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SOME ASPECTS OF ORISSA SUPER CYLONE OF OCTOBER 1999

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ABSTRACT : October 29, 1999 will be remembered in the history of Orissa as Black Friday. Millions of people became homeless and over 20000 died in the century's worst cyclone that ripped through coastal Orissa. Super cyclone with winds 260 to 300 km/hr hit the 150 km coast of Orissa with a storm surge that created the Bay of Bengal water level 25 feet higher than normal. Most of the tree cover on the coast and closer to half a million livestock were lost. It was the nastiest natural catastrophe in the history of Orissa and one of the worst in India. This paper summarizes the details of this cyclone and its effects.

INTRODUCTION

Cyclone is the name used for strong tropical storms in the Indian Ocean, Pakistan, Bangaladesh and Burma. These storms form in the Bay of Bengal or the Arabian Sea and move in west or northwesterly direction. Like all other tropical systems, cyclones form in warm water and between 5 and 20 degrees latitude on either side of the equator. A fully developed cyclone is spread 150-180 km across and 10 to 15 km high. It spirals around a center with wind speed of 160 km/hr. Many cyclonic storms affect east coast of India every year and cause a huge loss of life property. Recent studies (Subbarmayya and Subba Rao, 1981; Mooley, 1980; Pant and Rupa Kumar, 1997) of cyclonic activity in the Bay of Bengal over the hundred year period reveal that the majority of the intense tropical cyclones form over the Bay of Bengal in pre-monsoon and post-monsoon phases with May, October, and November being the months with greatest frequency. O'Hare (1997) maintains that these high non-monsoon period cyclone are the result of weak upper air easterly circulation in Spring, Autumn and Winter. Mooley (1980, 81) using time series data for the period 1877 - 1976 has shown that the frequency of severe cyclonic storms in the Bay of Bengal increased throughout the period with the highest decadal frequency of storm action during 1967-76. A 1976 to 1995 update of this time series by O'Hare (1996) indicates that storm frequencies over the Bay have declined in recent decades. Studies of the National Climatic Data Centre (NCDC 1996) storm trajectories in the Bay of Bengal for the last two decades highlight the Andhra Coast as being particularly susceptible to cyclonic impact. Like Andhra and Tamil Nadu, Orissa also experiences full fury of cyclonic storms and disturbances. The state of Orissa has broader costal plains which are vulnerable to frequent severe cyclonic storms formed in the Bay of Bengal. Analysing the 100 years cyclonic storms affecting the Orissa state Patel and Krishnakumar (2001) have found that most of the cyclonic storms and depressions affected the state during May to

November. The potential of damage through high wind, high tidal surges and heavy rains associated with cyclonic storm make it one of the worst weather related natural hazards. De and Joshi (1998) have presented an overview of the hazards associated with tropical cyclone in North Indian Ocean.

For prediction of movement and intensification of tropical cyclones, it is required to study the genesis of the storm. Raghvendra (1973) and Mooley (1980), have considered several aspects of storm genesis in the Bay of Bengal. While Ganeshan (1994) has calculated the probability of a latitude strip being affected by cyclonic system. For the last three years the coverage and quality of satellite derived wind over the Indian Ocean region have improved considerably with the operation of Meteosat-5. This satellite has been equipped with water vapour channels and it is possible to get information on good quality water vapour winds (WVW) at middle to upper atmospheric levels. These WVW's have proved to be of immense use for a number of applications particularly by the Numerical Weather Prediction Centers world over. Velden Et al, (1992, 1997) have shown that by including satellite derived winds into the tropical cyclone analysis, the error of tract forecasts can be reduced.

The Dvorak analysis is generally accepted means of monitoring tropical cyclone formation and intensity changes using satellite imagery. This technique provides estimates of the current intensity (CI) of the storm from the satellite picture. If infrared satellite imagery is available for eye patterns, then the scheme utilizes the difference between the temperature of the warm eye and the surrounding cold could types. The larger the differences the more intense the T-number and a 'current intensity', CI number. Using the empirical relationship between CI and Maximum Mean wind and pressure difference (ΔP) between centre and the periphery of the storm a table is presented for various intensities of storm.

