



Cyclone Vulnerability and Risk Analysis for the North-Coastal Districts of Andhra Pradesh: Integrating Disaster Management

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Abstract:

This paper is an attempt to analyze the cyclone vulnerability and risk analysis for the north-coastal districts of Andhra Pradesh using an integrating disaster management approach. It is used to examine an expected casualty rate by considering prone area inundated due to the cyclone Hudhud for a wind speed of 190 kmph from outputs of storm surge, and also number of existing cyclone shelters as inputs. The results indicate that out of 470 villages in 4 north-coastal districts of Andhra Pradesh, the affected villages due to cyclone Hudhud are 237. According to analysis of vulnerability at risk, affected villages categorized into 4 classes as, low, medium, high and very high respectively. In the four north coastal districts, out of the total affected people, more than 10% of rural is at risk and 4.3% of urban is at high risk. Further, the findings show that the existing cyclone shelters (370) can accommodate only 6.7% of rural at risk and hence safe places shall be identified for the remaining 93.3% of rural is at risk. This analysis enables the officials involved in disaster management and rescue operations to concentrate on the identified affected villages of population at risk and also to identify safe places for evacuation during cyclone Hudhud.

Index Terms - North-Coastal Districts, Vulnerability, Risk, Visakhapatnam, Cyclone Hudhud.

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1. INTRODUCTION

Vulnerability is the extent to which a community, structure, services or geographic area is likely to be damaged or disrupted by the impact of particular hazard, on account of their nature, construction and proximity to hazardous terrains or a disaster prone area (DFID, 2005)¹. In India, Andhra Pradesh is one of most natural disaster prone states because of its long coastline and geographical location. It is observed that about 44 percent

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of the state is vulnerable to tropical storms and related hazards, in addition to monsoon depressions bring heavy to very heavy rains causing floods in the inland rivers between June and September. In the state, many areas adjacent to coastal districts are vulnerable to flash floods. The state has a population of 49.4 million with density 308 persons/sq.km, out of which proportion of rural population is 70.4% while that of urban is 29.6%, as per 2011 census².



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Climate of Andhra Pradesh is normally graded as semi-humid and dry (NCAP) and receives total rainfall of about 1128 mm and 996 mm. Due to its different geo-climatic conditions, it has always prone to natural disasters. It has been made vulnerable to tropical cyclones by the physical geographic position of the state along the eastern coast of India. 44 per cent of the state is cyclone-prone (APSDMA, 2017)³. In the past century, the AP hit by 103 cyclones and the coast between Ongole and Machilipatnam is extremely vulnerable to tropical waves. As classified by the Indian Meteorological Department (IMD) in 1999, Andhra Pradesh has two meteorological sub-divisions, Coastal Andhra Pradesh (CAP) and Rayalaseema (RSM). The CAP consists of nine districts and further subdivided into NCAP and South

Coastal Andhra Pradesh (SCAP) respectively to easily represent the climatic parameters of the Srikakulam, Visakhapatnam, Vizianagaram, East Godavari, West Godavari (NCAP) and Krishna, Guntur, Prakasam, Nellore sub-regions (SCAP).

Table-1 indicates that the magnitude of vulnerability to which type of hazard is prone. It is revealed that there are nine coastal districts like Visakhapatnam in the state based on magnitude of cyclone vulnerability is medium to high. As urban population, Visakhapatnam is the most urbanized district of the state having 47.5%. Out of total 13 districts in the state, nine are coastal districts and account for approximately 69% of its total population (34.19 million).

Table-1: Distribution of Coastal Districts in Andhra Pradesh by Type of Hazard

Type of hazard	Magnitude of vulnerability	Areas/Institutions
Natural Disaster		
Cyclone	Medium to High	All nine coastal districts such as Vishakhapatnam, Vizianagaram, Srikakulam, East Godavari and West Godavari, Krishna, Guntur and Nellore.
Flood/Flash flood	Medium to High	East & West Godavari, Krishna.
Earthquake	Low	Srikakulam, Vizianagaram.
Drought	Medium to High	All four Rayalseema Districts.
Man-made Disaster		
Forest fire	Medium to High	Subject to State requirements.

