MAUSAM, 49, 3 (July 1998), 279-284

551.515.1 (267.6)"1997"

Cyclones and depressions over Indian seas and neighbourhood during 1997*

1. Chief features

During the year 1997, one severe cyclonic storm with a core of hurricane winds, one severe cyclonic storm, one cyclonic storm, five deep depressions and one depression formed over north Indian seas. Out of these, only one deep depression formed over the Arabian Sea and rest of the systems originated in the Bay of Bengal. Seasonwise, a severe cyclonic storm with a core of hurricane winds formed in May, in pre-monsoon season, four deep depressions, one depression and a severe cyclonic storm formed during the monsoon season and one cyclonic storm and a deep depression formed in the post-monsoon season. None of the three storms crossed Indian coast. All the deep depressions and the depression which formed in the Bay of Bengal originated over head Bay of Bengal.

The tracks of the systems are given in Fig.1. Their brief history and monthly distribution are given in Tables 1 & 2 respectively.

2. Pre-monsoon season (March-May)

2.1. *Severe cyclonic storm with a core of hurricane winds (15-20 May 1997)*

On 15 May, a depression formed over south Bay of Bengal and adjoining south Andaman Sea and was centred at 0600 UTC near 6.5° N/90.5°E. Moving in a northerly direction, it intensified into a deep depression at 1200 UTC near 7.5° N/90.5°E. Moving slowly in the same direction, it intensified into a cyclonic storm near 9.0° N/90.5° E at 0300 UTC on 16 May. Maintaining its northerly course, it further intensified into a severe cyclonic storm at 0900 UTC of 17th near 13.5°N/91.5°E. At 0300 UTC of 18 May, it intensified into a severe cyclonic storm with a core of hurricane winds, near 16.5° N/90.5°E. System, then took a northnortheasterly course and crossed Bangladesh coast near Sitakundu at 1430 UTC of 19 May. It then, rapidly weakened into a land depression over Mizoram and further weakened into a low pressure area by 0000 UTC of 20 May.

(i) INSAT cloud features and other observations

The system was tracked mainly with the help of INSAT imagery from 150600 UTC to 191000 UTC. At 191200 UTC, coastal observations of Bangladesh were most crucial in fixing the centre. Maximum intensity of the system derived from INSAT imagery was T 5.0 from 190000 to 191000 UTC. Fig.2 is the satellite cloud photograph of Bay cyclone at 0000 UTC of 19 May 1997. As the system was away from the range of CDR Calcutta, centre of the system could not be fixed. However, the centre was estimated with the spiral fitments from 190600 UTC to 191000 UTC and these centres agreed very well with the INSAT imagery centres. Observations from Khepupara (Bangladesh) were very crucial and helped in fixing the centre, time and place of crossing the coast.

(ii) Pressure & wind

Based on the observations received from Bangladesh Meteorological Department, the lowest surface pressure recorded was 965 hPa by Khepupara observatory at 191200 UTC. The maximum surface wind recorded was 126 kt at Sitakundu at 190900 UTC.

(iii) Weather and damages

The system did not cause any damage over India except heavy rainfall in Andaman & Nicobar Islands on 17 and 18 May. However, the system caused widespread damage in Bangladesh. According to reports received from Bangladesh Meteorological Department, 155 people were killed, 1,12,160 houses fully damaged, road and other communications got badly affected.

3. Monsoon season (June-September)

Four deep depressions, one depression and a severe cyclonic storm formed during the monsoon season 1997.

3.1. *Deep depression over the Bay of Bengal (26-30 June 1997)*

A low pressure area formed over north Bay of Bengal and adjoining parts of Gangetic West Bengal and of Bangladesh on 23 and became well marked on 24 over northwest Bay of Bengal off West Bengal coast. It concentrated into a depression over the same area on 26 morning when it was centred near 21.0° N/89.5° E. Moving in a northwesterly direction, it intensified into a deep depression and crossed north Orissa-south West Bengal coast on 27. After crossing the coast, it moved in a westnorthwesterly direction, initially and then in northerly direction and weakened into a low pressure area on 30 over northern parts of Bihar Plains and adjoining parts of east Uttar Pradesh. It became less marked on 1 July over the same area.