Table 1

The relationship between T- number, wind speed and pressure difference (P)

Type of Distur-banc	CI/T number Intensity Scale	2 Wind speed in knots/hr	ΔP in hPa Indian seas
Low pressure area	1.5	< 17	--
Depression	2.0	17-27	4.5
Deep depression	2.5	28-33	6.1
Cyclonic storm	3.0	34-47	10
Severe cyclonic storm	3.5	48-63	15
Very severe cyclonic storm	4.0-6.0	64-119	20.9-65.6
Super Cyclone	6.5-8.0	> 120	80.9-143.3

Note: CI and T numbers are the same. 1 hPa = 1mb

SUPER CYCLONIC STORM OVER THE BAY OF BENGAL (25-31 OCTOBER, 1999)

Contrary to common knowledge, there were actually two devastating cyclones in late 1999 in India. The first hit the coastal states of Andhra Pradesh, Orissa and west Orissa coast on October 29. The latter was the most intense cyclone in last 114 years for the state of Orissa. This cyclone stewed for several days in the Bay of Bengal building strength before moving northwestward, where it came ashore perpendicular to NE-SW trending coastline. Thus, the full fury of the storm winds and its

accompanying powerful tidal serges were unleashed upon Orissa's coast. This cyclone caused unprecedented devastation owing combination of factors, the most important of them being the nature of the cyclone itself. It was a very high intensity cyclone (T-7 in what is called the Dvorak Scale of T-1 to T-8 in meteorological parlance). Another crucial and unique feature of this cyclone was that it remain fairly high with associated winds of over 100 km/hr in it's vortex. This is in fact an unusual feature because normally cyclonic systems weaken and die out in the absence of energy inflow through moisture laden surface wind, as they move over land. As the cyclone system was anchored near the coat, surface winds continued to feed moisture into it, resulting in heavy rainfall all across the sweep of the cyclonic circulation, extending hundreds of kilometers. It was battered for more than two day by its fierce winds and intense rains. It also produced huge storm surges (30 ft above mean sea level) and catastrophic floods, causing severe damage in 12 districts affecting a population of about 12 million. The real meteorological cause of the cyclone remaining stationary for two days over land is not yet known and is a subject for scientific investigation.

SYNOPTIC HISTORY AND TRACK OF SUPER CYCLONE

The cyclone started as an initial disturbance on 24th October near the gulf of Thailand and emerged in north Andeman Sea as a well marked low-pressure area on the morning of the 25th October. Moving westward, it concentrated into a depression over Tenasserim coast and neighborhood in the evening of the same day. Meteosat-5 derived winds at 200 hPa levels on 25th October, (1200 UTC[1]) clearly bring out the steering flow responsible for this movement (Bhatia, et al 2000). It further moved Northwestward and intensified into a deep depression by midnight. Subsequently, the system intensified further and developed into a cyclonic storm on October 26th morning when it was about 350 km from Port Blair. The system had been moving northwestwards under the influence of steering flow caused by subtropical ridge to its northeast at 200 hPa level. By 0300 UTC of 27th October, the system intensified to the stage of severe cyclonic storm and came under the influence of 200 hPa ridge axis providing upper level outflow favorable for its further development.

Moving in northwest direction, the storm began to intensify more rapidly into very severe cyclonic storm as the 27th progressed. By 1200 UTC winds had reached 166 km/hr with the centre about 630 km south-southwest of Chittagon, Bangaladesh. On October 28th, the cyclone continued its northwestward movement and intensified into a super cyclonic storm as the wind speed increased to over 260 km/hour as it approached Orissa coast. Dvorak T-number had reached T 6.5 / T7.0 by 1200 UTC of 28th. Although the cyclone hung over the sea near the coast a little longer than excepted, it crossed Paradip on October 29th between 10 am and 12 noon and wakened into very severe cyclonic storm with the centure about 30 km northeast of Bhubaneshwar in the evening of the same day. The lowest estimated central pressure of the storm was 920 hPa , reported by Area Cyclone Warning Center (ACWC), Chennai. The well formed cyclone eye was about 39 km across as depicted by satellite picture at 1730 hrs IST of 20th October. Table 2 lists the best track positions and intensities of this super cyclone at different intervals. Figure 1 is the display of this track. The Cyclone made landfall near Paradip

[1]UTC-Universal Time Coordinates. It is equivalent to Greenwich Mean Time (GMT).