The coastal region of Andhra Pradesh comprises of 974 km coastline and includes 9 districts of the state. The four districts of NCAP i.e. Vishakhapatnam, Vizianagaram, Srikakulam and East Godavari make up nearly half of the coastal region of the state. With high population density, the geographic location combined makes the north-coastal districts highly vulnerable to cyclones and its associated hazards like storm surge, high winds and heavy rainfall. During a cyclone, most lives are lost on account of floods and the devastating storm surge that often accompany cyclones. In case of severe cyclonic storms with storm surges, more than 90% of the fatalities occur due to drowning, either during the incoming water phase or

during the out surges (Rao, 2001)⁴. In severe cyclonic storms without storm surges, the deaths more or less evenly divided between drowning and the collapse of buildings, infrastructure.

1.1. Major Cyclones during 1977 - 2014

In the past 40 years, major cyclones caused immense loss of lives and livestock and massive damage to property, both people and Government as follows.

1) Severe cyclonic storm the most devastating in November 1977. Eight coastal districts affected. About 10,000 people killed, 250,000 cattle heads perished, 1 million houses damaged and crops on 1.35 million



hectares were damaged. Financial loss is Rs. 172 crore.

2) Cyclonic storm in May, 1979 with core of hurricane winds, heavy rains and floods. As many as 748,000 lakh houses damaged. Financial loss is Rs. 242 crore.

3) There were three cyclonic storms in October- November 1987 such as the first one in October, which was a severe storm but with no casualty. The second one, on 2-3 November was very severe. 10 districts affected. 119 people died; more than 100,000 houses and 960,000 ha of crops damaged; the loss is Rs. 126.48 crore.

4) Cyclone in July 1989 followed by heavy rains and floods. 22 districts affected. Death toll: 232; crops on about 600,000 ha lost; the loss Rs. 913.5 crore. It was followed by a cyclonic storm with no casualty.

5) Severe cyclonic storm in May 1990 with core of winds. 14 districts affected. Death toll: 817; houses damaged: 1.4 million; crop loss: more than 500,000 ha; loss Rs. 2,137.27 crore. It was followed by heavy rainfall in August in which 50 people died and the loss was assessed at Rs. 179 crore.

6) Severe cyclonic storm in November 1996 with core of hurricane winds. Four districts affected. Death toll: 1,077; houses damaged: 600,000; crop loss: 500,000 ha; loss Rs. 6,129.25 crore. One more severe cyclone in December claimed 27 lives.

7) Cyclone Laila in May 2010. 14 districts affected. Death toll: 22; houses damaged: 14,298; crop loss: 260,000 ha; loss Rs. 1,603 crore.

8) Severe cyclone Nilam in November 2012. Death toll: 30; crop loss: over 700,000 ha; loss: Rs. 1,710 crore.

9) Severe cyclone Phailin in October-November 2013. Death toll: 40; crop loss: Rs. 2,400 crore; loss: Rs. 420 crore, and

10) Severe cyclone Hudhud in October 2014.

1.2. Factors Responsible for Vulnerability

The present study has been employed the research methodology is the combination of descriptive and analytical. The secondary data was also including those were available

from different newspapers, bulletins, journals and published books. Furthermore, personal knowledge was used to make a meaningful interpretation of the data. For vulnerability of the state, some of the factors responsible to disasters are the following: 1) Almost half of the storms in the Bay of Bengal become severe cyclones often accompanied by storm surges, 2) Low lying areas along the coast are highly vulnerable to extensive flooding and deep inland sea water incursion, 3) High concentration of population, infrastructure and economic activities along the coast, 4) Lack of proper maintenance of the flood protection and irrigation systems, drains, embankments, and 5) Lack of comprehensive coastal zone and delta management.

