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## A STUDY OF VARDHA CYCLONE AND ITS IMPACTS IN TAMIL NADU

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*Abstract:* The vulnerability of India towards multiple disasters is well known. Every year numerous catastrophes nudge the nation and with changing climatic conditions the frequency and intensity of these events are increasing. India had been responding to disasters for many years and had been assisting cross boundary response also. The destruction from a tropical cyclone depends mainly on its intensity, its size, and its location. The main effects of tropical cyclone include heavy rain, strong wind, and large storm surges at landfall. Destruction caused by Cyclones. A Storm surge can be defined as an abnormal rise of sea level near the coast caused by a severe tropical cyclone; as a result of which sea water inundates low lying areas of coastal regions drowning human beings and life stock, causes eroding beaches and embankments, destroys vegetation and leads to reduction of soil fertility. This paper presents the details of the Cyclone Vardah and destruction caused by Cyclones affected areas on the north coastal areas of Chennai, Tiruvallur and Kancheepuram districts.

*Index Terms* - Cyclone Vardah, Vulnerability Hazards, Heavy Rain, Strong Wind, Storm Surges

### I. INTRODUCTION

#### INTRODUCTION

Tamil Nadu is prone to multi hazards, higher than other States and is frequented by hazards of various nature and different intensities. The vulnerability of the coastal community became exceedingly evident when Tsunami struck the southern coast of India. Besides Tsunami, the coastal community faces disasters like cyclone and floods periodically. The main effects of tropical cyclones include heavy rain, strong wind, large storm surges at landfall, and tornadoes. 'Vardah', the severe cyclonic storm had a unprecedented damage to infrastructure and properties. At the time of land fall, Chennai city and the Districts of Thiruvallur and Kancheepuram witnessed very heavy rain fall and very strong winds with a velocity of 130-140 kms per hour. 16 lives have been lost due to the cyclone. Due to the extensive damage caused to transmission lines, sub-stations, transformers and distribution lines, power supply was cut off in almost the entire city of Chennai as well as large parts of Kancheepuram and Thiruvallur Districts. This paper presents the details of a post disaster field investigation performed after the very severe cyclonic storm Vardah in the southern peninsular part of India.

### II Aims and objectives of the study

Despite having cyclone warnings and experiences of cyclones every year, the people are facing such calamities frequently. This was indented to take up this study. The aim and objectives of the study are:

1. To demarcate the cyclone affected area and vulnerable area.
2. To assess the Wind damages in the study area
3. To assess the Biological damages in the study area
4. To study the Relief and Rehabilitation programmes of the Govt.

### III Study Area

The Chennai district area covers 178.2 km<sup>2</sup> on the east coast of India. It is surrounded by the Bay of Bengal and inland districts of Tiruvallur and Kanchipuram. It lies between 12°59' N and 13°9' N latitude and 80°12' E and 80°19' E longitude at an average height of 6 m above the mean sea level on a sandy shelf breaker swept beach.

### IV. Profile of Tropical Cyclone Vardah

Hurricanes, cyclones, and typhoons are also the same weather phenomenon. They are called by different names in different places. The World Meteorological Organization has allowed them to name cyclones originating in the Bay of Bengal and Arabian Sea. The name Vardah, which means red rose, was given by Pakistan. Cyclone Vardah made landfall in Tamil Nadu and coastal Andhra Pradesh. Tropical cyclones passing over the northern part of the Indian Ocean are named by India, Pakistan, Bangladesh, Sri Lanka, Maldives, Myanmar, Oman and Thailand, turn wise. On 7th and 8th, heavy to very heavy rainfall was observed over south Andaman Sea and adjoining southeast Bay of Bengal. On 9th the region of heavy to very heavy rainfall shifted from northeast to northwest sector. On 10th, 32 cm rainfall was observed in southeast Bay of Bengal. On 11th, 16-32 cm rainfall was observed over southwest Bay of Bengal. On 12th, around 30 cm rainfalls was observed in the right forward sector of the system near north Tamil Nadu and adjoining south Andhra Pradesh. On 13th, 4-8 cm rainfall was observed over north interior Tamil Nadu and south interior Karnataka. 7 days average rainfall plot indicate that during initial stage 4-8 cm average rainfall was observed over south Andaman Sea and southeast Bay of Bengal within 10-14 degree north. However, in the later part of the week, 2-4 cm rainfall was observed between 10-14 degree north over southwest Bay of Bengal. A cyclone comes over land with exceptionally strong wind and heavy rainfall. When the cyclone approaches land, the outer edges start incorporating the air over the land. Once cyclone Vardah made its landfall, **the eye** passed over Chennai within hours. Heavy rainfall and high wind speeds followed. After it passed, rainfall subsided and wind speeds decreased. According to the IMD, the dense fog in northern India is linked to the cyclonic activity in Bay of Bengal because fog is usually observed in the December end, but this year it was seen earlier.