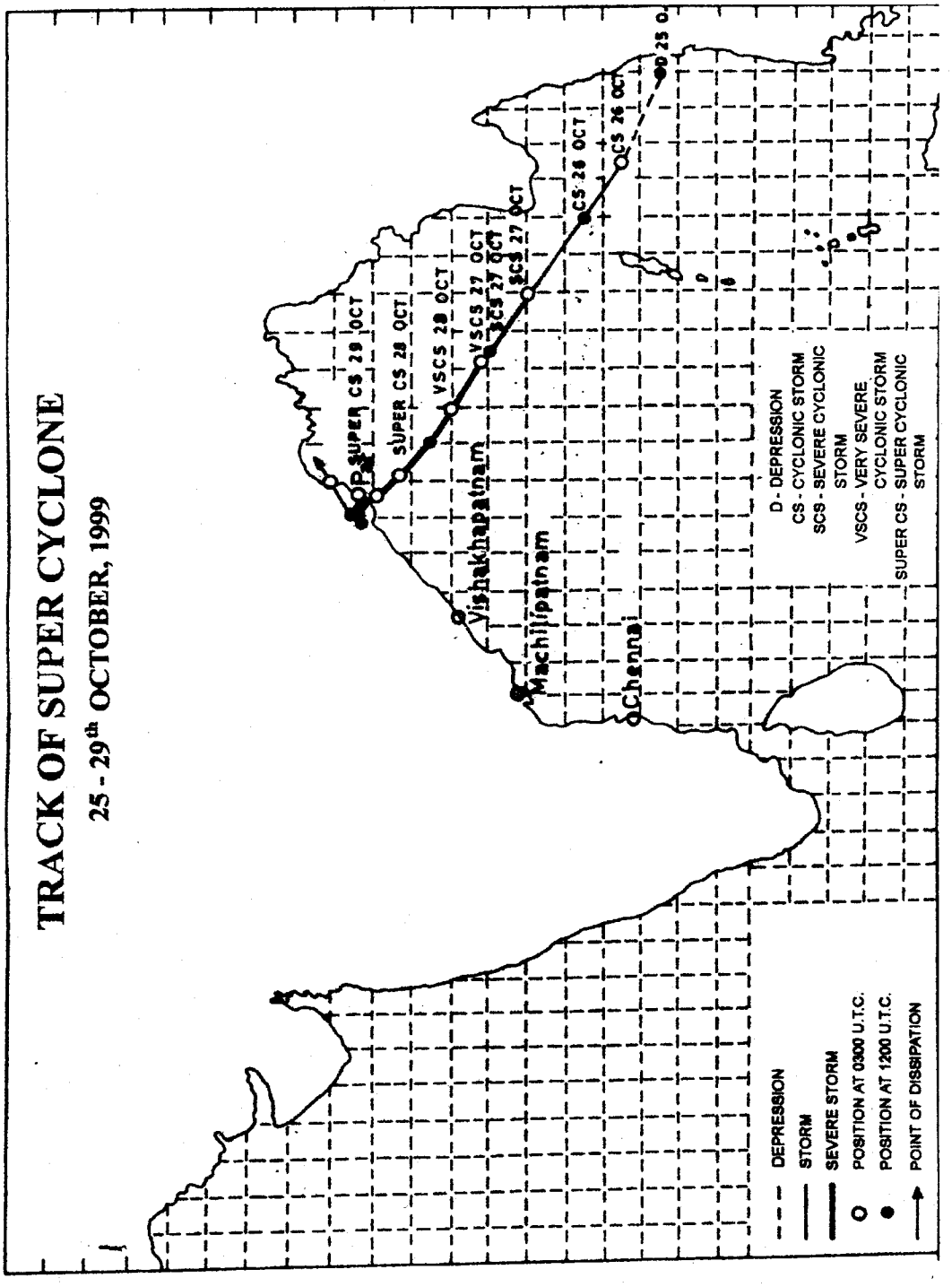

Fig. 1 : Track of Super Cyclone -- 25-29th Oct; 1999

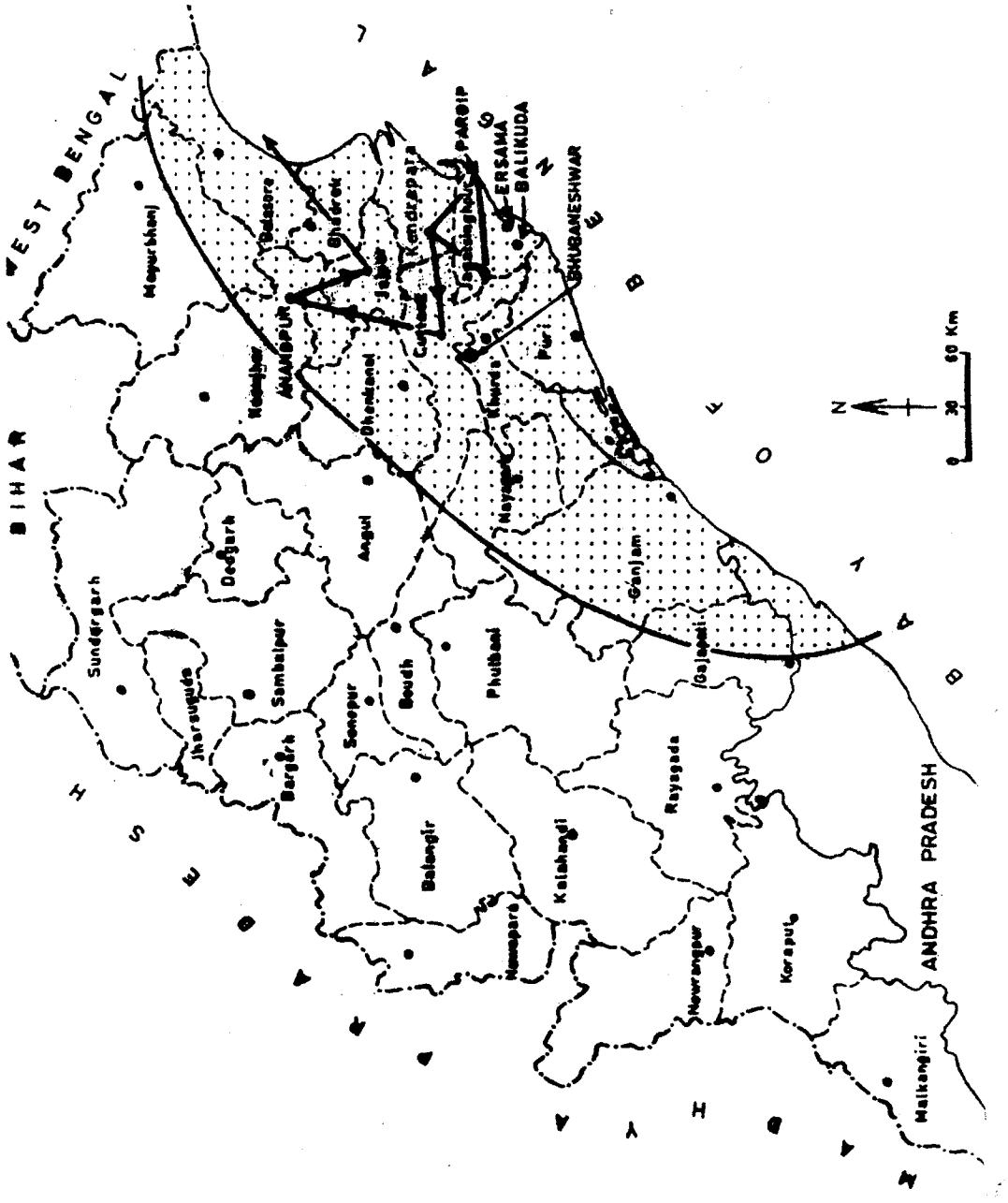

Fig. 2 : Area affected by super cyclone, 29th Oct. 1999

Table 2

Track of Super Cyclone 24th - 31th Oct., 1999

Date & Time UTC	Position Lat	Long	Pressure (Est. Cent. Pres) hPa	Wind Speed in Kts (Est. Max. Sus. Sur. Wind)	CI	Stage
25.10.1999 12 UTC	12.5°N	98°E	1002	25	1.5	Dep.
26.10.1999 03 UTC	13.5°N	95.5°E	1002	35	2.0	CS
26.10.1999 03 UTC	14.5°N	94.0°E	998	45	3.0	CS
27.10.1999 03 UTC	16.0°N	92.0°E	992	55	3.5	SCS
27.10.1999 15 UTC	17.0°N	90.5° E	986	65	4.0	VSCS
28.10.1999 03 UTC	18°N	89.0°	978	77	4.7	VSCS
28.10.1999 12 UTC	18.5°N	88.0°	940	115	6.0	VSCS
28.10.1999 18 UTC	19.3°N	88.0°E	921	140	7.1	Super cyclone
29.10.1999 03 UTC	19.9°N	86.7°E	921	140	7.0	Super cyclone
29.10.1999 06 UTC	20.2°N	86.4°E	935	127	7.0	SCS Crossed near Paradip Between 04 and 0530 UTC
29.10.1999 12 UTC	20.5° N	86.0°E	-	-	-	VSCS
30.10.1999 03 UTC	20.5°N	86.0°E	-	-	-	CS
31.10.1999 12 UTC	21.0°N	87.0°E	-	-	T 1.5	Dep.

Source: RSMC, New Delhi (2000)

Note:

1. No TI/CI values available between 29th 12 UTC and 31st 30 UTC
2. Est. based on the value corresponding for CI/TI
3. No est. valuse for TI/CI upto 1.5

between 0400 and 0530 UTC on 29th October and hit first the area between Ersama and Balikunda. It stalled for three hours in a triangle formed by Jagatsingpur, Kendrapara and Paradip, continued to Cuttack and stalled again, in Kapilas in the late evening. From Kapilas