1.3 Coping with the disaster: A Case of Cyclone Hudhud

Total human deaths due to Cyclone Hudhud, 46 were reported. Of these, 29 deaths were reported from Visakhapatnam district alone, while 15 people died in Vizianagaram. The loss of food grain production was estimated to be around 2.2 million tonnes, according to state government of Andhra Pradesh. After the cyclone, 135,000 people were still in relief camps in Andhra Pradesh. More than 3,176 km panchayat roads and 648 km municipal roads were reported to be damaged. Around 2.4 million customers in Visakhapatnam, Vizianagaram and Srikakulam districts were initially without power. Electricity supply was restored to 1.5 million consumers by October 20, according to government officials. By October 15, most train services to the affected areas restored. The bigger challenge was Vishakhapatnam airport. Navy and NDRF personnel helped AAI officials carry out restoration work of navigational tools and the runway. The prompt work showed results. On October 17, Air India resumed its flights from Vishakhapatnam airport (CDMA, 2017)⁵. The results of the study indicate that out of 470 villages in 4 north-coastal districts of Andhra Pradesh, the number of villages affected by Cyclone Hudhud is 237. According to the vulnerability analysis at risk, the affected



villages are classified into 4 classes: low, medium, high. In the four North Coast districts, of the total affected population, more than 10% of the rural population is at risk and 4.3% of the urban population is at high risk. Further, findings show that the existing cyclone shelters (370) can accommodate only 6.7% of the at-risk rural areas and safe locations are identified for the remaining 93.3% of the rural areas. This analysis will enable officials involved in disaster management and rescue operations to focus on identified affected villages at risk and identify safe locations during Cyclone Hudhud.

1.4. Disaster Vulnerability in Visakhapatnam District

Visakhapatnam district is vulnerable to different natural disasters such as cyclones, floods, droughts, Tsunamis, lightning on account of geographical conditions. Vulnerable to tropical cyclones and other cyclone related hazards in the district, cyclones about 30 % of the total geographical area. Flood condition in the district chiefly depends upon the rain fall received. Since 1980, 12 flash floods occurred out of 3 affected severely. Visakhapatnam district experiences wide variability in rainfall and susceptible to drought. Tsunami- 2004 showed that physiological impact on fisher folk communities along with the sea coast. There is no direct physical damage either to the public or to the property in this District. According to the earthquake Atlas the district has located Seismic zone in Moderate. In the past history of the Earthquake the district has got highest magnitude 5.0 and 3.8 on rector scale. During the South-West monsoon season, human & live-stock casualties are reporting sue to Lightening. The following are treated as man-made disasters: 1) Fire accidents, 2) Chemical accidents, 3) Train accidents, 4) Road accidents, 5) Nuclear disasters, and 6) Electrical short circuits.

1.5. Context of Disaster Management

There is a paradigm shift in Disaster Management approach from the earlier focus of response and relief to prevention and

preparedness. It is certainly possible to reduce the impact of Disasters by evolving appropriate preparedness, mitigation and response plans. Earlier, any disaster management was considered as a crisis management function that began with a disaster and closed soon after the relief and rehabilitation.

II. INTEGRATING DISASTER MANAGEMENT APPROACH

The Disaster Management Act 2005 mandated institutional setup at National, State, and District levels to have an integrating disaster management approach. For disaster prone areas, it is realized that process of mitigation should incorporate long term preventive and protective measures by adopting appropriate strategies (Jena, 2009)⁶. Mainstreaming of Disaster Risk Reduction (DRR) features into development planning of sectorial departments is one of the key areas identified and incorporated in the plan. The Government of India UNDP DRR programme envisages a holistic and integrated approach.

2.1. At National, State & District Levels

As a national priority, the Government of India set up high-powered committee in August 1999 for making recommendations on the preparation of disaster management plans and suggesting effective mitigation mechanisms in recognition the importance of disaster management (2004)⁷. For the first time, the 10th Five-Year Plan document had a detailed chapter on disaster management. The 12th Finance Commission also mandated to review the financial arrangements for disaster management. On 23rd December 2005, the Government of India enacted the Disaster Management Act, which envisaged the creation of National Disaster Management Authority (NDMA), headed by the Prime Minister of India, and State Disaster Management Authorities (SDMAs) headed by respective the Chief Ministers, to spearhead and implement a holistic and integrated approach to Disaster Management.