The maximum intensity of the system was T. 1.0 on Dvorak's scale from 261200 UTC to 271200 UTC.

(i) Rainfall/Damages

Widespread rain with heavy to very heavy falls at one or two places occurred over West Bengal, Orissa and Bihar. Due to heavy rains and floods normal life was disrupted and many highways in West Bengal were blocked. 500 houses were washed away and more than 40 thousand people rendered homeless due to breaches in the embankments.

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TABLE 1

Brief history of cyclonic storms and depressions over the Indian seas and neighbourhood during 1997

S.No.	Type of System	Life period	Point of crossing the coast	Estimated central pressure (hPa)	Recorded max. wind	Highest "T"No. (Estimated)
1.	SCS(H)	15-20 May	Bangladesh coast near Sitakundu	965	126 kt at Sitakundu at 0900 UTC of 19	5.0
2.	DD	26-30 June	North Orissa-south West Bengal coast near Digha	985	-	1.0
3.	DD	29 Jul-3 Aug	Orissa coast near Chandbali	-	-	1.5
4.	DD	4-9 Aug	West Bengal coast near Sagar Island	-	-	-
5.	DD	20-28 Aug	North Orissa coast between Paradip and Chandbali	-	-	2.0
6.	D	28-30 Aug	Orissa coast between Paradip and Puri	-	-	-
7.	SCS	23-27 Sept	Bangladesh coast	984	35 kt at 1200 UTC of 24 by ship ATMS	3.0
8.	CS	3-9 Nov	Dissipated over the Sea	1002	-	2.5
9.	DD	10-13 Nov	-Do-	-	-	2.0

D - Depression, DD - Deep depression, CS - Cyclonic storm, SCS - Severe cyclonic storm, SCH(H) - SCH with a core of hurricane winds

TABLE 2

Storms/depressions stastistics 1997

System	Winter	Pre-monsoon			Monsoon				Post-Monsoon			
	Jan – Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Over Bay of Bengal												
Depression	-	-	-	-	1	1	3	-	-	-	-	5
Cyclonic Storm	-	-	-	-	-	-	-	-	-	1	-	1
Severe Cyclonic Storm	-	-	-	-	-	-	-	1	-	-	-	1
SCH(H)	-	-	-	1	-	-	-	-	-	-	-	1
Total	-	-	-	1	1	1	3	1	-	1	-	8
Over land												
Depression	-	-	-	-	-	-	-	-	-	-	-	-
Over Arabian Sea												
Depression	-	-	-	-	-	-	-	-	-	1	-	1
Cyclonic Storm	-	-	-	-	-	-	-	-	-	-	-	-
Severe Cyclonic Storm	-	-	-	-	-	-	-	-	-	-	-	-
SCH(H)	-	-	-	-	-	-	-	-	-	-	-	-
Total	-	-	-	-	-	-	-	-	-	1	-	1

3.2. *Deep depression over the Bay of Bengal (29 July to 3 August 1997)*

A low pressure area formed in the evening of 28 July over north Bay. It concentrated into a depression on 29 morning near 21.0°N/89.0°E, about 220 kms eastsoutheast of Balasore. Moving in a westerly direction, it intensified into a deep depression on 30 morning near 21.0° N/87.5° E, about 50 km southeast of Balasore. It crossed north Orissa coast near Chandbali in the evening of 30. After crossing the coast, it moved in a westnorthwesterly direction and weakened into a depression on 31 evening over Bihar Plateau. It further weakened into a well marked low pressure area on 2 August over Haryana and neighbourhood.

Maximum intensity of the system was T 1.5 on Dvorak's scale from 291800 to 300300 UTC.

(*i*) *Rainfall/Damages*

Widespread rain with heavy falls at one or two places occurred over Uttar Pradesh, Haryana and Punjab. However, the system did not cause any damage.

