सत्यमेव जयते

DISASTER DAMAGES AND LOSSES

STUDY OF UNDERLYING CAUSES



Study on Cyclones Tauktae and Yaas

nidm
Resilient India - Disaster Free India

National Institute of Disaster Management

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FOREWORD



Global warming and resulting climatic conditions have triggered impacts resulting in disasters which further instigate severe physical, social and economic implications. For that instance, the high intensity cyclones which were rare until a few decades ago are now a frequent affair and occurring almost every year in India. A large section of the population is getting affected by frequently occurring disasters.

It is apt to state that in the era when disasters are not just natural and rare events, but climate change-induced (partially human-induced) and frequent, it is an alarming point for all to consider them as a threat to humanity if not tackled effectively and pro-actively.

The two recent cyclones (Tauktae, a tropical cyclone in the Arabian Sea and Yaas, a severe cyclone in the Bay of Bengal) affecting western and eastern coastlines in India left a devastating impact on lives and property. While our country is consistently working towards mitigating climate change, we need to focus more on this area. The need of the hour is to strengthen disaster resilience through disaster risk reduction and management with a specific focus on adaptation and preparedness.

This study intends to analyse and understand the factors that have led to the damages, including the fatalities, due to cyclones Tauktae and Yaas, and further to identify the recommendations for strengthening preparedness. Assessing the root causes behind the damages and losses due to the two cyclones in the affected areas will support in forming the basis for future disaster preparedness and preventive planning. It will also help in analysing the existing preparedness and warning mechanisms in these vulnerable states and subsequently identify the gaps in existing mechanisms.

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PREFACE



It gives me immense pleasure to present this study on 'Analyzing the damages due to cyclones "Tauktae" and "Yaas" and identifying the potential causes for the damages occurred' developed in collaboration with Sphere India that focuses on a very crucial aspect of assessing the damages and identifying the underlying causes due to frequently occurring climate change-induced disaster, cyclone. I strongly believe that this study will be valuable reference for the institutions, organizations, technical and non-technical personnel from the field if Disaster Risk Reduction and Disaster Management and other relevant stakeholders.

The study covers very significant objectives of assessing the physical, environmental and economic damages due to cyclones, identifying the key causative factors, solution-oriented recommendations and strategies and development of a "Methodological Framework" to be replicated in future similar scenarios.To objectively analyse the damages and identify potential causes of damages specific to each state, six domains of loss or damage due to cyclonic events are formulated: a. Damage & Loss of Human Lives b. Damage & Loss of Livelihoods c. Damage to Housing Structures d. Damage to Physical Infrastructure e. Damage to Social infrastructure and f. Damage to Environment.

The study derives specific and contextual recommendations and strategies for all the identified causes and challenges amplifying the damages during cyclones in the selected states for the study under four major levels: Governance-level, Physical (Infrastructural & Environmental)-level, Technical-level and Financial-level.

(Prof. Anil K Gupta)

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The report on 'Disaster Damages and Losses: Study of Underlying Causes- Case Study on Cyclones Tauktae and Yaas' has been developed based on consistent and focused efforts of all involved in the due course.

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Executive Summary

In recent years, the world has witnessed many extreme natural disasters, many of which can be attributed to the impacts of extensive climate change. India, in particular, has experienced a surge of extreme weather events recently, affecting both urban and rural areas. This study focuses on one such extreme weather event which can be highly attributed to changing climatic conditions and the resulting implication is in the form of a disaster i.e., Cyclones. The incidents of cyclones in the country have become a very frequent affair, more than it has ever been expected. The two recent cyclones (Tauktae, a tropical cyclone in the Arabian Sea and Yaas, severe cyclone in the Bay of Bengal), spreading across the western and eastern coastlines in India, have left devastating impacts on lives and properties. The damages were not only in the form of deaths and economic losses but have also left a deep impact on the environmental and social well-being of the affected areas. While the country (and the world at large) is consistently working towards mitigating climate change, the benefits of mitigation are much far to be experienced. The need of the hour is to strengthen disaster resilience through disaster risk reduction and management with a specific focus on adaptation and preparedness. To accomplish this, it has become necessary to shift focus towards analysing the damages caused by such events and identify the causative factors leading to the extent of damages experienced. It also highlights an important question that whether (or can) these damaging impacts could have been (or be) minimized? And if yes, then how? Hence, as indicative these are the definite questions this study intends to answer.

The identified objectives and the concrete outcomes from the study include:

a. assessing the physical, environmental and economic damages due to cyclones "Tauktae" and "Yaas" in the selected states,

b. identifying the key causative factors (exposure - to - hazard - related and vulnerability due to poor developmental and disaster management governance-related),

c. objectively-derived solution-oriented recommendations and strategies

d. development of a "Methodological Framework" to be replicated in future similar scenarios.

Considering the severity of impacts and damages, the four most critically affected states due to cyclone Tauktae (Gujarat and Maharashtra) and cyclone Yaas (West Bengal and Odisha) were selected as study areas to assess the damages due to the cyclones and identify the potential causes for the same.Further, to objectively analyse the damages and identify potential causes of damages specific to each state, six domains of loss or damage due to cyclonic events were formulated:

a. Damage & Loss of Human Lives

b. Damage & Loss of Livelihoods

c. Damage to Housing Structures

d. Damage to Physical Infrastructure

e. Damage to Social Infrastructure

f. Damage to Environment.

Under each of the identified domains of damage and loss, certain critical indicators are identified to understand and analyse the damages/losses while identifyingthe potential causes of damages/losses. Analysis dimensions of damages in each domain is intended to analyse the extent and impact on multiple levels of vulnerabilities like, gender-sensitive, age-sensitive, disability-sensitive, social marginalization-sensitive, economic-marginalization-sensitive, etc. The data requirement and collection methodology included detailed identification of data requirements for indicators formulated under each domain of damages and losses, determination of methods to measure or quantify each identified indicator under respective domains as well as identification of the potential data sources and data collection instruments to collect the data required. Multiple secondary and primary sources were identified, wherein data collection instruments included secondary data format/template for recording damages, household survey and key informant interviews at district/block/village level. For the purpose of geographical and numerical distribution of sample size at macro (district/block) and micro (village/ward) scale, stratified random sampling technique was utilized.

Assessment of the damages caused by the cyclones and the identification of potential causes for the same was further carried out through data analysis. Analysis of damages was conducted at two levels; first was state-level analysis to objectively understand type and extent of damages within each state at district and block level, second was inter-state analysis to gain insight in the patterns and variations in damages that occurred across the selected states for this study. Identification of causes and its variations across states provides detailed insights about the probable causes either exposure to hazard (cyclone intensity) related or vulnerability to cyclone (disaster management and development) related. The hazard intensity was experienced highest in Gujarat and West Bengal attributing evidently to the fact that these states faced maximum damages. Further, the discovery on causes aggravating the vulnerability of all 4 states revealed that the building bye-laws and standards critically lacked cyclone-resilient building construction guidelines and there was acute absence of dedicated codes for developing cyclone-resilient physical infrastructure. Land Use planning zoning regulations and development control regulations lacked DRR with special focus on cyclone resiliency in coastal regions. The disaster management governance related drawbacks include lack of periodic mapping, vulnerability and risk assessments, early warning systems ignorant of low literacy and digital divide factors, absence of area-specific, geography-specific or social diversity-specific evacuation plans at grassroot level, inclusivity-ignorant plans and policies, ineffective implantation of community-based preparedness and response approaches, siloed working mechanisms and finding crisis.

Further, most importantly, specific and contextual recommendations and strategies for all the identified causes and challenges amplifying the damages during cyclones in the selected states for the study were formulated under four major levels: Governance-level, Physical (Infrastructural & Environmental)-level, Technical-level and Financial-level. All the proposed solutions directly intend to reduce the extent of damages in each of the

identified six domains. This infers effective disaster management, resilient and diversified livelihood development, cyclone - resilient building and physical infra-structures, DRR-based LU planning and DCRs, vulnerability-based development, Nature based solutions, Eco-DRR, adaptative mechanism, etc., directly aiming to reduce damage/loss of human lives, livelihoods, housing, environment, physical and social infrastructure.

Hence, it is apt to conclude that in the era when disasters are not just natural and rare events but climate-changeinduced (partially humaninduced) and frequent, it is an alarming point for all to consider them as a threat to humanity if not tackled effectively and pro-actively.

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Introduction

INTRODUCTION

1

1.1 Background and Context

In recent years, the world has witnessed many extreme natural disasters, many of that can be attributed to the increased climate change impacts. India, in particular, has experienced a surge of extreme weather events recently, affecting both urban and rural areas. Cyclones, flash floods, intense wind and storms, heat waves, etc. are just some of the climate change-induced disasters which the country is facing every year.

This study focuses on one such extreme weather events that can be highly responsible to changing climatic conditions and the resulting implication in the form of a disaster i.e., Cyclones. The last few years have witnessed the incidents of cyclones in the country as a very frequent affair as compared to the previous records. The two recent cyclones affecting both sides of the coastline in India have left a devastating impact on both the lives and properties. The damages have clearly accounted the number of deaths, socio-economic losses and environmental switches in the affected areas. One of the two recent cyclones, 'TAUKTAE' (pronounced as Tau'Te) was a powerful, deadly and damaging tropical cyclone in the Arabian Sea that affected the western coastline of the country caused devastating and intense impacts in the coastal states of Gujarat and Maharashtra while other western coastal states like Kerala, Karnataka and Goa suffered lesser impacts of the same (The Weather Channel, 2021). Another severe cyclone, Yaas in the Bay of Bengal, thrusted upon the eastern coastline causing severe damages in the coastal states of West Bengal and Odisha including Bihar, Jharkhand and eastern Uttar Pradesh that were also affected. The cyclone Yaas caused the most damage in south Bengal and north-western Odisha (The Weather Channel, 2021).

In the light of these frequent disasters and the resulting destruction, it has become necessary to shift focus towards analysing the damages caused by such events and identify the causative factors leading to the extent of damages experienced. It also highlights an important question that whether (or can) these damaging impacts could have been (or be) minimized? And if yes, then how? Hence, as indicative, this study/project attempts to assess the losses and damages caused by the two recent cyclones based on the objectively identified indicators. Further, in the next stage, the study investigates preparedness measures and identifies the probable and possible causes which would have aggravated the damages or which would have failed to minimize the damages, thus providing deeper insights into the scenario. Based on this, accurate and solution-oriented strategies and recommendations can be followed to avoid the extent of destruction during future similar events.

1.2 Cyclones "Tauktae" and "Yaas" – About and their Impacts

1.2.1 Cyclone Tauktae

Extremely Severe Cyclonic Storm, Tauktae, was a powerful, deadly and damaging tropical cyclone in the Arabian Sea that became the strongest tropical cyclone to make landfall in the state of

Gujarat since the 1998 and one of the strongest tropical cyclones to ever affect the west coast of India. The second depression, first cyclonic storm, first severe cyclonic storm, first very severe cyclonic storm and first extremely severe cyclonic storm of the 2021 in the North Indian Ocean cyclone season, Tauktae originated from a tropical disturbance that was first monitored by the India Meteorological Department on May 13. The disturbance drifted eastward and organized into a deep depression by May 14. The storm soon took a northward turn, continuing to gradually intensify. The system strengthened into a cyclonic storm and was named Tauktae later that same day. Tauktae continued intensifying on May 15, reaching to severe cyclonic storm status later that day. Tauktae began to parallel the coast of the Indian states of Kerala, Karnataka, Goa and Maharashtra, before rapidly intensifying into a very severe cyclonic storm, early on May 16. Early on May 17, Tauktae intensified into an extremely severe cyclonic storm, reaching its peak intensity soon afterward. Later that same day, Tauktae underwent an eyewall replacement cycle and weakened Before re-strengthening, it neared the coast of Gujarat and made landfall soon afterward (India Meteorological Department, 2021).

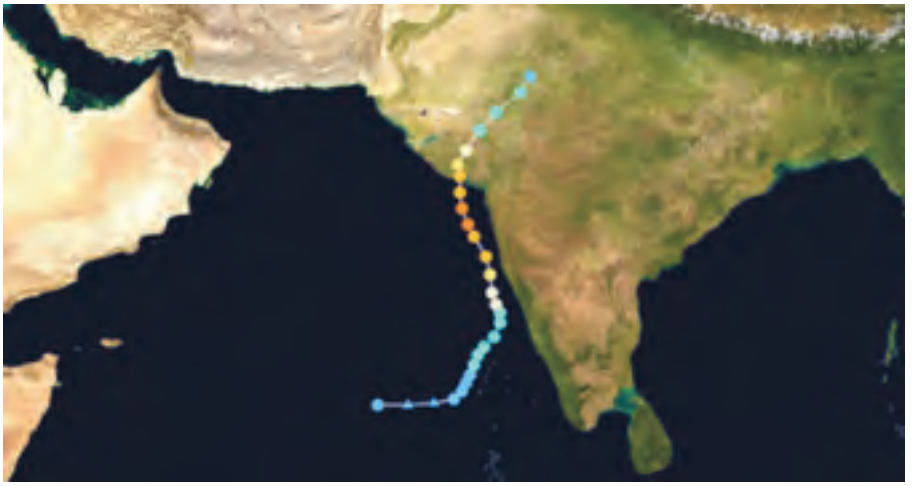


Figure 1: Map plotting the track and intensity of the storm
Source: Wikipedia, 2021 created using WikiProject Tropical cyclones/Tracks
(background image is from NASA and tracking data is from NOAA)

After making landfall, Tauktae gradually weakened as it turned north-east, moving further inland. On May 19, Tauktae weakened into a well-marked low-pressure area. It brought heavy rainfall and flash floods to areas along the coast of Kerala and on Lakshadweep. There were reports of heavy rain in the states of Goa, Karnataka and Maharashtra as well (Express, 2021).

In total, 169 people had died as a result of Cyclone Tauktae, with at least 80 others injured. 10 died in Kerala, 8 in Karnataka, 3 in Goa, 18 in Maharashtra, 64 in Gujarat while 66 died from the sinking of Barge P305. 11,774,038 people had been affected, 257,135 evacuated and over 56,846 houses destroyed (Reliefweb, 2021). 69,429 electric poles and 196 roads had been damaged. More than 40,000 trees had been uprooted. Water supply system in 5,951 villages were blighted too. Mumbai

also experienced impact of the storm, with airports being closed for safety reasons. RMSI Cyclone Model estimated the loss of 15,000 crore (US$2.0 billion) due to the cyclone.

Considering the severity of impacts and damages in the two most critically affected states due to cyclone Tauktae, Gujarat and Maharashtra were selected as study areas to assess the damages and identify the potential causes for the same.

1.2.2 Cyclone Yaas

Very Severe Cyclonic Storm, Yaas, was a relatively strong and very damaging tropical cyclone that made landfall in Odisha and brought significant impacts to West Bengal during late May 2021. The second cyclonic storm, second severe cyclonic storm and second very severe cyclonic storm of the 2021 during the North Indian Ocean cyclone season, Yaas formed from a tropical disturbance that the India Meteorological Department first monitored on May 23. Conditions in the basin favoured development as the system became a deep depression later that day, before intensifying into a cyclonic storm on the next day and received the name Yaas. The system further intensified as it turned to the northeast, becoming a severe cyclonic storm on May 24 despite moderate wind shear. Marginally favourable conditions further continued as Yaas accelerated towards north-east, strengthening into a Category-1equivalent tropical cyclone and to a very severe cyclonic storm on May 25. Yaas crossed northern Odisha coast around 20 km south of Balasore at its peak intensity as a very severe cyclonic storm on May 26. Upon landfall, the JTWC and IMD issued their final advisories as Yaas further weakened inland while turning north-north-westwards (India Meteorological Department, 2021).



Figure 2: Map plotting the track and intensity of the storm
Source: Wikipedia, 2021 created using WikiProject Tropical cyclones/Tracks
(background image is from NASA and tracking data is from NOAA)

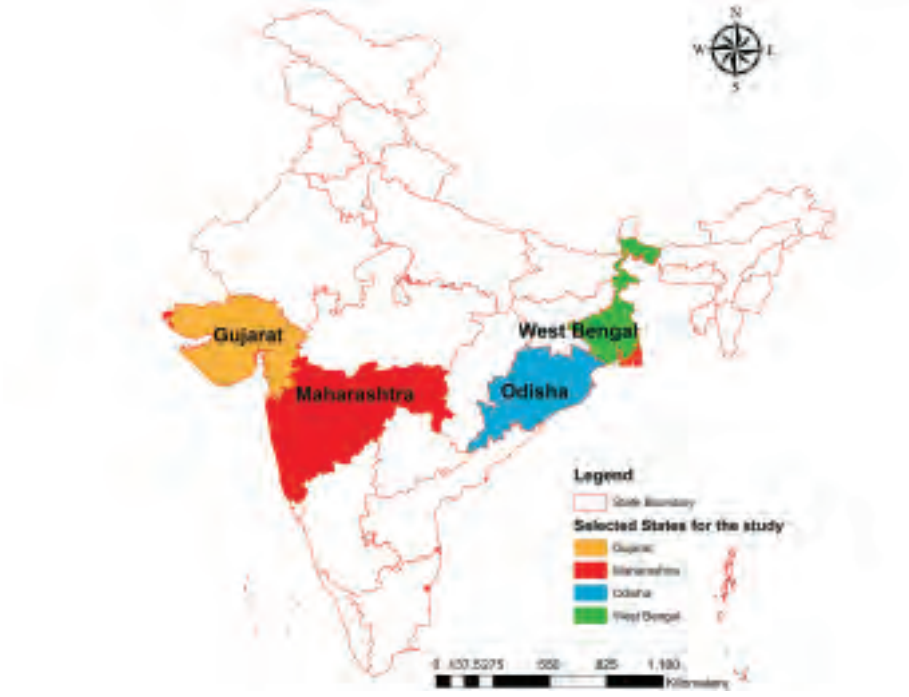
Farmlands throughout Odisha, West Bengal and some parts in Jharkhand were damaged by flooding, while small boats in the Bay of Bengal were damaged. Electrical lines in these states were knocked down causing thousands of power outages (TV18, 2021). In West Bengal, more than 4,500 villages were mutilated. Various rural homes and agricultural lands were hard-hit.Basic needs such as drinking water, sanitation and the like were also hard to come by. At least 143 marine vehicles were broken (Reliefweb, 2021). Despite the heavy rains in Odisha, many residents had been evacuated, so few people felt Yaas' impact. The state, however, was still heavily affected, with 120 village settlements being flooded and heavily damaged by the rains (CNN, 2021).

The total damages in West Bengal, the most heavily rammed Indian state by Yaas, were estimated to be around 20 thousand crore (US$2.76 billion)(India, 2021).

Considering the severity of impacts and damages in the two most critically affected states by the cyclone Yaas, West Bengal and Odisha were selected as study areas to assess the damages and identify the potential causes for the same.

1.3 Selected study areas (states) for the study

Cyclone Tauktae - Considering the severity of impacts and damages in the two most critically affected states due to cyclone Tauktae, Gujarat and Maharashtra were selected as study areas to assess the damages thus caused and identify the potential causes for the same.



Map 1: Selected States for this study
Source: Generated by Author, 2021 referring shapefiles from IMD

1.4 Study Objectives

1. Assessing physical, environmental and economic damages due to cyclones Tauktae and Yaas in the four critically affected coastal states of the country.
2. An objective understanding of the development-related and disaster management-related governance mechanism and framework triggering the exposure and vulnerability of the affected areas to multi-sectoral destruction.
3. Implementation and solution-oriented formulation of recommendations and strategies to effectively reduce risk and impacts during future cyclonic events.

1.5 Expected Outcomes

The outcomes or deliverables expected from the study are –

1. Analysis of type and extent of damages due to cyclones "Tauktae" and "Yaas" in 4 selected states.
2. Identification of the key causative factors (exposure to hazard-related and vulnerability-related) leading to the amplified extent of damage in each state.
3. Solution-oriented recommendations and strategies to act against the causative factors, thus minimizing the damages in future events.
4. Development of a "Damage and Cause Assessment Framework with potential solutions" as a methodology and proposed to be replicated in future scenarios.

1.6 Rationale of the study

In the times of unprecedented extreme weather events triggered by climate change impacts like temperature rise, sea-level rise, intense and frequent weather events, severe tropical cyclones affecting India sets the appropriate demonstration of the devastation these climate change-induced disasters can bring. While in 2021, there have been two major cyclones- Cyclone Tauktae and Cyclone Yaas, 2020 alone witnessed five cyclones formed over the north Indian Ocean - Amphan (super cyclonic storm), Nivar and Gati (very severe cyclonic storms), Nisarga (severe cyclonic storm) and Burevi (cyclonic storm).

While the country (and the world at large) is consistently working towards mitigating climate change, the benefits of mitigation are much far to be experienced. The need of the hour is to strengthen disaster resilience through disaster risk reduction and management with a specific focus on adaptation and preparedness. To accomplish this, it is imperative to understand the baseline situation of the extent of damage and its triggering factors. Thus, this study attempts to assess the losses and damages caused by the two recent cyclones based on the objectively identified indicators. Further, in the next stage, the study investigates the probable and possible causes which would have aggravated the damages or which would have failed to minimize the damages, thus providing deeper insights into the scenario. Based on this, accurate and solution-oriented strategies and recommendations can be followed to avoid the extent of destruction during future similar events. The study also intends to develop a replicable methodology that can be adopted with contextual revisions in similar other affected regions during potential future climatic disasters like cyclones.

1.7 Significance of the study in aligning towards Sustainable Development Goals, Sendai Framework for Disaster Risk Reduction and Climate Change Adaptation

Alignment with SDGs

The Damage Assessment Framework or Methodology formulated under the scope of this study effectively justifies its relevance, crucially considering the Sustainable Development Goals (SDGs) adopted by India as mentioned in the report SDG India Index. Out of the total 17 SDGs, this study aligns partially with the targets under 12 SDGs through the domains, their respective indicators and the analysis dimensions, identified and formulated for assessing the damage and loss in 4 Indian states due to extreme cyclonic events, such as, Tauktae and Yaas. The scope of the study considers critical goals like no poverty, zero hunger, gender equality, clean water and sanitation, reduced inequalities, climate action, life underwater, life on land, industry, innovation and infrastructure, sustainable cities and communities, good health and well-being. The following table explains the correlation between SDGs and respective targets and the components of the Damage Assessment methodology derived and adopted for this study.

Table 1: Table showing correlation and alignment of this study and the targets defined under SDGs

Targets under SDGs		Components of Damage Assessment Methodology
SDG 1 – No Poverty		
	1.4 By 2030, ensure that all men and women,in particular, the poor and the vulnerable, have equal rights to economic resources as well as access to basic services, ownership and control over land and other forms of property, inheritance, natural resources, appropriate new technology and financial services,including microfinance.	The methodology considers the vulnerability of socially/ economically marginalized, age-sensitivity and gender-sensitivity while assessing damages to livelihood, housing, environment, physical and social infrastructure.
	1.5 By 2030, build the resilience of the poor, especially those in vulnerable situations, and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters.	The assessment intends to identify causative factors and further propose solutions to build resilience and increase adaptability.
SDG 2 – Zero Hunger		
	2.4 By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality.	The methodology considers the damage caused due to disasters to the primary sector (agricultural-based) livelihood.

SDG 3 – Good Health and Well-being		
	3.3 By 2030, end the epidemics of AIDS, tuberculosis, malaria and neglected tropical diseases and combat hepatitis, water-borne diseases and other communicable diseases. 3.d Strengthen the capacity of all countries, in particular developing countries, for early warning, risk reduction and management of national Photo courtesy of Nilanjana Bose, UNFPA and global health risks.	Under the assessment framework, the health issues occurring as a result of the disaster is considered as a major factor in Damage to human lives. Also, the presence and effectiveness of early warning and preparedness are evaluated.
SDG 5 – Gender Equality		
	5.a Undertake reforms to give women equal rights to economic resources, as well as access to ownership and control over land and other forms of property, financial services, inheritance and natural resources, in accordance with national laws.	The methodology considers the gender-sensitivity while assessing damages to livelihood, housing and environment.
SDG 6 – Clean Water and Sanitation		
	6.6 By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes.	The methodology considers the damages to the environment under 4 major categories: water resources, land, vegetation cover and biodiversity.
SDG 9 – Industry, Innovation and Infrastructure		
	9.1 Develop quality; reliable, sustainable and resilient infrastructure, including regional and transborder infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all.	The methodology considers the vulnerability of socially/ economically marginalized, age-sensitivity and gender-sensitivity while assessing damages to physical and social infrastructure.
SDG 10 – Reduced Inequalities		
	10.2 By 2030, empower and promote the social, economic and political inclusion of all, irrespective of age, sex, disability, race, ethnicity, origin, religion or economic or other status. 10.4 Adopt policies, especially fiscal, wage and social protection policies, and progressively achieve greater equality.	In the assessment designed, damage to livelihoods is accounted with major consideration to impact on vulnerable classes, thus including gender, age and socio-economic marginalization. Further, the results of the assessment are intended to channelize appropriate recommendations for equal livelihood opportunities and security for all.

SDG 11 – Sustainable Cities and Communities		
	11.5 By 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations. 11.b By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels. 11.c Support least developed countries, including through financial and technical assistance, in building sustainable and resilient buildings utilizing local materials.	The assessment methodology directly attempts to quantify the damages caused to human lives and livelihood in the event of disasters (especially climate change-induced disasters). The ultimate aim of this study is to come up with implementable solutions and recommendations to foster mitigation, adaptation and resilience to climate-related hazards and disasters. One of the prominent causes of housing damage and an obvious solution to be incorporated as a part of this study is resilient and vernacular housing.
SDG 12 – Responsible Consumption and Production		
	12.2 By 2030, achieve the sustainable management and efficient use of natural resources.	The methodology considers the damages to the environment under 4 major categories: water resources, land, vegetation cover and biodiversity.
SDG 13 – Climate Action		
	13.1 Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries. 13.2 Integrate climate change measures into national policies, strategies and planning. 13.3 Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning. 13.b Promote mechanisms for raising capacity for effective climate change-related planning and management in least developed countries and small island developing States, including focusing on women, youth and local and marginalized communities.	The ultimate aim of this study is to come up with implementable solutions and recommendations to foster mitigation, adaptation and resilience to climate-related hazards and disasters.
SDG 14 – Life Below Water		
	14.2 By 2020, sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, including strengthening their resilience, and take action for their restoration in order to achieve healthy and productive oceans.	The methodology considers the damages to the environment with a specific focus on water resources and marine biodiversity.

SDG 15 – Life on Land		
	15.2 By 2020, promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally. 15.3 By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world.	The methodology considers the damages to the environment with a focus on forest land and vegetation cover.

Source: Generated by Author, 2021 referring SDG India Index, GoI, 2021

Alignment with SFDRR

The Sendai Framework for Disaster Risk Reduction (SFDRR), 2015-2030, has been adopted at third UN World Conference in Sendai, Japan. It provides action-oriented framework for reducing disaster risk and enhancing disaster resilience by setting out four priorities for action and seven global targets. SFDRR advocates for effective management of disaster risk rather than just the management of disasters.



Figure 3: SFDRR Global Targets
Source: United Nations, 2015

Based on the mapping of DRR mechanism and identification of causes of damages, the study proposes objective recommendations and strategies considering the intentions and objectives of SFDRR principles and targets.

Alignment with Climate Change Adaptation

The climate change we are experiencing is unprecedented in human history and has dramatic implications on every aspect of life, as evident by increasing instances of climate induced disasters (UNEP). National policies like National Disaster Management Plan (2019) and National Action Plan for Climate Change (NAPCC) address climate change as key thematic areas for disaster risk reduction, that, at sub national level, is adopted as State Action Plans on Climate Change (SAPCC). The study proposes objective recommendations and strategies considering the intentions and objectives of climate change adaptation at regional, local and community level.

1.8 Scope and Limitations of the study

The study proposes a damage-assessment framework to quantify and qualitatively analyse the destruction caused by cyclone Tauktae and Yaas in 4 coastal states i.e., Gujarat, Maharashtra and West Bengal, Odisha respectively. Though some other neighbouring states were also affected by the 2 cyclones, under the scope of this study these 4 prominently and intensely impacted states have been hand-picked.

Also, the study attempts to analyse the damages under defined categories: Damage and Loss to human lives, Damage to Livelihoods, Damage to Housing structures, Damage to Social Infrastructure, Damage to Physical Infrastructure and Damage to Environment. The idea is to cover all crucial domains of damages and losses caused due to cyclonic events. However, the scope has been limited to mainly physical, environmental and economical domains. For instance, social domain i.e., assessing the psycho-social component post-disaster has not been considered under the scope of damage assessment as a part of this study.

As a part of identifying the probable causes of damages, the factors contributing to or amplifying the damages in the affected area have been considered. The focus is on factors leading to increased exposure, risk and vulnerability while mainly analysing the governance and developmental domains. The study scope excludes causative factors in terms of anthropogenic reasons for inducing global warming and climate change, hence the climatic events/disasters.

Further, it is important to note that however the study attempts to conduct a holistic primary data-based analysis of damages and identification of potential causes to derive contextual and specific recommendations, the study faces limitations of data availability as constraint while collecting the pursued data from households and key informants. Hence, this must be kept in mind throughout the study.

*****



Domains and Indicators for Damage Assessment & Identification of Causes

Domains and Indicators for Damage Assessment & Identification of Causes

2

2.1 Identified Domains for assessing the Damages and potential Causes

Every year, millions of people are affected by both human-caused and natural disasters. These disasters can lead to extensive damages and have a huge impact on livelihood opportunities and on people's ability to cope with further stresses. Impacts such as loss of assets can lead to increased vulnerability of poor people and a "downward spiral of deepening poverty and increasing risk."

To assess the damages and losses due to Cyclone Tauktae and Cyclone Yaas in the study area, 6 indicators have been identified, focusing on the physical, environmental and economic damages, for a qualitative and quantitative analysis to accomplish the study objectives.

1. Damage and Loss of Human Lives

Disasters pose significant risk to the safety of human life along with health and well-being of the affected population. The risk may vary depending on various factors such as occupation, gender, age, social status, etc. Disasters may also lead to serious injuries, permanent disabilities and health concerns along with fatalities. Assessment of Damage and Loss of Human Lives will focus on quantifying the number of Deaths, Permanent Disabilities, Injuries, Health Issues, Missing people in the severely affected areas while analysing the factors contributing the increased risk and aggravated impact.

2. Damage to Housing Structure

Destructive climate-related events take a toll, especially in a vulnerable area, where individuals may already live-in unsafe housing and hazardous locations. Good housing conditions are a prerequisite for the well-being of a family. Housing is not only a shelter for a family to live in, but also in many cases, a setting for an economic enterprise. Housing restoration also emerges as one of the most critical recovery needed post disaster. To understand the extent of damage to housing and plan for resilience, the Assessment of Damages to housing structures will analyse extent of loss and the underlying factors that contributed to the extensive damage.

3. Damage and Loss of Livelihoods

When disasters strike, they have a direct impact on the livelihoods and food security of the affected population. Assessment of Damage and Loss of Livelihoods will look at understanding the livelihood patterns and occupational profile of a region and subsequent income productivity and economic losses in the study areas due to the cyclones.

4. Damage to Physical Infrastructure

The physical infrastructure essential for well-being of everyday functioning of people is frequently damaged due to disasters and affects people's lives adversely. The damage may result in disruption of services like water supply, sewerage disposal, outage of electricity, break in communications, collapse of buildings, roads and bridges, etc. After these direct impacts of disaster on

infrastructure, there could be secondary impact on the services of associated industries. Service failures may occur due to damaged infrastructure. Assessment of Damages to physical infrastructure will focus on Water Supply, Sewage Disposal, Drainage Network, Electricity and Telecommunication and Road Network, also analysing the damages, causes and the impact they have on the affected population.

5. Damage to Social Infrastructure

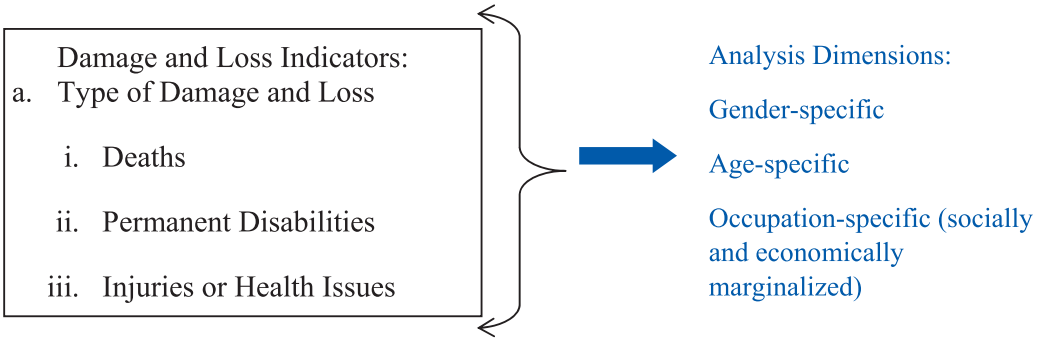
Social Infrastructure, a subset of the infrastructure sector includes assets that accommodate social services like health care, education, community facilities etc. Social infrastructure plays an important role in both the economic development and the development of society's quality of life by providing basic services and facilities. Damage to social infrastructure adversely impacts the recovery of the affected population. Assessment of Damage to Social Infrastructure will look at quantifying the losses and analyse the causes and impact.

6. Damage to Environment

Disasters create substantial environmental degradation and ecological imbalance. Any interaction of disasters and environment has both short-term and long-term effects. Various disasters can completely defoliate forests and cause other types of structural changes to ecosystems. Wildlife can be killed by the force of the disaster or impacted indirectly through changes in habitat and food availability. Endangered species are especially vulnerable when habitat is destroyed. Assessment of Damages to Environment will focus on damage to environmental components like Water Sources, Vegetation Cover, Land, Marine, terrestrial and wild life.

2.1.1 Formulation of Indicators to assess Damages

Under each of the identified domains of damage and loss, certain critical indicators are identified to understand and analyse the damages/losses as described below –



1. Damage and Loss of Human Life

The scope of the study includes critically analysing the causes that lead to fatalities in cyclone related incidents. To develop comprehensive understanding of the causes and subsequently strengthen the preparedness and EWS mechanisms, it is imperative to analyse the following

factors, that are to be included in questionnaire tools:

Cause of Death:

Cyclone and related incidents may lead to direct and indirect death:

- **Direct death:** Due to force of nature e.g., wind, flood water gushing, electric pole falling, tree falling, house collapse etc.
- **Indirect death:** Existing morbidity can also be a factor for death e.g., cardiovascular disease persons may die due to shock from disaster, prolonged stagnation of flood water can lead to water- and vector-borne diseases etc.

Time of Death (When):

Understanding in which phase of disaster the person has died:

- **Pre-disaster warning phase:** This will include documenting factors like receiving of alerts, understanding of alerts by next of the kin of the deceased, quality of evacuation support, fatalities during transportation for evacuation etc.
- **During disaster:** Understanding time of death, whether during search and rescue operations, due to untimely access to health care, quality/ mishap of/ during transportation to health facility, unsafe/ sanitary shelter conditions etc.
- **Post disaster:** Will include mostly indirect deaths due to existing morbidity or other health issues.

Who has died: (if any of these apply re-check on points under "When")?

Understanding who has died in such incidents, including their occupation and socio-economic conditions.

- First responder/ emergency support staff/ civil defense volunteer
- Differentially abled
- Lower socio-economic status
- Women headed households

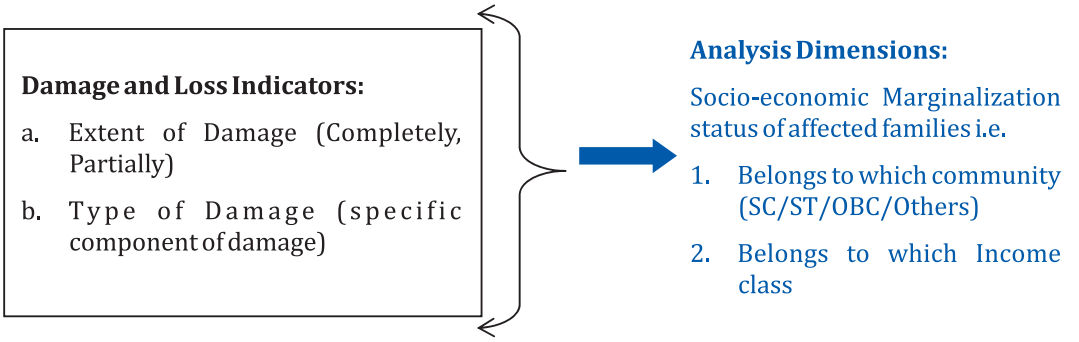
What was the person doing at the time of death?