it travelled to Anandpur, retreated to Jajpur and finally dissipated into sea at Balasore (Fig 2). The most severely affected districts (housing 11 million people) were Balasore, Bhadrak, Cuttack, Jagatsinghpur, Jajpur and Kendrapara. The districts of Khurda, Puri, Nayagarh, Ganjam, Gajapati, Keonjhar, Mayurbhang and Dhenkanal were partially affected with 30 to 50% damage.

There have been only three other tropical cyclones in recent years to reach this intensity in the Bay of Bengal. A similar storm of the same intensity crossed the Orrissa coast near Paradip during 26 to 31st October 1971. The second was Andhra cyclone of December 1977. and the third one was in may 1991 which caused many thousands of deaths in Bangladesh.

DAMAGE STATISTICS

The damage caused was threefold: Physical impact by strong winds, resulting storm surge and flash flood, and saline inundation. The districts of Kendrapara, Jagatsingpur and Puri suffered from a 7 m high tidal surge which swept 20 km inland in some places. Parts of Balosore, Cuttack, Ganjam and Puri districts have high salinity levels in their ground water. With the recent sea ingress caused by the cyclone this problem will be aggravated. Besides, due to floods in all the rivers flowing through these districts vast areas of agricultural lands have been sand cast. As the coastal Orissa is predominantly agrarian, the damage to agriculture has a vast impact on household income and food security. As system was of unprecedented intensity, it