, moving northwestwards, it became severe on the morning of 17th when it was centred near 12·5°N, 63°E. Continuing to move northwestwards, it gradually weakened into a depression close to coast of Arabia by the evening of the 19th. Then it skirted the coast and was caught up in a westerly trough. It moved eastwards and weakened into a low pressure area over north and adjoining central Arabian Sea by the evening of 21st and into a trough of low pressure off Gujarat coast by the 23rd.

This system did not cause any severe weather or damage in India. There was, however, widespread

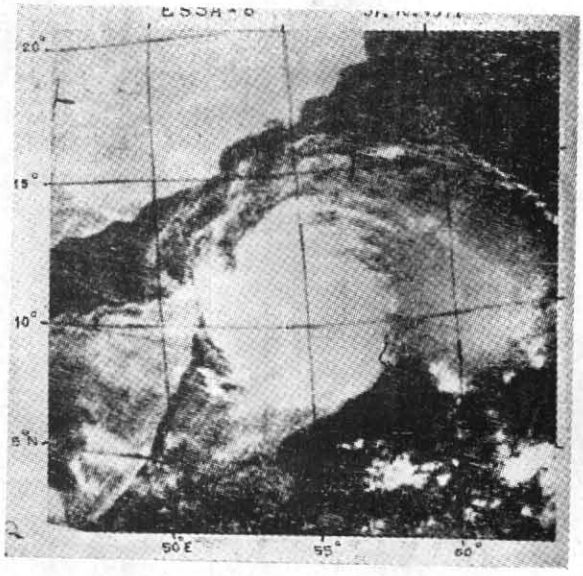

Fig. 10
ESSA-8 View of the cyclone in stage X-2 at 0600 Z of 31 October 1971

rain in the Arabian Sea Islands and Kerala on the 14th and 15th in association with this system. Minicoy recorded 16 cm of rain on the 14th.

The reports from ships available near the field of this disturbance are given in Table 9.

Minicoy and Amini Divi recorded a pressure defect of 4 mb on the morning of 14th. The wind in the lower troposphere was E/20-40 kt at Minicoy on the 14th and E/30-35 kt at Amini on the 15th.

This system was tracked solely with the help of satellite cloud pictures. The satellite pictures showed that this system was in stage C on the 15th and 16th and in stage X-2 from the 17th to 19th. The maximum wind speed estimated from the cloud pictures was about 70 kt. This gave an estimated pressure of 987mb at the centre of the storm.

4. Land depressions

1. *Depression — 26-29 July 1971*

A low pressure area formed over north Bay on the evening of 25th. Under the influence of a cyclonic circulation in the lower and middle troposphere, that moved westwards across Burma, a depression formed over Gangetic West Bengal and adjoining head Bay of Bengal on the morning of 26th with its centre near 22°N, 88·5°E.

Moving westnorthwestwards rather fast across north Madhya Pradesh and adjoining south Uttar Pradesh, it weakened into a low pressure area over east Rajasthan on the 30th and merged with the seasonal low by the next day.

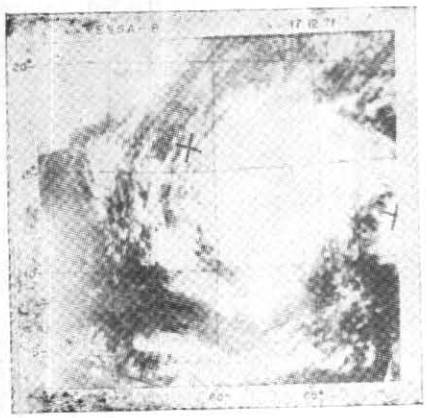

Fig. 11
ESSA-8 view of the severe cyclone at about 0600Z of 17 December 1971

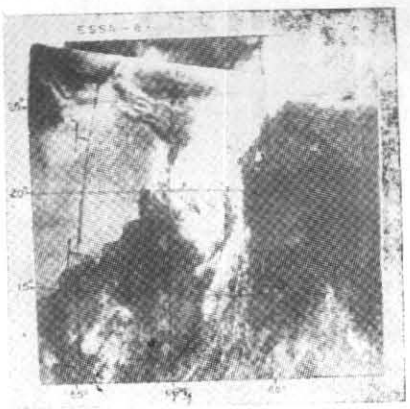

Fig. 12
ESSA-8 view of the cyclone in its dissipating stage, at about 0600Z on 21 December 1971. The cloud bend extending northeastwards shows the system caught in a westerly trough

Under the influence of this system, the monsoon was active in Gangetic West Bengal, Orissa and Bihar State on the 26th and 27th, in east Madhya Pradesh on the 27th and 28th, in west Madhya Pradesh on the 29th and in Rajasthan on the 29th and 30th. Heavy rains in east Rajasthan caused some deaths in Kota district in addition to heavy losses to public property and disruption of road traffic between Ajmer and Jaipur. The notable rainfall amounts were —

Date	Station	Rainfall (cm)	Date	Station	Rainfall (cm)
26	Jamshedpur AP	23	29	Sawai Madhopur	13
	Sandheads	12		Banswara	13
27	Jharsuguda	12		Hoshangabad	12
28	Kota City	20		Rajgarh	12
	Kota Airport	19	30	Jalore	17
	Ambikapur	12		Nimach	12
	Umaria	11		Erinpura	12

The surface wind at Sandheads was SW/35-40 kt and at Sagar Island W/SW 20 kt at 0300 and 1200 Z of 26th and the pressure defect near the centre of the depression was 6 to 7 mb on the 26th and 27th.

2. *Depression — 30 August to 1 September 1971*

A well marked low pressure area formed over central Madhya Pradesh on the 28 August and persisted there on the 29th. It concentrated into a depression on the morning of the 30th with its centre between Umaria and Pendra. Moving initially northwest and later northnorthwest, it weakened into a low pressure area over southwest Uttar Pradesh by 2 September.

This system caused widespread rain with isolated heavy falls in Vidarbha on the 30th, in Madhya Pradesh on 30 and 31 August and in Uttar Pradesh on the 1st and 2nd September. The notable amounts of rainfall were —

Date	Station	Rainfall (cm)	Date	Station	Rainfall (cm)
30Aug	Gondia	23	1 Sep	Rewa	11
	Jashpurnagar	15	2 Sep	Shahjahanpur	24
	Nagpur	12		Bareilly	23
31Aug	Umaria	13		Sitapur	22
	Pendra	13		Kheri, Nainital	17
1 Sep	Faizabad	17		Bahraich	14
	Allahabad	13		Lucknow (Amausi)	12
	Sultanpur	12			

The flood situation in Uttar Pradesh caused by a low which moved across Uttar Pradesh in the first week of August and by the depression in the second week of August, further worsened. The districts of Lucknow, Jaunpur, Sultanpur and Azamgarh in Uttar Pradesh were very seriously hit by the floods. A large number of houses collapsed in Uttar Pradesh causing some loss of life.