Understanding geographical location and what person was doing at the time of death:

- Running to escape from hazard etc.
- Sleeping and unaware of situation (after receiving warning or no warning received)
- Was standing under a tree when lightning struck
- Was restoring critical service (power etc.)
- Fishing in sea or deep sea
- Was working in agriculture field

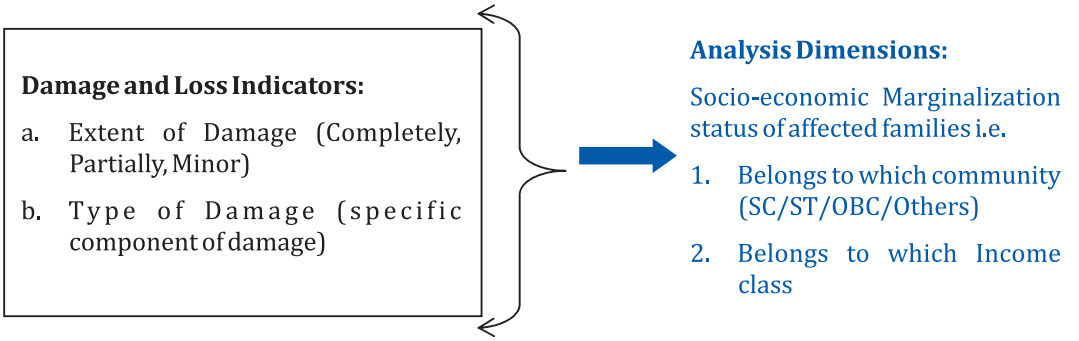
2. Damage to Physical Infrastructure

The scope of the study includes the following physical infrastructure - Water Supply, Sewage Disposal, Drainage Network, Electricity and Telecommunication and finally, Road Network

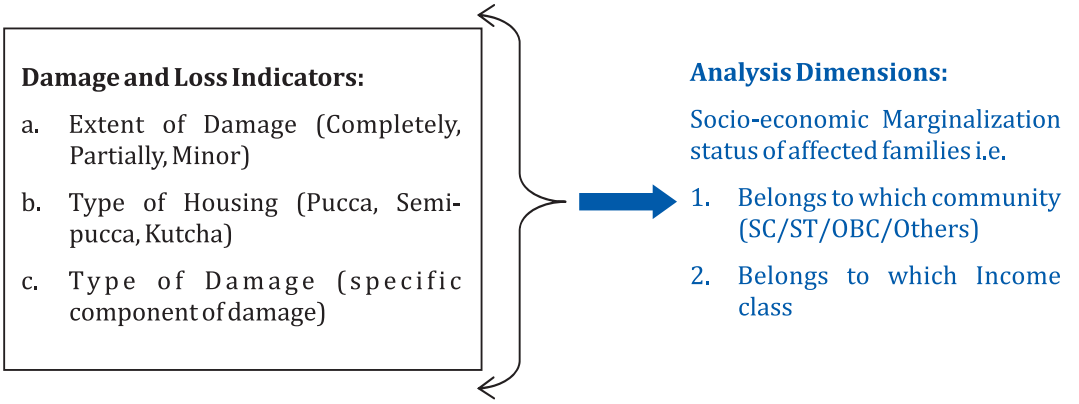


3. Damage to Social Infrastructure

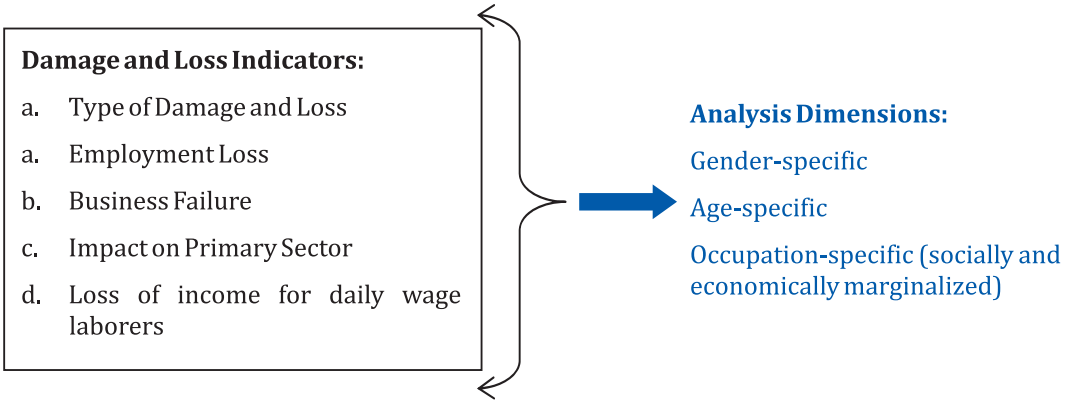
The scope of the study includes following social infrastructure - Health, Education, Administrative, Community and Religious Facilities



4. Damage to Housing Structure

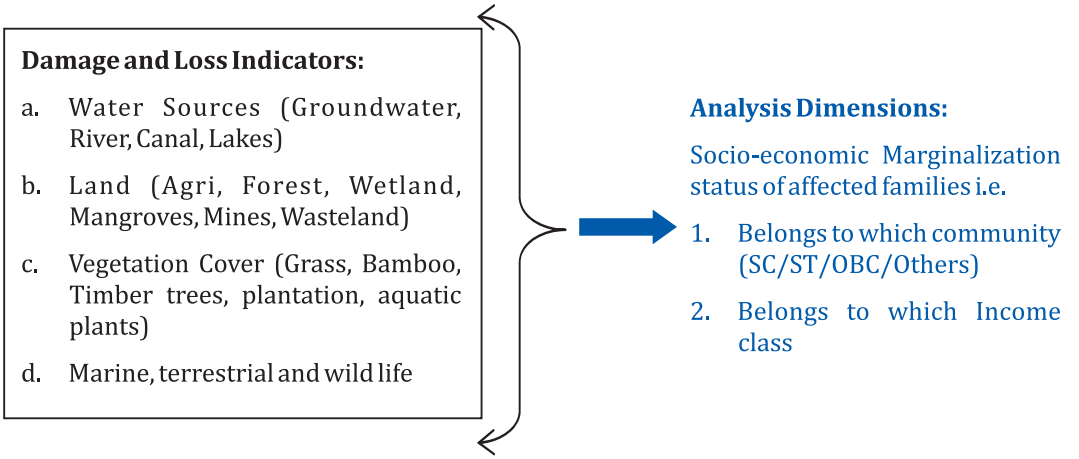


5. Damage and Loss of Livelihood



6. Damage to Environment

The scope of the study includes the following ecosystems - Agro, Forest, Freshwater and Coastal Ecosystem



2.1.2 Formulation of Indicators for identifying the potential Causes

Under each of the identified domains of damage and loss, certain critical indicators are identified to understand and identify the potential causes of damages/losses as described below:

1. Damage and Loss of Human Life

Damage and Loss Indicators:

a. Disaster Preparedness

b. Disaster Response

c. Development-related

2. Damage to Physical Infrastructure

The scope of the study includes the following physical infrastructure - Water Supply, Sewage Disposal, Drainage Network, Electricity and Telecommunication, as well as Road Network

Damage and Loss Indicators:

a. Hazard Vulnerability & Assessment

b. Structural Standards/Codes/Guidelines

c. Planning &Land Use-related Regulatory Mechanisms

d. Infrastructural Maintenance and Hazard Resistance

3. Damage to Social Infrastructure

The scope of the study includes following social infrastructure - Health, Education, Administrative, Community and Religious Facilities

Damage and Loss Indicators:

a. Hazard Vulnerability & Assessment

b. Structural Standards/Codes/Guidelines

c. Planning &Land Use-related Regulatory Mechanisms

4. Damage to Housing structures

Damage and Loss Indicators:

a. Hazard Vulnerability & Assessment

b. Structural Standards/Codes/Guidelines

c. Planning &Land Use-related Regulatory Mechanisms

5. Damage and Loss of Livelihood

Damage and Loss Indicators:

a. Dependency on Infrastructure

(identifying whether livelihood is affected due to disruption in any infrastructural services)

b. Resilient Livelihoods

(identifying whether livelihood is impacted due to absence of disaster-resilient practices of livelihood)

c. Livelihood Diversification

(identifying whether the affected families have source of livelihood in multiple sectors or not and which is the dominant source)

6. Damage to Environment

The scope of the study includes the following ecosystems - Agro, Forest, Freshwater and Coastal Ecosystem

Damage and Loss Indicators:

a. Adaptation and Resilience Measures

(identifying whether the damage to environment is due to absence of adaptative and resilient measures like nature-based solutions)



Data Requirement and Collection

Data Requirement and Collection

3

3.1 Data Requirement, Sources &Collection - Methodology and Instruments

This section attempts to answer the following 3 crucial questions –

Q1. What are the varying data requirements for different types of losses and damages which occur post-disaster?

Q2. How to measure or quantify the losses and damages?

Q3. What are the potential data sources and instruments to collect relevant data?

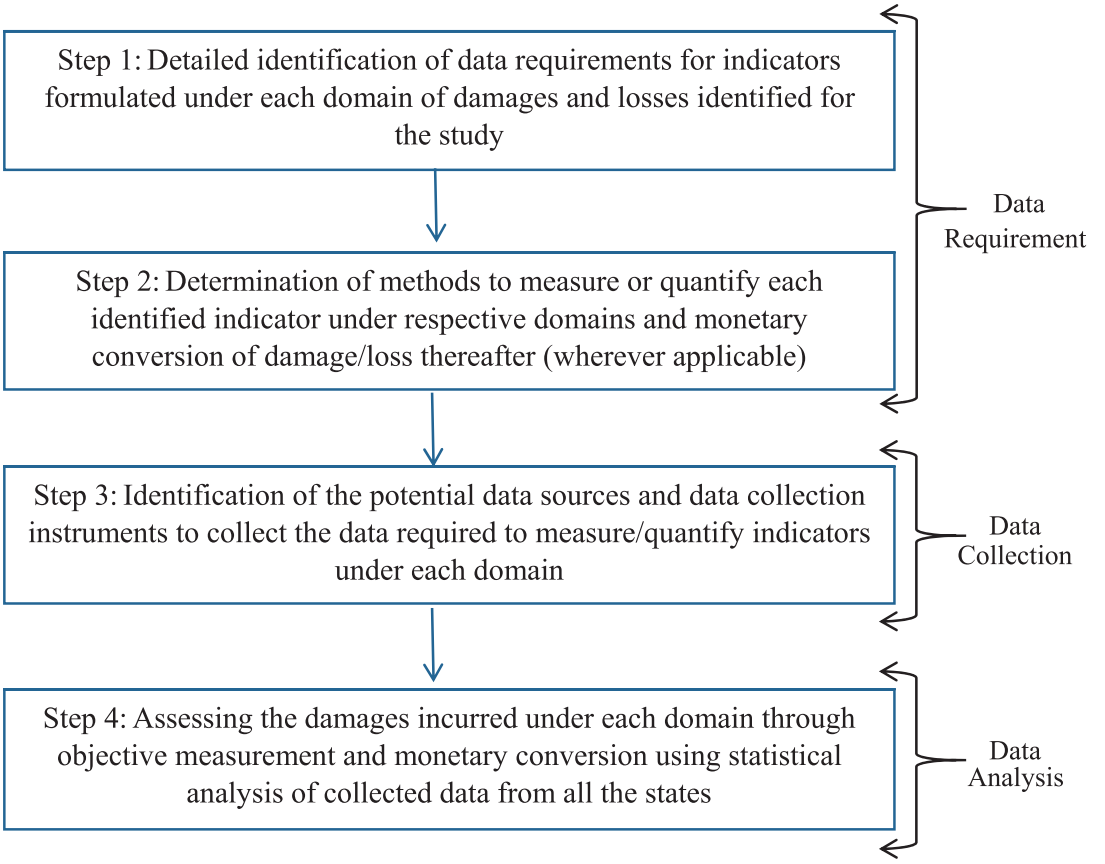


Figure 4: Data Requirement and Collection Methodology for the study
Source: Generated by Author, 2021

Step – 1 Detailed identification of data requirements for indicators formulated under each domain of damages and losses identified for the study

Step–2 The next step included the determination of methods to measure or quantify each identified damage and loss indicator and conversion of resultant values into monetary terms (wherever applicable).

Table 2: Methods to measure/quantify indicators under each domain of damage and loss

S. No.	Domain of Damage and Loss	Method to measure/quantify
1.	Damage and Loss of Human Life	1. Calculate the number of people under each type
2.	Damage to Physical Infrastructure	1. Calculate the quantity based on the extent and type of damage 2. Calculating the estimated cost of the damages based on each type and extent
3.	Damage to Social Infrastructure	1. Calculate the number of structures damaged based on the extent and type of damage 2. Calculating the estimated cost of the damages based on each type and extent
4.	Damage to Housing structures	1. Calculate the number of houses damaged based on the extent and type of damage 2. Calculating the estimated cost of the damages based on each type and extent
5.	Damage and Loss of Livelihood	1. Calculate the number of people and families affected under each type of loss/damage 2. Calculating the estimated daily/monthly loss of revenue/income
6.	Damage to Environment	1. Calculate the number of different types of water sources affected in terms of water quantity and quality 2. Calculate the amount of land affected due to varying reasons 3. Calculate the reduction in yield productivity/area and decline in species of vegetation 4. Calculate the number of marines, terrestrial or wildlife affected

Source: Generated by Author, 2021

Step–3 Once the data required is determined, the potential data sources and data collection instruments are identified for each domain as described below –

Table 3: Identified Data Sources and Data Collection Instruments for the study

S.No.	Type of Source	Data Sources	Data Collection Instruments
1.	Secondary Data Source	Media, Local Government and concerned departments Community Level Institutions	Post Disaster Need for Assessment Reports, Situation Reports, Media Reports, Government Reports
2.	Primary Data Source	Households, Community representatives, Observation-based, Local Government and concerned departments, Social Facilities	Questionnaire Survey, Interviews, Reconnaissance Survey, FGDs

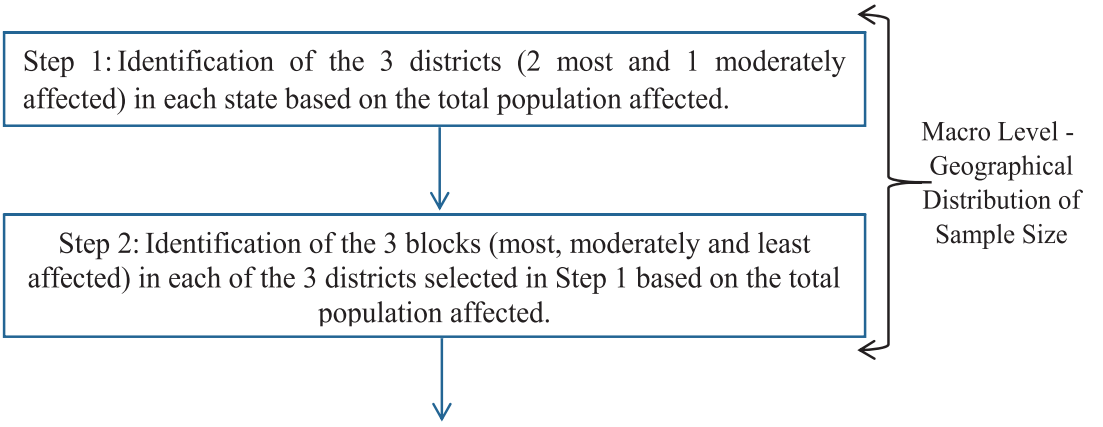
Source: Generated by Author, 2021

The secondary data collection format, HH Survey Questionnaire and Questionnaire for Local authorities/community representatives are attached in Annexure.

Step – 4 Post data collection, based on the method of quantification/measurement (Step – 3), the damages and losses that occurred in the affected states can be understood and analysed.

3.2 Sampling Technique and Sample Size Determination for Household Survey

In each of the 4 states finalized for this study, the sampling technique is determined using a methodology thus formulated.



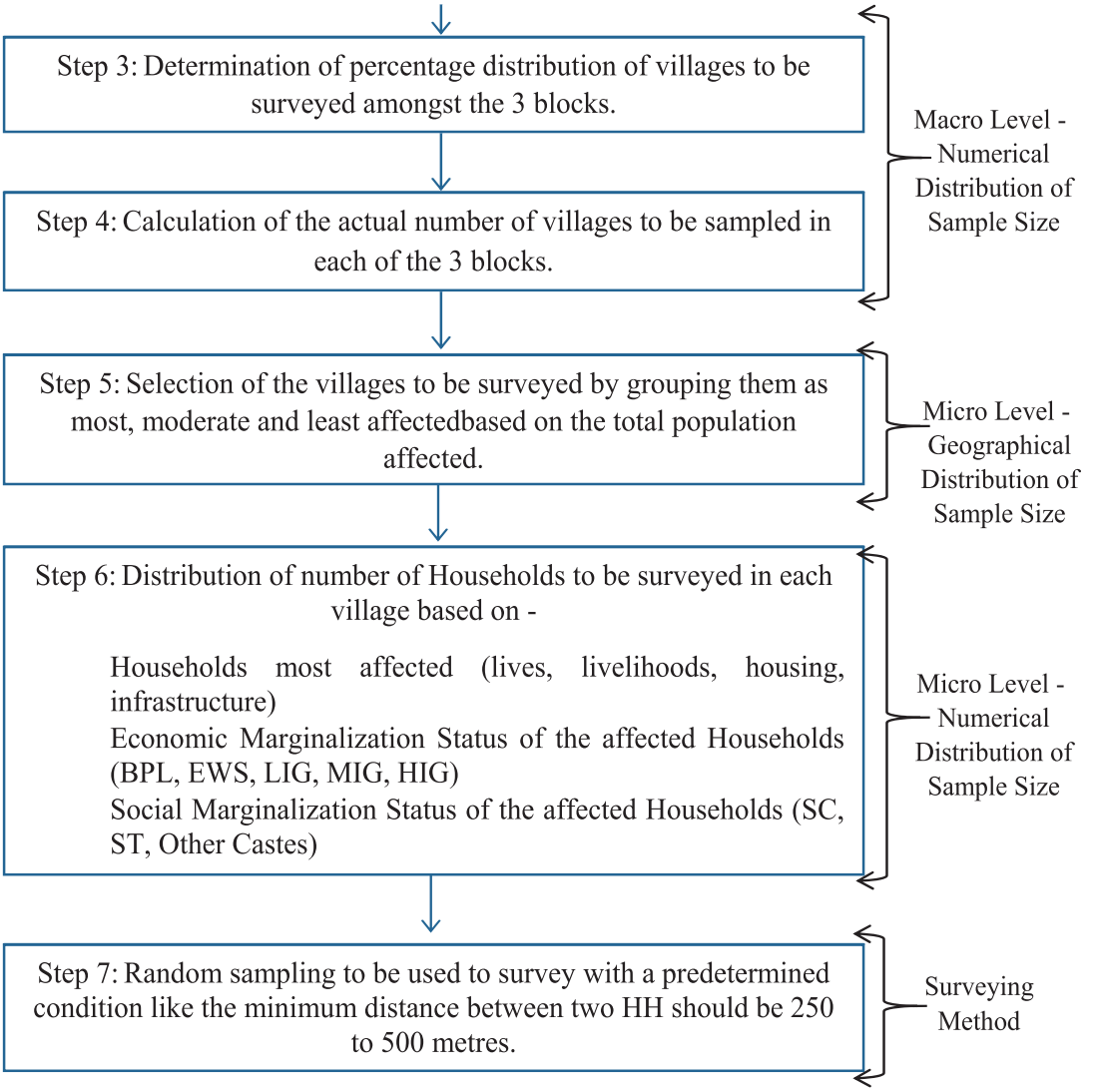


Figure 5: Sample Size Calculation and Sampling Technique Determination Methodology
Source: Generated by Author, 2021

Hence the sampling technique to determine the sample size for this study is **"Stratified Random Sampling."**

The total number of sample Household surveys to be considered for each district is100 **Households,** given the available resources and time.

Step – 1 Identification of the 3 districts(2 most and 1 moderately affected) in each state based on the total population affected. District level affected population data provided by the government will provide the most affected districts by the cyclones.

Step – 2 Identification of the 3 blocks (most, moderate and least affected) in each of the 3 districts selected in Step 1 based on the total population affected.

Step – 3 Determination of percentage distribution of villages to be surveyed amongst the 3 blocks is proportionately calculated based on the ratio of number of villages affected in each block to the total number of villages affected in that district.

> **Note –** The range of minimum number of villages to be taken in each block is 3 and the maximum number to be taken is 15 villages. Also, the number of minimum HH surveys to be taken in each village is considered as 10 households, covering all socio-economic groups.

Step – 4 To calculate the actual number of villages and households to be sampled in each of the 3 blocks, a backward-calculation approach is used.

The total number of samples to be taken in each district are decided as 100 HH and a 10 HH are to be surveyed in each village. Therefore, total 10 villages need to be distributed amongst the 3 blocks based on the proportion derived in Step 3. Hence, the proportionately distributed number of villages in each block gives the number of HH to be surveyed in each block.

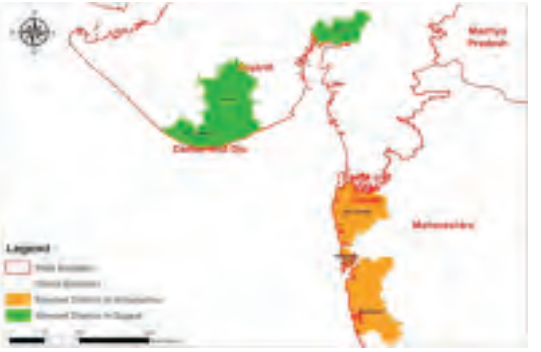
Step – 5 Once the sample size i.e., the number of villages and households to be surveyed in each block is determined, the villages to be surveyed is selected by grouping them as most, moderate and least affected. This will help in preparing a geographical map with the sample size (HH to be surveyed) distributed at the village level.

Step-6 The number of HH to be surveyed in each village (predetermined as 10 HH) must be proportionately distributed amongst the households based on the following factors -

- Households most affected (lives, livelihoods, housing, infrastructure)
- Marginalization Status of the affected Households (BPL, EWS, LIG, MIG, HIG)
- Social Marginalization Status of the affected Households (SC, ST, Other Castes)

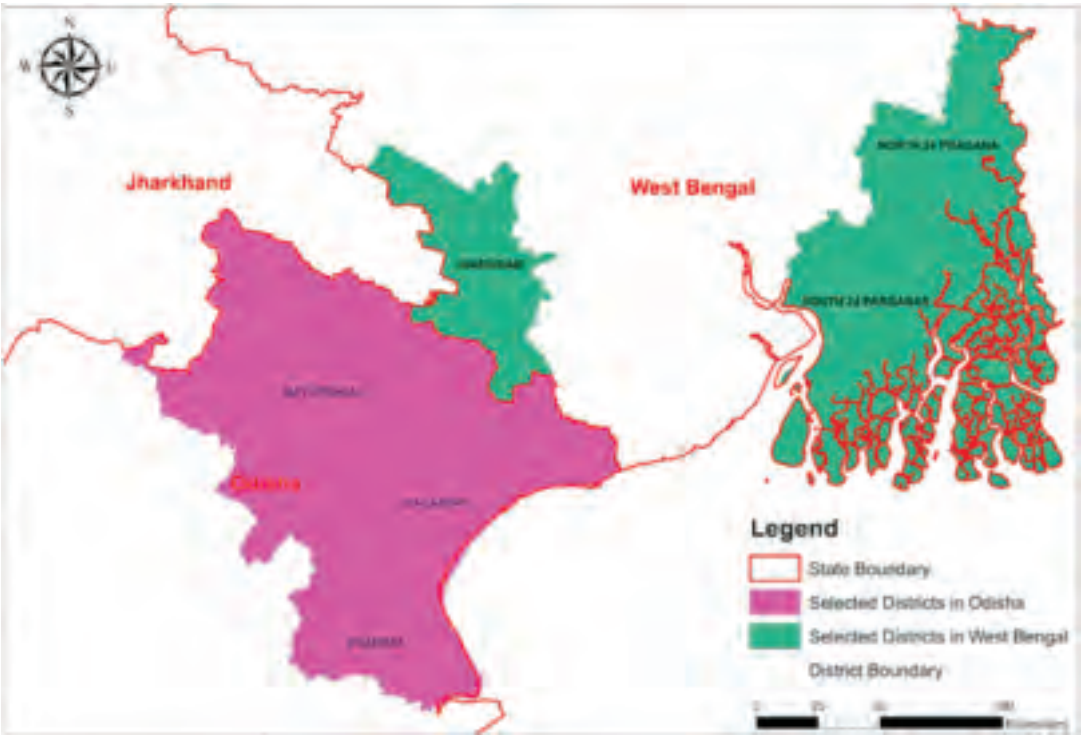
Step–7 After the sample size (number of HH to be surveyed) is distributed based on socio-economic class in each village, random sampling to be used to survey with a predetermined condition, like the minimum distance between two HH should be 250 to 500 metres.

3.3 State-wise Selection of Districts/Blocks/Villages and Distribution of Sample Size for Household Survey and Key Informant Surveys



Map 2: Selected Districts in Gujarat and Maharashtra
Source: Generated by Author, 2021 referring shapefiles from IMD

The selection of three districts to conduct the study was based on a "qualitative judgement approach". Two most and one moderately affected district were selected in each state i.e., Gujarat, Maharashtra, West Bengal and Odisha after due consultation and technical inputs from the state coordinators and ground level agencies. The factors during selection incorporates extent of damages, geographical coverage and type of settlements (rural/urban).



Map 3: Selected Districts in West Bengal and Odisha
Source: Generated by Author, 2021 referring shapefiles from IMD

Further, the selection of the most, moderate and least affected blocks in each of the identified districts also followed the similar approach. As explained in the previous section, the determined sample size for each district in 4 states in numerically and geographically distributed at macro and micro levels.

The selected areas and the distributed sample size for each state at all levels has been explained in detail in following sections.

3.3.1 Gujarat

Table 4: Name and Size of Sampled Villages in Selected Districts

District 1 -Amreli (Most affected)			
MOST AFFECTED BLOCK			
Amreli	**4 Villages (Min)**	**No. of Samples (HH)**	**No. of Samples (KII)** (Min)
	Vadhera	10	1
	Rohisa	10	1
	Bhada	10	1
	Kadiyali	10	1
MODERATELY AFFECTED BLOCK			
Khambaha	**3 Villages (Min)**	**No. of Samples (HH)**	**No. of Samples (KII)** (Min)
	Borala	10	1
	Kantala	10	1
	Chakrva	10	1
LEAST AFFECTED BLOCK			
Jafrabad	**3 Villages (Min)**	**No. of Samples (HH)**	**No. of Samples (KII)** (Min)
	Harpura	10	1
	Shedhubbhar	10	1
	Radadiyakhijadiya	10	1
1 KII at Block level 1 KII at District level			

Source: Generated by Author, 2021

Table 5: Name and Size of Sampled Villages in Selected Districts

District 2 -GirSomanath (Most affected)			
MOST AFFECTED BLOCK			
Una (ULB)	**4 Ward (Min)**	**No. of Samples (HH)**	**No. of Samples (KII)**(Min)
	Una Golden City	10	1
	Una Chandra Kiran Society	10	1
	Una Jasraj Nagar	10	1
	Una Ambawadi 2	10	1
MODERATELY AFFECTED BLOCK			
GirGadhada	**3 Villages (Min)**	**No. of Samples (HH)**	**No. of Samples (KII)**(Min)
	Kanakiya	10	1
	Zudavadi	10	1
	Juna ugala	10	1

LEAST AFFECTED BLOCK			
Kodinar	**3 Villages (Min)**	**No. of Samples (HH)**	**No. of Samples (KII)**(Min)
	Mityaj	10	1
	Velva	10	1
	Jithla	10	1
1 KII at Block level 1 KII at District level			

Source: Generated by Author, 2021

Table 6: Name and Size of Sampled Villages in Selected Districts

District 3 – Anand (Moderately affected)			
MOST AFFECTED BLOCK			
Khambhat	**4 Villages (Min)**	**No. of Samples (HH)**	**No. of Samples (KII)**(Min)
	Pandad	10	1
	Vadgam	10	1
	Mitali	10	1
	Tarakpur	10	1
MODERATELY AFFECTED BLOCK			
Tarapur	**3 Villages (Min)**	**No. of Samples (HH)**	**No. of Samples (KII)**(Min)
	Galiyana	10	1
	Varsdad	10	1
	Gorad	10	1
LEAST AFFECTED BLOCK			
Sojitra	**3 Villages (Min)**	**No. of Samples (HH)**	**No. of Samples (KII)**(Min)
	Runaj	10	1
	Palol	10	1
	Bhalada	10	1
1 KII at Block level 1 KII at District level			

Source: Generated by Author, 2021

3.3.2 Maharashtra

Table : Name and Size of Sampled Villages in Selected Districts

District 1– Palghar (Most affected)			
MOST AFFECTED BLOCK			
Dahanu	**4 Villages (Min)**	**No. of Samples (HH)**	**No. of Samples (KII)**(Min)
	Kalamdevi	10	1
	Dhundalwadi	10	1
	Kasa	10	1
	Ashte	10	1

MODERATELY AFFECTED BLOCK			
Palghar	**3 Villages (Min)**	**No. of Samples (HH)**	**No. of Samples (KII)** (Min)
	Arnala	10	1
	KelveMangaladevi	10	1
	Mahim	10	1
LEAST AFFECTED BLOCK			
Vasai	**3 Villages (Min)**	**No. of Samples (HH)**	**No. of Samples (KII)** (Min)
	ArnalaBachavpada	10	1
	Arnala	10	1
	Neelima Mangesh	10	1
1 KII at Block level 1 KII at District level			

Source: Generated by Author, 2021

Table 8: Name and Size of Sampled Villages in Selected Districts

District 2 –Raigad (Most affected)			
MOST AFFECTED BLOCK			
Mahad	**4 Villages (Min)**	**No. of Samples (HH)**	**No. of Samples (KII)** (Min)
	Kondivte	10	1
	Hirkaniwadi	10	1
	Ladwali	10	1
	Punade	10	1
MODERATELY AFFECTED BLOCK			
Poladpur	**3 Villages (Min)**	**No. of Samples (HH)**	**No. of Samples (KII)** (Min)
	Parle	10	1
	Loharmal	10	1
	Howre	10	1
LEAST AFFECTED BLOCK			
Mangaon	**3 Villages (Min)**	**No. of Samples (HH)**	**No. of Samples (KII)** (Min)
	Dongaroli	10	1
	Ghode pen	10	1
	Kegaon, Uran	10	1
1 KII at Block level 1 KII at District level			
Mumbai (Urban) (Moderately affected)			
MOST AFFECTED WARD			
		No. of Samples (HH)	**No. of Samples (KII)** (Min)
Cheetah Camp/Mandala -M/E ward		40	1

MODERATELY AFFECTED WARD		
Worlikoliwada - G/S ward	**No. of Samples (HH)**	**No. of Samples (KII)**(Min)
	30	1
LEAST AFFECTED WARD		
Colaba - A ward	**No. of Samples (HH)**	**No. of Samples (KII)**(Min)
	30	1
1 KII at Block level 1 KII at District level		

Source: Generated by Author, 2021

3.3.3 Damage to Housing structures

Table 9: Name & Size of Sampled Villages in Selected Districts

District 2 – Raigad (Most affected)			
MOST AFFECTED BLOCK			
Mahad	**4 Villages (Min)**	**No. of Samples (HH)**	**No. of Samples (KII)**(Min)
	Kondivte	10	1
	Hirkaniwadi	10	1
	Ladwali	10	1
	Punade	10	1
MODERATELY AFFECTED BLOCK			
Poladpur	**3 Villages (Min)**	**No. of Samples (HH)**	**No. of Samples (KII)** (Min)
	Parle	10	1
	Loharmal	10	1
	Howre	10	1
LEAST AFFECTED BLOCK			
Mangaon	**3 Villages (Min)**	**No. of Samples (HH)**	**No. of Samples (KII)** (Min)
	Dongaroli	10	1
	Ghode pen	10	1
	Kegaon, Uran	10	1
1 KII at Block level 1 KII at District level			
Mumbai (Urban) (Moderately affected)			
MOST AFFECTED WARD			
Cheetah Camp/Mandala -M/E ward		**No. of Samples (HH)** 40	**No. of Samples (KII)**(Min) 1

MODERATELY AFFECTED WARD		
Worlikoliwada - G/S ward	**No. of Samples (HH)**	**No. of Samples (KII)**(Min)
	30	1
LEAST AFFECTED WARD		
Colaba - A ward	**No. of Samples (HH)**	**No. of Samples (KII)**(Min)
	30	1
1 KII at Block level 1 KII at District level		

Source: Generated by Author, 2021

3.3.3 West Bengal

Table 9: Name & Size of Sampled Villages in Selected Districts

District 1 - 24 Pargans South (Most affected)			
MOST AFFECTED BLOCK			
Sagar	**4 Villages (Min)**	**No. of Samples (HH)**	**No. of Samples (KII)**(Min)
	Bankimnagar	10	1
	Sibpur	10	1
	Sumatinagar	10	1
	Chemaguri	10	1
MODERATELY AFFECTED BLOCK			
Pathar Pratima	**3 Villages (Min)**	**No. of Samples (HH)**	**No. of Samples (KII)**(Min)
	Durbachoti	10	1
	Gopalnagar	10	1
	Kishorinagar	10	1
LEAST AFFECTED BLOCK			
Namkhana	**3 Villages (Min)**	**No. of Samples (HH)**	**No. of Samples (KII)**(Min)
	Patigunia	10	1
	Nadavanga	10	1
	Iswaripur	10	1
1 KII at Block level 1 KII at District level			
District 2 - 24 Pargans North (Most affected)			
MOST AFFECTED BLOCK			
Hingalganj	**4 Villages (Min)**	**No. of Samples (HH)**	**No. of Samples (KII)**(Min)
	Rupamari	10	1
	Kumirmari	10	1
	Banstali	10	1
	Bhanderkhali	10	1

MODERATELY AFFECTED BLOCK			
Sandeshkhali - 1	**3 Villages (Min)**	**No. of Samples (HH)**	**No. of Samples (KII)**(Min)
	Bholakhali	10	1
	Nityaberiya	10	1
	Bora Sehara	10	1
LEAST AFFECTED BLOCK			
Sandeshkhali -2	**3 Villages (Min)**	**No. of Samples (HH)**	**No. of Samples (KII)**(Min)
	Atapur	10	1
	Manipur	10	1
	DwarirJangal (Sandeshkhali)	10	1
1 KII at Block level 1 KII at District level			
District 3 - Jhargram (Moderately affected)			
MOST AFFECTED BLOCK			
Jamboni	**4 Villages (Min)**	**No. of Samples (HH)**	**No. of Samples (KII)**(Min)
	Dharsa	10	1
	Enyata	10	1
	Bansoro	10	1
	Kalibandh	10	1
MODERATELY AFFECTED BLOCK			
Binpur - 2	**3 Villages (Min)**	**No. of Samples (HH)**	**No. of Samples (KII)**(Min)

Source: Generated by Author, 2021

3.3.4 Odisha

Table 10: Name and Size of Sampled Villages in Selected Districts

District 1 – Bhadrak (Most affected)			
MOST AFFECTED BLOCK			
Dhamnagar	**4 Villages (Min)**	**No. of Samples (HH)**	**No. of Samples (KII)**(Min)
	Sodha	10	1
	Gobindagadiya	10	1
	Karda	10	1
	Koleipada	10	1
MODERATELY AFFECTED BLOCK			
Basudebpur	**3 Villages (Min)**	**No. of Samples (HH)**	**No. of Samples (KII)**(Min)
	KismatKrusnapur	10	1
	Sana Krusnapur	10	1
	Bangaligheri	10	1