3.3. *Deep depression over Bay of Bengal (4-9 August)*

A well-marked low pressure area formed over north Bay of Bengal on 4 and concentrated into a depression on the same evening near 21.5° N/89.0°E, about 150 kms southsoutheast of Calcutta. Moving in a northwesterly direction, it intensified into a deep depression on 5 morning and crossed West Bengal coast slightly east of Sagar Islands around 1430 hrs IST of 5. After crossing the coast, it moved in a northwesterly direction and lay centered at about 50 km southwest of Daltonganj on 6 morning and over northeast Madhya pradesh (close to Satna) on the same evening. On 7 morning, it weakened into a depression over northern parts of west Madhya Pradesh close to Shivpuri. It moved in a westnorthwesterly direction and further weakened into a well-marked low pressure area on 8 morning over west Rajasthan.

(*i*) *Rainfall/Damages*

The system caused widespread rain in West Bengal, Orissa, Madhya Pradesh and east Rajasthan. It did not cause any damage.

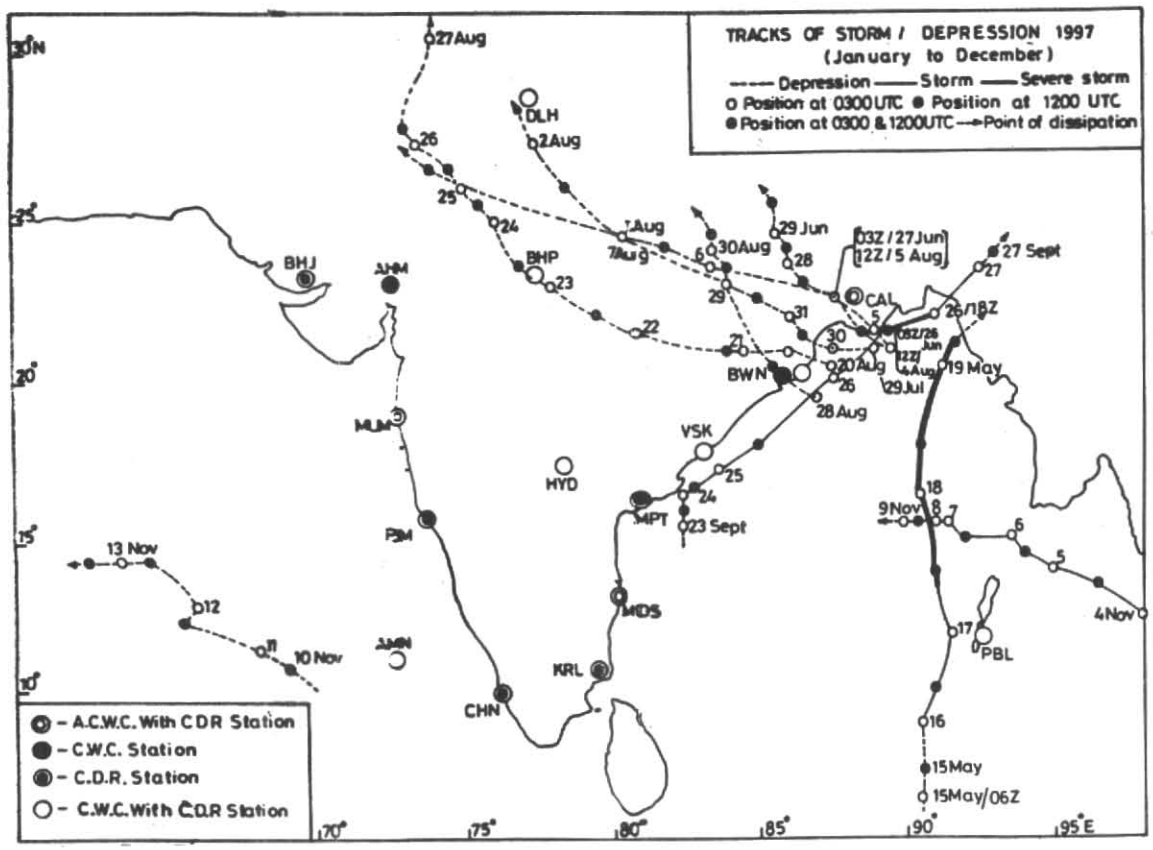

Fig.1. Tracks of cyclonic storms/depressions during 1997

3.4. *Deep depression over the Bay of Bengal (20-28 August 1997)*

A low pressure area formed over northwest Bay of Bengal and adjoining parts of north Orissa-West Bengal coast on 17. It became well-marked on 18 over the same region. On 20 morning, it concentrated into a depression, probably deep, near 20.5° N/87.5° E, about 80 km east-southeast of Chandbali. Moving in a westnorthwesterly direction, it crossed north Orissa coast between Paradip and Chandbali in the afternoon of 20 as a deep depression. It lay centered over Orissa near 21.0° N/84.5° E, about 180 kms northwest of Bhubaneswar on 21 morning and over east Madhya Pradesh, very close to Raipur (22.0° N/81.0°E) on 