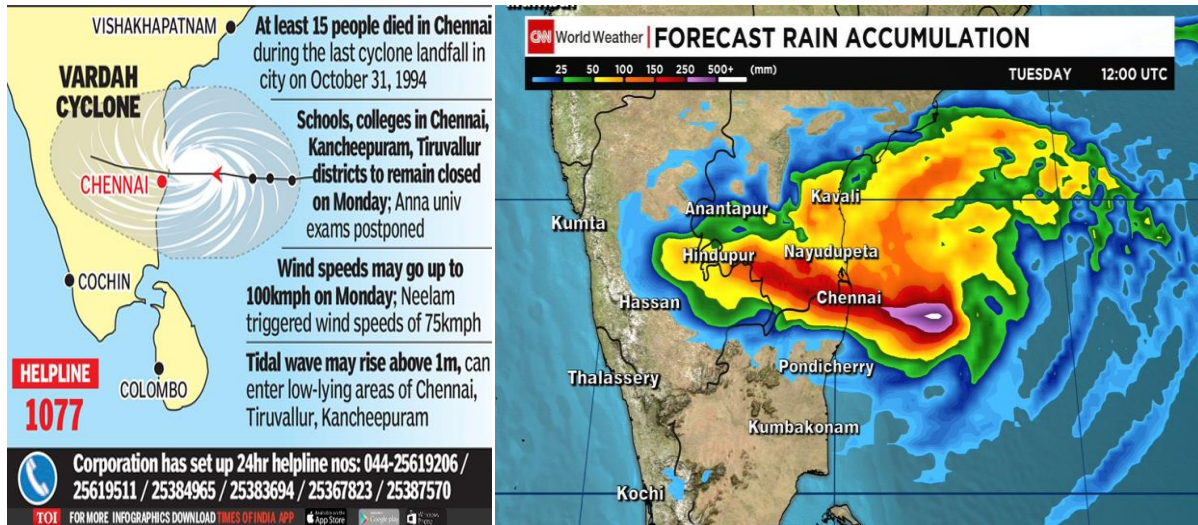
**Table: 1**

#### Verification of Heavy Rainfall Forecast

Date	Heavy Rainfall Warning Issued
11.12.2016 0300	Isolated heavy to very heavy falls over south coastal Andhra Pradesh, north coastal Tamil Nadu and Puducherry to commence from 11th December evening for subsequent 36 hrs. The rainfall intensity will increase gradually becoming heavy to very heavy rainfall (7-19 cm) at a few places and isolated extremely heavy rainfall ( $\geq 20$ cm) over Chennai, Thiruvallur and Kanchipuram districts of Tamil Nadu and Nellore and Prakasam districts of Andhra Pradesh on 12th December.
12.12.2016	Gale winds speed reached to 100-110 kmph gusted to 120 kmph along & off Chennai, Thiruvallur and Kanchipuram districts of Tamil Nadu and Nellore and Prakasam districts of Andhra Pradesh. Squally wind speed reaching 50-60 kmph gusting to 70 kmph along and off remaining districts of north Tamilnadu & Puducherry and south Andhra Pradesh coasts during the same period. Storm Surge of height 1m above the astronomical tide occurred near Pulicat lake at 1200 hours IST of 12th December.
13.12.2016	Heavy rainfall at many places with very heavy falls at few places and isolated extremely heavy rainfall over Chennai, Kancheepuram, Tiruvallur, districts of Tamil Nadu. Isolated Heavy to very heavy rainfall at a few places over Villipuram, Vellore, Krishnagiri, Tiruvannamalai