LEAST AFFECTED BLOCK			
Bhandaripokhari (ULB)	**3 Wards**	**No. of Samples (HH)**	**No. of Samples (KII)**(Min)
	Ward 6	10	1
	Ward 7	10	1
	Ward 11	10	1
1 KII at Block level	**1 KII at District level**		
District 2 - Balasore (Most affected)			
MOST AFFECTED BLOCK			
Baliapal	**4 Villages (Min)**	**No. of Samples (HH)**	**No. of Samples (KII)**(Min)
	Ambchua	10	1
	Dagara	10	1
	Kankadapal	10	1
	Chaumukh	10	1
MODERATELY AFFECTED BLOCK			
Sadar	**3 Villages (Min)**	**No. of Samples (HH)**	**No. of Samples (KII)**(Min)
	Municipality	10	1
	Parikhi	10	1
	Sindhia	10	1
LEAST AFFECTED BLOCK			
Bhograi	**3 Villages (Min)**	**No. of Samples (HH)**	**No. of Samples (KII)**(Min)
	Kumbhiragadi	10	1
	Badapahi	10	1
	Khadibil	10	1
1 KII at Block level	**1 KII at District level**		
District 3 - Mayurbhanj (Moderately affected)			
MOST AFFECTED BLOCK			
Kaptipada	**4 Villages (Min)**	**No. of Samples (HH)**	**No. of Samples (KII)**(Min)
	Podadiha	10	1
	Bhandaripal	10	1
	Ambapichhula	10	1
	Sarat	10	1
MODERATELY AFFECTED BLOCK			
Udala	**3 Villages (Min)**	**No. of Samples (HH)**	**No. of Samples (KII)**(Min)
	Kuchiladiha	10	1
	Jalada	10	1
LEAST AFFECTED BLOCK			
Gopabandhunagar	**3 Villages (Min)**	**No. of Samples (HH)**	**No. of Samples (KII)**(Min)
	Sainkula	10	1
	Kuamara	10	1
	Jaypur	10	1
1 KII at Block level	**1 KII at District level**		

Source: Generated by Author, 2021



Mapping existing Governance Mechanisms in each state

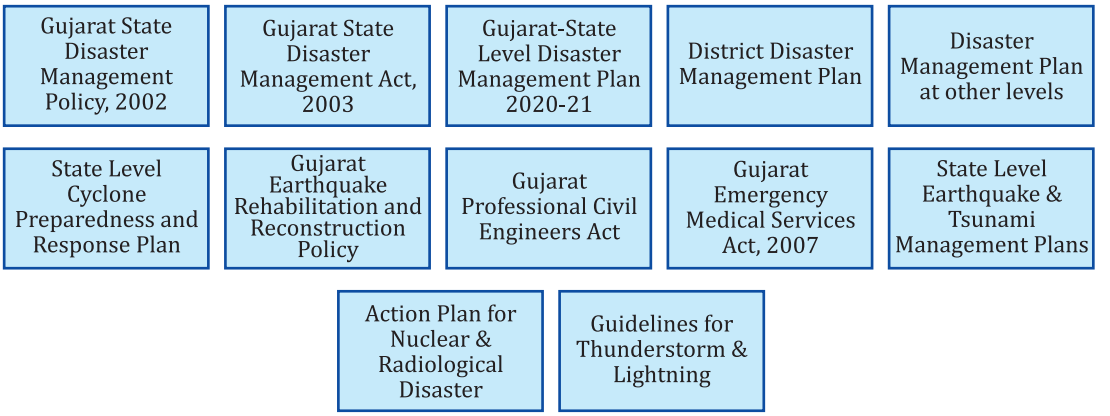
Mapping existing Governance Mechanisms in each state

4

4.1 Existing Disaster Management Mechanisms

4.1.1 Gujarat

Policies, Plans and Regulatory Frameworks



Source: Gujarat State Disaster Management Authority 2021, Gujarat State Disaster Management Plan 2020-21

State Level Cyclone Preparedness and Response Plan

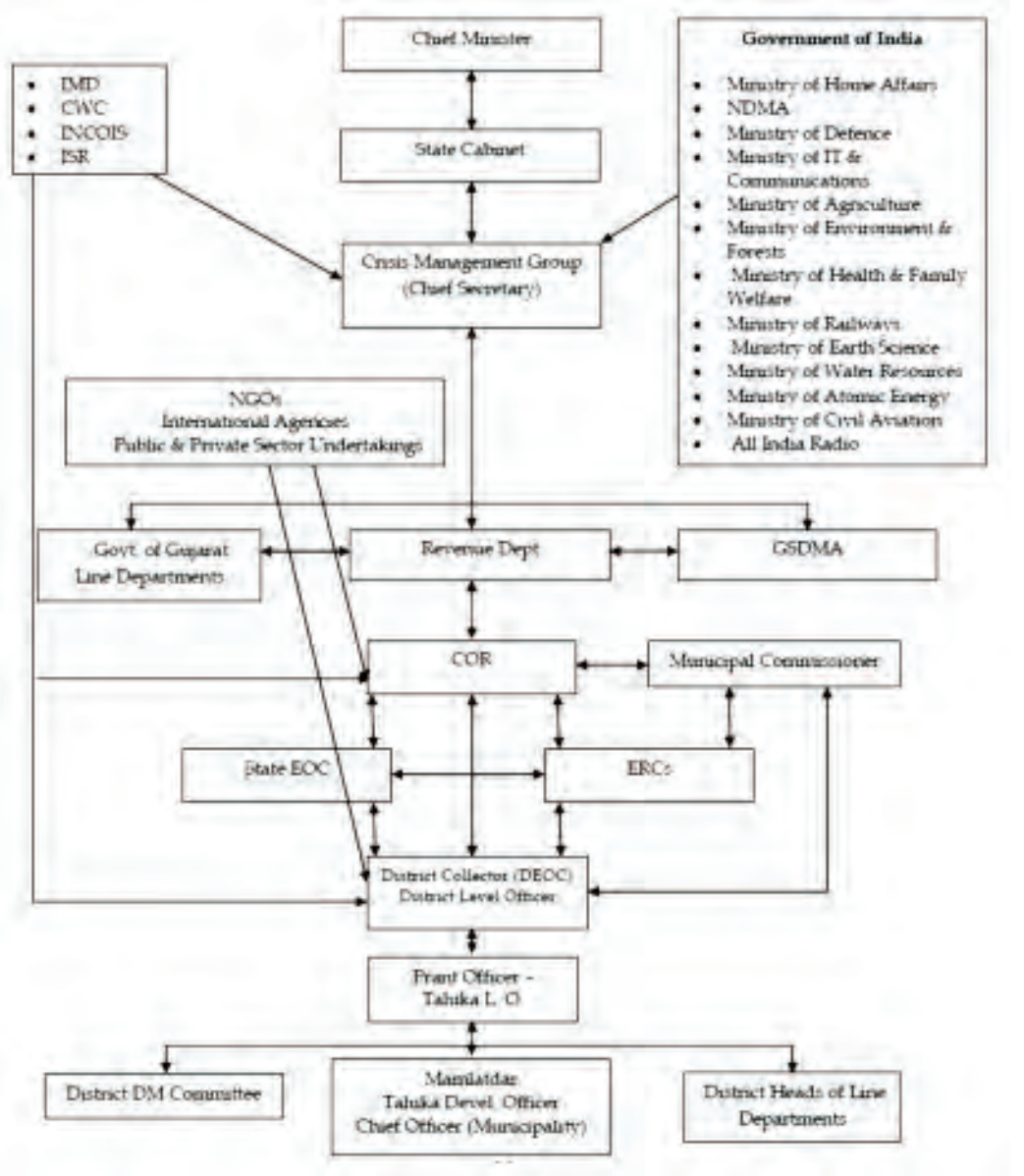
GSDMA has prepared a State Level Cyclone Preparedness and Response Plan to mitigate the effects of cyclone, associated floods and storm surge hazards.

The plan provides the cyclone vulnerability and risk assessment, preparedness measures to be undertaken by each and every department of the State Government, the existing system of cyclone forecasting and warning dissemination to various stakeholders and the measures to be taken by the concerned departments for emergency response. The plan has been circulated to all the relevant line departments of the State Government for its implementation.

Hazard and Vulnerability Assessment

GSDMA has prepared a comprehensive Hazard Risk and Vulnerability Atlas (HRVA) for the State covering six major hazards namely Earthquake, Tsunami, Flood, Cyclone, Drought, including Chemical and Industrial hazards. The Atlas can not only be used for hazard risk identification but also for risk reduction and activities related to future development planning in the State.

State level Cyclone Management Structure



Source: Gujarat State Disaster Management Authority, 2021

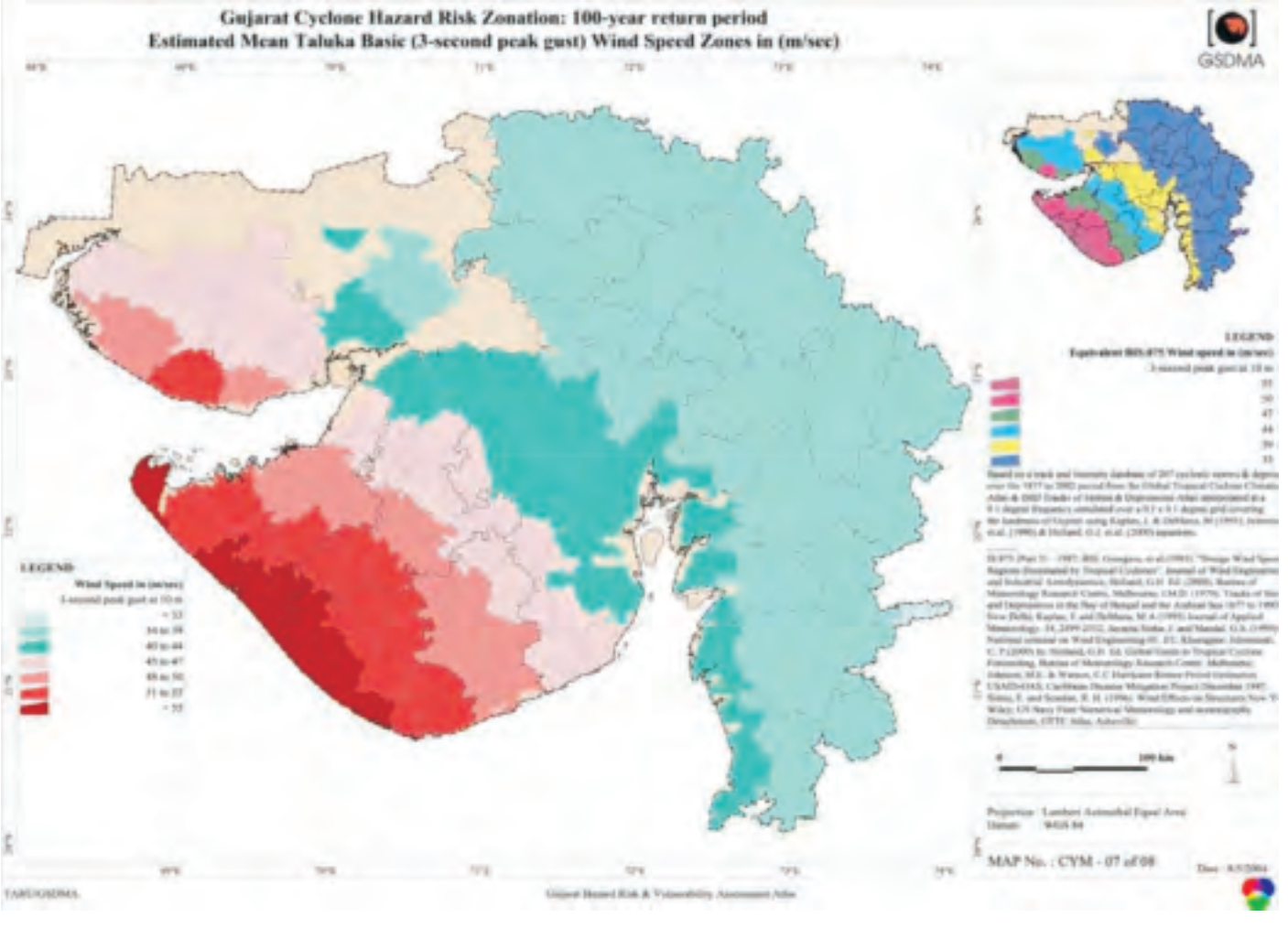


Figure 6: Gujarat Cyclone Hazard Risk Zonation
Source: Gujarat State Disaster Management Authority, 2021

Institutional Framework
(Organizational structure, coordination/collaboration, Capacities, etc.)

Agencies	Roles & Responsibilities
Gujarat State Disaster Management Authority (GSDMA)	• Promotes an integrated and coordinated system of disaster management including prevention or mitigation of disaster by the State, local authorities, stakeholders and communities. • Collect/cause to be collected data on all aspects of disasters & disaster management and analyze it and further conduct research& study relating to the potential effects of events that may result in disasters. • Acts as a repository of information concerning disasters and disaster management • Lays down the policies and plans for disaster management in the State. • Promotes or causes to promote awareness and preparedness, advices and trains the community and stakeholders (Gujarat State Disaster Management Authority, 2021).
Gujarat Institute of Disaster Management (GIDM)	• Provides training related to disaster management in close coordination with NIDM. • Undertakes activities for human resource development, public education and community awareness, safety etc. in disaster education and management
State Fire & Emergency Services	• Provides crucial immediate response during any disaster • Provides regular training to the fire staff in using and maintaining the equipment (Gujarat State Disaster Management Authority, 2021)
State Crisis Group	• Apex body in the state to deal with major chemical accidents and to provide expert guidance for the same • Reviews all district off-site emergency plans in the State with a view to examine its adequacy in accordance with the Manufacture, Storage and Import of Hazardous Chemicals, Rules and forward a report to the Central Crisis Group once in three months • Assists the State Government in the planning, preparedness and mitigation of major chemical accidents in state • Continuously monitor s the post-accident situation arising out of a major chemical accident in the State and forward a report to the Central Crisis Group (Gujarat State Disaster Management Authority, 2021)
Institute of Seismological Research (ISR)	• Engaged in dedicated seismological research • Monitors seismic activity of Gujarat round the clock thr ough a dense network of 50 broadband seismograph station (20 connected by VSAT) and 50 Strong Motion Accelerograph in Gujarat • Reports earthquake location along with magnitudes within 10 minutes of the arrival of seismic waves • Engaged in seismic microzonation of areas prone to earthquakes • Provides consultancy services to various private companies in feasibility studies related to seismicity of the area prior to establishing a major project (Gujarat State Disaster Management Authority, 2021)

Bhaskaracharya Institute for Space Applications and Geo-Informatics (BISAG)	• State level nodal agency to facilitate the use of spatial and geo-spatial technologies for the planning and developmental activities pertaining to agriculture, land and water resource management, wasteland development, watershed development, forestry, disaster management, infrastructure and education. • Provides specialized services and solutions in implementing map-based Geo-Spatial Information Systems. • Provides GIS solutions for disaster management and specialized needs of Public Safety agencies like police, fire and ambulance services. • Provides e-governance solutions to address varying GIS and MIS needs of governments and municipal corporations(Gujarat State Disaster Management Authority, 2021).
State Disaster Response Force (SDRF)	• GSDMA, through the Home Department, has created 11 State Disaster Response Force (SDRF) Companies with a total strength of around 1000 personnel • 11 Companies of SDRF are stationed at Vadodara (2 Companies), Ahmedabad, Madana, Godhra, Nadiad, Gondal, Valiya, Vav, Gandhinagar and Rajkot. • A list of equipment s to be procured for providing training to the SDRF teams has also been finalized with inputs from NDRF, Gandhinagar • Training of SDRF has started in Basic Course; two teams of 77 personnel have been trained so far. Personnel trained in Basic Course will further be trained in Specialized Courses through NDRF and other training Institutes(Gujarat State Disaster Management Authority, 2021).

Source: Gujarat State Disaster Management Authority 2021, Gujarat State Disaster Management Plan 2020-21

Cyclone Tauktae Response by State Government

Review and Coordination by State government

- CM joined a virtual review meeting from Bhavnagar convened by Union Home Minister to assess preparedness for cyclone and assured to take all necessary measures, specifically for COVID care, as advised by Union Home Minister.
- Gujarat CM reviewed the situation in the coastal Valsad and Gir Somnath districts through telephonic hotline from the State Control Centre late in the night and directed the collectors to deal with the situation with 'Zero Casualty' approach. PM spoke to CM on the related situation & preparedness in the State and assured all assistance & support from the Centre.
- In the wake of Tauktae, CM announced the suspension of Corona vaccination drive for the next two days i.e., May 17 & 18 - Monday & Tuesday, and urged citizens to remain indoors considering the possibility of heavy rains along with cyclone in the state.
- The CM of Gujarat conducted meeting with CM of Maharashtra to assess the impact caused by the cyclone in two states.

Preparedness and Response of Districts

- District Gir Somnath, Kutch, Devbhumi Dwarka, Porbandar, Bhavnagar and Vadodara setup control rooms and deployed dedicated teams to handle areas in case of emergency. District

Collectors also called emergency meetings and instructed team to manage rescue & relief as per COVID safety guidelines.

- District Helplines were activated and extended till Taluka.

Evacuation

- 2,38,808 people of 23 coastal and adjoining districts shifted to safer places/relief camp. COVID patients from affected areas were also shifted to safer areas and hospitals.

Deployment of Response Forces

- 10 teams of SDRF along with local police, SRP, Home guard, Aapdamitra had been deployed in effected districts.
- More than one lakh cops, including 13,000 home guards, 30,000 Gram Rakshak Dal (GRD) jawans had been deployed in Saurashtra region.
- Police was also doing patrolling in interior areas to assess the situation.
- The state government had deployed rapid restoration teams to clear roads and restore electricity.

Compensation

- The Gujarat government has approved a compensation of Rs. 4 lakh each to the kin of those who have died due to various incidents related to cyclone Tauktae that ravaged coastal areas of the state. PM announced ex gratia compensation of Rs 2 lakh each for the families of those killed and Rs 50,000 for those injured.
- State government has provided help to cyclone Tauktae-hit fishermen, with assistance in repairing their damaged boats and houses apart from the financial aid.
- Government of Gujarat has announced financial assistance for Cyclone Tauktae damaged and destroyed houses. For fully damaged pukka house Rs. 95,100/-, partially damaged pukka/ semi pukka house Rs. 25,000/- and damaged kutcha house Rs. 10,000/- and for damaged Cattle shed Rs. 5,000/-.

4.1.2 Maharashtra

Policies, Plans and Regulatory Frameworks

Maharashtra Disaster Management Plan 2016	Maharashtra Disaster Risk Reduction Programme	District Disaster Management Plan

Source: Maharashtra State Disaster Management Authority 2021, Maharashtra State Disaster Management Plan 2016

Hazard and Vulnerability Assessment

Hazard, Risk Assessment and Vulnerability Mapping has been done for Earthquake, Flood, Cyclone, Drought and Landslide as according Maharashtra Disaster Management Plan 2016.

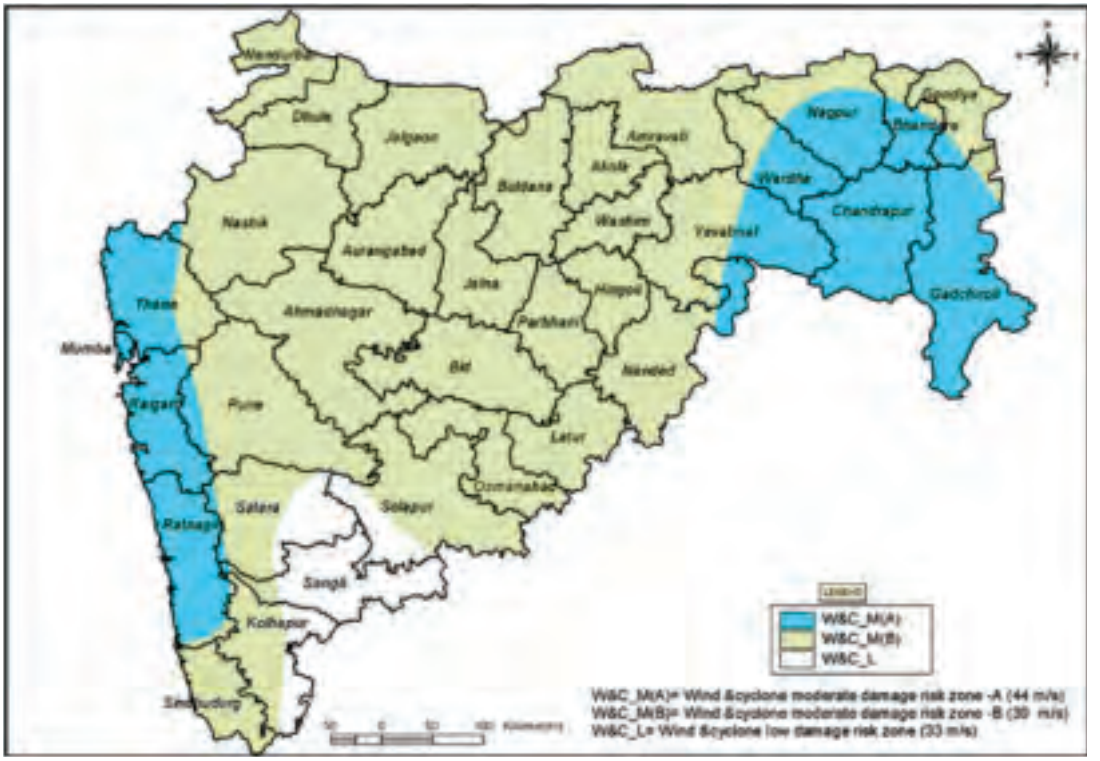


Figure 7: Maharashtra- Wind and Cyclone Risk Zone
Source: Maharashtra State Disaster Management Authority, 2016

Institutional Framework
(Organizational structure, coordination/collaboration, Capacities, etc.)

Maharashtra State Disaster Management Authority, 2006	Relief and Rehabilitation] Department, Government of Maharashtra (India)	State Emergency Operation Center (SEOC)	State Executive] Committee (SEC)
State Disaster Response Force (SDRF)	State Emergency Operation Centre (SEOC)	Divisional Disaster Management Coordinators (DDMCs)	District Disaster Management Officers (DDMOs)
	Regional Disaster Management Centres (RDMCs)	District Disaster Management Authority (DDMA)	

Source: Maharashtra State Disaster Management Authority 2021,
Maharashtra State Disaster Management Plan 2016

Cyclone Tauktae Response by State Government

Review and Coordination by State government(Sphere India , 2021)

- The Dy. Chief Minister reviewed the preparedness activities with senior officials to manage the cyclone.
- The Hon'ble CM took stock of the damage of fishing boats. He also took stock of the interrupted Air & Rail services from the relevant departments.

Dissemination of Warnings and Bulletins(Sphere India , 2021)

- The government disseminated high alerts in coastal areas. Government of Maharashtra had sent general alert to the district administrations and ensured evacuation of at-risk population to safe places and related preparedness.

Preparedness of Districts(Sphere India , 2021)

- Precautions had been taken to ensure that the power supply to COVID hospitals ought not to be disrupted. Alternate electricity supply arrangements were also in place. Patients in three COVID care centres in Mumbai were relocated to safer facilities with priority.
- Structural changes were made in the Jumbo COVID centres so that water did not enter the centres and no leakages in the tent were seen. But evacuation was still needed.
- Provisions had been made to continue the electricity supply in all the COVID hospitals.
- Shelters like schools, etc. were prepared in line with COVID protocols, if required.
- All public facilities were kept in a state of readiness with power back-up and essential medicines.

Identification of Shelters(Sphere India , 2021)

- Temporary shelters were set up across the Mumbai city.
- 193 COVID-19 patients admitted in a makeshift center in Mumbai's Bandra-Kurla Complex had been shifted to other BMC-run hospitals due to the heavy rains that lashed the city.

Evacuation Plan(Sphere India , 2021)

- 13,425 persons were evacuated to safer place/relief camps
- 3 Jumbo COVID care Centres were evacuated. 230 COVID-ICU patients in the Jumbo COVID Centres across Mumbai were shifted safely to other hospitals.

Communication(Sphere India , 2021)

- Police and other officials are deployed.Mantralaya control room was in sync with district control room for emergency operations.
- The police had been asked to maintain close coordination with the Brihanmumbai Municipal Corporation officials ward-wise to implement mitigation measures.

4.1.3 West Bengal

Policies, Plans and Regulatory Frameworks



Source: West Bengal Disaster Management and Civil Defence Department 2021, West Bengal State Disaster Management Plan 2015-16

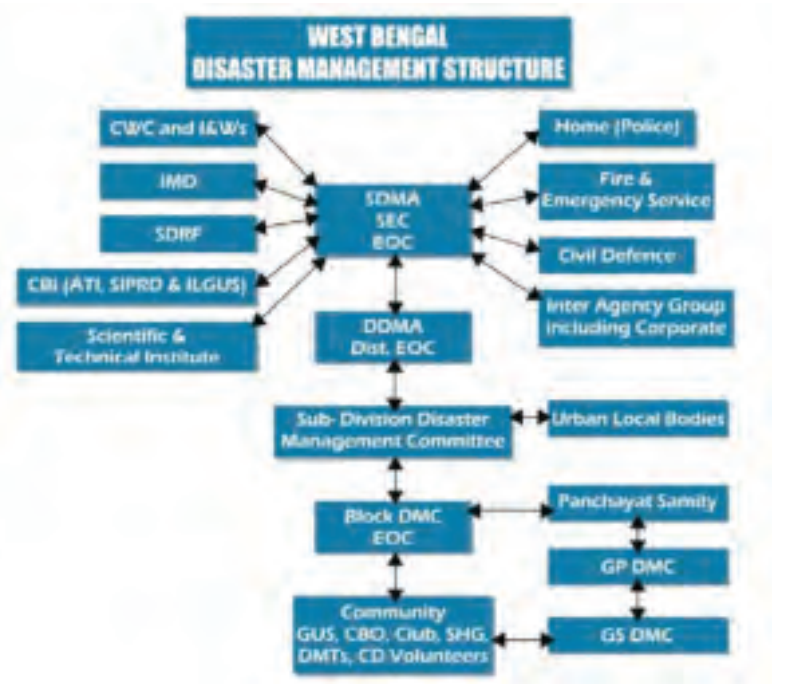
Hazard and Vulnerability Assessment

Vulnerability of the state against disasters like Flood, cyclone, Earthquake, Tsunami, Landslide, Heatwave and Drought have been mapped by the State in Disaster Management Plan.



Figure 8: Cyclone Vulnerability Map- West Bengal
Source: West Bengal Disaster Management and Civil Defence Department, 2021

Institutional Framework
(Organizational structure, coordination/collaboration, Capacities, etc.)



Source: West Bengal State Disaster Management Authority, 2016

Agencies	Roles & Responsibilities
Directorate Of Disaster Management:	• The Government of West Bengal emphasised to prioritize the system of Disaster Management and for this purpose, brought two different Departments, Department of Disaster Management and Civil Defence under one minister so that it becomes easier to effectively coordinate in crisis and ensure holistic disaster management. • A direct outcome of this merger is running of the State Control Room 24X7 on all days of the year with the staff from the Departments of Civil Defense & disaster Management. (West Bengal Disaster Management and Civil Defence Department, 2021)
State Disaster Response Force (SDRF):	• States are encouraged to create response capabilities from within their existing resources. To start with, each State may aim at equipping and training a few companies in smaller states or one battalion equivalent force in the case of bigger states. • They will also include women members for looking after the needs of women and children. NDRF battalions and their training institutions will assist the States/UTs in this effort. • The States/ UTs will also be encouraged to include DM training in the basic and in -service courses of their respective Police Training Colleges for gazette and non-gazette police officers.

	• Status of Constitution of State Disaster Response Force: Seven Companies from West Bengal SAP Battalion and three from Kolkata Police have been working as State Disaster Response Force (SDRF). (West Bengal Disaster Management and Civil Defence Department, 2021)
State Emergency Operation Centre (EOC):	• EOC is an off-site facility functioning from State / District HQ. The EOC will take stock of the emerging situation and assist the incident managers in mobilizing the respective line department resources, manpower and expertise along with appropriate delegated authorities for the on-scene actions / responses. • State EOC will keep the DEOC and field EOC informed of the changing situation and support extended. Emergency communication, SMS alert & warning system, decision support system and resources management system are few of critical components inbuilt into State EOC i nfrastructures. The basic functions of EOC, derived on the basis of functional framework of disaster management would be to: • Receive, monitor and assess disaster information. • Keep track of available resources. • Monitor, assess and track response units & resource requests. • Manage resource deployment for optimal usage. • Make policy decisions and proclaim local emergencies as needed. • Provide direction and management for EOC operations through Standard Operations. • Guide (SOG), set priorities and establish strategies. • Coordinate operations of all responding units, including law enforcement, fire, medical, logistics, etc. • Augment comprehensive emergency communication from EOC to any field operation when needed or appropriate. • Maintain EOC security and access control. • Provide recovery assistance in response to the situations and available resources. Keep senior, subordinate and tenant officials informed. • Keep local area (Village/town/City, district and State) informed. • Operate a message center to log and post all key disaster information. • Develop and disseminate public information warnings and instructions. • State EOC is seamlessly connected with National EOC on up-stream and with all District EOC on downstream. (West Bengal Disaster Management and Civil Defence Department, 2021)
District Disaster Management Authority (DDMA):	• Each DDMA will be headed by the respective District Magistrate, District Collector (DC), Dy. Commissioner as the case may be, with the elected representative of the Local Authority as the Co-Chairperson. DDMA will act as the planning, coordinating and implementing body for DM at District level and take all necessary measures for the purposes of DM in accordance with the Guidelines laid down by the NDMA and SDMA. • It will, inter alia, prepare the District DM plan for the District and monitor the implementation of the National Policy, the State Policy, the National Plan & the State Plan concerning its own District and prepare the District Plan.

	• The DDMA will also ens ure that the Guidelines for prevention, mitigation, preparedness and response measures lay down by NDMA and SDMA are followed by all Departments of the State Government, at the District level as well as by the Local Authorities in the District (West Bengal Disaster Management and Civil Defence Department, 2021).
Local Authorities:	• Local Authorities would include Panchayati Raj Institutions (PRIs), Municipal Corporations, Municipalities, District & Cantonment Boards and Town Planning Authorities that would control & manage civic services. • These bodies will prepare DM Plans in cons onance with the Guidelines of NDMA, SDMAs & DDMAs and will ensure capacity building of their officers & employees for managing disasters, carry out relief, rehabilitation and reconstruction activities in the affected areas (West Bengal Disaster Management and Civil Defence Department, 2021).
Trust / Organizations managing Places of Worships & Congregation:	•Each establishment / organization identified as "critical infrastructure and key resource", including places of congregation in the state of West Bengal prepare and implement "onsite"and "off -site" Disaster Management Plan in consultation with respective DDMA. •They also carry out mitigation, response, relief, rehabilitation and reconstruction activities(West Bengal Disaster Management and Civil Defence Department, 2021).
Private Sector:	•The private sector is being encour aged to ensure their active participation in the predicate activities in alignment with the overall plan developed by the SDMA. •They adhere to the relevant rules regarding prevention of disasters, as may be stipulated by relevant authorities in the State, as a part of CSR undertakes DRR projects in consultation with State / District Authority for enhancing State's resilience (West Bengal Disaster Management and Civil Defence Department, 2021).
Community Groups and Volunteer Agencies:	•Local community groups and voluntary agencies including NGOs normally have active role in prevention and mitigation activities under the overall direction and supervision of the SDMA or DDMA. •They should be encouraged to participate in all training activities as may be organized and should familiarize themselves with their role in State disaster management(West Bengal Disaster Management and Civil Defence Department, 2021).

Source: West Bengal Disaster Management and Civil Defence Department 2021, West Bengal State Disaster Management Plan 2015-16

Cyclone Yaas Response by State Government

Review and Coordination by State government (Sphere India, 2021)

- Chief Secretary took review meeting. All departments concerned took necessary preparatory steps. Fishing had been banned. For hospitals and vaccine centres, power backup plan had been made. Sufficient stock of relief materials had been kept ready.

Preparedness of Districts (Sphere India, 2021)

- Regular preparedness review meetings were conducted with most risk prone districts through video conference from State Emergency Operation Centres (EOC).
- Essential items had been stockpiled in vulnerable areas and was in the process of evacuating people from low-lying coastal areas to the shelters. Quick Response Teams had also been activated in the coastal districts.
- Taking lessons from the past, the state electricity department made all possible arrangements to avoid interruptions to power supply particularly in the hospitals and safe homes that housed a huge number of COVID-19 patients. Special teams were deployed in the six districts that had been identified to be at high risk of devastation for undertaking immediate electricity restoration work.

Evacuation(Sphere India, 2021)

- Approx.15,04,506 people had been evacuated from coastal districts

Deployment of Response Forces(Sphere India, 2021)

- 20 teams of SDRF had been deployed.
- 46 NDRF teams had been deployed in Cyclone affected areas of East Medinipur, North 24 Parganas and South 24 Parganas districts.

Communication(Sphere India, 2021)

- A central unified command war room was set up at the Kolkata Police headquarters for cyclone Yaas, which worked to ensure cutting down response time.
- State Emergency Operation Centre (EOC) of West Bengal (WB) at Disaster Management & Civil Defense Department, Nabanna (with toll free no. 1070) was made functional and was monitoring the situation with all likely to be affected districts.
- PWD, PHED, Health & Family Welfare, Irrigation, Power and Fisheries department of WB were directed to open their control rooms (24 hours).

4.1.4 Odisha

Policies, Plans and Regulatory Frameworks

State Disaster Management Policy	State Disaster Management Plan 2019	District Disaster Management Plan	Village Disaster Management Plan
Departmental Disaster Management Plan	Disaster Management Rules	Odisha Relief Code	Disaster Resilient Housing (Odisha Disaster Recovery Project)
	Heat Action Plan 2020	Industrial Disasters Action Plan	

Source: Odisha State Disaster Management Authority, Odisha State Disaster Management Plan 2019

Hazard and Vulnerability Assessment



Figure 9: Wind and Cyclone Zones- Odisha
Source: Odisha State Disaster Management Authority 2021

OSDMA has developed district wise multiphaser maps for all districts of Odisha.