22 morning. Continuing its westnorthwesterly movement, it lay centered near 23.0° N/78.0°E, very close to Hoshangabad on 23 morning and near 25.0° N/76.0°E, close to Kota in east Rajasthan on 24 morning. It moved in a northnorthwesterly direction and was centered near 26.0° N/75.0°E, about 60 km southeast of Jaipur on 25 morning. It lay centered near 27.0° N/74.0°E, about 150 kms southeast of Bikaner on the evening of 26. It then recurved and moved in a northnortheasterly direction. It weakened into a depression and lay centred near 30.5° N/74.0°E, about 50 kms south of Ganganagar on 27 morning. It further weakened into a well-marked low pressure area over north Pakistan and neighbourhood in the same evening and merged with the seasonal trough on 28.

The maximum intensity of the system was T 2.0 at 200600 UTC on Dvorak's scale.

(*i*) *Rainfall/Damages*

The system caused fairly widespread rain over Gangetic West Bengal, Orissa, Madhya Pradesh and Rajasthan. 12 people died due to heavy rains and floods in Orissa.

3.5. *Depression over the Bay of Bengal (28-30 August 1997)*

A low pressure area formed over north Andaman Sea on 25 and concentrated into a depression on 28 morning near 19.5° N/87.0° E, about 120 kms southeast of Paradip. Moving in westnorthwesterly direction, it crossed Orissa coast between Paradip and Puri by noon of 28. It continued to move in a westnorthwesterly direction and weakened into a well-marked low pressure area on 30 evening over Bihar and adjoining parts of east Uttar Pradesh and northeast Madhya Pradesh and further weakened in a low pressure area on 31 August.

(*i*) *Rainfall/Damages*

Widespread rain with heavy to very heavy falls at one or two places occurred over Orissa, Gangetic West Bengal, Bihar and parts of east U.P.