districts of Tamil Nadu, Nellore district of coastal Andhra Pradesh and Chittoor, Anantapuram & Cuddapah districts of Rayalaseema.

Source: Government of India Ministry of Earth Sciences India Meteorological Department p.p. 61



Source: IMD, BULLETIN NO.: 44 (BOB 06/2016), IAG-AP, IAG-TN

### Districts wise Wind speeds and Surge of Tropical Cyclone Vardah

The model simulated estimated maximum wind speeds of about 100-110 kmph along and off Chennai, Thiruvallur and Kancheepuram district of Tamil Nadu and adjoining Chittoor and Nellore district of Andhra Pradesh.

**Table 2**  
**Wind speeds and Surge**

District	State	Wind Speed (kmph)	Surge (m)
Thiruvallur	Tamil Nadu	109.62	0.82
Nellore	Andhra Pradesh	109.50	1.23
Puducherry	Puducherry	50.83	0.18

Source: Report of RMSI

#### 4.1. Damage due to Very Severe Cyclonic Storm Vardah

##### i) Loss of Human Lives

About 8,000 people from low-lying areas in north Chennai, Pazhaverkadu in Tiruvallur district and villages off Mamallapuram, in Kanchipuram district were safely evacuated to 95 relief shelters. 24 deaths related to the cyclone have been reported in the state of Tamil Nadu.

##### ii) Infrastructure damage

Cyclone Vardah caused colossal damage to infrastructure like roads, bridges, reservoirs, tanks, drinking water supply, school and public health buildings, electrical installations, habitats such as huts & houses, crops, cattle losses. The state Government estimated the damage to the tune of Rs 22,573 crores (The Hindu dated the 28th December, 2016).

##### iii) Damage on Trees

120 kmph Gusty winds of cyclone Vardah uprooted hundreds of trees in the city. At least one lakh of the estimated 4.5 lakh trees in the city have been uprooted by cyclone Vardah. According to estimates, around one-fourth of the 6.5-per cent tree cover in Chennai has vanished in the wake of the cyclone. Even though the wind spared none, felling all species of trees, exotic, non-native species, particularly the rain tree (Kaatuvagai or thoongumoonchi), peltophorum (yellow flametree) and gulmohur, bore the brunt of the fury. 482 electric poles in Chennai and 4,000 electric poles in rural areas had fallen As many 224 roads were blocked and 24 huts damaged .Power supply was suspended in many parts of these regions as a precautionary measure. The winds uprooted electricity poles disrupting transmission of high tension electricity to substations.

The severe Cyclone Vardah, which hit the coast of Chennai, has caused destruction worth up to \$1 billion to the industries. The hurricane-strength storm caused by Vardah overturned cars and caused extensive damage to buildings, besides it has also significantly hit agricultural sector, destroying banana plantations, papaya groves, rice paddies and others thereby causing widespread destruction worth up to \$1 billion,

#### iv) **Transportation damage**

Transportation in Chennai and surrounding districts was affected after train and air services were halted in view of the extreme weather conditions. All suburban train services have also been suspended. Southern Railway has announced cancellation of all 17 trains originating from Chennai Central, as well as Egmore. Long distance buses have been stalled and traffic came to a grinding halt in most areas with uprooted trees and electric poles blocking the roads. In Chennai, only a minuscule number of vehicles plied as heavy winds and rains posed serious obstacles to movement. Vehicular movement on the Ashok Pillar-Kodambakkam main road was affected with fallen tree branches. Road transport was also affected but civic workers in Chennai, Tiruvallur and Kanchipuram districts brought out battery-run electric woodcutters to remove fallen trees and clear roads.