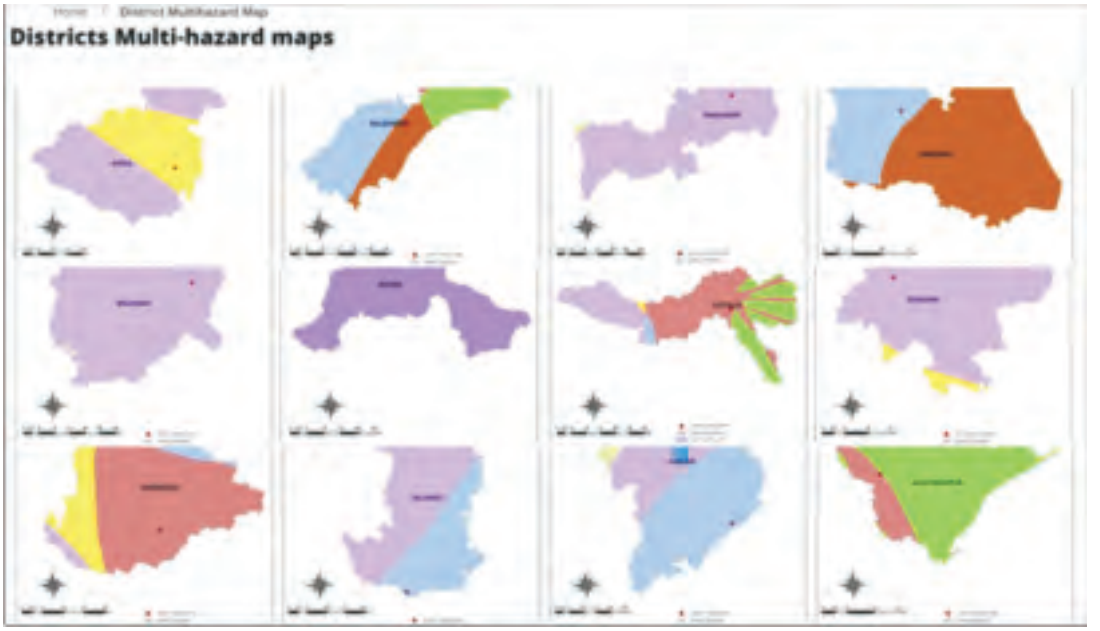
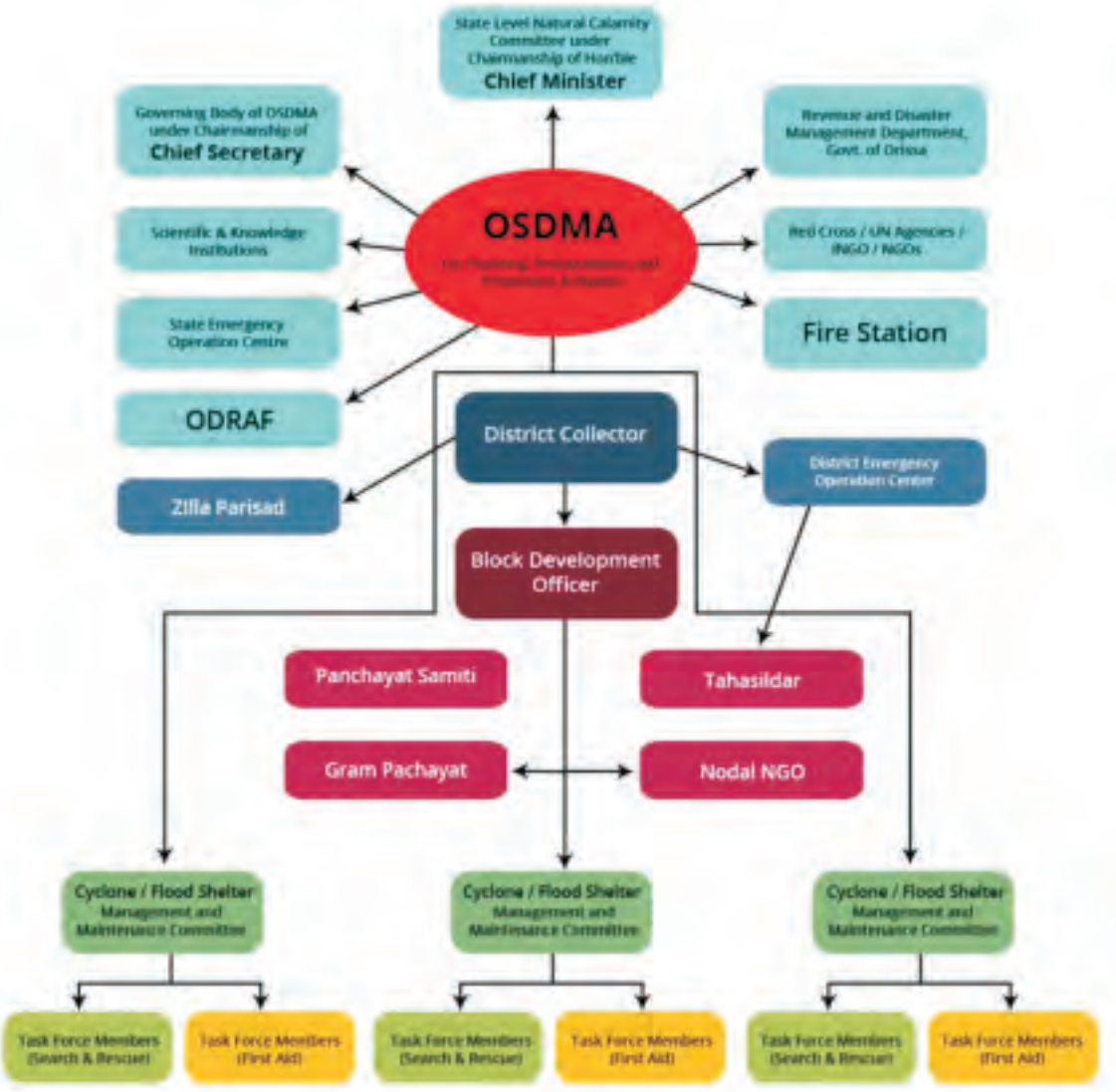


Figure 10: District Multi-hazard Maps- Odisha
Source: Odisha State Disaster Management Authority 2021

Institutional Framework (Organizational structure, coordination/collaboration, Capacities, etc



Figure 11: Network of Odisha State Disaster Management Authority
Source: Odisha State Disaster Management Authority, 2019


State Level Natural Calamity Committee under Chairmanship of Hon'ble Chief Minister
Governing Body of OSDMA under Chairmanship of Chief Secretary
Revenue and Disaster Management Department, Govt. of Orissa
OSDMA
Scientific & Knowledge Institutions
Red Cross / UN Agencies / INGO / NGOs
State Emergency Operation Centre
Fire Station
ODRAF
District Collector
District Emergency Operation Center
Zilla Parisad
Block Development Officer
Panchayat Samiti
Tahasildar
Gram Pachayat
Nodal NGO
Cyclone / Flood Shelter Management and Maintenance Committee
Cyclone / Flood Shelter Management and Maintenance Committee
Cyclone / Flood Shelter Management and Maintenance Committee
Task Force Members (Search & Rescue)
Task Force Members (First Aid)
Task Force Members (Search & Rescue)
Task Force Members (First Aid)
Task Force Members (Search & Rescue)
Task Force Members (First Aid)

Agencies	Roles & Responsibilities
State Crisis Group (SCG):	• The State Crisis Group is the apex body in the State to deal with major chemical accidents and to provide expert guidance for handling such accidents. Without prejudice to the functions specified under sub-rule (1), the State Crisis Group shall, a) Review all district off-site emergency plans in the State with a view to examine its adequacy in accordance with the Manufacture, Storage and Import of Hazardous Chemicals, Rules and forward a report to the Central Crisis Group once in three months. b) Assist the State Government in managing chemical accidents at a site. c) Assist the State Government in the planning, preparedness and mitigation of major chemical accidents at a site in the State. d) Continuously monitor the post-accident situation arising out of a major chemical accident in the State and forward a report to the Central Crisis Group. e) Review the progress report submitted by the District Crisis groups. f) Respond to queries addressed to it by the District Crisis groups. g) Publish a list of experts and officials in the State who are concerned with the management of chemical accidents (Odisha State Disaster Management Authority, 2021).
Local Crisis Group	• Prepare local emergency plan for the industrial pocket. • Ensure dovetailing of the local emergency plan with the district off-site emergency plan. • Train personnel involved in chemical accident management. • Educate the population likely to be affected in a chemical accident about the remedies and existing preparedness in the area. • Conduct at least one full scale mock- drill of a chemical accident at a site every six months and forward a report to the District Crisis Group. • Respond to all public inquiries on the subject(Odisha State Disaster Management Authority, 2021).
District Crisis Group (DCG)	• Assist in the preparation of the district off-site emergency plan. • Review all the on-site emergency plans prepared by the occupier of Major Accident Hazards installation for the preparation of the district off-site emergency plan. • Assist the district administration in the management of chemical accidents at a site lying within the district. • Continuously monitor every chemical accident. • Ensure continuous information flow from the district to the Centre and State Crisis Group regarding accident situation and mitigation efforts. • Forward a report of the chemical accident within fifteen days to the State Crisis Group. • Conduct at least one full-scale mock-drill of a chemical accident at a site each year and forward a report of the strength & the weakness of the plan to the State Crisis Group (Odisha State Disaster Management Authority, 2021).
Odisha State Legal Services Authority (SALSA):	• Odisha State Legal Services Authority is a Statutory Body established under the Legal Services Authorities Act, 1987. The Hon'ble Chief Justice of High Court of Odisha is the Patron-in-Chief of the Odisha Legal Services Authority and the Sr. Judge of the High Court of Orissa is the Executive Chairman of the Odisha Legal Services Authority. • To look after the legal services pertaining to the High Court, there is the High Court Legal Services Committee, that is chaired by a sitting Judge of the High Court and the Registrar (Judicial). The Orissa High Court is functioning as the Secretary of High Court Legal Services Committee.

	• The State Legal Services Authority monitors and guides the District Legal Services Authorities and Taluk Legal Services Committees in achieving the aims and objectives of the Act. There are 30 District Legal Services Authorities in the State of Odisha and 81 Taluk Legal Services Committees functioning under them (Odisha State Disaster Management Authority, 2021).
Odisha Disaster Rapid Action Force (ODRAF)	• In the post-super cyclone reconstruction and preparedness phase, it was felt necessary to constitute a professionally trained group equipped with State-of-the-art emergency equipment to assist the civil administration in search & rescue operation and relief line clearance for effective management of disasters in the event of natural as well as human induced disasters. • The Government of Odisha formed Odisha Disaster Rapid Action Force (ODRAF) vide notification no.939/CD dated 07.06.2001. ODRAF is a multi-disciplinary, multi-skilled, high-tech force for all types of disasters. ODRAF aims at reducing casualties, clearance of communication channels, quick deployment of personnel & equipment's and minimize expenditure & time lag and support institutional arrangement. • In 3 phases, ten units of ODRAF have been set up. The ODRAF units are strategically located throughout Odisha. Locations of these units are identified on the basis of vulnerability profile to cut down the response time for their deployment. The ODRAF Units do not have any geographical /territorial restrictions in terms of area of operation (Odisha State Disaster Management Authority, 2021).
State Emergency Operation Centre	• The State Emergency Operation Centre has been made operational at Rajiv Bhawan, Bhubaneswar, with state of art communication net-work. The State EOC functions round the clock throughout the year. • The Organisation is headed by the Special Relief Commissioner (SRC) who exercises all administrative and financial powers. He is assisted by a group of experienced officers and staff. During any natural disaster, the office functions round the clock in an emergency mode (Odisha State Disaster Management Authority, 2021).

Cyclone Yaas Response by State Government

Review and Coordination by State government (Revenue and Disaster Management Department, Government of Odisha, 2021)

- The Hon'ble Chief Minister reviewed the status of preparedness for impending cyclone with the Secretaries of line Departments & the Collectors on 22.05.2021 through VC. Three rounds of preparatory meetings were faced by the Chief Secretary and the Special Relief Commissioner (SRC) with the Collectors of 14 probable districts likely to be affected by the cyclone.
- District Administration alerted and guided through elaborate Video Conferencing by the Special Relief Commissioner and the Chief Secretary.

Dissemination of Warnings and Bulletins (Revenue and Disaster Management Department, Government of Odisha, 2021)

- IMD weather Bulletins & cyclone warnings were disseminated to the Collectors, Departments and other stake holders at regular intervals.
- Early warning voice messages were disseminated through Alert Siren Systems installed in coastal areas under Early Warning Dissemination System (EWDS).

- Community Level Volunteers and Task Force Team members of Multipurpose Cyclone/ Flood Shelters were engaged for ensuring family preparedness, warning dissemination and expediting evacuation.

Preparedness of Districts (Revenue and Disaster Management Department, Government of Odisha, 2021)

- The district administration of 14 vulnerable districts were directed to keep Multipurpose Cyclone Shelters (MCS)/ Multipurpose Flood Shelters (MFS) in readiness and to identify adequate safe RCC roofed public buildings for use as additional shelters to accommodate evacuees observing COVID-19 protocol.
- Total 6891 (860 MCS/ MFS and 6031 additional shelters) shelters were identified and kept in readiness with cumulative capacity to accommodate more than 9 lakh people in 14 districts, maintaining social distancing norms.
- Facility verification check had been conducted in all the Multi-Purpose Cyclone and flood shelters in the coastal & adjoining districts.

Evacuation Plan(Revenue and Disaster Management Department, Government of Odisha, 2021)

- Evacuation Plan was made for evacuation of people from the vulnerable locations. PRIs and WSHGs were involved in evacuation and Shelter management.
- Total 7,03,058 peoples were evacuated and accommodated in 6870 relief camps.

Deployment of Response Forces (Revenue and Disaster Management Department, Government of Odisha, 2021)

- 52 teams of NDRF, 60 teams of ODRAF, 206 Fire Service teams and 86 wood cutting teams of Forest & Environment Department (Total- 404 Teams) were pre-positioned in 10 coastal & adjoining districts for search & rescue operation and road clearance.

Communication (Revenue and Disaster Management Department, Government of Odisha, 2021)

- The Collectors, the State Disaster Response Forces and other officers having Satellite Phones were directed to recharge and keep the phones ready for use. The Digital Mobile Radio installed in six coastal districts were also tested and kept ready for use for communication with the Collectors, the BDOs and others in case the telephone / cell phone networks are down due to cyclone.

Preparedness Measures taken by various departments (Revenue and Disaster Management Department, Government of Odisha, 2021)

- Engineering Departments like Works, Rural Development, Housing and Urban Development, Energy, Water Resources and Panchayati Raj & Drinking Water (PR&DW) also made arrangement for immediate restoration of damaged infrastructure.

4.1.5 Financing Mechanisms

National Disaster Response Funds and State Disaster Response Funds

The 15th Finance Commission recommended retaining the existing cost-sharing patterns between the centre and states for disaster management funds. The cost-sharing pattern between centre and states is: (i) 90:10 for north-eastern and Himalayan states and (ii) 75:25 for all other states. State disaster management funds also have a corpus of Rs 1.6 lakh crore (centre's share is Rs 1.2 lakh crore).

- There is also a concept of flexi-fund in development programmes, that allows the State Governments to spend 25% of programme resources on implementing mitigation measures. 15 FC recommends that the mitigation fund created should be used for those local level and community-based interventions to reduce risks and promote environment-friendly settlements & livelihood practices (Government of India, 2020).

Annual Allocation for States for Disaster Management

(Rs. crore)

Year	2021-22	2022-23	2023-24	2024-25	2025-26	Total
Union share	22184	23294	24466	25688	26969	**122601**
States' share	6799	7137	7491	7864	8261	**37552**
Total (Union + States' share)	**28983**	**30431**	**31957**	**33552**	**35230**	**160153**
Percentage increase over previous year	-	5	5	5	5	

Source: 15th Finance Commission Report, 2020

- The State Disaster Response Funds (SDRF) would receive 80 per cent of the total State Disaster Risk Management Funds (SDRMF) while the State Disaster Mitigation Fund (SDMF) would get 20 per cent of the allocation. Within the SDRF allocation of 80 per cent, there would be three sub-allocations: Response and Relief (40 per cent), Recovery and Reconstruction (30 per cent) and Preparedness & Capacity-building (10 per cent). While the funding windows of SDRF and SDMF are not inter-changeable, there could be flexibility for re-allocation within the three sub-windows of SDRF (Government of India, 2020).

Distribution of Total States Allocation

(Rs. crore)

Funds (percentage distribution)	Amount
SDMF (20)	32031
SDRF (80)	128122
i) Response and Relief (40)	64061
ii) Recovery and Reconstruction (30)	48046
iii) Preparedness and Capacity Building (10)	16015
Total (SDMF + SDRF) (100)	**160153**

Source: 15th Finance Commission Report, 2020

- Along with other recommendations for Disaster Management, the 15th Finance Commission has additionally sanctioned a grant of Rs 800 crore for Odisha to further strengthen the early warning dissemination system (EWDS) in cyclone prone areas (15th Finance Commission Report, 2020).

Other Sources of Funds

- Further, in addition to the assistance from the SDRF and NDRF, many State Governments have also been allocating funds from their budgetary resources for response and relief. State Governments also avail loans for supporting larger recovery and reconstruction projects. Some of the other mechanisms as specified in the respective State's SDMPs are mentioned below:

	Gujarat	Maharashtra	West Bengal	Odisha
NDRF	✓	✓	✓	✓
SDRF	✓	✓	✓	✓
Chief Minister's Relief Fund (CMRF)	✓			✓
Public Private Partnership	✓		✓	
Grant in Aid	✓		✓	
Corporate Social Responsibility (CSR) Funds	✓			
Disaster Bonds	✓			
Donations	✓			
Recovery Measures-Introduction of Special Tax	✓			
Funds Disbursement and Audit	✓			

Source: Generated by Author, 2021

4.1.6 Identification of Key issues and Challenges

	Gujarat	Maharashtra	West Bengal	Odisha
State Disaster Management Plan	✓	✓	✓	✓
District Disaster Management Plan	✓	✓	✓	✓
Village Disaster Management Plan	×	×	×	✓
Departmental Disaster Management Plan	×	✓	✓	✓
State Emergency Operation Centre	✓	✓		

	Gujarat	Maharashtra	West Bengal	Odisha
District Emergency Operation Centre	✓			
Taluka Emergency Operation Centre	✓			
Early Warning Dissemination System				✓
AapdaMitras	✓	✓	✓	✓
Hazard and Vulnerability Mapping (State andDistrict Level)	✓	✓	✓	✓
Hazard and Vulnerability Mapping (Village Level)	×	×	×	×
Cyclone Preparedness and Response Plan	✓	✓	✓	✓
Mapping of Multipurpose Cyclone Shelters				✓

Source: Generated by Author, 2021

- **State Disaster Management Plans:** While all 4 states have robust State Disaster management Plans, there are challenges in terms of implementation. Plans for Maharashtra and West Bengal have also not been updated since 2016. Further, there is a need to focus to building resilient systems and infrastructure at policy level through SDMPs.
- **Early Warning and Communication systems:** In some cases, there is no effective mechanism installed or in operation at sensitive coastal line across the affected states. State and agencies depend on IMD reporting. While in places Early Warning systems are effectively connected with PRI and Local Administration, remote areas often do not have the facilities to reach out with a shorter time frame. Also, there is a need to strengthen community based early warning system and the system should be effective and inclusive, so that it can be understood by all.
- **Departmental SOPs or Plans:** Absence of departmental SOPs or Disaster Management Plans or poor implementation of the existing protocols, especially for engineering departments, is a major setback that will subsequently lead to damages to physical infrastructure.
- **Capacity of relevant stakeholders:** There is a need of improving capacity and sensitization towards disaster risk and management of not just government officials concerned with disaster management, but also of the officials from various engineering and line departments and the representatives of Panchayat, the Urban Local Bodies and community at large.
- **Coordination amongst relevant stakeholders:** In cases where there is no single operation system for Response, there is a need to strengthen the communication and coordination between all relevant departments for effective response.

- **Risk and Vulnerability Assessment at Village Level:** While hazard mapping or zonation is done at state and district level in the states, village level vulnerability and risk mapping are required for analyzing the true scenarios of vulnerable populations living in highly cyclone prone coastal areas.
- **Village Level Disaster Management Plan:** Only Odisha has a village level DM plan.All states need to adopt Village level planning as vulnerable communities and local people are always at the frontline to experience the impacts whenever a disaster strike. These plans can support in achieving Community-level preparedness, capacity building, awareness and resilient communities.
- **Evacuation Plans:** There is a need to strengthen the evacuation plan and ensure that it is inclusive towards all sections of the society. Further, there is also a need of robust mechanism for prepositioning and mapping of Multipurpose Cyclone/Flood shelters for effective evacuation planning.
- **Engagement of Community:** There is a greater need for community engagement in all processes and mechanisms for a more inclusive and decentralized response.
- **State Disaster Response Force:** There is need for strengthening and empowering State Disaster Response Force (SDRF) and District Disaster Response Force (DDRF) to improve their technical capacities and make them self-sufficient.
- **Monitoring and Evaluation Mechanisms:** A strong monitoring system and social audit is required to ensure effective execution and implementation of State, District and Village level Disaster Management Plans.
- **Budget Allocations:** Appropriate allocations should be made for preparedness in all states and mainstreaming DRR. Development programme needs to be made a priority and accordingly budget provision should be made for each department.

4.2 Existing Developmental Mechanisms relevant to DRR

4.2.1 Gujarat

Guidelines for cyclone resistant construction of buildings in Gujarat by GSDMA –

The aim of these guidelines is firstly, to briefly explain the action of wind on buildings and state the general principles of planning and design. Secondly, to bring out details to prevent the non-structural damage in the various building. Thirdly, to deal with the safety aspects of traditional non-engineered buildings. And finally, to suggest retrofitting details which could be adopted in existing buildings to minimize the damages under high winds (Gujarat State Disaster Management Authority, 2001).



Figure 12: Wind and Cyclone Hazard Map with probable max. surge height and risk factor for Gujarat
Source: Gujarat State Disaster Management Authority, 2001

The cyclone resilient guidelines detail the suggestive planning aspects like site selection, plan forms & orientation, roof architecture, wall openings, glass panelling, etc. for new construction in areas prone & vulnerable to high/medium intensity cyclones. They also mention about foundation, masonry walls, framed buildings aspects in detail (Gujarat State The cyclone resilient guidelines also mention about the retrofitting measures for different types and components of buildings like Non-engineered buildings, thatched house, tiled building, compound house, lamp masts, water tanks, engineered buildings, etc. and an approximate cost to carry out each to make the existing structures resilient to cyclonic events (Gujarat State Disaster Management Authority, 2001).





Figure 13: Planning and Structural Guidelines for buildings in cyclone prone areas in Gujarat
Source: Gujarat State Disaster Management Authority, 2001

Gujarat State Disaster Management Plan (GSDMP) –

The State Disaster Management Plan clearly "SUGGESTS" the following preventive and mitigative strategies to develop risk reduction mechanism and resilience in events of cyclones and resulting flooding. The suggestive measures on structural front proposes conservation, regeneration, expansion and newly-development of natural buffers like plantation, mangroves and natural catchment areas. Measures to strengthen road infrastructure and grey infrastructure like dams, embankments, flood walls, etc. are also highlighted in SDMP. The mitigative measures also highlights importance of building bye-laws and development regulations for structures in flood plains(Gujarat State Disaster Management Authority, 2017).

Table 11: Mitigation Measures for Cyclone/Tsunami

Task	Activities	Responsibility
	Structural Measures	
Shelter Belt	1. Ensure shelter belt plantation and mangrove regeneration	• RevenueDept. • COR • ForestDept.
Strengthening of Infrastructure	1. Construct missing roads and bridges in cyclone proneareas 2. Strengthen /repair of existing roads and bridges in cyclone proneareas 3. Strengthen dams and canals 4. Construct newsalineembankmentand repair existingones	• RevenueDept. • COR • R & BDept. • IrrigationDept.

Source: Gujarat State Disaster Management Authority, 2017

Table 12: Mitigation Measures for Floods

Task	Activities	Responsibility
Structural Measures		
Construction	1. Improve design for irrigation and flood protective structures 2. Construct dams, flood protection wall, flood diverting channels etc. 3. Strengthen /repair of existing roads and bridges and other critical infrastructure in floodplains. 4. Strengthen dams and canals	• Revenue Dept. • COR • Irrigation Dept. • Central Design Organization (CD O) • R & B Dept. • All line Dept.
Development of Catchment Area	1. Develop catchment area of the flood plain ○ Forestation ○ Landsloping ○ Small reservoirs/Checkdams/ponds etc.	• Revenue Dept. • COR • Irrigation Dept. • Forest & environment Dept.
Flood Proofing	1. Implement specific building by laws for buildings and structures in the flood plains	• Revenue Dept. • COR • Irrigation Dept. • UDD, Panchayat & Rural Housing • Local Bodies
Techno-legal Regime	1. Enact and enforce laws regulating developmental activities in flood plain	

Source: Gujarat State Disaster Management Authority, 2017

4.2.2 Maharashtra

Maharashtra State Disaster Management Plan

The State Disaster Management Plan clearly "SUGGESTS" the following preventive and mitigative strategies to develop risk reduction mechanism and resilience in events of cyclones and resulting flooding. The suggestive measures on structural front proposes conservation, regeneration, expansion and newly-development of natural buffers like plantation, mangroves and natural catchment areas. Measures to strengthen road infrastructure and grey infrastructure like dams, embankments, flood walls, etc. are also highlighted in SDMP. The mitigative measures also highlight importance of building bye-laws and development regulations for structures in flood plains (Maharashtra State Disaster Management Authority, 2010).

Preventive and Mitigative Strategies during Cyclones -

1. Safe siting in cyclones prone areas–Measures pertaining to selection of sheltered site, orientation of site, creation of wind breaks, layout of buildings is discussed.
2. Shelter Plantation - The shelter protection plantation belt of Casuarina trees, which are fast growing recyclables, has substantially helped to protect the human settlements provided in the leeward side of cyclones. The resistance of the trees withstands the wind force.
3. Drainage - It is important to provide adequate storm water drainage to the sites and maintain the system through periodic inspections so that the system does not obstruct the flow in natural courses and causes inundation in periods of cyclones.
4. House design - The ABC of cyclone protection housing are:Anchorage, Bracing and Connection. The cyclone resistant shelters can be built at individual level or at community level. The key principle underlying cyclone resistant building construction is the secure tying up of all elements in the buildings from foundation to roof (Maharashtra State Disaster Management Authority, 2010).

Preventive and Mitigative Strategies during resulting Flooding due to Cyclones -

1. Regulations - This would include
   - Not permitting unrestricted new development in the hazard prone areas
   - Anchoring and flood proofing structures to be built in known flood prone areas
   - Built-in safeguards for new water and sewage systems and utility lines from flooding
   - Enforcing risk zone, base flood elevation and floodway requirements
   - Prohibition on development in wetlands
   - Prescribing standards for different flood zones on flood maps.
2. Safe siting in flood hazard areas
3. Development and Redevelopment Policies
4. Flood proofing and Elevation
5. Dams and Reservoirs, Dikes, Levees and Flood walls
6. Channel Alterations, High Flow Diversions
7. Stormwater Management
8. Coastline Protection
9. Watershed Management

Land-use planning and regulations -

Proper long-term land use planning by incorporating all geology-related data available would identify & allocate hazard-free areas for industrial & urban development and thus be by far the most effective way of dealing with disasters.

Authorities in charge of disaster management should, therefore, have at their disposal reliable estimates of the type, severity and location of the damage likely to occur. Damage to property can be limited, for example, building codes can be enforced.

Introduction of the legal enforcement of property insurance against damage, inflicted by disaster events, may be considered as one of the most efficient ways to ensure that building codes are followed and properly allocated according to realistic criteria based on actual geological conditions.

Regulations have a potentially greater impact on loss reduction than any other single management tool and have been widely used. Development that conforms to regulations is less prone to damage than pre-existing development. Regulation is largely a local government responsibility. Effective enforcement often requires more training, personnel and financial resources than many communities can provide. Regulations cannot provide full protection for; they have a limited impact on existing buildings and infrastructure prone to hazards(Maharashtra State Disaster Management Authority, 2010).

National Cyclone Risk Mitigation Project (NCRMP)

The National Cyclone Risk Mitigation Project (NCRMP) is a pioneer project drawn up by Ministry of Home Affairs (MHA)/Union Territories (UTs), Government of India (GOI), to be implemented in 13 Cyclone prone coastal States/UTs with World Bank assistance. In Maharashtra, the project will be implemented in Coastal Districts i.e., Thane, Ratnagiri, Sindhudurg, Raigad, Mumbai and Mumbai Suburban (Maharashtra State Disaster Management Authority, 2010).

The core components of this project are;

Component A – Last Mile Connectivity for the dissemination of cyclone warnings and advisories from district/ sub-district level to communities, to be implemented by NDMA in consultation with participating States.

Component B - Construction of physical infrastructures for cyclone risk mitigation to be implemented by the States.

Component C – Technical assistance for capacity building on hazard risk management to be implemented by States.

Component D – Project Management and Monitoring applicable to all implementing agencies.

4.2.3 West Bengal

West Bengal State Disaster Management Plan

The State Disaster Management Plan clearly "SUGGESTS" the following preventive and mitigative strategies to develop risk reduction mechanism and resilience in events of cyclones and resulting flooding. The suggestive measures on structural front proposes engineered structures specific to cyclone resilience development, grey infrastructures like dams, embankments, flood walls, etc. & conservation, regeneration, expansion and newly-development of natural catchment areas. Land use control and flood plain zoning are the key strategies highlighted in state disaster management plan. The mitigative measures also highlights importance of community-based mitigation and owner-driven approaches for building cyclone resilient housing structures (West Bengal State Disaster Management Authority, 2016).

Preventive and Mitigative Strategies during Cyclones -

1. Land use control - It is designed so that least critical activities are placed in vulnerable areas. Location of settlements in the flood plains is utmost risk. Siting of key facilities must be marked in the land use.
2. Engineered Structures - Structures need to be built to withstand wind forces. Good site selection is also important. Majority of buildings in coastal areas are built with locally available materials and have no engineering inputs. Good constructions practice should be adopted.
3. Community Based Mitigation - Construction of cyclone resistant houses and strengthening of existing houses should be done through community participation. Local engineers and masons can take part in the construction of the buildings in their area and demonstrate to the people about disaster resistant construction methods (West Bengal State Disaster Management Authority, 2016).

Preventive and Mitigative Strategies during resulting Flooding due to Cyclones -

1. Structural measures: Attempts to Modify Flood
   (a) Dams and Reservoirs
   (b) Embankment
   (c) Drainage Improvements
   (d) Channel Improvements
   (e) Diversion of Flood Waters
   (f) Using Natural Detention Basin
2. Non- Structural Measures: Attempts to modify susceptibility of Flood

Flood plain zoning: It aims to regulate the developments in the flood plains, so that it is compatible with 'Flood Risk'. It recognizes the basic fact that the flood plains are essentially the domain of the river, and as such all developmental activities must be compatible with the flood risk involved (West Bengal State Disaster Management Authority, 2016).

4.2.4 Odisha

Odisha State Land Use (Planning) Policy

Proposed Interventions for Disaster Prone Areas

The state shall focus on disaster resilient developments by strengthening its coastal disaster riskreduction programme, with clear demarcation of no-go zones and major accident hazardvulnerability in the districts of Baleshwar, Bhadrak, Jajpur, Kendrapada, Jagatsinghpur,Cuttack, Khurda, Puri, Ganjam and parts of Gajapati, Dhenkanal, Kendujhar and Mayurbhanj.These districts are not only vulnerable to very high cyclonic impact and flooding, they formpart of the rice bowl and also happen to the districts witnessing rapid development andupcoming investments in secondary & tertiary economy.The state will also focus on the districts of Malkangiri, Koraput, Kandhamal, Gajapati, Kendujhar& parts of Ganjam toreduce incidences of forest fire and encourage voluntary relocationof vulnerable population to settlements outside forest areas (Govt. of Odisha, 2019).

Investments and incentives will be focussed to:

- Conserve and create mangrove forests as bio shields against coastal hazards
- Harness flood water and ensure maintenance of natural drainage pattern
- Check unregulated growth of settlements in forest periphery, eco-sensitive areas, aquifer recharge areas and influence area of MAHs.
- Encourage crop diversification and alternative employment in disaster prone districts (Govt. of Odisha, 2019).

Odisha State Disaster Management Plan

Implementation of Sendai Framework in Odisha context –

Table 13: Proposed interventions in Odisha SDMP aligning with Sendai Framework

Priorities for Action	Activities to be done
Strengthening Disaster Risk Governance to manage disaster risk	a) Strengthening local level resilience through enhanced role of local institutions (PRIs, ULBs) and communities in DRR. b) Urban local bodies and the Panchayats to follow building bye-laws. c) Effective system and procedure for quality monitoring and accountability. d) Identify flood prone areas - future construction of buildings to be guided
Investing in Disaster Risk Reduction for Resilience	a) 10% of all funds at the District level must be devoted to schemes which will help in DRR b) Sensitize Private builders about the need for disaster resilient building construction. c) Train masons/contractors on disaster resilient building construction.

Source: Odisha Disaster Management Authority, 2019

Procedure for Mainstreaming of DRR and CCA in Development Planning -

1. Project appraisal

- ensuring that development gains from individual projects are sustainable
- ensuring that potential disaster risk reduction benefits of both dedicated risk reduction projects and other development projects are optimized and
- highlighting related issues of responsibility and accountability (Odisha Disaster Management Authority, 2019).

2. Monitoring and evaluation of projects from DRR/CCA angle -

The capacity to monitor and evaluate DRR initiatives, generate hard evidence on related inputs, outputs, results & impacts and learn lessons for the future is an essential component for mainstreaming. DRR initiatives can and should be monitored and evaluated. Problems relating, for instance, to potentially lengthy time lags in the realization of benefits can be overcome to some extent by using leading or process indicators that provide a measure of progress towards the achievement of project objectives (e.g., the number of schools constructed to withstand earthquakes of a particular magnitude) (Odisha Disaster Management Authority, 2019)..

Mainstreaming DRR into the developmental plans is an important mandate of the Disaster Management Act, 2005. Integration of disaster risk reduction measures into ongoing flagship programmes are being used as an entry point for mainstreaming DRR in development plans. Steps for ensuring the incorporation of DRR into various ongoing programmes/plans are as follows(Odisha Disaster Management Authority, 2019):

(a) Identification of key programme /projects.

(b) Identification of entry points within the programme for integration of DRR (structural, nonstructural and other mitigation measures) at various levels viz. state, district and local levels.

(c) Close coordination with concerned departments such as the State Planning Commission/ body and the Finance Department for promoting DRR measures into development plans and policies

(d) Allocation of dedicated budget for DRR within the departmental plans.

(e) Preparation of guidelines for integration of disaster risk reduction measures into development plans of the department at the district and sub-district level.

(f) Review & Incorporation of DRR provisions in the policies, rules & regulations.

4.2.5 Identification of Key issues and Challenges – comparative study

Table 14: A comparative study on Development-related DRR Mechanisms in all 4 states Source: Generated by Author, 2021 referring State Disaster Management Plans from all 4 states, Gujarat State Disaster Management Authority, 2017; Maharashtra State Disaster Management Authority, 2010; Odisha State Disaster Management Authority, 2019; West Bengal State Disaster Management Authority, 2016

States	Structural Interventions relevant to DRR (in particular Cyclones)		Planning Interventions relevant to DRR (in particular Cyclones)
	Building Structures	*Physical Infrastructures*	*Land Use Restrictions or Development Control Regulations*
GUJARAT	GSDMA has prepared guidelines for construction/reconstruction of cyclone-resilient building structures giving details about several components and types of housing specific to risk and vulnerability mapping of coastal regions. Gujarat SDMP lists the adherence to building bye-laws and development regulations as a major mitigative strategy for cyclones and resulting flooding.	Measures to strengthen road infrastructure and construction of grey infrastructure like dams, embankments, flood walls, etc. are mentioned in Gujarat SDMP.	Gujarat SDMP proposes conservation, regeneration, expansion and newly-developednatural buffers like plantation, mangroves and natural catchment areas as a land-use planning mechanism to reduce impacts of cyclones and resulting floods.
	Limitations and Challenges		
	Though the "suggestive" measures, both structural and planning related that have been laid out the by the state authorities, there still are no concrete policies, codes, guidelines and regulatory mechanisms in place. 1. Comprehensive DCR by State Government does not consider DRR component in any form while preparing codes and regulations governing building structures and their planning. 2. Absence of dedicated codes and guidelines for developing physical infrastructure resilient to cyclonic events in coastal regions.		

<table>
<tr><td></td><td colspan="3">3. Strict Enforcement of policies and norms considering multi-hazard DRR approach in land-use planning and framing, DCR is absent.
4. 100% enforcement and implementation of the above-mentioned DRR provisions inSDMP is challenging as the pointers in SDMP appears general and lacks application-level policies/regulations w.r.t cyclones.
5. Guidelines for Cyclone-resilient building structures by GSDMA do not hold any regulatory base for mandatory implementation in coastal districts of Gujarat.</td></tr>
<tr><td rowspan="3">MAHARASHTRA</td><td>Maharashtra SDMP mentions site selection, site orientation, wind breaks, building layout and design as important criteria for cyclone-resilient building construction.</td><td>Flood protection grey infrastructure like Dams and Reservoirs, Dikes, Levees, and Flood walls has been highlighted as important mechanisms in the state DMP.</td><td>SDMP proposes need for development and re-development policies/regulations relevant for floodplains and flood zones, natural buffers like plantation/mangroves, watersheds, etc.</td></tr>
<tr><td colspan="3">Limitations and Challenges</td></tr>
<tr><td colspan="3">Though measures, both structural and planning related have been laid out by the state authorities in SDMP, there still are no concrete policies, codes, guidelines and regulatory mechanisms in place.