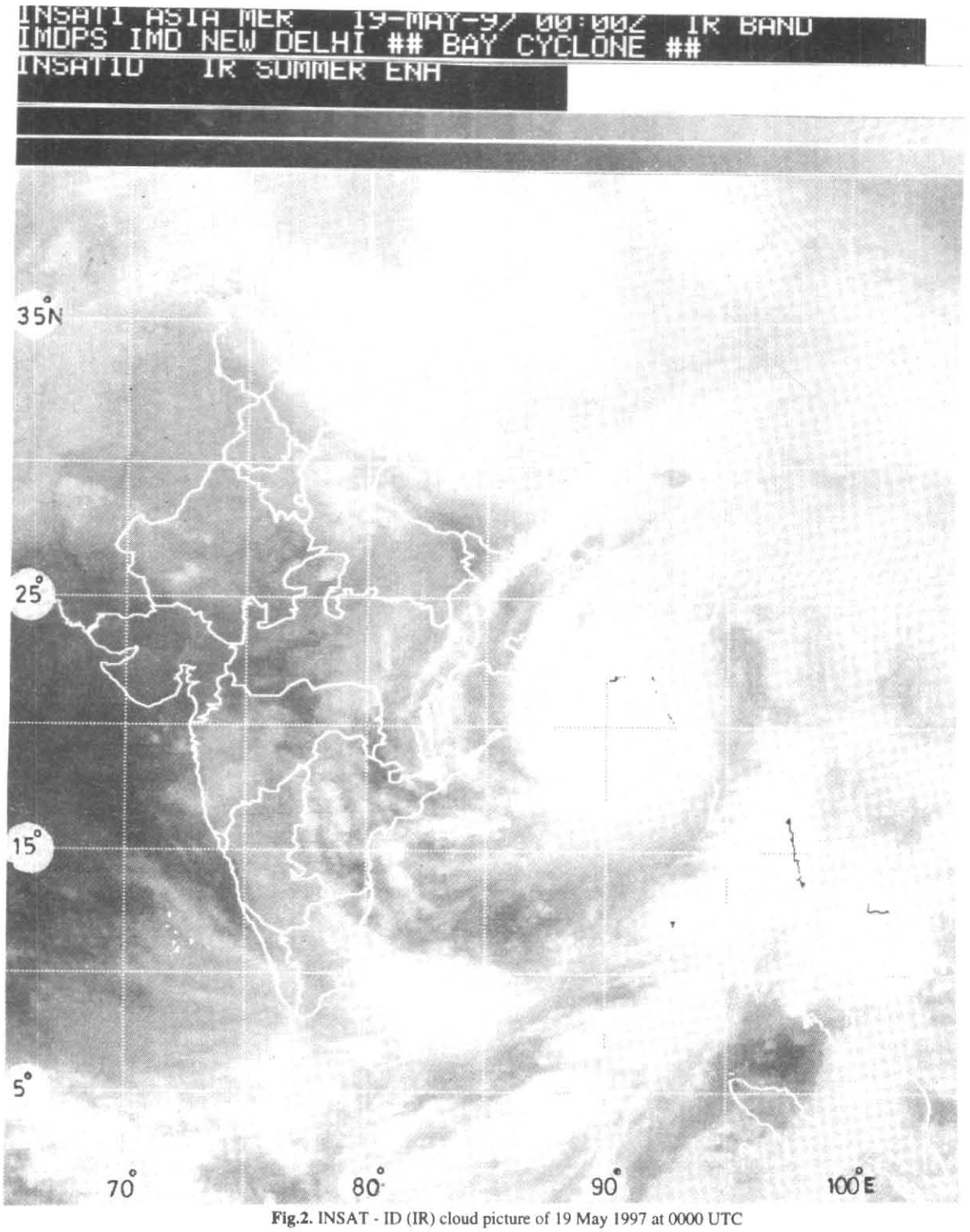

Fig.2. INSAT - ID (IR) cloud picture of 19 May 1997 at 0000 UTC

3.6. *Severe Cyclonic storm over the Bay of Bengal (23-27 September 1997)*

A well-marked low pressure area formed over west-central Bay of Bengal off Andhra Pradesh coast on 22 evening. On 23, it concentrated into a depression near 15.5° N/82.5°E. Moving in a northerly direction, it intensified into a deep depression near 16.0° N/82.5° E, about 75 km south-southeast of Kakinada on the same evening. It then, intensified into a cyclonic storm near 16.7°N/82.9° E on 24 evening and into a severe cyclonic storm near 22.0° N/91.0° E at 261800 UTC. Skirting the east coast, it crossed Bangladesh coast near Hatia at 2100 UTC of 26 and weakened into a cyclonic storm near 23.5° N/92.5° E on 27 morning. It further weakened into a depression near 24.0° N/93.0°E on