#### v) **Crop damage**

Severe Crop damages occurred in Tiruvallur, Kanchipuram, Vellore and Tiruvannamalai districts of north Tamil Nadu. There was damage to paddy, groundnut, blackgram, greengram and coconut causing a loss of nearly 33 % in these districts in an area of 34206.13 Hectare. The estimated loss of Agriculture produce valued Rs. 35571 Crore.

**Table 3**  
**Damage Details**

S.No. Crop	Total Area damaged in Hectares	Production Loss (MT)	Avg. Market Price/MT (Rs.)	Value of the produce Lost (Rs. in crores)
1. Paddy	33980.86	220876	16000	35340.09
2. Millets	58.44	2507	15000	37.60614
3. Pulses	41.8	314	80000	25.08
4. Sugarcane	44.82	41683	2300	95.86998
5. Oilseeds	63.06	145	50000	72.519
6. Perennial crops Coconut	16.62			
	Total	34206.10	22547	35571.37287

Source: Government Of India Ministry Of Earth Sciences India Meteorological Department p.P. 35

## 4.2. District wise Details of Area affected by Cyclone “Vardah”

### (a) **Tiruvallur:**

Due to Cyclone Vardah, the Paddy crop cultivated in Tiruvallur district was severely affected in 11 blocks. Out of the total area (87000 Hectare) cultivated in the district, 45518 Hectare Paddy was severely affected. In this 32241 Hectare Paddy was affected with >33% crop damage. And also 16.62 Hectare Coconut was also affected. The trees were totally uprooted from the field. Totally 32257.62 Hectare area was affected with >33% crop damage which includes 2700.40 Hectare area of SF/MF and 5237 Hectare of Other farmers. 37370 farmers were affected due to this Vardah cyclone. The total Assistance sought for Tiruvallur district is Rs.4355.53 lakhs @ Rs.13500/ Hectare to Paddy crop and Rs.18000/ Hectare to Coconut crop.

### (b) **Kanchipuram**

Due to Cyclone Vardah, the crops viz., Paddy, Ground nut and Pulses crops cultivated in Kanchipuram district were severely affected in 13 blocks. Out of the total area cultivated (49500 Hectare) in the district, 6002.20 Hectare area under agricultural crops was severely affected. In this, Paddy --1625.70 Hectare, Ground nut --54 Hectare and Pulses --35 Hectare were affected with >33% crop damage. In total 1714.70 Hectare area was affected with >33% crop damage which includes 1679.20 Hectare area of SF/MF and 35.50 Hectare of other farmers. 2398 farmers were affected due to this Vardah cyclone. The total Assistance sought for Kanchipuram district is Rs.231.483 lakhs @ Rs.13500/ Hectare to annual crops.



**(c) Vellore**

The crops viz., Paddy, Millets, Ground nut Pulses and Sugarcane crops cultivated in Vellore district were severely affected in 15 blocks. Out of the total area (1, 24, 800 Hectare) cultivated in the district, 780.12 Hectare agricultural crops were severely affected. Due to cyclone Vardah, Paddy --101.16 Hectare, Millets -58.44 Hectare, Groundnut --9.06 Hectare, Pulses -- 6.8 Hectare, Sugarcane -- 44.82 Hectare and Coconut -- 0.53 Hectare were affected with >33% crop damage. In total 220.81 Hectare area was affected with >33% crop damage which was belonging to SF/MF only. 498 farmers were affected due to this Vardah cyclone. The total Assistance sought for this affected area of Vellore district is Rs.29.81 lakhs @ Rs.13500/ Hectare to annual crops.

**(d) Tiruvannamalai**

Due to Cyclone Vardah, the Paddy and Sugarcane crops cultivated were severely affected in Arani block of in Tiruvannamalai district. Out of the total area cultivated under Paddy (57300 Hectare) in the district, 139 Hectare area was severely affected. In this, 13 Hectare Paddy area cultivated by 48 numbers of SF/MF was affected with >33% crop damage.