1. Development Control and Promotion Regulations by Urban Development Department does not consider DRR component in any form while preparing codes and regulations governing building structures and their planning.
2. Absence of dedicated codes and guidelines for developing physical infrastructure resilient to cyclonic events in coastal regions.
3. Strict Enforcement of policies and norms considering multi-hazard DRR approach in land-use planning and framing, DCR is absent.
4. 100% enforcement and implementation of the above-mentioned DRR provisions in SDMP is challenging as the pointers in SDMP appears general and lacks application-level policies/regulations w.r.t cyclones.</td></tr>
<tr><td>WEST BENGAL</td><td>West Bengal SDMP highlights engineered structures for protection from cyclone with careful site selection.</td><td>Flood protection grey infrastructure like Dams and Reservoirs, Dikes, Levees, and Flood walls has been highlighted as important mechanisms in the state DMP.</td><td>West Bengal SDMP proposes need for land-use control relevant for floodplains and flood zones, natural detention basins, etc.</td></tr>
</table>

	Limitations and Challenges
WEST BENGAL	Though measures, both structural and planning related have been laid out the by the state authorities in SDMP, there still are no concrete policies, codes, guidelines and regulatory mechanisms in place. 1. Building Regulations for Industrial Growth Centres & Parks of WBIIDC in West Bengal does not consider DRR component in any form while preparing codes and regulations governing building structures and their planning. 2. Absence of dedicated codes and guidelines for developing physical infrastructure resilient to cyclonic events in coastal regions. 3. Strict Enforcement of policies and norms considering multi-hazard DRR approach in land-use planning and framing, DCR is absent. 4. 100% enforcement and implementation of the above-mentioned DRR provisions in SDMP is challenging as the pointers in SDMP appears general and lacks application-level policies/regulations w.r.t cyclones.

Source: Generated by Author, 2021 referring State Disaster Management Plans from all 4 states, Gujarat State Disaster Management Authority, 2017; Maharashtra State Disaster Management Authority, 2010; Odisha State Disaster Management Authority, 2019; West Bengal State Disaster Management Authority, 2016



State-level Analysis of the Damages and Causative Factors

State-level Analysis of the Damages and Causative Factors

5

5.1 Gujarat – Damage and Cause Assessment

Tauktae, the first cyclonic storm of 2021 over the north Indian Ocean was the most intense cyclonic storm after the 1998 Kandla Cyclone. It caused damage and loss to Human Lives, Property and Livelihoods, multifariously. The Cyclone has adversely impacted social groups and demographics, affecting varied income groups and occupations.

In Gujarat, 11.7 Lakh people were affected across the 23 affected districts. These were (Amreli, Bhavnagar, Gir Somnath, Ahmedabad, Kheda, Anand, Vadodara, Surat, Valsad, Rajkot, Navsari, Panchmahal, Junagadh, Bharuch, Patan, Morbi, Botad, Porbandar, Surendranagar, Kutch, Devbhoomi Dwarka, Jamnagar, Sabarkantha.

Gujarat	
District Affected	23
Population Affected	11.7 Lakh
Villages Affected	4,619
Persons Evacuated	2,38,808
Houses Damaged	Kutcha Houses - 86455; Pucca Houses-20562
Human Lives Lost	79
Injured	90
Loss to Livestock	8783
Maximum Wind Speed	160 -170 gusting to 185
Rainfall	Heavy to extremely heavy rainfall activity, on Gujarat, Daman & Diu, Dadra Nagar and Haveli on 17th and 18th

Source: Primary Source through State Coordinator, 2021

For the purpose of undertaking the Damage Assessment Study, we conducted Household and Key Informant surveys across the state of Gujarat to make a comprehensive analysis of the damage at state, district, block and village level. The three districts that were surveyed are Amreli (most affected), Gir Somnath (most affected), Anand (moderately affected). Three blocksin each district were surveyed, with a minimum of 3 villages per block. The blocks surveyed in Gujarat are Amreli, Khambaha and Jafrabad for Amreli distric; Una, Gir Gadhada and Kodinar for Gir Somnath district and Khambat, Tarapur and Sojitra for Anand district.

Damage documented by State in the 3 districts:

Table 16: Damage Documented in Gujarat

	Amreli	Gir Somnath	Anand
No. of Deaths	26	14	2
No. of Injured		39	1
Fully Damaged Houses (Pucca+Kutcha)	2568	1084	64
Partially Damaged Houses (Pucca+Kutcha)	40442	65474	1606
Damaged Huts	1014	644	14

Source: Primary Source through State Coordinator, 2021



Image 1: Damaged Coastal Huts in Amreli
Source: Primary Survey Field Coordinator, 2021



Image 2: Damaged Houses in Anand District of Gujarat
Source: Primary Survey Field Coordinator, 2021

Sample Survey Findings

5.1.1 Damage and Loss to Human Lives

At state level and district level, deaths and health injuries are the most common types of damages witnessed by the people of Gujarat. As per the scope of this study, Households who have experienced any form of damage and loss to human lives were sampled to understand the causes that led to these fatalities in the affected districts of Gujarat.

The cumulative-district level analysis however infers deaths and injury as the most common type of damages to human lives as shown in figure 14. The proportion of disruptions to health facilities causedby the cyclone can be inferred through the inconvenience caused to human lives and their access to basic medical services. At district level, it was found that no individual in the sampled districts of Gujarat went

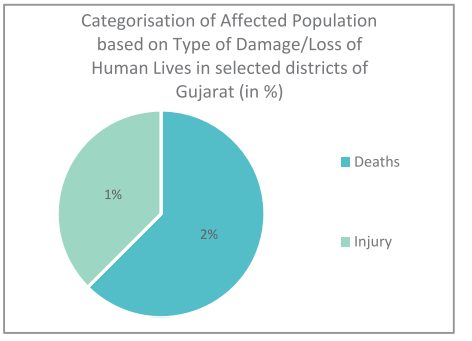


Figure 14: Categorisation of affected population based on type of damage in Gujarat

missing. However, in Amreli, 5% of the sampled population were found to be dead while 3% of the sampled population reported to have incurred injury (life threatening in some cases) because of the cyclone. No major damage to human lives was reported from Anand and Gir Somnath district of Gujarat.

Human Deaths

Kin of 21 deceased people were identified and interviewed. 1 in Anand, 9 in Gir Somnath and 12 in Amreli. When talking about the destination of deaths, it was found that Khamba Village of Amreli district witnessed almost 80% of the deaths witnessed in the state.

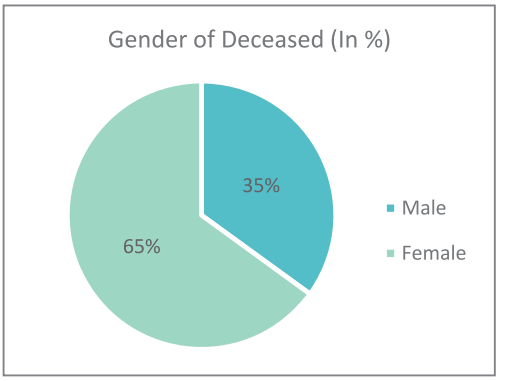


Figure 15: Gender of Deceased

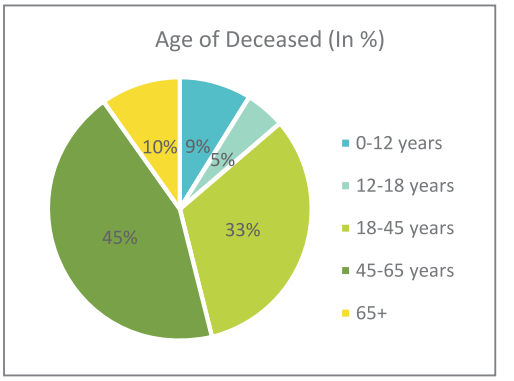


Figure 16 : Age of Deceased

The following section focuses on the causes and factors leading to the fatalities. While majority of the deceased were male aged 46-55 years, 2 children, aged 5 and 7, also died during the cyclone. Most of the deceased were engaged in farming. 7 of them were working on farms as seasonal workers. Out of these 21 deaths, majority were caused directly because of the disaster. As shown in figure 18 and 19, 85% of the deceased had no access to neither emergency health services nor received early warnings for the disaster.

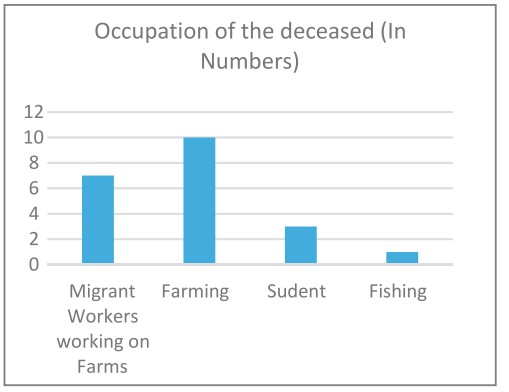


Figure 17: Occupation of Deceased

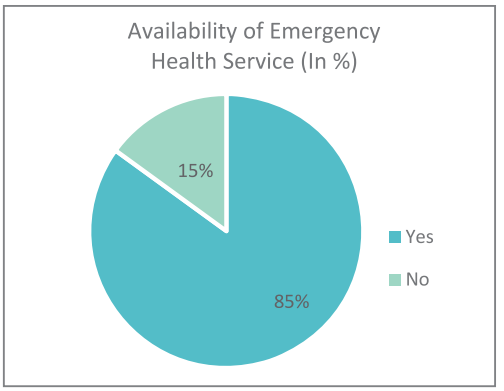


Figure 18: Emergency health services availability for Deceased

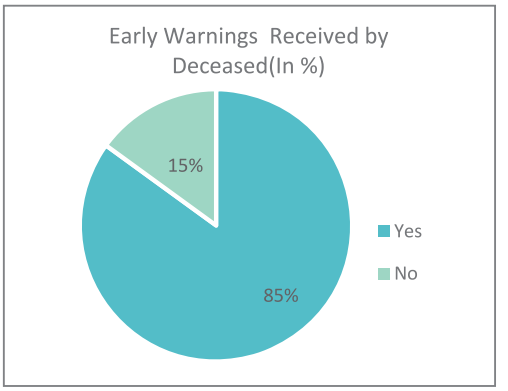


Figure 19: Early warning information received by deceased

Out of 21 deaths, 10 were caused by house collapse while inhabitants were sleeping unaware of the situation. In Amreli, members of 2 families working as seasonal farm workers and living in Kutcha Huts in Vadi, died. 3 people died due to head injuries sustained while they were outside and fell while running from hazard. 1 person suffered injury due to rock falling on the head. In cases where death is caused due to house/wall collapse, housing typology was either kutcha or semi pucca house. 18 of the 21 deceased received the early warnings and it was understood by them.

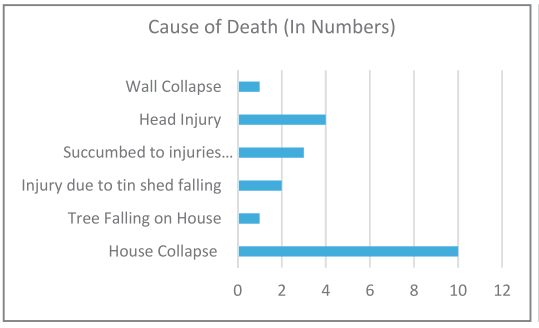


Figure 20: Cause of Death

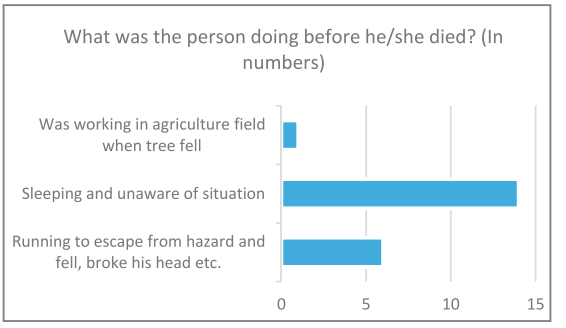


Figure 21: Task the person was doing before death

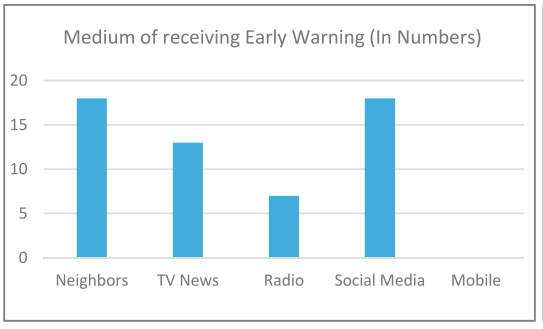


Figure 22: Medium of receiving early warnings

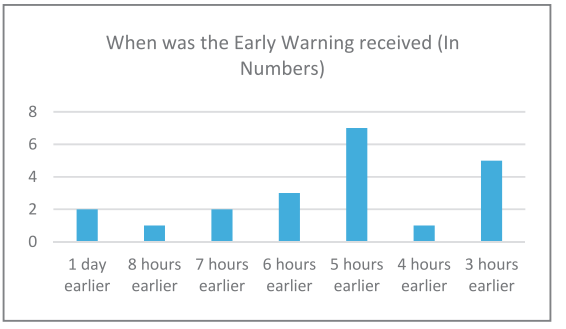


Figure 23: Early warning receiving duration

Early Warning was received through Neighbours, TV News, Radio and social media. In most cases, early warning was received only 3-5 hours earlier as shown in figure 32. None of the deceased had relocated to safer location as they were not able to understand the intensity of the disaster and they were confident that they will be safe inside the houses.

Copy of Death Certificates collected by Field coordinators:



Compensation procedure – Tauktae cyclone

Compensation and relief delivery procedure is an important process during any disaster period. The state government has certain set of norms which is followed by local government of disaster affected area. Following procedure was seen during Cyclone Tauktae in Gujarat:

Village Panchayat

During Tauktae cyclone, there was chaos in public transport.So,the village panchayat informed about the data of fatality and causality after two days of occurrence. The panchayat members (Sarpanch and Talati) found out the details and informed the Block office – revenue department – TDO and Mamlatdar.

Survey team

The district collector set up survey team on the basis of rapid assessment of damage and fatality. Deputy Mamlatdar, deputy engineers, Zonal officers, Talati and gram Sevak were assigned as the members of the team. During the survey, all details of damage and fatality were collected in the approved forms and in presence of team leader. Thereafter, the panchnamu was done with the signatures of all members.

Survey team took all the details and submittedtothe block level concerned officer (Mamlatdar), who then sent all details to the district level officer (District collector and District Development Officer).Within 10 days after that, compensation reached the victim or the nominee's accounts by Cheque after getting and verifying proper documents.

Taluka development Officer is liable for rural areas and Mamlatdar is liable for urban areas.

Document's requirement:Aadhar card, Ration cards, Bank passbook and details, Genealogy (pedhinamu), Death certificate and medical certificate.

Families Affected:

Of the population found to be affected across the three sampled districts, it was observed that 30% of the affected population were male adults as shown in figure 24, while the least affected category was of male children. Talking about the social group construct, 25% of the affected families belonged to OBC category while only 13% belonged to Scheduled Tribe category. No person of Scheduled Caste category was found to be affected (refer figure 25).

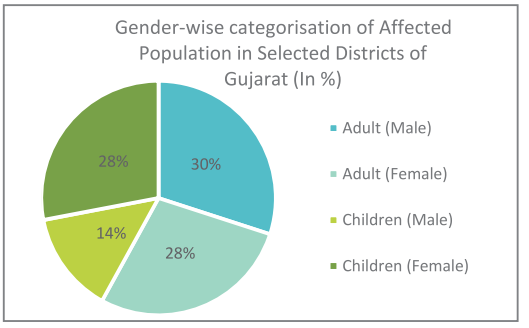


Figure 24: Gender-wise categorisation of affected population in Gujarat

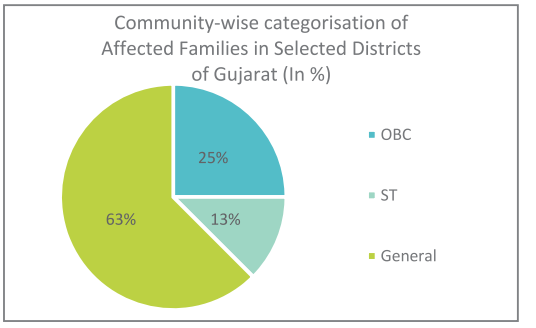


Figure 25: Community wise categorisation of affected families in Gujarat

Upon categorising the families affected based on the occupation they were engaged in; as per figure 26, it was seen that 75% of the families were engaged in Farming while only 25% of the affected families worked as Migrant workers. No major impact was seen on other occupations at large. Talking about the Income groups of the families affected, 88% belonged to 5000-10,000

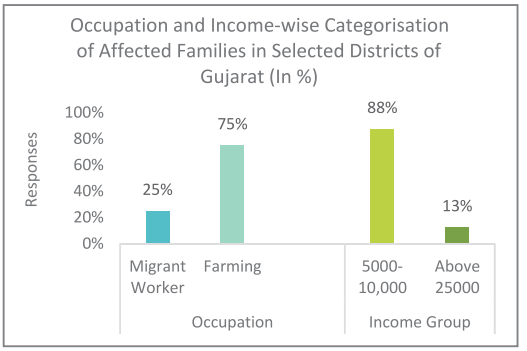


Figure 26:Occupation and Income-wise categorisation of Affected Families in Gujarat

monthly income category. This aligns with the types of occupations that have been affected which are predominantly Farming and Migrant workers for the sampled districts of Gujarat.

Early Warning Information Dissemination:

The Early Warning information dissemination analysis for all the sampled districts shows that over 70% of surveyed families received early warnings regarding the onset of disaster. Over 85% of families understood its meaning in all the three districts of Gujarat. However, the proportion of families that relocated to safer places varied across districts. 70-80% of the families in Amreli and Gir Somnath relocated to safer places while only 47% of the families surveyed in Anand relocated. The average evacuation lead time for Anand was the highest at 21 hours while it ranged between 3-4 hours for Amreli and Gir Somnath suggesting a comparatively better disaster risk preparedness and resilience in both these sampled districts (refer figure 27).

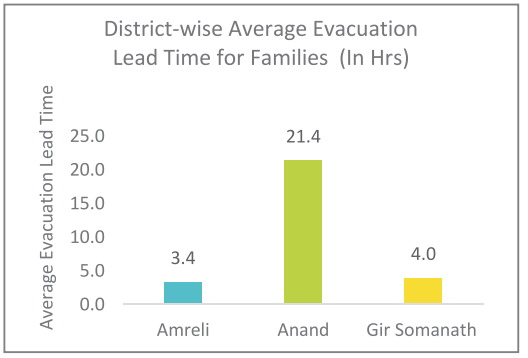


Figure 27: District-wise Early Warning Information Dissemination & Uptake in Gujarat

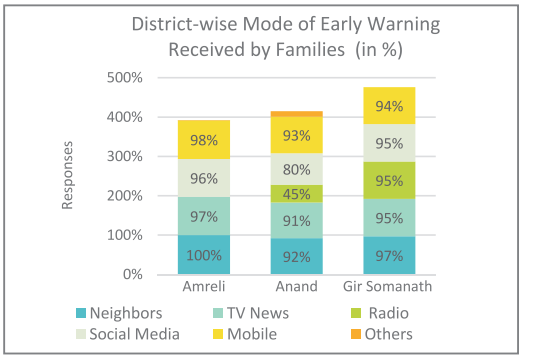


Figure 28: District-wise Average Evacuation Lead Time for affected Families in Gujarat

The most common mode of disaster warning awareness was through TV news, Radio, social media, Neighbours and mobile phones (refer figure 29). Amreli had easy access to all the modes of disaster warnings and awareness except for radio. For all the sampled districts, there was overlapping modes of information awareness, which means that each family received disaster early warning through almost all mediums of information.

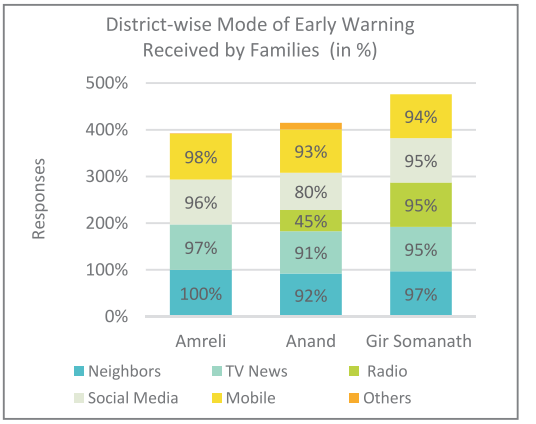


Figure 29:District-wise Medium of Receiving Early Warnings by Affected Families

It is to be noted that radio was the least used mode of disaster awareness for Amreli. However, for the remaining two sampled districts, all families received warnings from all the five identified modes of information awareness.

After understanding the Early Warning information, 60-75% of surveyed families across Amreli and Gir Somnath relocated to safer places and stayed there for 0-2 days. Families of Anand district who relocated to safer locations, 25% of them stayed for over 6days, which is evidently the maximum duration of stay across the sampled districts of Gujarat.

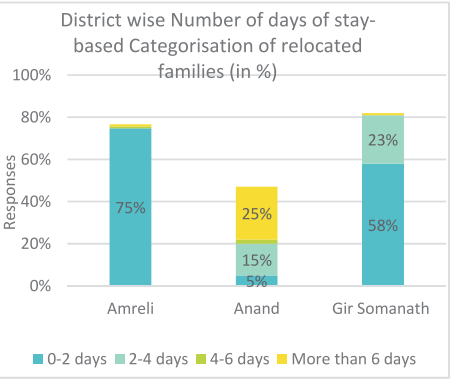


Figure 30:District wise Number of days of stay for relocated families in Gujarat

When talking about relocation to safer places, we have tried to correlate the numbers with the percentage cases where transport arrangements were made by the government to implement smooth relocation services of the population living in disaster prone areas or already affected by the cyclone. As seen earlier, Gir Somnath had better arrangements for disaster evacuation, response and rescue. To further it, of the 77% families relocated to safer place, 58% families moved using the transport arrangements made available by the government as shown in figure 31. The percentage seems minute for Gir Somnath while no transport arrangements was made by Anand district to move (approx. 47% of families) to safer locations.

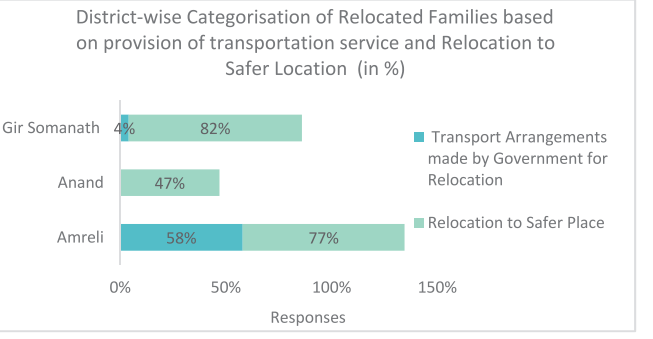


Figure 31:District-wise Categorisation of Relocated Families based on provision of transportation service in Gujarat

Though a large proportion of the families affected did relocate to safer places, yet a cumulative for all the sampled districts of Gujarat suggests that 21% of the families did not relocate. When these families were asked about the reasons for, 73% of the families responded that the houses in which they are living are ancestral property. Hence, the fear of losing the ancestral property lingered and forced them to stay back. For few others, it was seen that they felt much safer at their homes rather than the make-a-shift camps made available by the government. People portrayed lack of confidence in the services or arrangements made by the authorities and hence preferred taking the risk and stayed back in their houses located at the disaster-prone areas.

5.1.2 Damage and Loss of Livelihoods

Damage and loss to livelihood category under the Household Survey was incorporated to analyse the impact of cyclone over the three economic sectors, i.e., the primary sector, the secondary and the tertiary sector.

The block-wise impact assessment of cyclone on livelihoods of people infers to have caused maximum losses to businesses followed by losses in primary sector. One most witnessed observation at block level is that, Amreli block had over 91% of families incurring losses in business. Employment losses were not very common. However, such losses were significantly visible in Khambaha block of Amreli (refer figure 32).

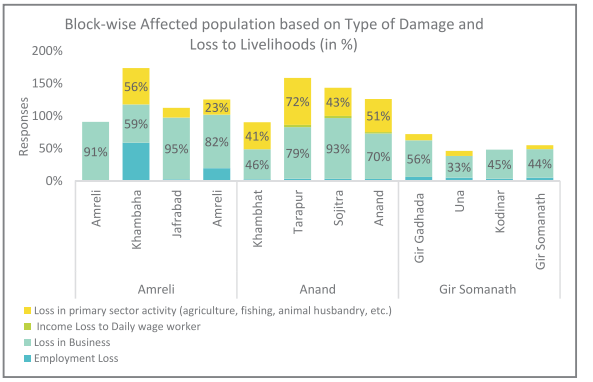


Figure 32:Block-wise Affected population based on Type of Damage and Loss to Livelihoods in Gujarat

Families whose Livelihoods have been Affected

When families whose livelihoods were affected were analysed based on the social group construct, it was seen that 10% of the families affected belonged to Scheduled Caste category, as shown in figure 33, indicating that maximum damage at a cumulative district level was witnessed by this particular community followed by Other Backward Classes.

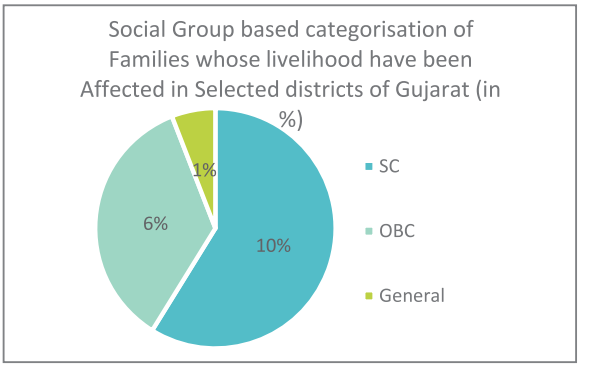


Figure 33: Social Group based categorisation of families whose livelihood are affecte

Families whose livelihoods had been affected, the majority of them were engaged in Farming. Approximately 70% of the affected families in Amreli and Anand were engaged in Farming while this occupation proportions were smaller for Gir Somnath. The next most common occupation that was affected by the cyclone was Animal Husbandry for Anand and Gir Somnath while Migrant

workers were mostly affected in Amreli district (refer figure 34).

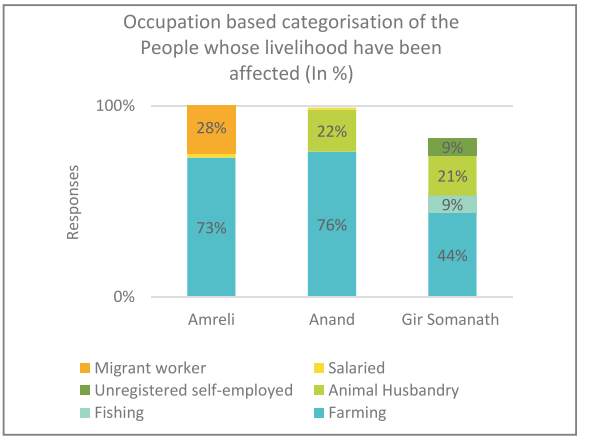


Figure 34: Occupation based categorisation of the People whose livelihood have been affected

Economic Sectors Specific Damage Analysis:

In Gujarat, when the three economic sectors were analysed district wise, it was seen that in both Amreli and Anand, primary sector was the most affected economic sector followed by tertiary sector. Secondary sector was the least affected economic sector across the sampled districts of Gujarat. (Data regarding damages in Gir Somnath were not available).

1. Primary Sector:

District level analysis specifically to identify the activities within primary sector states that for Amreli, Farming was the most affected primary sector activity. This was also inferred while analysing the occupations of the families affected. For Anand district, it was again witnessed that Farming was the most affected livelihood, however, visible impact was seen on Animal Husbandry as well. (Data regarding damages in Gir Somnath were not available).

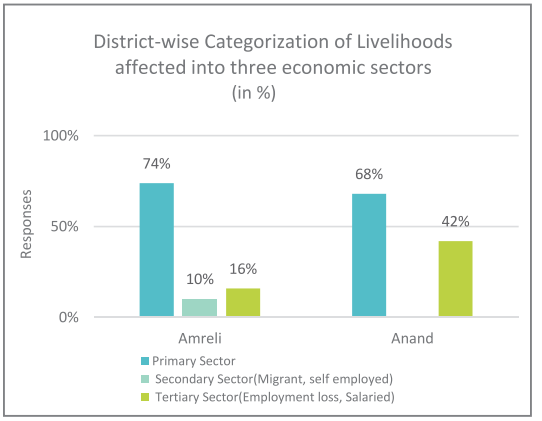


Figure 35:District-wise Categorization of Livelihoods affected into three economic sectors in Gujarat
Note: Data not available for Gir Somnath

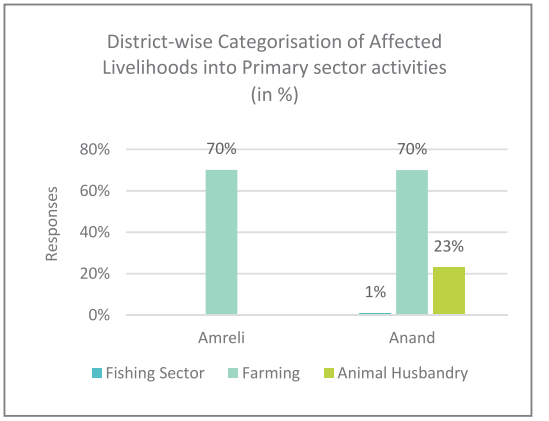


Figure 36:District-wise Categorisation into Primary sector activities for Gujarat
Note: Data not available for Gir Somnath

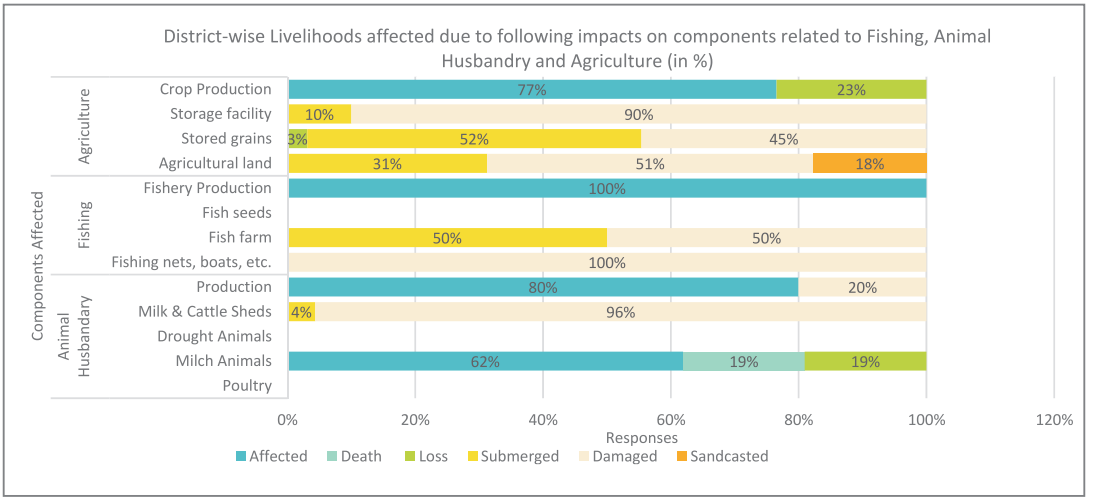


Figure 37:District-wise Livelihoods affected due to following impacts on components related to Fishing, Animal Husbandry and Agriculture

For a better understanding regarding the components of each primary sector activity, an in-depth analysis was made with respect to the impacts caused by the cyclone specific to the components (refer figure 37). For Agriculture, 77% crop production was affected and 23% losses were made. 90% of the storage facility for agriculture was damaged and 52% of stored grains were submerged. Additionally, 51% of the agricultural land was damaged.

For Fishing, 100% production was affected, 50% of fish farm was damaged while the other 50% was submerged. Almost all the fishing nets, boats were damaged.



Image 3: Destroyed farming areas for Animal Husbandry in Anand
Source: Primary Survey Field Coordinators, 2021

For Animal Husbandry, 80% of the production was affected while 96% of the milk/cattle sheds were damaged. 62% of the Milch animals were affected while a minute portion died.

It was eventually seen that for Gujarat, almost all the components of primary sector activities had impacts in one form or the other. However, the number of components (Animal Husbandry/Fishery) that died was negligible. Similarly, losses scaled were minimum, impling that the quantum of damage that happened to primary sector activities were recovered quickly.

2. Secondary Sector

When reasons for losses in secondary sector were analysed for all three districts, it was witnessed that losses in revenue from daily production and manufacturing was the most crucial reason for losses in Anand while this made least contribution to the losses in Amreli district. For Amreli,

disruptions to power and water supply contributed toward majority losses. Negligible contributions to losses in secondary sector was made because of the permanent employment losses due to down-sizing (refer figure 38).

3. Tertiary Sector

The reasons for losses in tertiary sector, losses in revenue from daily services and structural damages to workplaces caused visible hinderances and losses in Anand. While the most prominent reason for losses in tertiary sector for Amreli was disruptions in power supply and water supply. No specific reason-based analysis was witnessed for tertiary sector losses in Gir Somnath.

The overall livelihood losses at household level were analysed. The estimated average economic losses were the highest for families whose livelihood were affected. The average estimated (refer figure 39) for the days when cyclone affected the livelihoods of people were approximately 45k for Amreli, while it amounted to less than 10K for Anand and Gir Somnath.

Livelihood Practices:

It is to the best of interest for the state and districts to incorporate diversified livelihood practices. However, for Gujarat, it was seen that over 90% of livelihood practices in Anand and Gir Somnath were not diversified as shown in figure 41. Whereas, contrary to this, approximately 70% of livelihood practices in Amreli were diversified. In cases, where livelihoods were diversified, Secondary sector was seen as the most dominant sector followed by primary sector.

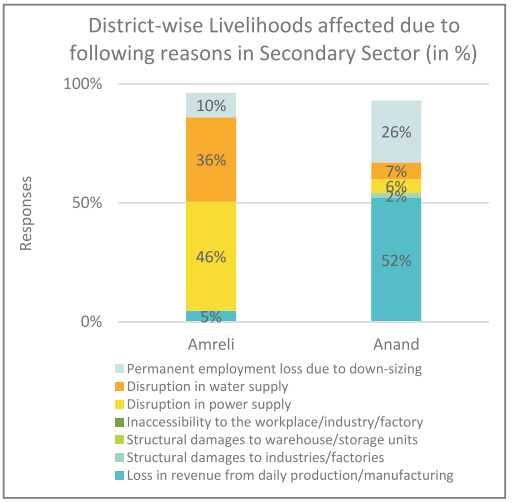


Figure 38:District-wise Livelihoods affected due certain identified reasons in Secondary Sector for Gujarat
Note: Data not available for Gir Somnath

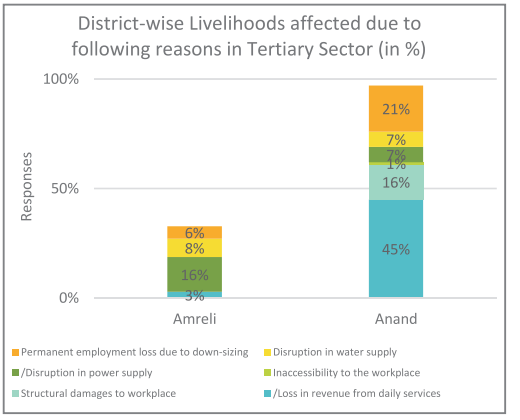


Figure 39:District-wise Livelihoods affected certain identified reasons in Tertiary Sector for Gujarat
Note: Data not available for Gir Somnath

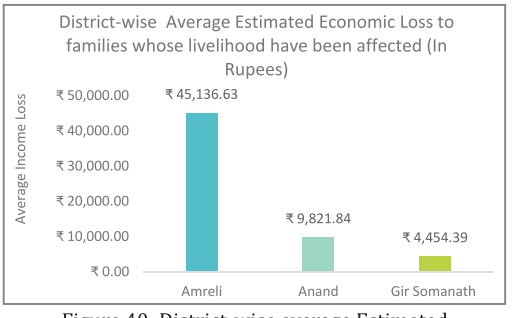


Figure 40: District-wise average Estimated Economic Loss to families in Gujarat

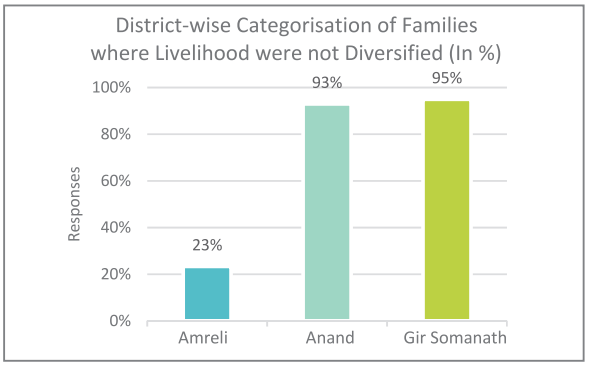


Figure 41: District-wise Categorisation of Families where Livelihood were not Diversified in Gujarat

After analysing the diversification of livelihood practices, it was very important to understand whether resilient livelihood practices are being followed or not.