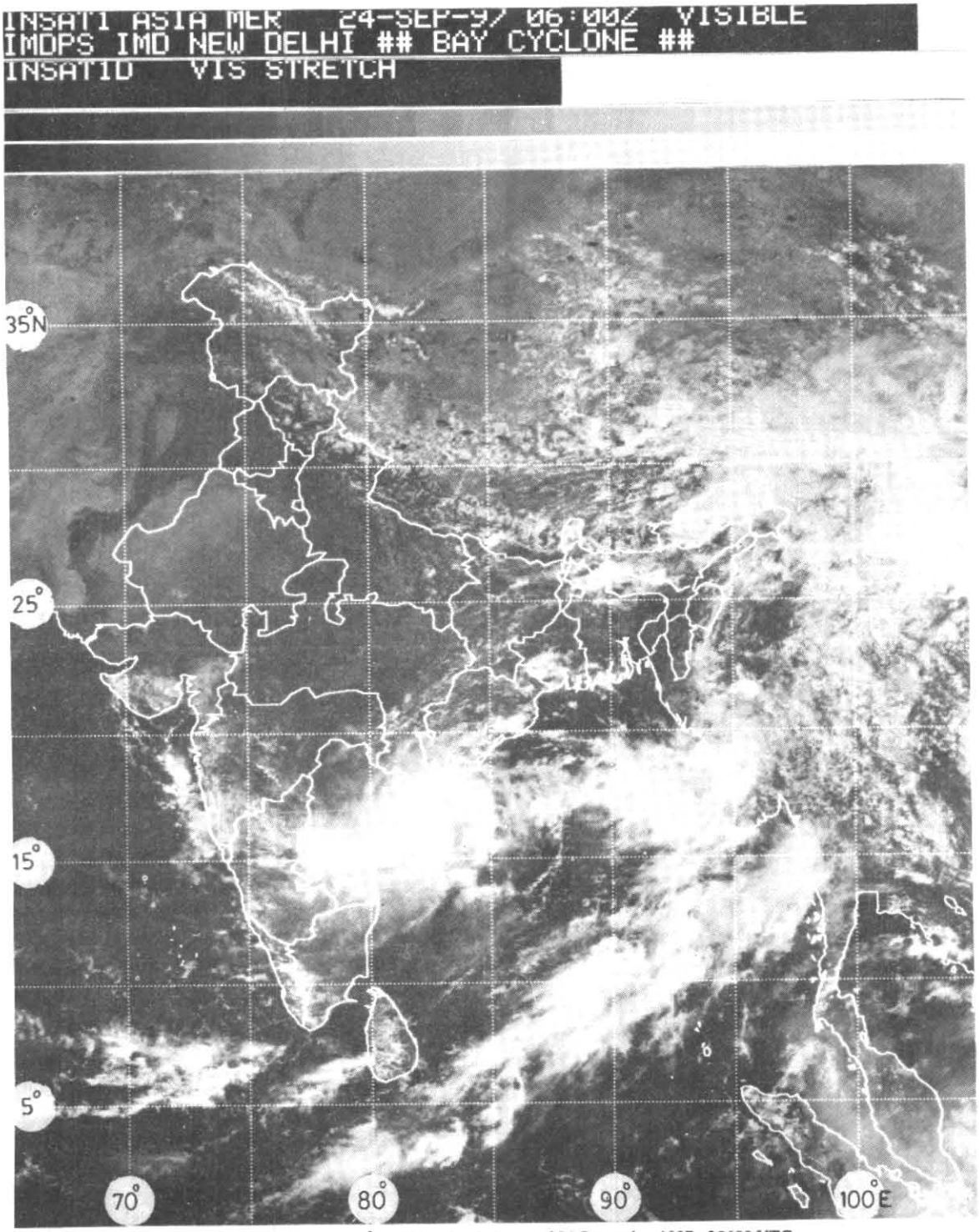

Fig.3. INSAT - 1D (visible) cloud picture of 24 September 1997 of 0600 UTC

the same evening. Finally, it moved in northeasterly direction and weakened further.

(*i*) *INSAT/Radar observations*

The system was tracked mainly with the help of INSAT imageries and two crucial ships' observations, till it was observed by CDR Machilipatnam at 240300 UTC. Subsequently, the coastal observations; INSAT imageries; CDR Machilipatnam Visakhapatnam and Paradip observations helped in fixing the centre and intensity of the system. CDR Paradip reported an "eye" of the system from 260600 to 260900 UTC. Fig.3 is the satellite cloud photograph of Bay cyclone at 0600 UTC of 24 September 1997. The peak intensity of

occasions. Observations from Khepupara radar (Bangladesh) helped in finding the time and place of crossing the coast.

(ii) Other features

Lowest estimated central pressure was 984 hPa at 261800 UTC. The system skirted the east coast right from south Andhra Pradesh coast to West Bengal coast and crossed ultimately the Bangladesh coast. Initially, the system moved with a speed of 6 kmph from 240300 UTC to 250300 UTC and 21 kmph from 250300 UTC to 260300 UTC and then with the speed 33 kmph from 260300 UTC to 261800 UTC.