Despite of all the precautionary measures taken by the state and district administration there was an extensive damage to road infrastructure Houses, roads, sewage pipes and power lines and public property. The extensive damage caused to transmission lines, transformers, distribution lines, and power supply was cut off in most of the places in Chennai, Tiruvallur and Kancheepuram districts. As per the media reports more than 10,000 electric poles have been wrecked and more than 800 transformers damaged and extensive damage to the sewerage facilities drinking and water infrastructure affecting the water supply to the people. The state government is making all efforts to clear the roads blockage, rectifying the powerlines, phone lines and water supply. Boats and nets were damaged and washed away in the coastal areas.

**V.Conclusion**

Cyclone Vardah hit the Tamil Nadu capital on 12th December, 2016. Its impact was so severe that it uprooted trees, boards, hoardings, damaged compound walls and resulted in disruption of power supply. The cyclonic storm Vardah made landfall near Chennai resulting in heavy rainfall which left the city drenched. But most people, aware of the nature's fury, remained indoors, leaving the roads across the city virtually deserted. Cyclone Vardah's trail of destruction was immense as the eye of the storm ripped through Chennai, but the loss of lives (around 18 in Tamil Nadu) was minimal, that shows how the improvement in readiness to face such extreme weather events. It was touching that the disaster relief teams forcibly evacuated people in low-lying areas and near the sea in Tamil Nadu and Andhra Pradesh to safe shelters.

**5.1. RESULTS AND DISCUSSION**

The coastal belt of Chennai is vulnerable to the impact of cyclone and the vulnerability is increasing with urbanization, industrialization, and increase in tourism industry, whose potential is not tapped fully. Cyclones are more frequent occurrence in Chennai, Kanchipuram, and Thiruvallur districts of Tamil Nadu, and major cyclones occur at an interval of three to five years. Most cyclones are associated with heavy rainfall and consequent flood hazard. Therefore, priority should be given to cyclone and flood hazard. The coastal belt of Chennai is vulnerable to impact of cyclones and the vulnerability is increasing with urbanization, industrialization, and increase in tourism industry whose potential is not tapped fully. Any disaster management plan and developmental activities should take into consideration vulnerability for natural hazards. Cyclones are more frequent in Chennai and Kanchipuram districts, and major cyclones occur at an interval of three to five years. Most cyclones are associated with heavy rainfall and consequent flood hazard.

## 5.2. Findings

- The natural increase in population and subsequent demand to infrastructures to accommodate the population exaggerates the vulnerable situation during hazard-prone seasons. As cyclones cause variety of damages to the living communities, certain precautionary measures can reduce the risk of the cyclone damages.
- Accommodation at shelters, forming bio-shields, drainage regulations, construction of homes at higher level with the ground floor not used for dwelling. Insurance cover for homes and belongings against damage and loss during disasters, early warning system, and proper dissemination of the threat, evacuation route, etc., are recommended for minimizing the disaster impacts.
- Buildings in vulnerable areas should be retrofitted to withstand the force of the wind, particularly public buildings, industries, coastal structures, and resorts. During Cyclone Vardah, mobile towers, transformers, and electric posts fell causing power outage and blocking the traffic. The design of the structures were not made taking into consideration wind speed. So, guidelines should be framed for design of the structures to withstand a possible wind with a speed above 250 kmph

## 5.3, Suggestion:

- The devastation caused by Cyclone Vardah again highlighted the importance of the strict implementation of Coastal Zone regulations.
- Even though the coasts currently support a large population, yet in order to restore at least some of the ecosystems that have provided natural flood control and other protections from time to time, it is necessary to implement CZ regulations.
- Cyclone Vardah also highlighted the importance of early warning and its dissemination in order to reduce the impact of cyclones.
- Any disaster management plan and developmental activities should take into consideration increasing vulnerability for natural hazards.

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