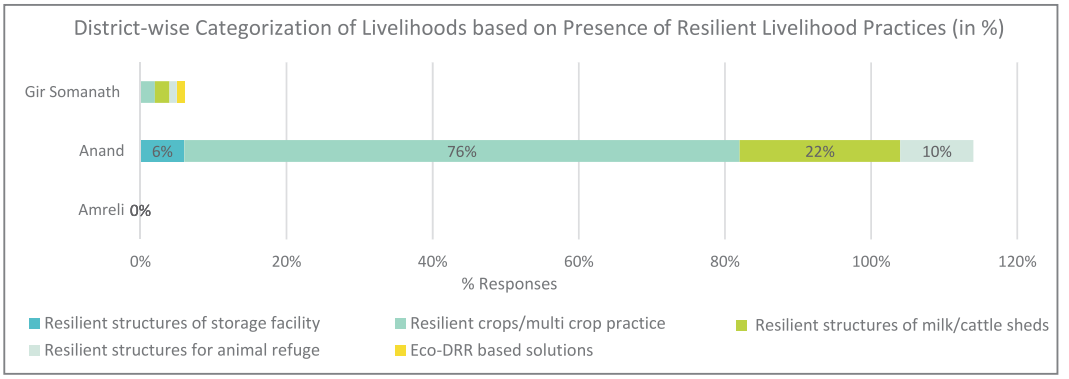


Figure 42: District-wise Categorization of Livelihoods based on Presence of Resilient Livelihood Practices in Gujarat

When assessed, it was seen that Anand practised maximum number of resilient livelihood methods (refer figure 42). The most practiced one was resilient crops or multi crop practice. This was followed by resilient structures of milk/ cattle sheds and animal refuge. A very negligible portion of livelihood practices in Gir Somnath were resilient in nature, *while no resilient livelihood practices were followed in Amreli.*

5.1.3 Damage to Housing Structures

After detailed analysis of the people and their livelihoods being affected, under this domain we are going to assess the damage caused to housing structures within the sampled districts of Gujarat. The ownership of these houses varies from owned and rented to mortgage on loan. In Gujarat, 99% of the houses were owned by the families while a meagre 1% were rented. No cases of houses mortgaged on loans were seen in the sampled districts of Gujarat.

The extent of damage caused by cyclone on the houses of Gujarat ranged from severely and partially damagedto fully damaged. A cumulative district level analysis for Gujarat depicted that of the total number of houses surveyed, 52% of these housing structures were kutcha houses





Image 4: Damaged Housing Structures in Amreli
Source: Primary Survey Field Coordinators, 2021

(refer figure 43), which can significantly be correlated to the quantum of damage. Further to it, approximately 37% of the total houses surveyed were found to be semi-pucca houses while only 11% of these were pucca houses.

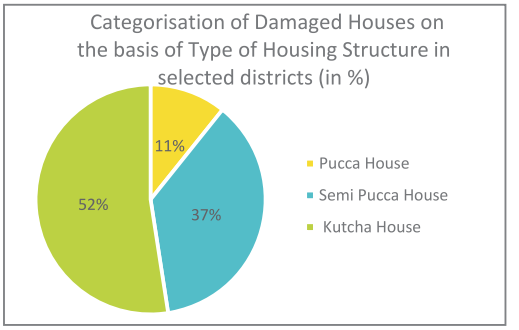


Figure 43: Categorisation of Damaged Houses on the basis of Type of Housing Structure in Gujarat

Talking about the extent of damage, 30-35% of these sampled houses were partially or severely damaged. The proportion of fully damaged houses scaled to be low with only 15%. There were cases in the state where no houses were damaged. This can possible because they happened to be located far from the disaster area or were fully-engineered pucca housing structures. 29% of these surveyed houses were severely damaged. The type of housing and the extent of damage can be associated with the fact that when the number of pucca structures are high the extent of damage can possibly be low.

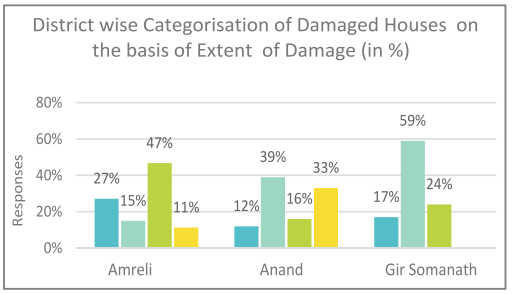


Figure 44: District wise Categorisation of Damaged Houses on the basis of Extent of Damage in Gujarat

When a district level analysis for the extent of damage to housing structures were done. It was found that 30-50% of the housing structures in Anand and Gir Somnath were not at all damaged (refer figure 44), while the percentage was only 15% in Amreli. This indicated that the remaining houses in all the three districts were somehow damaged, of which 47% in Amreli were partially damaged. Not many houses in in Gir Somnath were severely damaged while in Anand, the percentages were significant at 33%. The Fully damaged cases across all the three districts were somewhere between 10-20%.

A district level correlation analysis was done between extent of damage and type of housing structures. For Amreli, it was seen that despite being kutcha houses, 91% of houses were not damaged while the majority proportion of damage was seen in semi pucca houses at 70% being severely damaged (refer figure 45). For Anand, again, major part of the kutcha houses was not

damaged. However, 58% of the pucca houses were partially damaged. For Gir Somnath, 83% of kutcha houses were not damaged while 50-70% of pucca and semi-pucca houses were partially damaged. The overall picture reveals that the type of housing structure (kutcha or Pucca) had no direct impact or relation with the extent of damage in the sampled districts of Gujarat.

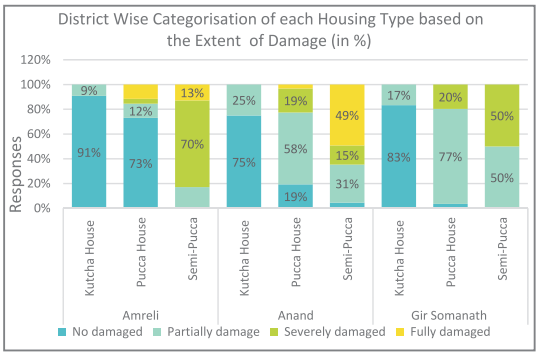


Figure 45:District Wise Categorisation of each Housing Type based on the Extent of Damage

The component of housing structures i.e., the foundation and Plinth, the roof or the walls, openings and columns were eventually assessed. For Amreli, it was seen that only Roofs were damage, of which 67% were fully damaged (refer figure 46) and the remaining structures were partially damaged. When talking about roof, the type of damage that was seen were either cracks, total or partial destruction. In Anand, roofs and walls/ openings/columns components were damaged where majority of roof was partially damaged while the wall component was 100% severely damaged, i.e., vertical cracks, wall tilting, corner separation, bulging, diagonal cracks near openings, cracks at beam-column junction and buckling of columns were the visible kinds of damage witnessed. In Gir Somnath, all the three components were damaged and were mostly either partially damaged or severely damaged. Of the foundation and plinth, the type of damage seen was cracks, scouring and settlements.

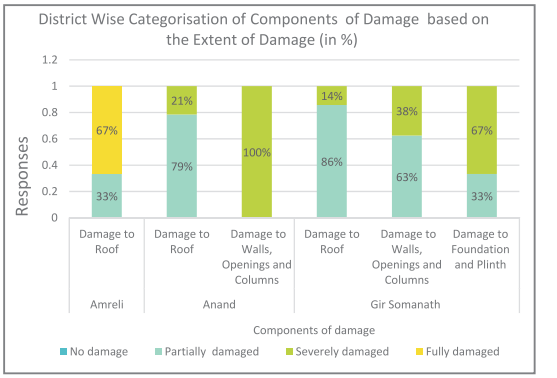


Figure 46: District Wise Categorisation of Components of Damage based on the Extent of Damage

Talking about the repair status, only 1% of damages to foundation and plinth were repairable. In case of damage to walls, columns and openings, only 4% were of repairable status while in case of damage to roofs, 12% were of repairable status.

The estimated cost of damages incurred district-wise was averaged. The least at Rs. 10,000 for Gir Somnath while it was the maximum for Anand at Rs. 1,00,000. It was averaged somewhere between Rs. 30,000-35,000 for Amreli. As witnessed from the numbers, it can be comprehended that Gir Somnath incurred maximum losses and therefore in lieu of the damage, 14% of the damaged housing structures received compensation for reconstructions and retrofitting. *No visible cases of disbursal of monetary compensations to other two districts were seen.* After the disaster subdued and with the compensation received by the households of Gir Somnath, the entire reconstruction of the damaged houses was completed in approximately 10-12 days. For the other two districts, since monetary compensations were not provided in maximum cases, the reconstruction period varied, to as low as 15 days to as high as 3 months.

Cause Identification

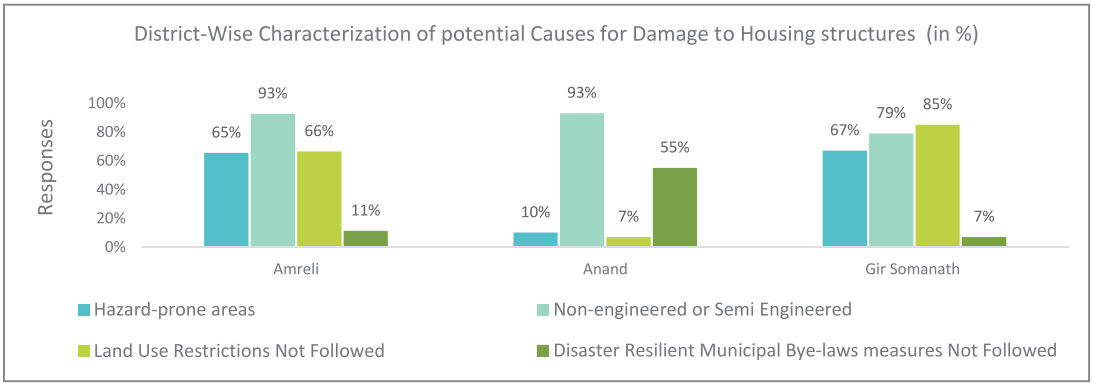


Figure 47: District-Wise Characterization of potential Causes for Damage to Housing structures in Gujarat.

Once damage assessment is done, it is important to identify the causes of damages to the housing structures. For this parameter assessment, four causes have been identified (refer figure 47), i.e., whether the houses were constructed on hazard prone areas, if the housing structures were engineered or semi-engineered building structures, if disaster resilient municipal bye-laws were followed and if land use restrictions were followed. Talking about the damage, we identified the housing structures in the sampled districts of Gujarat were either constructed on hazard prone areas or were non/semi-engineered building and those that did not follow the land use restrictions nor the municipal bye-laws.

For a better understanding of these parameters, a descriptive paragraph is under-stated.

Hazard Prone Areas	Hazard-prone areas refer to the coastal regions vulnerable to cyclonic events, sub-divided based on the extent of vulnerability which is identified by the Disaster Management Authorities and technical institutions.
Semi and Non-Engineered Buildings	Semi-engineered buildings refer to buildings made from intuitively structural materials like burnt bricks, laid in cement or lime mortar with RC slab/roofs without proper design or supervision and offer some resistance to cyclonic damage. Non-Engineered buildings are constructed using non-standard materials like Agri-waste & local construction practices and are highly unsafe & vulnerable to cyclonic damage.
Land Use Restrictions	DRR-oriented Planning and Land Use Restrictions refer to Zoning and Development Control Regulations (DCR) which specifically cater to the vulnerability of the area to disasters (cyclone here) and offer resilience and adaptative mechanisms
Buildings Codes	Municipal Bye-laws/Buildings Codes and Guidelines refer to structural standards laid out for buildings to foster cyclone-resilient construction

When these four parameters were assessed with respect to the housing structures, it was found that over 90% of the housing structures in Anand and Amreli were non/semi-engineered building structure. 60% of the housing structures in Amreli and Gir Somnath were located in hazard prone areas while in Anand, only 10% of these structures were located at hazard prone areas. 60-70% of

housing structures of Amreli and Gir Somnath did not follow any land use restrictions. However, most of the houses in Anand were build following the land use restriction laws. Talking about adherence to disaster resilient municipal bye-laws, for both Amreli and Gir Somnath, there were maximum compliance while it was least for Anand district of Gujarat.



Image 5: Destroyed Residential Structures in Amreli
Source: Primary Survey Field Coordinators, 2021



Image 6: Destroyed Residential Structures in Gir Somnath
Source: Primary Survey Field Coordinators, 2021

5.1.4 Damage to Physical Infrastructure

The cyclone caused major service disruption to the physical infrastructural elements like Water supply, electricity & telecommunication and road network. Talking about the families affected by disruption to physical infrastructures, it was seen that families of Amreli witnessed maximum service disruptions, with over 80% families facing difficulties in accessibility to water supply, electricity and road transportation network (refer figure 48). For both Anand and Gir Somnath, approximately 50% of the families surveyed and was concluded that they faced service disruptions to electricity and telecommunication.

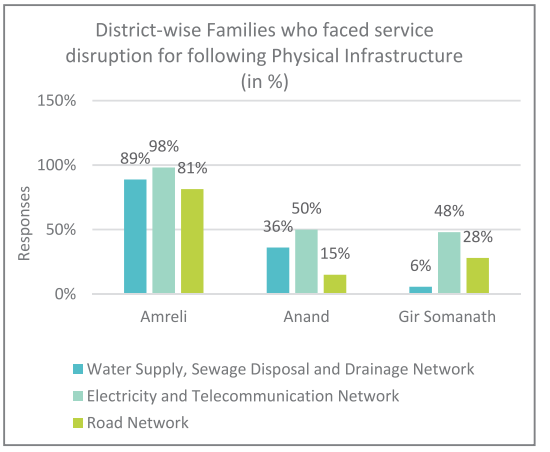


Figure 48:Families who faced service disruption for Physical Infrastructure in Gujarat

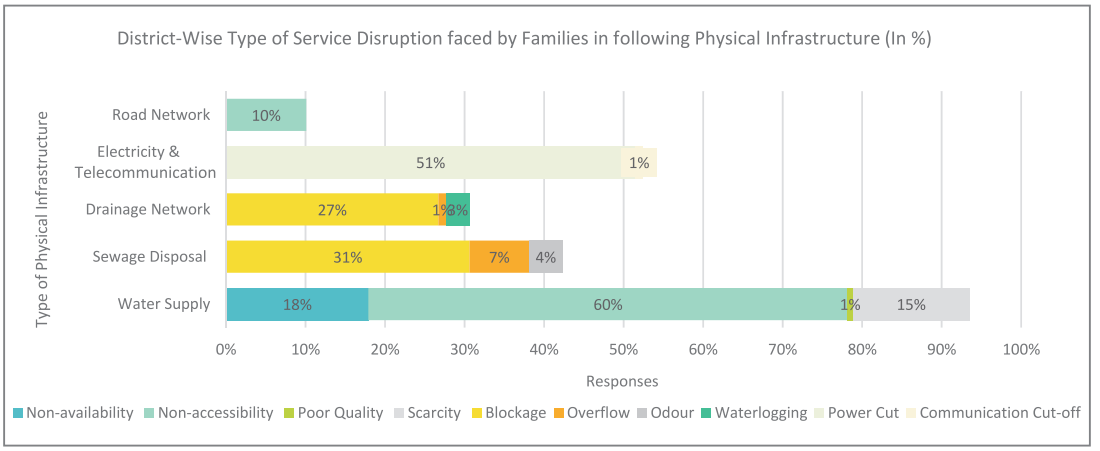


Figure 49: District-Wise Type of Service Disruption faced by Families in Gujarat (Physical Infrastructure) in Gujarat

The most common type of service disruptions for water supply was in-accessibility, non-availability, poor quality and scarcity. At a cumulative district level, it was seen that 60% of families couldn't access the water supply services (refer figure 49). 15% of the families faced issues of water scarcity and non-availability of water supply. Service disruptions for sewage disposal constituted blockage, foul odour and sewerage overflow. For all the sampled districts, it was seen that 31% of the families faced issues of blockage while 5-7% families faced odour and overflow issues. Service disruptions for drainage network were blockage, overflow and waterlogging, of which maximum families faced issues of drainage blockage and water logging.

Of the sampled families, 51% faced electricity outrage while only 10% were not able to access road and transportation networks.

When damages at household level were analysed, it was seen that 30-43% of families in both Anand and Amreli districts were affected by the service disruptions to electricity and telecommunication infrastructures due to damage at household level (refer figure 50). 10-13% of the families were affected by service disruption to the road networks of Anand and Amreli due to damage at household level. Families in Gir Somnath witnessed least service disruptions to physical infrastructural due to damages at household level.

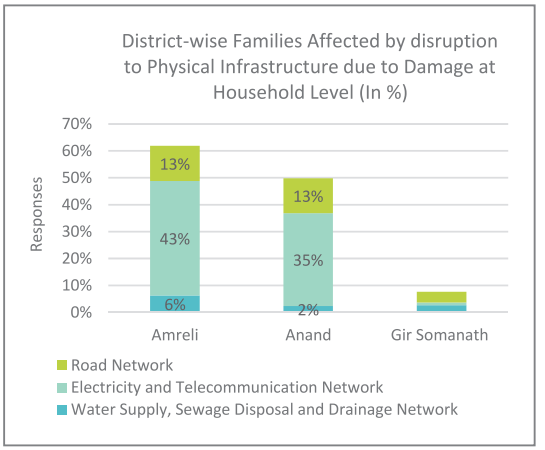


Figure 50: District-wise Families Affected by disruption to Physical Infrastructure due to Damage at Household Level in Gujarat

The duration of disruption to water supply facility faced by families in the sampled districts of Gujarat ranged from 2 days to a maximum of 45 days. Similarly, the duration of service disruption to electricity and

telecommunication service faced by families went up to a maximum of 60 days while it was limited to 45 days only for road networks.

Talking about the extent of damage to these physical infrastructures, 10-15% of these structures were witnessed to be partially damaged, while in majority cases, families were not sure about the extent of damage happened.

Marginalised Families

In order to analyse the impact of service disruptions to physical infrastructures on marginalised

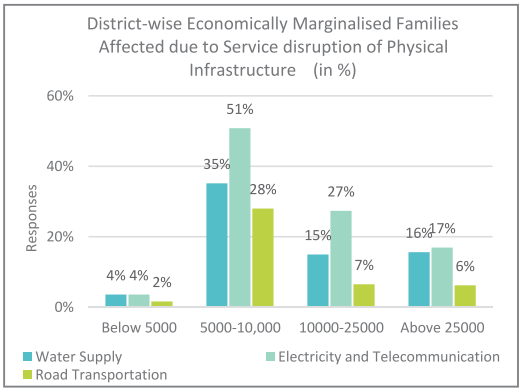


Figure 51: Economically Marginalised Families Affected by damage to Physical Infrastructures in Gujarat

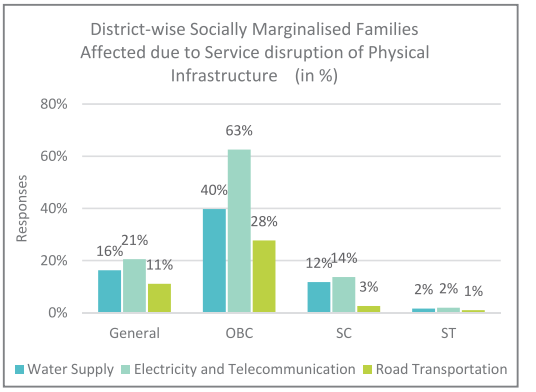


Figure 52: Economically Marginalised Families Affected by damage to Physical Infrastructures in Gujarat

families, we have analysed this parameter in two ways. One is by analysing the impact over economically marginalised families. Approximately, 30-50% of economically marginalised families faced service disruptions to water supply, electricity and road network (refer figure 51). Families whose monthly earned family income is below Rs. 5000, rarely faced any service disruptions. Here, it is highly possible that they may not really have accessibility to these infrastructures in the first place.

Talking about the impact of service disruptions to physical infrastructures on socially marginalised families, it was seen that maximum service disruptions were faced by the OBC community, with 40-60%. This was followed by Scheduled caste category. However, the proportions were low, with 10-12% of the families (refer figure 52). Scheduled Tribes were the least impacted social group in Gujarat due to damages to physical infrastructures.

Cause Identification:

Cause identification for damages to physical infrastructures was done based on eight parameters. These parameters are explained as below.

Hazard Prone Areas	Hazard-prone areas refer to the coastal regions vulnerable to cyclonic events, sub-divided based on the extent of vulnerability which is identified by the Disaster Management Authorities and technical institutions.
Semi and Non-Engineered Buildings	Semi-engineered buildings refer to buildings made fr om intuitively structural materials like burnt bricks, laid in cement or lime mortar with RC slab/roofs without proper design or supervision and offer some resistance to cyclonic damage. Non-Engineered buildings are constructed using non-standard materials like Agri-waste & local construction practices and are highly unsafe & vulnerable to cyclonic damage.
Land Use Restrictions	DRR-oriented Planning and Land Use Restrictions refer to Zoning and Development Control Regulations (DCR) which specifically cater to the vulnerability of the area to disasters (cyclone here) and offer resilience and adaptative mechanisms
Buildings Codes	Municipal Bye-laws/Buildings Codes and Guidelines refer to structural standards laid out for buildings to foster cyclone-resilient construction
Vulnerability Assessment	Vulnerability Assessment refer to identifying and quantifying vulnerabilities of buildings and other structures specific to type and intensity of vulnerability to hazards (cyclone).

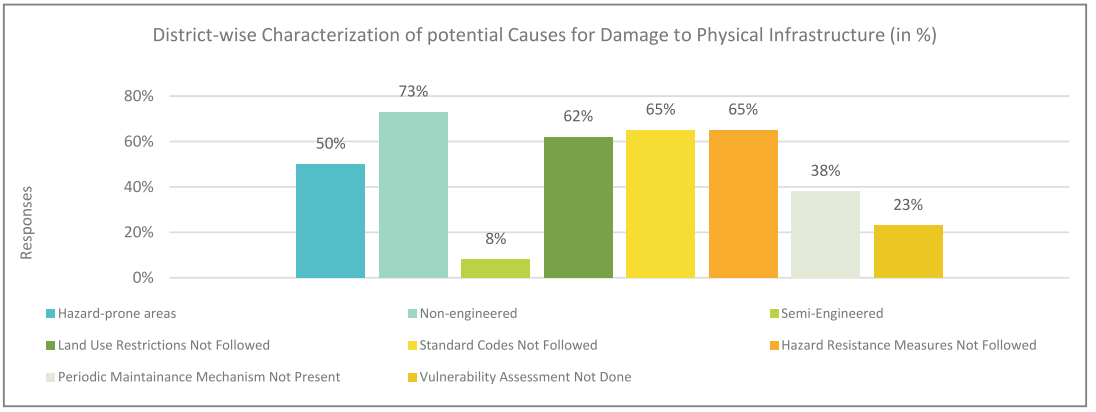


Figure 53: District wise Potential Causes for Damage to Physical Infrastructure in Gujarat

Based on the above-described parameters, it was evidenced that 50-60% of the physical infrastructures within the sampled district area were constructed at hazard prone areas. These were non-engineered building structures. These did not follow land use restriction norms nor the standard code or any hazard resistance measures (refer figure 53). Approximately 20-30% of these structures did not have any periodic maintenance mechanism nor undertook vulnerability assessments.

5.1.5 Damage to Social Infrastructure

Cyclone had major impact overthe social infrastructure elements categorised into health facilities, education facilities, administrative facilities, religious and community facilities. The cyclone caused hinderance to these elements of social infrastructure that led to service disruptions of some to the most essential services. Analysing the percentages of family's district wise that faced social infrastructural service disruptions, it was seen that majority service disruptions were witnessed in Gir Somnath and Amreli district of Gujarat. The most affected facility that caused major service disruptions to families was Health Facilities with approximately 62% families in

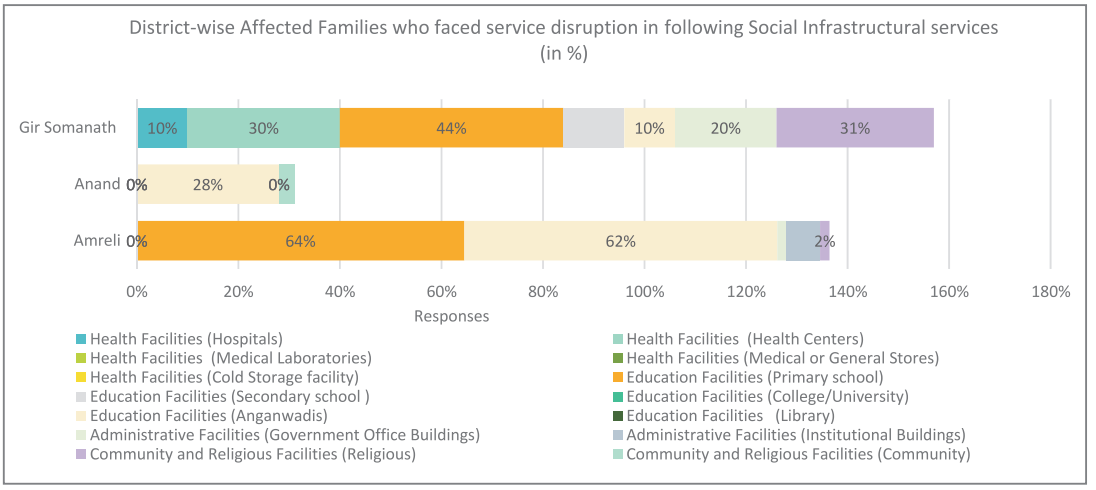


Figure 54: District-wise Affected Families who faced service disruption in Social Infrastructural services in Gujarat

Amreli being affected but the percentage was quite low for Anand and Gir Somnath. The next critical service that was disrupted was Education Facility, particularly primary schools. In Amreli 64% of families faced accessibility issues to primary schools while the percentage was at 44% for Gir Somnath. Anand did not face any major service disruptions to educational facilities. Administrative facilities and Religious/community facilities were damaged too. However, they did not cause any major hinderance in the form of service disruptions to the families.

Further to it, talking about specifically the type of service disruptions the families faced, of the responses that were collated, it was seen that Education and Health service were not available to be accessed or engaged with by the families across the three sampled districts of Gujarat. Whereas, the administrative services available portrayed poor quality of service to the families. *Not much information was available regarding the type of service disruption faced by families with respect to religious and community facilities.*

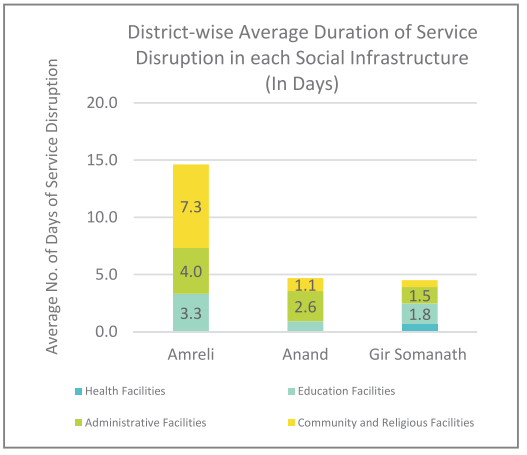


Figure 55: Duration of Service Disruption in each Social Infrastructure in Gujarat

Duration of service disruption to each element of social infrastructure was collated and therefore, it was seen that Amreli had maximum days of service disruptions across all elements of social infrastructure, compared to the other two districts. Not much information was available regarding the duration of service disruption to health facilities. It ranged from 2-3 days for educational facilities (refer figure 55) for all the sampled districts. Duration of service disruptions to administrative facilities ranged between 1-2 days for Anand and Gir Somnath while it was highest at 4 days for Amreli. Duration of disruption to

religious/community facilities was the least for Anand and Gir Somnath.It was averaged at 7 days for Amreli.

Marginalised Families:

In order to analyse the impact of service disruptions to social infrastructures on marginalised families, we have analysed this parameter in two ways. One is by analysing the impact over economically marginalised families (analysing the income factor). Approximately 62% of families faced service disruptions to social infrastructural facilities belonging to Rs.5000-10000 income groups alongside a minuscule 3% families affected belonging to below Rs. 5000 income group, suggesting that families whose monthly earned family income is below Rs. 5000, rarely faced any service disruptions to social infrastructural elements (refer figure 56).

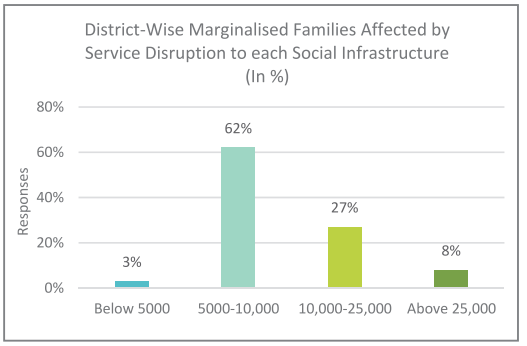


Figure 56: Marginalised Families Affected by damage to social Infrastructures in Gujarat

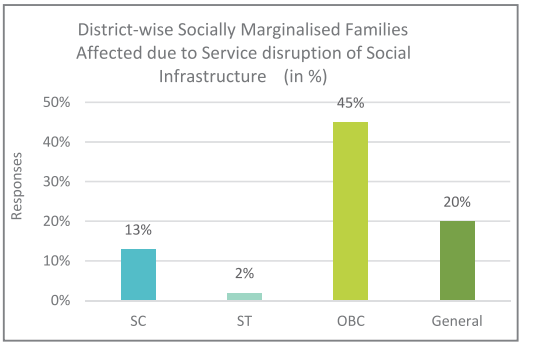


Figure 57: Socially Marginalised Families by damage to social Infrastructures in Gujarat

Focussing on the socially marginalised families affected, it was seen that 45% of the families affected by service disruptions belonged to Other Backward classes while 13% of these families belonged to Scheduled Caste community. Families from Scheduled Tribes community were the least affected social group (refer figure 57).

Cause Identification:

Cause identification for damages to social infrastructures was done based on six parameters. These parameters are explained as below.

Hazard Prone Areas	Hazard-prone areas refer to the coastal regions vulnerable to cyclonic events, sub-divided based on the extent of vulnerability which is identified by the Disaster Management Authorities and technical institutions.
Semi and Non-Engineered Buildings	Semi-engineered buildings refer to buildings made from intuitively structural materials like burnt bricks, laid in cement or lime mortar with RC slab/roofs without proper design or supervision and offer some resistance to cyclonic damage. Non-Engineered buildings are constructed using non -standard materials like Agri -waste & local construction practices and are highly unsafe & vulnerable to cyclonic damage.
Land Use Restrictions	DRR-oriented Planning and L and Use Restrictions refer to Zoning and Development Control Regulations (DCR) which specifically cater to the vulnerability of the area to disasters (cyclone here) and offer resilience and adaptative mechanisms

Buildings Codes	Municipal Bye-laws/Buildings Codes and Guidelines refer to structural standards laid out for buildings to foster cyclone-resilient construction
Vulnerability Assessment	Vulnerability Assessment refer to identifying and quantifying vulnerabilities of buildings and other structures specific to type and intensity of vulnerability to hazards (cyclone).

Based on the above-described parameters, it was found that 60-65% of the social infrastructures within the sampled district area were constructed at hazard prone areas and were non-engineered building structures. 40% of these did not follow any standard codes. Most importantly, 19% of these structures did not undertake vulnerability assessments to adjudge the safety elements.

5.1.6 Damage to Environment

The Environment domain has been specifically incorporated to identify the impact and extent of damage the cyclone has caused to various components of environment. The components of environment that have been analysed are:

1. Water sources which specifically constitutes ground water, lake, rivers and canals. At a cumulative district level analysis, it was seen that one lake in Gujarat was affected and damaged because of the cyclone (refer figure 59). Talking about the families that were affected because of the damage caused to water sources, it was seen that not many families were affected by the damage caused to water sources but it was seen that area around these water sources were damaged and broken, polluting the water sources.
2. Land constitutes agricultural land, forest, wetland, mines, mangroves and wastelands. An approximate 13% of the families surveyed were affected by the damage caused to different components of land. 41 families were affected by the damage to agricultural lands while 22 families were affected by the damage

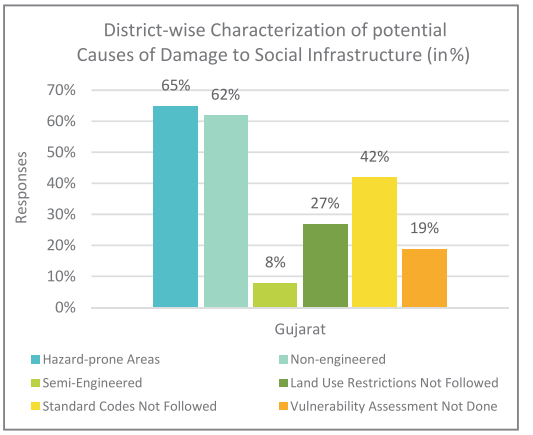


Figure 58: Characterization of potential Causes of Damage to Social Infrastructure in Gujarat

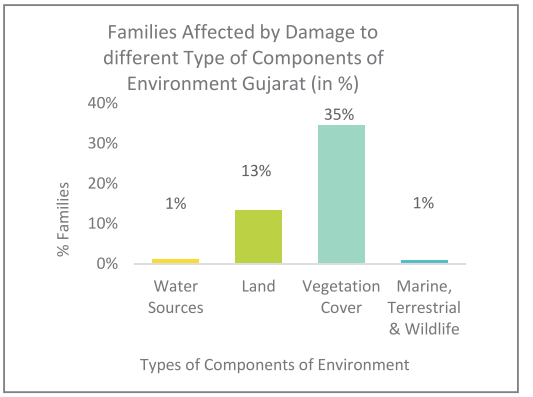


Figure 59: Families Affected by Damage to different Components of Environment in Gujarat



Image 7: Destroyed for Cultivable Lands in Amreli
Source: Primary Survey Field Coordinator, 2021

caused to wetlands. Damage to land critically impacted families by destroying their agricultural lands, causing losses in production and livelihoods.

3. Vegetation Cover constitutes grass, bamboo, timber trees, plantation and Aquatic plants. Cumulative district level analysis states that 35% of the families surveyed were affected by the damage caused to vegetation cover. The most important conclusion here was, 106 families were affected because of the damage caused specifically to plantation and 20 families were affected by damage caused to timber trees.

4. Marine, Terrestrial and Wildlife.The cumulative district level analysis for Gujarat shows that negligible proportions of families were affected by the damage caused to this component of environment. This suggests that not many families were dependent on this component for livelihood. However, of the families that have responded, the most common form of damage witnessed by them was drowning of animals because of the increased water levels.

5.2 Maharashtra – Damage and Cause Assessment

In Maharashtra, 10 districts were affected (Thane, Raigad Palghar, Ratnagiri, Sindhudurg, Satara, Mumbai City, Mumbai Suburban, Pune, Kolhapur) by Super severe cyclonic storm Tauktae.

Table 17: General Details of Sampled State

Maharashtra		Raigad	Most Affected
District Affected	10	Palghar	Most Affected
Persons Evacuated	13,425	Mumbai	Moderately Affected
Houses Damaged	Fully-81; Partially- 13021		
Human Lives Lost	19		
Injured	37		
Loss to Livestock	11		
Maximum Wind Speed	114 kmph		
Rainfall	Heavy to extremely heavy rainfall activity, over coastal Maharashtra on 15-16th north Maharashtra on 16-17th		

Source : Primary Source through State Coordinator, 2021

For the purpose of undertaking the Damage Assessment Study, we conducted Household and Key Informant surveys across the state of Maharashtra to make a comprehensive analysis of the damage at state, district, block and village level. The three districts that were surveyed are Raigad (most affected), Palghar (most affected) and Mumbai (moderately affected). Three blocks/Wards under in each district were surveyed, with a minimum of 3 villages per block





Image 8: Flooded Regions in Sampled districts of Maharashtra
Source: Primary Survey Field Coordinator, 2021

Sample Survey Findings

5.2.1 Damage and Loss to Human Lives

The assessment analysis of damages to human lives in the three surveyed districts and its blocks in Maharashtra infers to have affected Raigad and Palghar districts the most. As evident from the adjoining graph, it has been stated through the survey responses that people of Mumbai (Urban), particularly in WorliKoli Wada block was least affected by the cyclone. Mangaon of Raigad district and Vasai from Palghar district were the most affected blocks with approximate 20-25% of the population surveyed to be affected by the cyclone (refer figure 60).