A ship ATMS reported pressure of 998.1 hPa and wind 190°/35kt when it was very close to the centre of the system at 1200 UTC of 24 September.

(iii) Weather and damages caused

The system did not cause any damage. However, the coastal Andhra Pradesh from Machilipatnam to Visakhapatnam experienced strong wind and also received heavy rainfall. Principal amount of rainfall were as follows:

Station	*District*	*Rainfall (cm)*
	24 September 1997	
Bapatla	Guntur	21
Avanigadda	Krishna	20
Tenali	Guntur	15
Amlapuram	East Godavari	14
Machilipatnam	Krishna	13
	25 September 1997	
Kakinada	East Godavari	40
Koderu	West Godavari	18
Tuni	East Godavari	17
Peddapuram	East Godavari	17
Rampachodavaram	East Godavari	16

From the preliminary reports of Government of Andhra Pradesh, following damages were caused:

1.	No. of deaths	32	(Guntur 14, Visakhapatnam 2, East Godavari 7, West Godavari 1, Krishna and Prakasam 4 each)
2.	Breaches to tanks	39	
3.	Houses damaged	1470	
4.	Cattle deaths	326	

4. Post-monsoon season (October-December)

4.1. *Cyclonic storm over the Bay of Bengal (3-9 November 1997)*

The typhoon LINDA which was over Gulf of Thailand moved westwards and emerged into north Andaman Sea as a cyclonic storm near 12.5° N/98.0°E at 0300 UTC of 4. Moving in a westnorthwesterly direction it weakened into a deep depression at 0300 UTC of 9 near 15.5° N/90.0°E. It moved in a westerly direction and further weakened into a depression in the afternoon of 9. The system weakened rapidly into a well-marked low pressure area over the east-central Bay of Bengal by the evening of 9 September.

(i) INSAT/Radar observations

The system was tracked by INSAT imagery all through. No ship's or coastal observations were available. INSAT imagery indicated an increase in the intensity of the system from T 2.0 to T 2.5 at 050500 UTC and on weakening of the system at 060400 UTC to T 2.0. Subsequently the system once again intensified to T 2.5 at 061800 UTC. The system showed weakening of the system to T 2.0 at 080300 UTC and to T 1.5 at 090300 UTC. The system dissipated over east-central Bay of Bengal.

The system being far away from the east coast, could not be tracked by any radar.

(ii) Other Features

The system had lowest estimated central pressure (ECP) of 1002.0 hPa at 051200 UTC and 060300 UTC.

The speed of the system was 15 kmph from 040300 UTC to 050300 UTC and 10 kmph from 050300 UTC to 061200 UTC. Subsequently, the system moved very slow (less than 3 kmph).

(iii) Weather and damage caused

Northern parts of Andaman & Nicobar Islands received fairly widespread rainfall from 4 to 7 November. The system did not cause any damage. Principal amounts of rainfall were:

6 November - Port Blair	7.7 cm
8 November - Long Islands	7.2 cm
9 November - Long Islands	7.0 cm
Car Nicobar	7.1 cm

4.2. *Deep depression over the Arabian Sea (10-13 November 1997)*

A well-marked low pressure formed over Kerala and adjoining parts of Tamil Nadu on 8. It moved westwards across Kerala and Lakshadweep area and lay centered over southeast Arabian Sea with its central region near 11.0°N/69.0° E on 10. It concentrated into a deep depression on 11 and lay centred at 110300 UTC within half a degree of 11.5° N/68.0°E. On 12, it lay as a deep depression centred at 120300 UTC near 13.0° N/66.0°E. The deep depression over east-central Arabian Sea weakened into a depression on 13 and lay centred at 130900 UTC near 14.5° N/62.5°E. It further weakened into a low pressure area.

The maximum intensity of the system was T 2.0 from 120500 UTC to 130300 UTC.

Since the system dissipated over the Sea area far away from the Indian coast and it did not cause any adverse weather over the country.