The NDMA is the apex body that is mandated to lay down the policies, plans and



guidelines for the prevention of disaster, or the mitigation, or preparedness and capacity building (Damon, Coppola 2007)⁹. It lays down the guidelines to be followed by the SDMAs in drawing up State Plans and such other measures for dealing with threatening disaster situations as it may consider necessary. Further coordinates, the enforcement and implementation of the policies and plans. Under the Ministry of Home Affairs, Government of India, the DM division is responsible for response, relief and preparedness for natural calamities and man-made disasters except drought and epidemics (CRED, 2009)⁸. The DM division is also responsible for legislation, policy, capacity building, prevention, mitigation and long term rehabilitation. It gives useful links of India Meteorological Department (IMD), Indian National Centre for Ocean Information Services (INCOIS), Central Water Commission (CWC) and Geological Survey of India (GSI) that give forecast and other details on various natural hazards. It has several manuals that can be used for assessment of damage, mitigation measures, disaster developmental plans etc. viz. the Disaster Management Division Acts such as the Civil Defence Act 1968 and the Disaster Management Act 2005, the Disaster Management Division Rules and

Regulations, the Civil Defence Rules 1968, the Civil Defence Regulations 1968, the Annual Report of National Authority Rules 2006, the National Institute of Disaster Management Rules 2006, the National Institute of Disaster Management Regulations 2006, the notification of National Disaster Response Force (NDRF) Rules 2008 should be made available so as to know that the rules and regulations and compliance requirements.

2.2. Disaster Management: At District Level

As per the integrated disaster management approach, district disaster management authorities in the state of Andhra Pradesh are headed by respective 13 district collectors who are responsible to spearhead and implement in consonance with national policy. For the district disaster management, the district authorities of Visakhapatnam are at the verge of completing the DDMP e.g. revenue department is the nodal agency. Hence the CDMP of GVMC follows in the lines of DDMP efficiently. Under which DOC/EOC, the department of public safety and security operates should synchronize the functions of the five teams with respective functionaries at the District level. Accordingly in Visakhapatnam District Disaster Management Authority is formed with following members as shown in Table-2.

Table-2: Distribution of Coastal Districts in Andhra Pradesh by Type of Hazard

Sl. No.	Designation	Position
1	The District Collector & the Magistrate of the district	Chairperson & Ex-officio
2	The Chairperson of the ZillaParishad of the district	Co-Chairperson
3	The Superintendent of Police of the district	Member
4	The Project Director, District Rural Development Agency (DRDA)	Member
5	The District Medical & Health Officer of the District	Member
6	The Joint Collector as the Chief Executive Officer of the ZillaParishad of the district	Member Convener

Along with critical organizations namely Police, Power, Communications, Roads & Buildings, Fire Department, Irrigation and Command Area Development and Medical & Health Department the DDMP integrates the Departments of Animal Husbandry, Agriculture, AP Civil Supplies, AP Civil Supplies

Corporation, Panchayati Raj, Fisheries and Rural Water Supply.

III. STRATEGIES FOR CYCLONE HUDHUD MANAGEMENT.

The following phase wise strategies are practiced effectively by district administration for disaster management:

3.1. Pre-Disaster Strategies



Early warning system is an effective under Cyclone Warning Centre, Visakhapatnam: India Meteorological Department. Through multiple methods of informing such as FM radio, location specific loud speakers and mobiles at tower area transmission, Billboard Scrolling along the streets etc. However, public address system needs to be reinforced. Cyclone warnings have levels. Based on the level of intensity, action plans for response and recovery should be chalked out. Although procedure remains largely the same, possible changes could be in terms of vulnerable location and level of arrangements. While, GVMC maintains data on the household property by taxation, the finance team should make the assessment of the vulnerable areas before the disaster. Commissioner initiates preparedness plan, the Disaster Operation Centre (DOC) receives information from CWC once. The plan of action of GVMC is within its spatial jurisdiction. At district level, the DOC is required to synchronize the action plan. Vulnerable localities are identified, especially that of fishermen along with the coast. For these vulnerable localities, Disaster Operation Road Network (DORN) should be regulated by authorized personnel. The DORN access should be denied to highly vulnerable areas along with provision of safety and security to property by authorized and trained personnel. Ward level personnel may be identified for training in such operations. Depending on the level of warning evacuation process should be taken up. Water, Food and medicine arrangements are made at cyclone shelters. Basic amenities should be provided for sleeping and toilets. Storage tanks, generators, cooking equipment and public addressing systems should be provided at the shelters. During the situational operations, the following activities should be organized that could engage people as capacity building. Children should be provided with entertainment to create stress free environments. To check and maintain the addresses of key members along with telephone numbers