caused very heavy damage and devastation of large tree cover along the coastal districts of Orissa and West Bengal. Over 20,000 of human lives and 5,00,000 of livestock were lost and more than a million rendered homeless. Widespread rainfall and also exceptionally heavy falls occurred over coastal Orissa and west Bengal on 29, 30 and 31 October. Exceptional heavy to very heavy rainfall (cms) reported is as follows, IMD (2000).

Rainfall in 24 hrs (cm)

	October 30, 1999	October 31, 1999
Station		
Bhubaneshwar	43	10
Anandpur	40	30
Akhuapada	36	17
Puri	18	12

It could have been a more severe and shocking storm if the cyclone had hit anything further north or even further south of Paradip. South Orissa, where Paradip port is situated, is not known for experiencing higher storm surge because the offshore sea water is deeper as compared to Balsore and further upto Bangladesh where it is very shallow. Same is the case in Andhra Pradesh and Tamil Nadu where shallow of-shore water is ideal for high storm surges. According to Kalsi (1999) cyclones in the Bay of Bengal are not that intense as thosein Pacific or even Atlantic as the extension of the Bay is very small, however the funnel shape of the Indian coast line and the shallow offshore waters act as a catalyst in intensifying the cyclonic storm and causing a more damage. Futher, due to very high density of population along the coastal area, the devastation is also on a large scale.

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