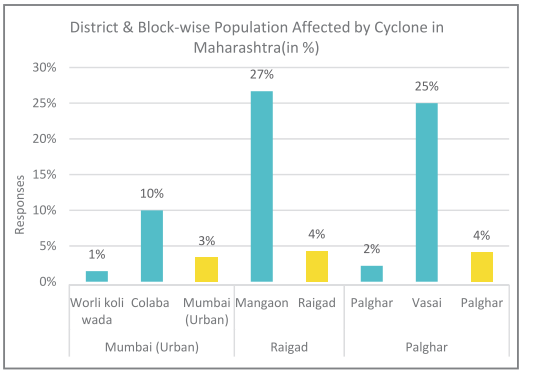


Figure 60: Block-wise Population Affected by Cyclone in Maharashtra

Talking about the type of damages, the cumulative-district level analysis infers that deaths, health issues, injury and physical disabilities were the visible type of damages to human lives witnessed in Maharashtra. The quantum of disruptions to health facilities can be assessed based on the inconvenience caused to human lives and their access to medical services. At district level, it was seen that only one percent of the sampled families of Mumbai went missing. Raigad witnessed maximum number of deaths within the state. No deaths or missing reports were seen in Palghar. It, nonetheless, reported maximum numbers of physical disability cases and injury (Very few responses were received for Raigad).

Human Deaths

Human deaths in Maharashtra were specifically analysed along various parameters like gender, age, occupation, and the cause of death. Of the data collected in Raigad for the deceased

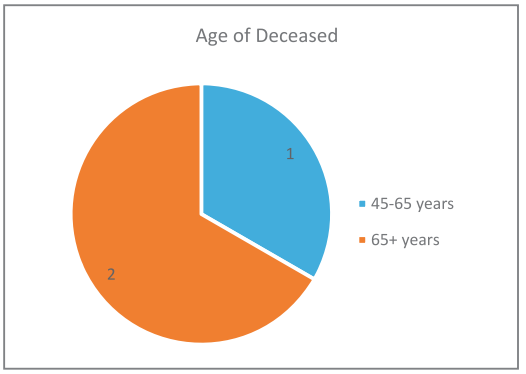


Figure 61: Age of Deceased

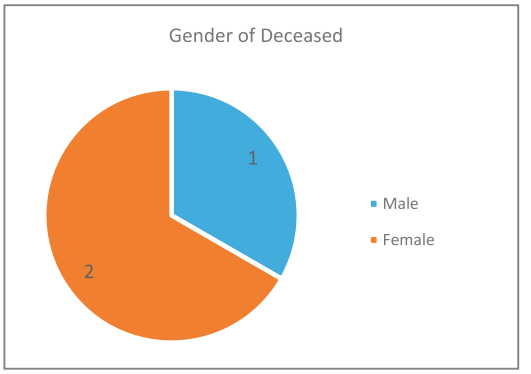


Figure 62: Gender of Deceased
Age of Deceased

individuals, 2 were females while 1 person was male (refer figure 62). Of the deceased females, one of them was the head of the household. One very important factor for such numbers can be absence of disaster early warning information awareness. From the assessments, it has been seen that none of the deceased individuals in Raigad received any early warning information for the disaster that was approaching the district.

2 of the people that died aged above 65 years, referring to the non-accessibility to early warning awareness and information regarding the disaster (refer figure 61).

Of the people died, 2 of them were working as vegetables and flower sellers, while 1 of the deceased worked as a daily wage worker. Talking about the causes of death, all the deceased happened to die directly because of the cyclone. One of them was hit by broken tree while others got hit by the walls that collapsed due to the storm. None of the 3 deceased were involved in response and rescue operations.

Families Affected

Of the population found to be affected across the three sampled districts, it was found that 26% of the affected population were male adults and approximately similar proportion of females were affected (refer figure 63). Strikingly, the most affected gender category was of male children.

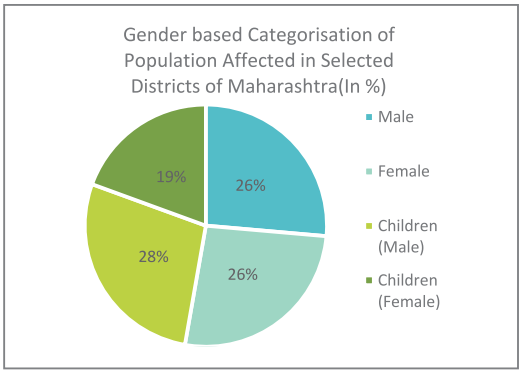


Figure 63: Gender based Categorisation of Population Affected in Maharashtra

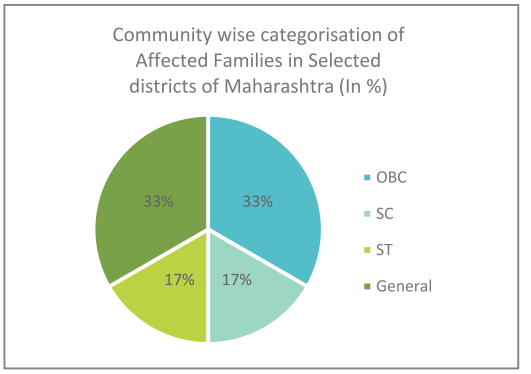


Figure 64: Community wise categorisation of Affected Familiesin Maharashtra

Talking about the social group construct, 33% of the affected families belonged to OBC category while only 17% belonged to Scheduled Tribes or Scheduled Caste category (refer figure 64).

Upon categorising the families affected based on the occupation they were engaged in; it was seen that 58% of the families were engaged in Fishing while 17% of the families worked were Salaried Employees (refer figure 65). No major impact was seen on other occupations, at large. Talking about the Income groups of the families affected, 58% belonged to Rs.5000-10,000 monthly income category. This is well associated with the types of occupations that have been affected, which is majorly Fishing for the sampled districts of Gujarat. A nominal percentage at 25% of the families affected earned a monthly income between Rs. 10,000-25,000, which again can be associated with the next most affected type of occupation which is salaried employees.

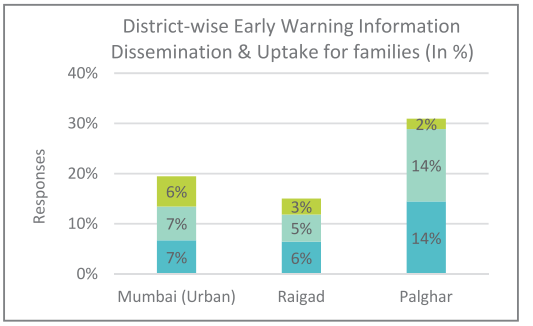


Figure 65: Income & Occupation based Categorisation of Affected Families in Maharashtra

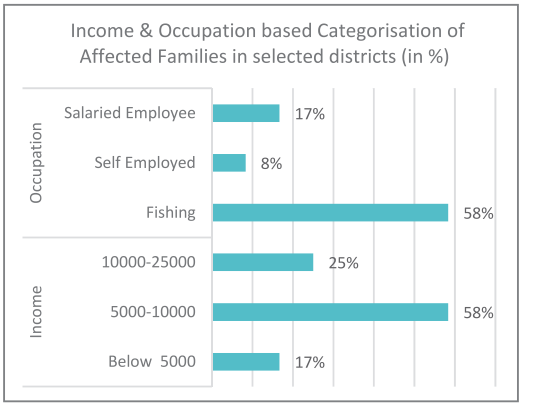


Figure 66: District-wise Early Warning Information Dissemination & Uptake for families in Maharashtra

Early Warning Information Dissemination:

The Early Warning information dissemination analysis for all the sampled districts shows that only 7-10% of surveyed families received early warnings regarding the onset of disaster.Only 5-10% of families understood the meaning in all the three districts (refer figure 66). The proportion of families that relocated to a safer place were the least witnessed throughout the assessment at 2-6% only in all the three districts of Maharashtra. While Palghar had the maximum percentages of families who received and understood the early warning yet it had the least percentages of families that relocated to safer places. In Mumbai, 7% of the sampled families received and understood the warnings, of which 6% relocated, implying 90% of the families that received early warnings, understood the severity of the situation and laid their trust on the evacuation team and the government. Yet, the overall percentages were very low which eventually represents the requirement of building a robust early warning awareness system within all the three districts of Maharashtra.

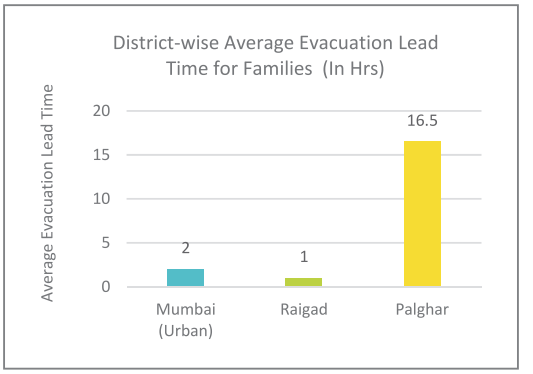


Figure 67: Average Evacuation Lead Time for Families in Maharashtra

The average evacuation lead time for Palghar was the highest at 16 hours while it ranged between 1-2 hours for Raigad and Mumbai suggesting a comparatively better disaster risk preparedness and resilience in both these sampled districts (refer figure 67).The most common mode of disaster warning awareness was through TV news, Neighbours and mobile phones. Palghar had easy access to all the mediums of information awareness with maximum proportion of information received through TV News. Radio and social media were the least used mode of early warning awareness for both Mumbai and Raigad. However, Raigad particularly received most of the information through TV news which means there was no strong linkages and accessibility to other modes of information awareness.

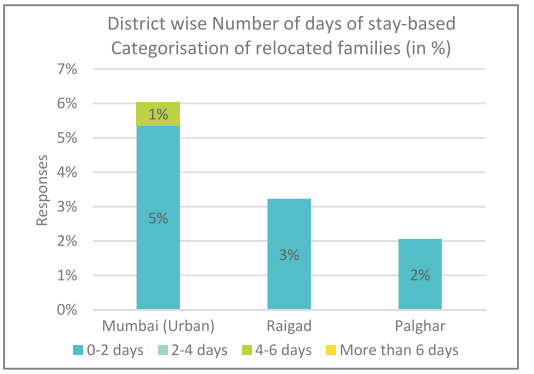


Figure 68: District wise Number of days of stay for relocated families in Maharashtra

After understanding the Early Warning information, 2-5% of surveyed families across all the three districts of Maharashtra relocated to safer places and stayed there for 0-2 days (refer figure 68). Families of Mumbai district who relocated to safer locations, a very few of them stayed for 4-6 days and evidently the maximum duration of stay across the sampled districts of Maharashtra.

When talking about relocation to safer places, we have tried to correlate the numbers with the percentage cases where transport arrangements were made by the government to implement smooth relocation services of the population living in disaster prone areas or already affected by the cyclone. As witnessed earlier, Mumbai had better arrangements for disaster evacuation, response and rescue compared to the other districts. However, of the 6% families relocated to safer place, very fewmoved using the transport arrangements made available by the government. No transport arrangements were made by Palghar and Raigad district to move the families to safer locations.

A very small proportion of the families affected did relocate to safer places. A cumulative for all the sampled districts of Maharashtra suggests that 96% of the families did not relocate to safer locations. People did not really respond to the approximate reasons for their resistance to relocation. It has to be observed from these percentages that people portrayed lack of confidence in the services or arrangements made by the authorities and hence preferred taking the risk and stayed back in their houses located at the disaster-prone areas.

Monetary Compensation:

Almost all districts of Maharashta received compensations for the damages caused by the cyclone. The data received regarding compensations distributedto affected families in Palghardepicts that an average amount of Rs. 12,700 was given by the government as monetary compensation to people who were rendered physically disabled or were injured by the cyclone. Raigad administration gave compensations to the families of deceased persons while Mumbai

administration gave compensations to the families whose members have acquired health issues and injury because of the damage caused by the cyclone.

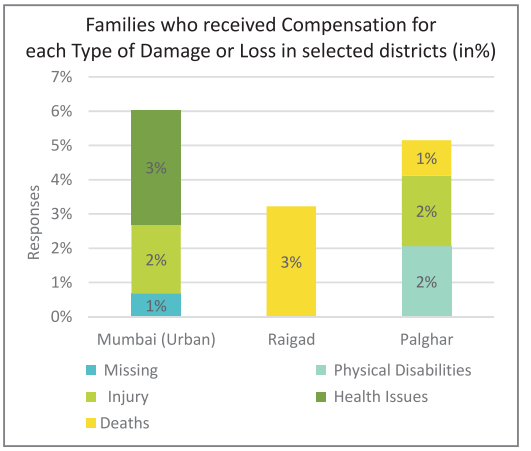


Figure 69: Families who received Compensation for damages to human lives in Maharashtra

5.2.2 Damage and Loss of Livelihoods

Damage and loss to livelihood category under the Household Survey was incorporated to analyse the impact of cyclone over the three economic sectors, i.e., the primary sector, the secondary and the tertiary sector.The block wise impact assessment of cyclone on livelihoods of people infers to cause maximum losses to business followed by losses in primary sector. One important observation witnessed at block level is that Dahanu had over 93% families who faced losses in businesses (refer figure 70). Similarly, In Cheetah Camp block of Mumbai, 71% of families faced losses in business. Primary sector losses were evident in Raigad and Palghar but it was least affected in Mumbai.

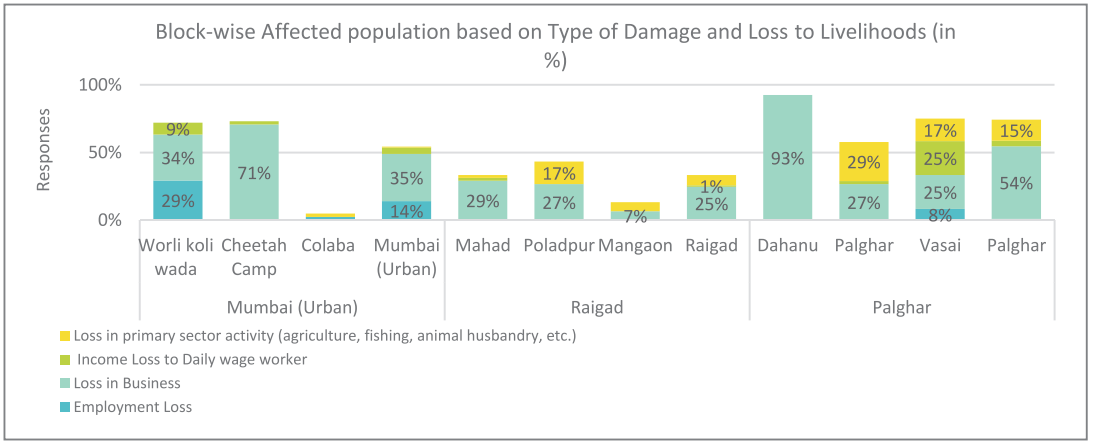


Figure 70: Block-wise categorisation of population whose livelihoods have been affected in Maharashtra

Families whose Livelihoods have been Affected

When families whose livelihoods were affected were analysed based on gender, it was seen that 57% of the people affected were male (refer figure 71), indicating that majority population involved in earning livelihoods for their families were male.Only 11% of the population whose livelihoods were affected are females.

Families whose livelihoods have been affected, the majority of them were engaged in fishing. Approximately 40% of families in all the three districts of Maharashtra were engaged in fishing followed by 36% families engaged in farming sector (refer figure 72). While the percentages were smaller for animal husbandry and self-employment, 20% of the families were salaried.

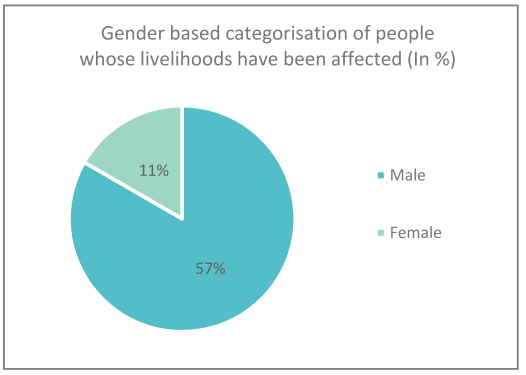


Figure 71: Gender based categorisation of people whose livelihoods have been affected

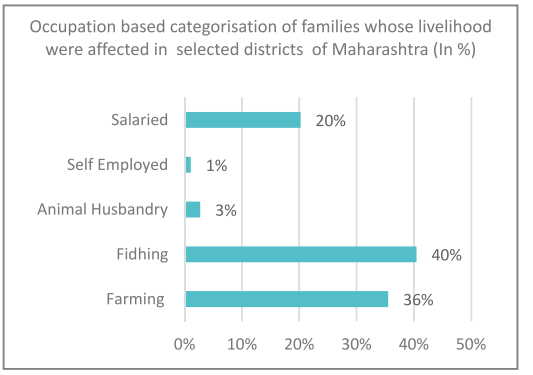


Figure 72: Occupation based categorisation of people whose livelihoods have been affected

Economic Sector Specific Damage analysis:

In Maharashtra, when the three economic sectors were analysed district wise, it was seen that in Palghar, primary sector was the least affected economic sector while it was the most affected sector in Mumbai and Raigad districts of Maharashtra. Approximately 40% of families whose livelihoods had been affected belonged to secondary and tertiary sector (refer figure 73). Tertiary sector was the least affected economic sector in the sampled district of Raigad, i.e., family's dependent on primary sector as source of livelihoods were the most affected in Mumbai and Raigad, which can very well be associated

be associated with fishing and farming as the most common occupation type of people affected by cyclone.

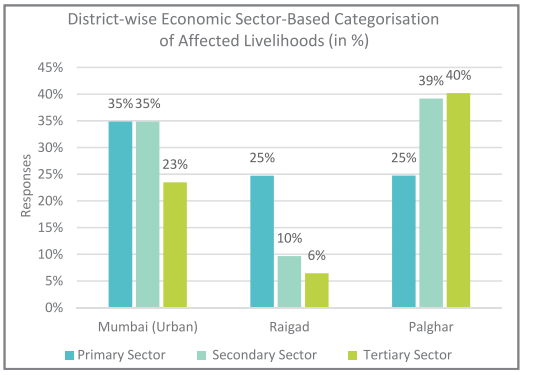


Figure 73: District-wise Economic Sector-Based Categorisation of Affected Livelihoods

1. Primary Sector

District level analysis specifically to identify the activities within primary sector states that for Mumbai, fishing was the most affected primary sector activity that was also inferred while analysing the occupations of the families affected. For Palghar district, it was witnessed that farming was the most affected livelihood, followed by fishing. However moderate impact was seen on all the primary sector activities in Raigad indicating that this particular district was not solely dependent on one primary sector activity and had diversified sources of livelihoods within the primary sector.

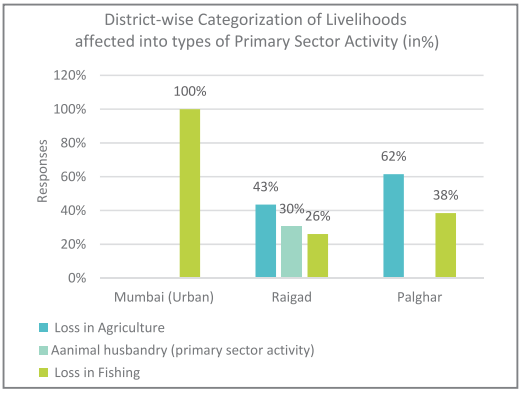


Figure 74: District-wise Categorization of Livelihoods affected into types of Primary Sector Activity

For a better understanding regarding the components of each primary sector activity, an in-depth analysis was made with respect to the impacts caused by the cyclone specific to the components. For Agriculture, 100% crop production was affected by the cyclone (refer figure 75). 96% of the storage grains for agriculture were submerged. Additionally, 54% of the agricultural land was submerged while 43% was damaged.

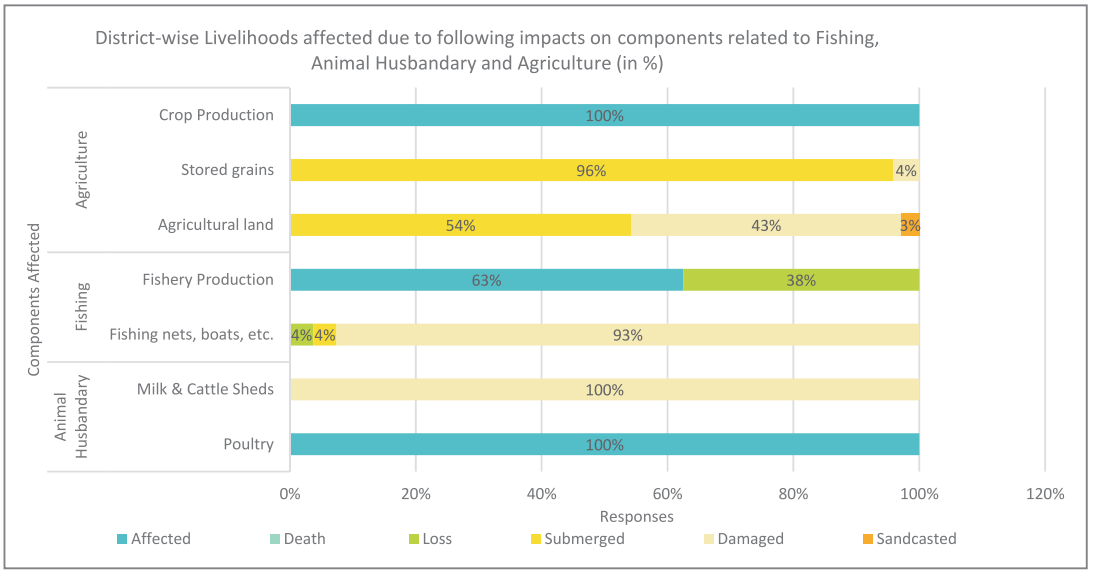


Figure 75: District-wise Livelihoods affected due to certain impacts on components related to Primary sector activities in Maharashtra

For Fishing, 63% production was affected and 50% losses were witnessed in fishery production. Almost all the fishing nets and boats were damaged due the cyclone, therefore, affecting maximum people whose occupation was fishing.

For *Animal Husbandry,* 100% of the Poultry was affected. Similarly, 100% of the milk/cattle sheds were damaged.

It was eventually observed that for Maharashtra, almost all the components of primary sector activities were altered in one form or the other. However, the number of components (Animal Husbandry/Fishery) that died was negligible. Similarly, losses scaled were minimum which implies that the quantum of damage that happened to primary sector activities were recovered quickly.

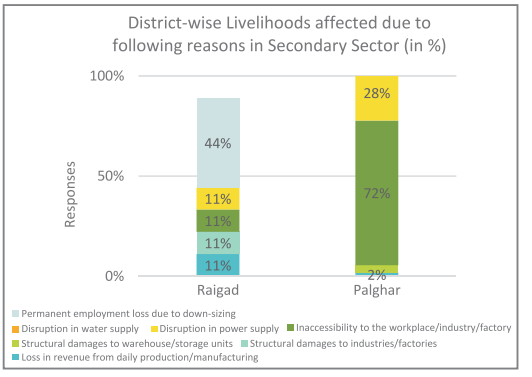


Figure 76: District-wise Livelihoods affected due to following reasons in Secondary Sector activities in Maharashtra

2. Secondary Sector

When reasons for losses in secondary sector

was analysed for all three districts, it was witnessed that losses due to permanent employment loss due to down-sizing was the most crucial reason for losses in Raigad while this reason had least contribution to the losses in Palghar. For Palghar, inaccessibility to workplace/industry was the main reason for bringing losses in secondary sector. Since primary sector was majorly affected in Mumbai, the reasons for losses in secondary sector for Mumbai were not defined specifically.

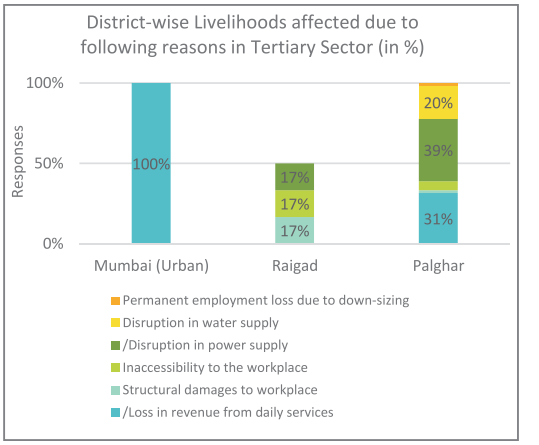


Figure 77: District-wise Livelihoods affected due to certain reasons in Tertiary Sector activities

3. Tertiary Sector

The reasons for losses in tertiary sector, Losses in revenue from daily services caused visible hinderances and losses to tertiary sector in Mumbai. Comparing it, the most prominent reason for losses in tertiary sector for Palghar was disruptions in power supply and water supply. For Raigad, the reason for losses to tertiary sector was mostly workplace related-structural damages, inaccessibility and disruptions in power supply.

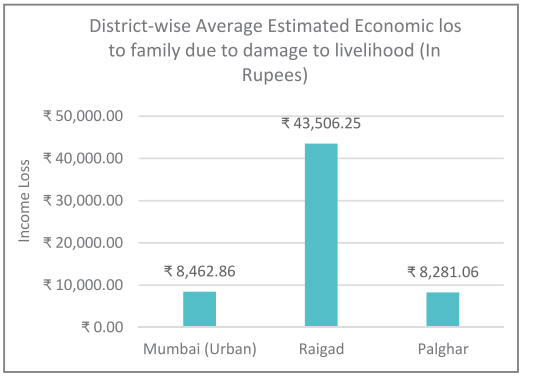


Figure 78: District-wise average economicloss to family due to damage to livelihood activities in Maharashtra

The overall livelihood losses at household level were analysed. The estimated average economic losses for Raigad were the highest for families whose livelihood have been affected. The average estimated losses for the days when cyclone affected the livelihoods of people were approximately 43k for Raigad (refer figure 78), while it amounted to less than 10K for Mumbai and Palghar.

Livelihood Practices:

It is to the best of interest for the state and districts to incorporate diversified livelihood practices. However, for Maharashtra, it was seen that over 44% of livelihood practices in Mumbai were not diversified. Whereas, contrary to this, only 3% of livelihood practices in Raigad was not diversified (refer figure 79). In cases where livelihoods were diversified, primary sector was seen as the most dominant sector followed by secondary sector.

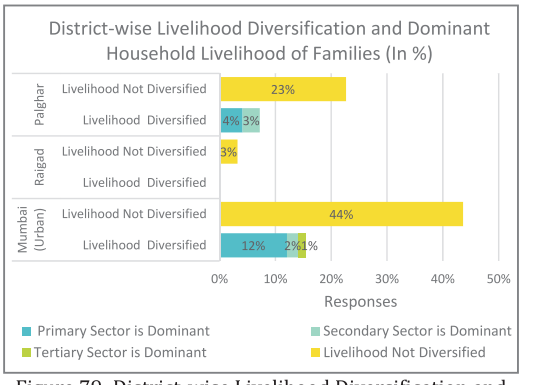


Figure 79: District-wise Livelihood Diversification and Dominant source of Livelihood for the affected Families activities in Maharashtra

After analysing the diversification of livelihood practices, it was very important to understand whether resilient livelihood practices were being followed or not. When assessed, it was seen that the families that practiced resilient livelihood methods were very low. Yet, Palghar indulged into maximum types of resilient livelihood practices. It followed resilient structures of storage facility along with multi crop practice (refer figure 80). Similarly, Raigad practiced multi crop practice while Mumbai followed resilient structures of milk/cattle sheds.

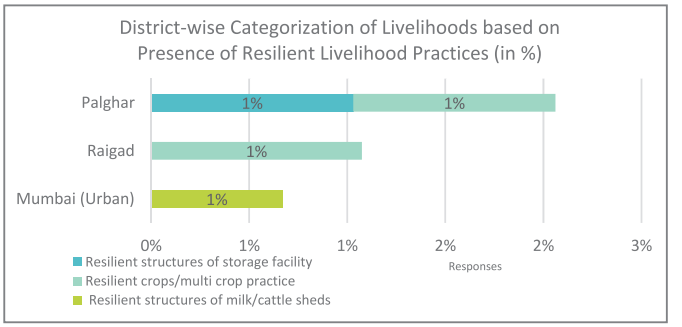


Figure 80: District-wise Categorization of Livelihoods based on Presence of Resilient Livelihood Practices in Maharashtra

5.2.3 Damage to Housing Structures

After detailed analysis of the people and their livelihoods being affected, under this domain we are going to assess the damage caused to housing structures within the sampled districts of Maharashtra. The ownership of these houses varies from owned and rented to mortgage on loan. In Maharashtra, 93% of the houses were owned by the families while 6% of the families were living in rented accommodations and a meagre 1% were mortgaged on loan.

The extent of damage caused by cyclone to the houses of Maharashtra ranged from severely and partial damages to full damages to the housing structures. A cumulative district level analysis for Maharashtra depicted that of the total number of houses surveyed, 42% of these housing structures were Pucca houses (refer figure 81), significantly correlating to the prominent percentages of houses damaged in Gujarat. Further to it, approximately 47% of the total houses surveyed were found to be semi-pucca houses while only 10% of these were kutcha houses.

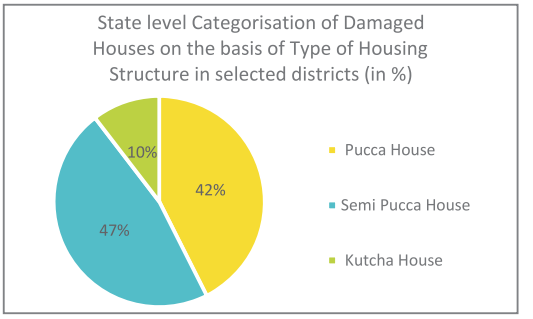


Figure 81: State level Categorisation of Damaged Houses on the basis of Type of Housing Structure in Maharashtra

Talking about the extent of damage,50% of these sample houses were partially damaged (refer figure 82). The proportion of fully damaged houses appeared to be very low with only 6% of houses to be fully damaged. There were cases in state, where no houses were damaged. This can be possibly because they happened to be located far from the disaster places or were pucca houses. The type of

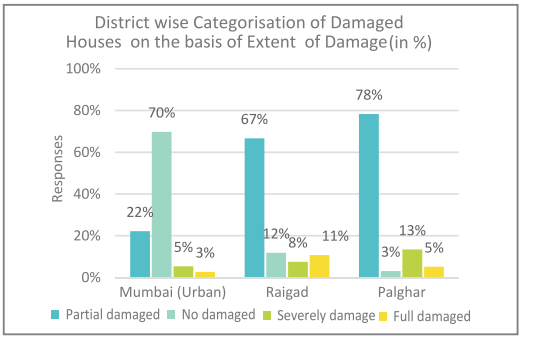


Figure 82: Categorisation of Damaged Houses on the basis of Extent of Damage in Maharashtra

housing and extent of damage can be associated, since the number of pucca structures can possibly indicate low levels of damage.

A district level analysis for the extent of damage to housing structures were done. It was found that 70% of the housing structures in Mumbai were not at all damaged while the percentage was only 12% in Raigad. The remaining houses where somehow damaged, of which 67% were partially damaged in Raigad. Very few houses in Palghar were severely or fully damaged while 78% of houses in Palghar were partially damaged.

A district level correlation analysis was done between extent of damage and type of housing structures. For Mumbai, it was seen 80% of pucca houses were not at all damaged.Yet, this was not the case for other districts (refer figure 83). 63% of the pucca houses were partially damaged and a similar percentage of pucca houses in Palghar were partially damaged. 80% of the kutcha houses were again partially damaged in Mumbai while 84% of the semi-pucca houses were partially damaged as well. The overall picture reveals that the type of housing structure (kutcha or Pucca) had no particular impact or relation with the extent of damage in the sampled districts of Maharashtra. It is to be brought into consideration that majority percentages of all types of houses in all the districts were partially damaged.

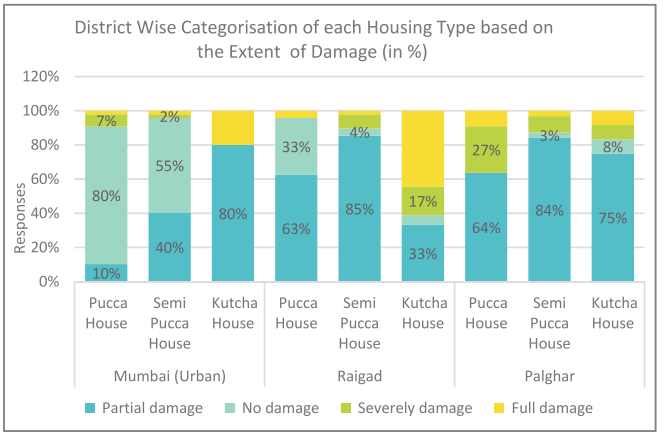


Figure 83: District wise Categorisation of each Housing Type based on the Extent of Damage

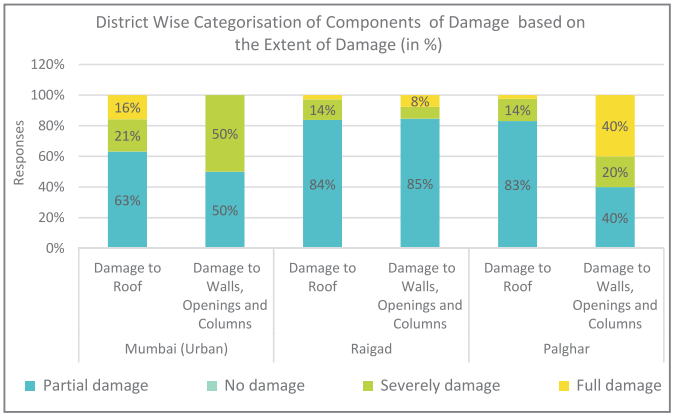


Figure 84: District wise Categorisation of Components of Damage based on the Extent of Damage

The component of housing structures i.e., the foundation and Plinth, the roof or the walls, openings and columns were eventually assessed (refer figure 84). For Mumbai, it was seen that roof and walls/openings/ columns were damaged, of which 63% were partially damaged and the remaining were either fully or severely damaged. When talking about roof, the type of damage that was seen were either cracks or total and partial destruction. 50% of damage to walls/openings/columns was partial while the remaining were severely

damaged. In Raigad, roofs and walls/openings/columns components were damaged where majority of roof was partially damaged and the wall component was 85% partially damaged, i.e., vertical cracks, wall tilting, corner separation, bulging, diagonal cracks near openings, Cracks at beam-column junction and buckling of columns were the visible kinds of damage type witnessed. In Palghar, 83% of the roof component was partially damaged while the damage to walls/openings and column component ranged from partial to full damage. Across all the three sampled districts of Maharashtra, we could not witness much of damage to foundation and plinth.

Talking about the repair status, in case of damage to walls, columns & openings, only 95% were of repairable status while in case of damage to roofs, 85% were of repairable status.

The estimated cost of damages incurred district wise was averaged the least at Rs. 10,000 for Mumbai while it was the maximum for Palghar at Rs. 1,00,000. It was averaged somewhere between Rs. 40,000-50,000. As witnessed from the numbers, it can be comprehended that Palghar incurred maximum damage cost and therefore in lieu of the damage, 31% of the damaged housing structures received compensation for reconstructions (refer figure 85). No visible cases of monetary compensation disbursal were witnessed for Mumbai while only 5% of damaged houses in Raigad received compensations.

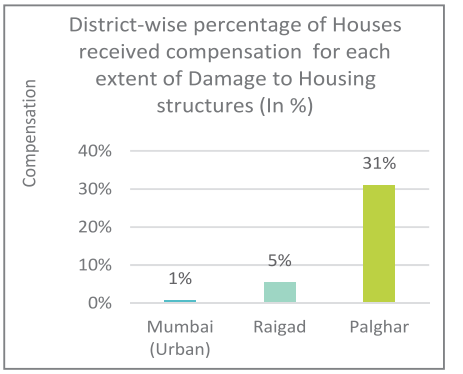


Figure 85: District-wise percentage of Houses received compensation for damages to housing structures in Maharashtra

After the disaster subdued and with the compensation received by the households of Palghar, the entire reconstruction of the damaged houses was completed in approximately 15-30 days. For Mumbai, the reconstruction period varied, to as low as 2 days to as high as 15 days. Again, for Raigad, the reconstruction period ranged from 2 days to 3months.