To inspect damage prone roads, bridges, check dams, causeways, under forest department

To inspect periodically the buildings, residencies, high causeways under forest department

To arrange maps showing the details of area with statistical data

To approach roads under forest department and their condition including bridges, causeways, railway crossing etc.

To maintain equipment's available such as sharp instruments, insecticides, diesel generators, dumpers, generator, cutters, ladders, ropes, flood lights, shovels, axes, hammers, cable wires, fire equipment's, de-dusting equipment's which can be used during emergency and will also ensure that they are in working condition

To take care of public shelters, other places to be used for evacuation with primary facilities such as water

To prepare a list of public properties in the damage prone forest areas and will make advance arrangements to less damage

3.2. During Disaster Strategies

To immediately contact the district control room and will assist in the work

To ensure that the staff at headquarter is on duty

To assign the work to be done by the subordinate officers and staff regarding transportation under DDMP to their sites

To arrange for wireless, telephones, manpower, forest guard in advance to disseminate the information of the disaster in the damage prone areas and will play a key role with district administration to warn the public

To provide tree cutting equipment's if available with the local forest guards or beat officers

To make in advance arrangement for fuel wood and bamboos for priority areas

3.3. Post-Disaster Strategies

To follow the instructions of District Liaison Officer

To carry out the duty assigned for search and rescue work. Take Lead in Forest Belt

To engage the resources and manpower available to manage the disaster

To prepare a primary report of damage for the affected areas

To take actions to provide electricity, water and latrine to the temporary shelters in the forest areas
To send task forces with vehicles, tree cutters, ropes, flood light, generator in case of closure of roads due to felling trees.

For response and recovery, necessary equipment should be located both at the rehabilitation shelters and collection points (Parasuraman and Unnikrishnan, 2001)¹⁰. In the situation with updated contact details, voluntary serving medical aid, restaurants, provisional stores etc. should be well coordinated. Transport facilities may be procured from APSRTC, Public and Private Organizations having bus fleet by Schools and Colleges, and private operators for evacuation and transporting of people and materials. During evacuation, routes and destination should be clearly scheduled with GPS trackers. Proper registry of people and material should be maintained with strict limit in occupancy of the bus to avoid chaos and possible accidents. The finance team should quickly make loss assessment of the vulnerable areas with support from planning team. The DORN would be restricted to public access until the recovery operations are complete. The resource team finishes the recovery operations along with the help of ward level volunteers after the assessment is done to restore the infrastructure.

IV. CONCLUSION

The present study aims to generate up-to-date information on disaster usage and procedures for coastal cyclone vulnerability and risk management. In order to analyse the occurrence, severity and impacts of the natural hazards affecting the coastal Andhra Pradesh, this research systematically examines existing literature. The storm management in Andhra Pradesh has been organised and implemented with the commitment by all the participants involved in the various activities in view of the pre,

during and post-cyclone impacts. The damage was assessed swiftly. In the four districts of AP, Srikakulam, Vizianagaram, Visakhapatnam, and East Godavari were most affected by the cyclone Hudhud. The government is taking action and offering rapid assistance to relief efforts in rain-affected areas notified authorities. However, before danger can arise, further consideration is needed and sufficient funding should be allocated for this reason. Monitoring of mitigation and cyclone relief funds should be undertaken in a consistent manner due to different disasters and there is a need to increase the cost of cyclone relief wherever possible. It is also recommended to promote shelterbelt planting along the coast to minimise wind speeds as part of protective measures and to enable people especially farmers to grow disaster-resistant crops.

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