When these parameters were assessed with respect to the housing structures, it was noted that over 90% of the housing structures in Palghar were non- or semi-engineered building structures and neither did they follow land use restrictions and building codes. 60% of the housing structures were located in Hazard prone.

Cause Identification:

Once damage assessment is done, it is important to identify the causes of damages to the housing structures. For this parameter assessment, four causes of damages have been identified, i.e., whether the houses were constructed on hazard prone areas, if the housing structure were engineered or semi-engineered building structures, if disaster resilient municipal bye-laws were followed and if land use restrictions were followed. Talking about the damage, we identified the housing structures in the sampled districts of Maharashtra that were constructed on Hazard prone areas, that were non/semi-engineered building and those that did not follow the land use restrictions neither the municipal bye-laws.

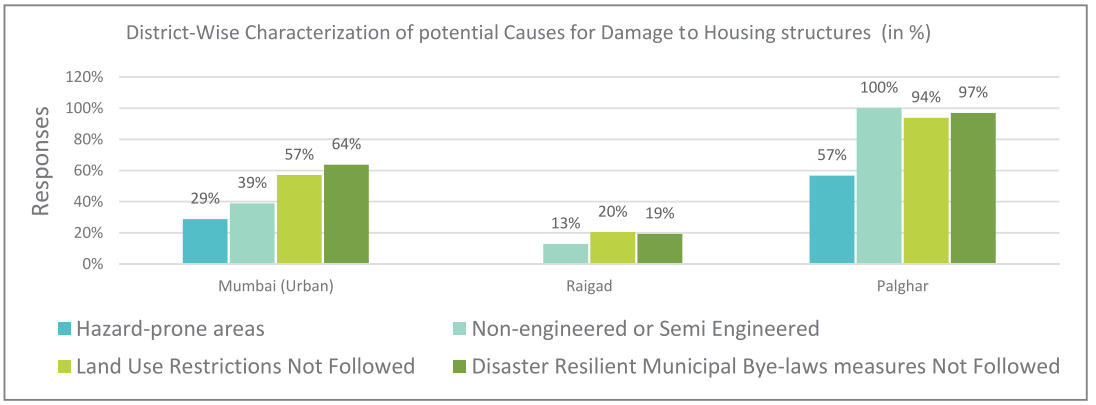


Figure 86: Characterization of potential Causes for Damage to Housing structures in Maharashtra

40-45% of housing structures in Mumbai were non/semi-engineered building structure and neither did they follow land use restrictions and building codes while this percentage was very low for Raigad. No housing structures in Raigad were built on Hazard prone areas while the percentage was at 29% only for Mumbai district.





Image 9: Flooded Coastal areas in Sampled districts of Maharashtra
Source: Primary Survey Field Coordinator, 2021

5.2.4 Damage to Physical Infrastructure

The cyclone caused a major service disruption to the physical infrastructural elements like water supply, electricity & telecommunication, and road network. Talking about the families affected by disruption to physical infrastructures, it was seen that families of Mumbai witnessed maximum service disruptions, with 20-28% families facing difficulties in accessibility to water supply and electricity services. The trend was very much

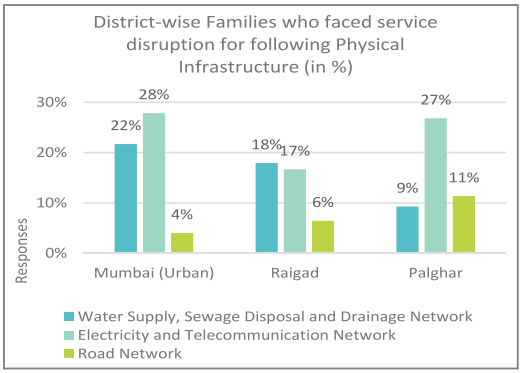


Figure 87: Families who faced service disruption (Physical Infrastructure) in Maharashtra

similar for Raigad, though magnitude was low. For Palghar, 27% of the families faced electricity & telecommunication service disruptions while not much disruptions were faced in water supply services and accessibility to road networks.

The most common type of service disruptions for water supply was in-accessibility, non-availability, poor quality and scarcity. At a cumulative district level, it was seen that 7% of families couldn't access the water supply services. 4% of the families faced issues of water scarcity and non-availability of water supply (refer figure 88). Service disruptions for sewage disposal constituted, blockage, odour and overflow. For all the sampled districts, it was seen not many of the sampled families faced issues regarding sewerage disposal. Service disruptions for drainage

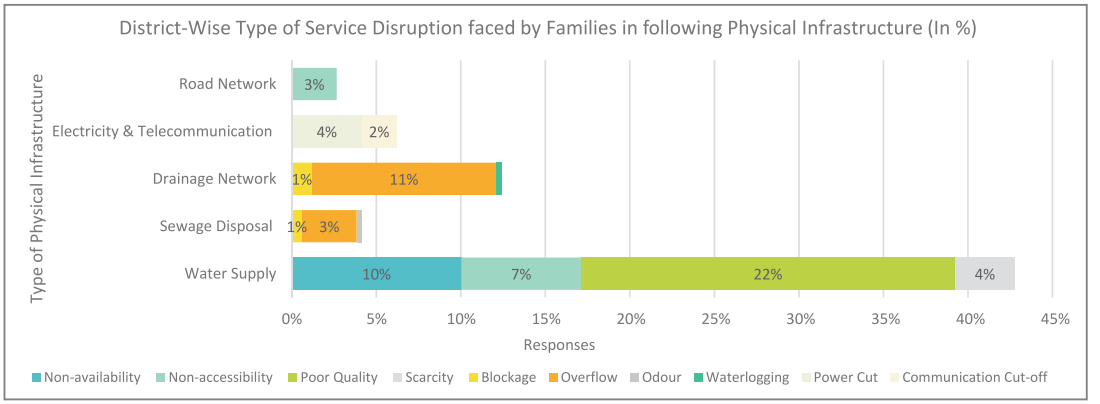


Figure 88: Type of Service Disruption faced by Families (Physical Infrastructure) in Maharashtra

network were blockage, overflow and waterlogging, of which maximum families faced issues of blockage and overflow.

Of the sampled families, very few of them faced issues regarding electricity outrage and accessibility to road and transportation network, while maximum type of service disruption was seen to water supply services only.

When damages at household level were analysed, it was seen that only 2-5% of the sampled families across Maharashtra were affected by the service disruptions to water supply, electricity & telecommunication and road network infrastructures due to damage at household level. Of the available responses, it was seen that maximum damage at household level was seen in Palghar (refer figure 89), mostly related to electricity and road network.

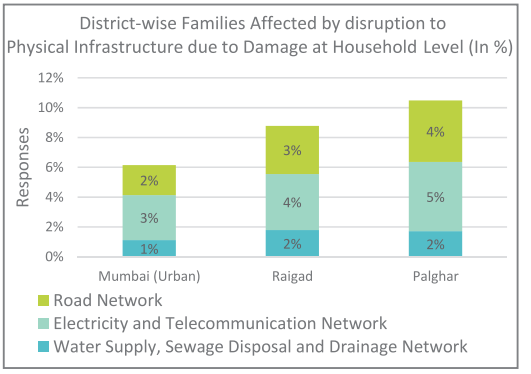


Figure 89: Families Affected by disruption to Physical Infrastructure due to Damage at Household Level in Maharashtra

The duration of disruption to water supply facility faced by families in the sampled districts of Maharashtra ranged from 2 days to

a maximum of 60 days. Similarly, the duration of service disruption to electricity and telecommunication service faced by families went up to a maximum of 90 days while it was limited to 45 days only for service disruptions to road networks.

Talking about the extent of damage to these physical infrastructures, 10-15% of electricity & Telecommunication structures were witnessed to be partially damaged, approximately 8% of Road networks were partially damaged and approximately 10% of the water supply infrastructures were partially damaged. Not many of the physical infrastructures were seen to have fully damaged because of the cyclone.

Marginalised Families

In order to analyse the impact of service disruptions to physical infrastructures on marginalised families, we have analysed this parameter in two ways. One is by assessing the impact over economically marginalised families. Approximately, 35% of economically marginalised families faced service disruptions to water supply, electricity and road network. 14% of families, whose monthly earned family income is below Rs. 5000, faced service disruptions as well (refer figure 90). Here, the comparative proportion is lower than those belonging to Rs.5000-10000 income group is possible because they may not really have accessibility to these infrastructures in the first place.

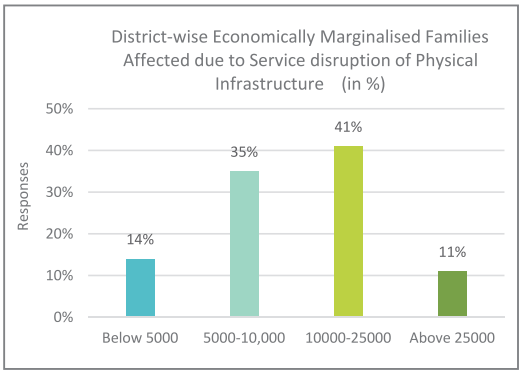


Figure 90: Economically Marginalised Families Affecteddue to Service disruption of Physical Infrastructure

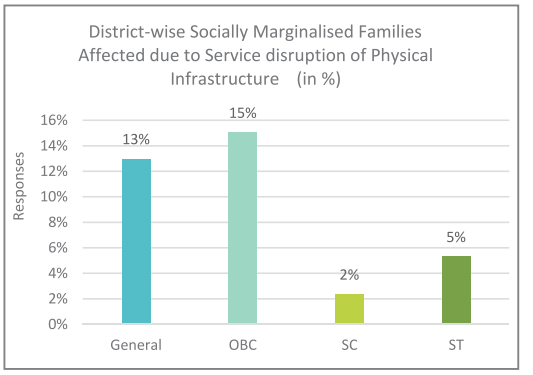


Figure 91: Socially Marginalised Families Affected due to Service disruption of Physical Infrastructure

Talking about the impact of service disruptions to physical infrastructures on socially marginalised families. It was seen that maximum service disruptions were faced by the OBC community, with 15% of the families (refer figure 91). This was followed by Scheduled Tribe category. However, the proportions were low, with only 5% of families from ST community facing service disruptions. Scheduled Caste was the least impacted social group in Maharashtra due to damages to physical infrastructures.

Cause Identification:

Cause identification for damages to physical infrastructures was done based on eight parameters.

Based on these parameters, it was noted that 83% of the physical infrastructures within the sampled district area did not follow land use restriction norms, did not follow any hazard

resistance measures, did not have any periodic maintenance mechanism nor undertook vulnerability assessments. 33% of these structures were built on Hazard prone areas while 67% of these were non-engineered structures.

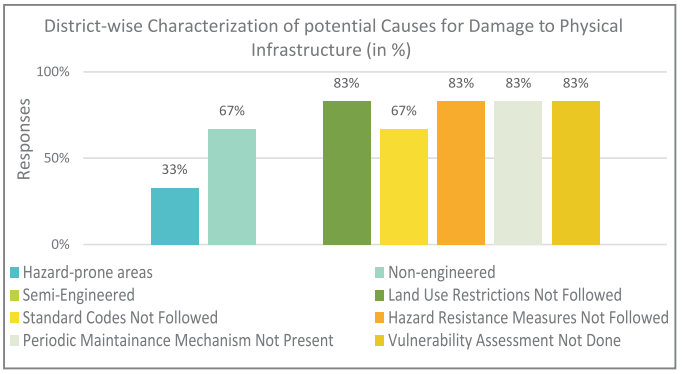


Figure 92: Characterization of potential Causes for Damage to Physical Infrastructure in Maharashtra

5.2.5 Damage to Social Infrastructure

Cyclone had major impact over the social infrastructure elements categorised into health facilities, education facilities, administrative facilities, religious and community facilities. The cyclone caused hinderance to these elements of social infrastructure which led to service disruptions of some to the most essential services.

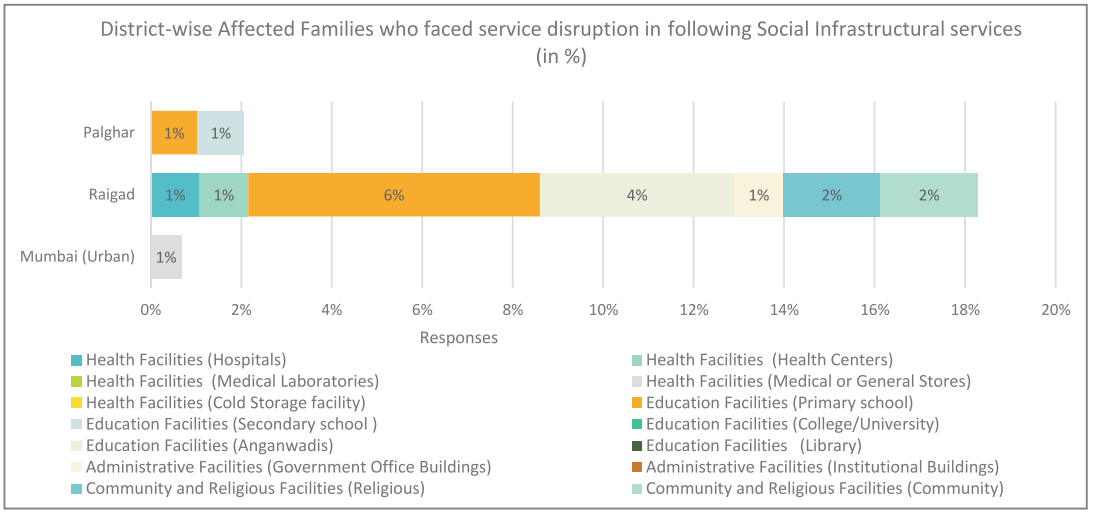


Figure 93: Affected Families who faced service disruption in following Social Infrastructural in Maharashtra

Maximum service disruptions to social infrastructures were witnessed in Raigad district with almost all social infrastructure facilities being damaged. Mumbai had least percentage of social infrastructure disruptions which can be associated to the quality of social facilities available in the city. Palghar again had least disruptions. However, here the reasons are mostly associated with the lack of prudent responses. In the district with maximum interruptions, education facilities were the most damaged one (refer figure 93). Taking specifically the type of service disruptions the families faced, of the responses that were collated, it was seen that education and health service

could not be accessed by the families across the three sampled districts of Maharashtra. Whereas, the administrative services available delivered poor quality of service to the families. Not much information was available regarding the type of service disruption faced by families with respect to religious and community facilities.

Duration of service disruption to each element of social infrastructure was collated and hence, it was seen that Raigad had maximum days of service disruptions across all elements of social infrastructure, compared to the other two districts (refer figure 94). Not much information was available regarding the duration of service disruption to health facilities. While days of service disruption to educational facilities was approximately 6 days for Raigad, it was 4.5 days for Palghar.

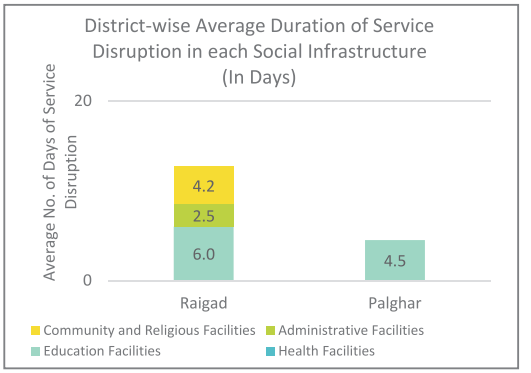


Figure 94: District wise Average Duration of Service Disruption in each Social Infrastructure

Evidently, Raigad and Palghar were the only sampled districts of Maharashtra that witnessed major service interruptions to social infrastructure services. Since, Mumbai had no major service interruptions, there were negligible duration of inconvenience to the population.

Marginalised Families:

In order to analyse the impact of service disruptions to social infrastructures on marginalised families, we have analysed this parameter in terms of income groups. By analysing the impact over economically marginalised families (analysing the income factor),approximately 72% of families faced service disruptions to social infrastructural facilities belonged to below Rs.5000 income group alongside anapproximately 23% families affected belong to Rs. 5000-10000 income group, suggesting that families whose monthly earned family income was below Rs. 5000, faced major service disruptions to social infrastructural elements.

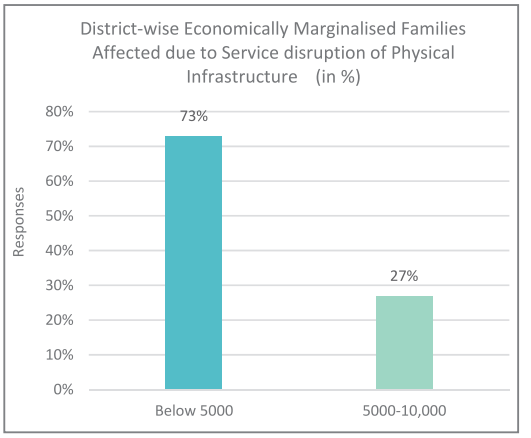


Figure 95: Economically Marginalised Families Affected due to Service disruption of Physical Infrastructure in Maharashtra

Cause Identification:

Cause identification for damages to social infrastructures was done based on four parameters. Based on the responses received, it was found that all the social infrastructural structures within the sampled district area were non-engineered building structures (refer figure 96). These did not follow any standard codes. Neither followed the land use restrictions nor did undertake any vulnerability assessments to adjudge the safety elements.

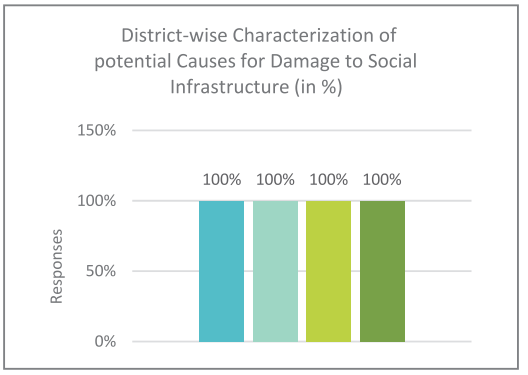


Figure 96: Characterization of potential Causes for Damage to Social Infrastructure in Maharashtra

5.2.6 Damage to Environment

The Environment domain has been specifically incorporated to identify the impact and extent of damage the cyclone had caused to various components of environment. The components of environment that has been analysed are:

1. Water sources which specifically constitutes, ground water, lake, rivers and canals. At a cumulative district level analysis, it was seen that few lakes in Maharashtra was affected and damaged because of the cyclone. Talking about the families that were affected because of the damage caused to water sources, it was seen that not many families were affected by the damage caused to water sources. When respondents were asked about the type of damage, it was seen that area around these water sources were damaged and broken polluting the water sources.

2. Land constitutes agricultural land, forest, wetland, mines, mangroves and wastelands. An approximate 15% of the families surveyed were affected by the damage caused to different components of land (refer figure 97). 41 families were affected by damage to agricultural lands while 22 families were affected by the damage caused to wetlands. Damage to land critically impacted families by destroying their agricultural lands, causing losses in production and livelihoods.

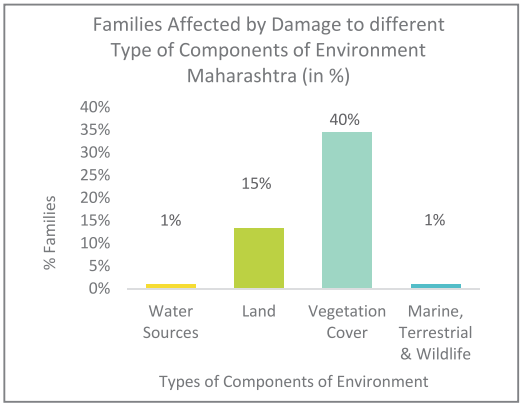


Figure 97: Families Affected by Damage to different Components of Environment in Maharashtra

3. Vegetation Cover constitutes grass, bamboo, timber trees, plantation and aquatic plants. Cumulative district level analysis states that 40% of the families surveyed were affected by the damage caused to vegetation cover. The most important conclusion here was, 106 families were affected because of the

damage caused specifically to plantation and 20 families were affected by damage caused to timber trees.

4. Marine, Terrestrial and Wildlife.The cumulative district level analysis for Maharashtra shows that negligible proportions of families were affected by the damage caused to this component of environment. This suggests that not many families surveyed were dependent on this component for livelihood. However, of the families that have responded, the most common form of damage witnessed by them was drowning of animals because of the increased water levels.

5.3 West Bengal – Damage and Cause Assessment

In West Bengal, more than 2 Crore people were affected across 18 affected districts by Cyclone Yaas. These districts are Purba Medinipur, South 24 Parganas, North 24 Parganas, Paschim Medinipur, Jhargram, Bankura, Purulia, Paschim Bardhaman, PurbaBardhaman, Hooghly, Howrah, Kolkata, Nadia, Birbhum, Murshidabad, Malda, Darjeeling and Kalimpong.

Table 18: General Details of Sampled State of West Bengal

West Bengal		24 Parganas South	Most Affected
District Affected	18	24 Parganas North	Most Affected
Population Affected	2 Cr+	Jhargram	Moderately Affected
Persons Evacuated	15,04,506		
Houses Damaged	Approx. 3 lakhs		
Human Lives Lost	1		
Injured			
Crop Affected	167 Ha		
Maximum Wind Speed	110-120 gusting to 130 kmph		
Rainfall	Heavy to very heavy rainfall at isolated places over Gangetic West Bengal on 26th May and heavy to extremely heavy rainfall over Sub-Himalayan West Bengal on 27th May.		

Source: Primary Source through State Coordinator, 2021

For undertaking the Damage Assessment Study, we conducted the Household and Key Informant Surveys across the state of West Bengal to make a comprehensive analysis of the damage at state, district, block, and village level.

The three districts that were surveyed are 24 Parganas South (most affected), 24 Parganas North (most affected), Jhargram (moderately affected). Three blocks in each district were surveyed with a minimum of 3 villages per block.



Image 10: Field Coordinatoranalyzing the Damage in 24 Parganas South District of West Bengal
Source: Primary Survey Field Coordinator, 2021

The blocks surveyed in West Bengal are Sagar, Pathar Pratima and Namkhana for 24 Parganas South districts;Hingalganj, Sandeshkhali-1 and Sandeshkhali-2 for 24 Parganas North and Jamboni, Binpur-2 and Jhargram (ULB) for Jhargram district.

As assessed by the state government, West Bengal suffered an approximate loss of Rs. 21,043 crores as damages caused by cyclone, against which an approximate amount of Rs. 4,343 Crores was sought for relief, restoration and reconstruction purposes (sourced from the 'Memorandum on very severe cyclone Yaas'). A sector specific analysis of the losses incurred states that the quantum of losses was the maximum for two sectors, i.e., the Primary Sector livelihoods and Physical Infrastructures. However, the assistance that have been expected for the same were somewhere between 4-8% of the losses.

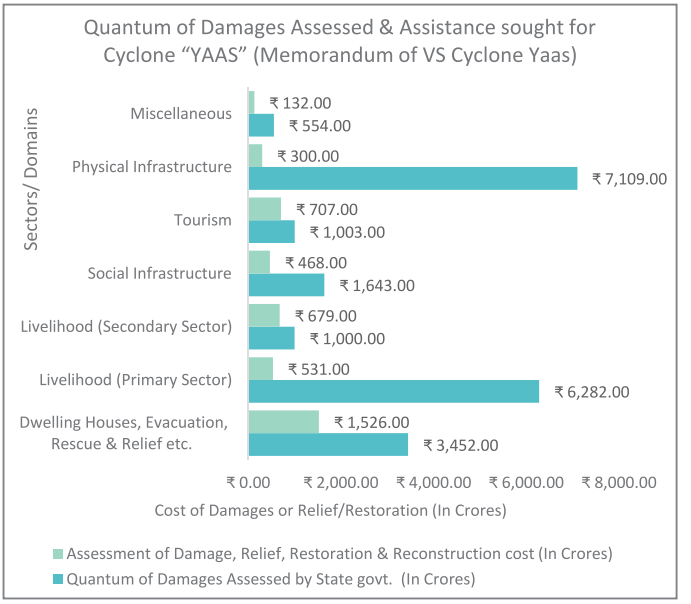


Figure 98: Quantum of Damages Assessed & Assistance sought for Cyclone "YAAS"

The Disaster relief efforts in response to the cyclone states to have evacuated a total of 7,26,377 people in the three surveyed districts is only 30-36% of the total population evacuated in West Bengal. Furthering on the same, the total expenditure incurred for the operation of relief camps was around Rs. 4,199 Lakhs.





Image 11: Flooded Coastal areas of 24 Parganas South
Source: Primary Survey Field Coordinators, 2021

5.3.1 Damage and Loss to Human Lives

For West Bengal, no deaths were reported in the sampled districts.

The assessment analysis of damages to human lives in the three surveyed districts and its blocks infers to have affected 24 Parganas South the most, followed by 24 Parganas North (refer figure 99). At block level, over 60% of the population were affected in 24 Parganas South. However, on a contrary, Jhargram suffered least damages to human lives.

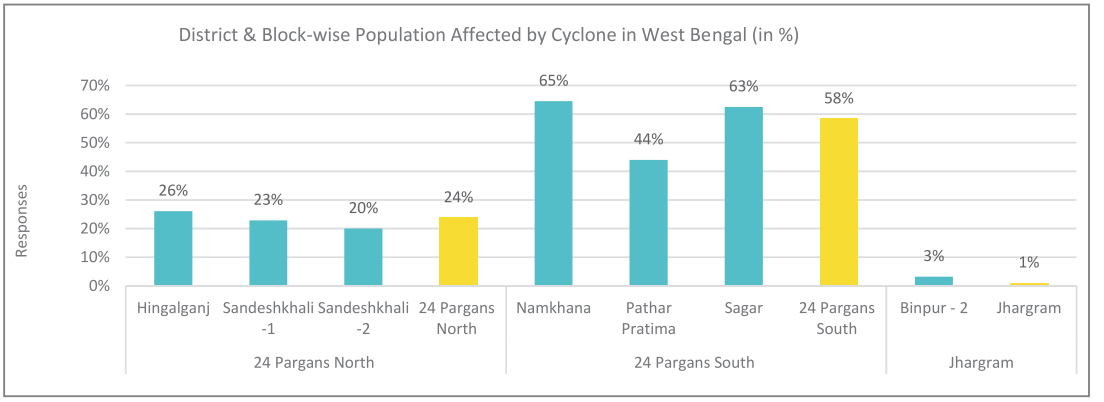


Figure 99: District & Block-wise Population Affected by Cyclone in West Bengal

Talking about the type of damages, the most common witnessed at the state level were Health Issues which inherently conveys the extent of hinderances caused to health facilities and the services because of the cyclone. T*he state & District level analysis, both conclude on having zero casualties in West Bengal.* However, the assessment results highlight health issues as the most evident type of damage, with 49% of families in 24 Parganas South and 25% families in 24 Parganas North being affected. Next most witnessed type of damage is Injuries happened during rescue, evacuation and relocation in response to the cyclone. Also as already seen, Jhargram have been least affected with no visible categorisation of damages into its types at district level.

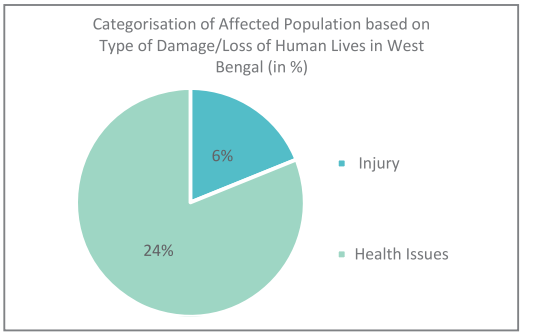


Figure 100: Categorisation of Affected Population based on Type of Damage in West Bengal

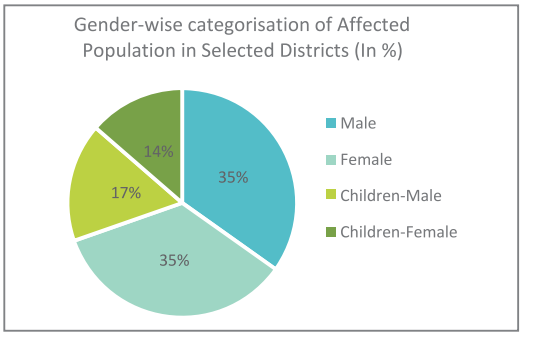


Figure 101: Gender-wise categorisation of Affected Population in West Bengal

Families Affected

Studying the characteristics of population affected has been particularly intended to infer on the socio-economic and cultural demographics of West Bengal through the

sampled districts & blocks. A cumulative level analysis depicts that an equal proportion of population affected were male and female at 35% (refer figure 101). 10-15% of the population affected were children. Talking about the social construct, 35% of the affected families belonged to Scheduled Caste Category while less than 10% of the families belongs to Scheduled Tribes and Other backward classes (refer figure 102). This parameter reveals that more than half of the families affected did not belong to marginalised categories.

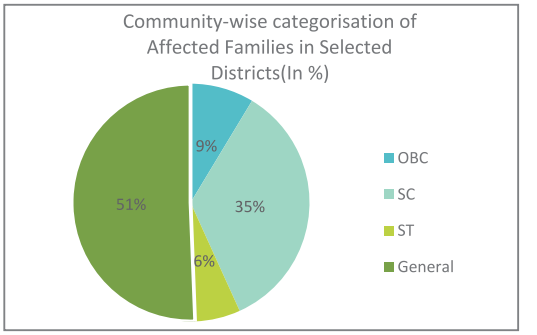


Figure 102: Community-wise categorisation of Affected Families in West Bengal

For all the three districts, farming appears to be the most common occupation for greater part of the affected families followed by fishing. Most affected income group was below Rs. 5000 and Rs. 5000-10000 category that also concludes that families belonging to low-income groups had been the most affected category of the population (refer figure 103).

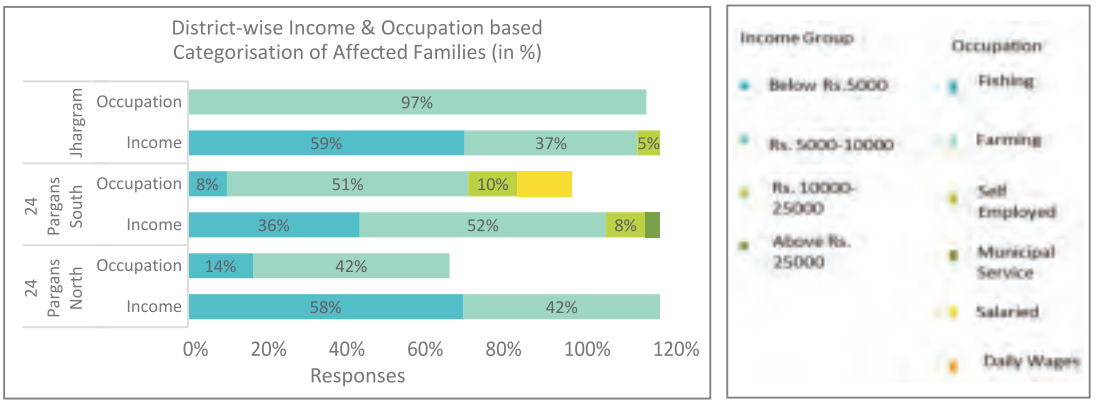


Figure 103: District-wise Income & Occupation based Categorisation of Affected Families in West Bengal

Monetary Compensation:

24 Parganas North was the only district to receive maximum average monetary compensations as Jhargram witnessed least damages. As evident from the adjoining graph, monetary compensations were sought only for people developing health issues which was maximum for 24 Parganas North, making the state level average compensation received by affected families to Rs. 537.



Figure 104: Average Compensation received as governmental support for each Type of Damage in West Bengal

Early Warning Information Dissemination:

The Early Warning information dissemination analysis for all the three districts shows that over 80% of surveyed

families received the early warnings, understood the meaning and relocated to a safer place (refer figure 105). The average evacuation lead time for 24 Parganas North and Jhargram was between 30-40 hours. However, it was least for 24 Parganas south, suggesting acomparatively better disaster risk preparedness and resilience. The most common mode through which the families

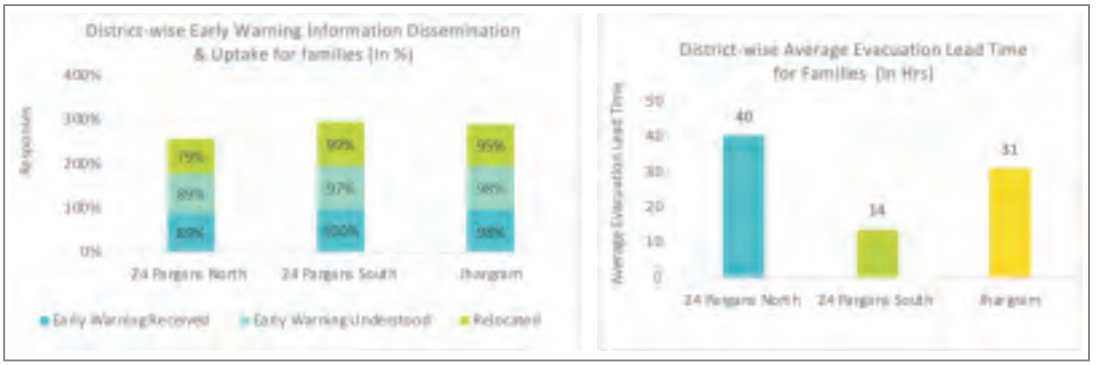


Figure 105: Early warning Information dissemination and average evacuation lead time for families affected in West Bengal

received Early Warnings was through TV news for all three districts (refer figure 106). Similarly, for all the three districts, Radio and social media are the least used mode of spreading the early warning information across these sampled districts of West Bengal. After understanding the Early Warning information, 80-95 % across sampled districts relocated to safer places and stayed there for over 6 days for 24 Parganas North & South (refer figure 107). However, since Jhargram witnessed least damages, the number of days of stay was between 0-2 days. For people who did not relocate to safer places, reasons were sought for the same out of which, majority families had expressed their dependence on pucca housing structure as a safety net against damages, whereas some had disagreed on the fact that cyclones could cause damages to live or structures. One very important reason witnessed for not relocating was interruption or damages to the road network outside the household, suggesting the connection of road networks and the correlated damages incurred to lives or livelihood.

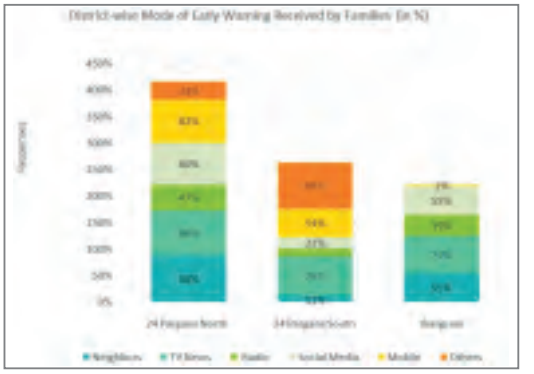


Figure 106: Mode of Receiving Early Warning by Families affected in West Bengal

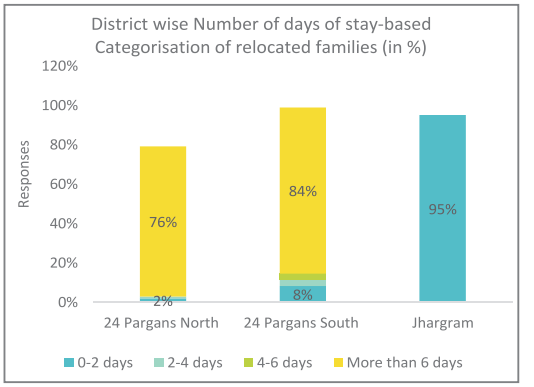


Figure 107: District-wise Number of Days of stay-based Categorization of relocated families (in %)

When talking about relocation to safer places, we have tried to correlate the numbers with the percentage cases where transport arrangements were made by the government to implement smooth relocation services of the population living in disaster prone areas or already affected by the cyclone. As observed earlier, 24 Parganas North & South had better arrangements for disaster evacuation, response and rescue. To further it, of over 70% families relocated to safer place. Only 20-25% families moved using the transport arrangements made available by the government. No transport arrangements were made by Jhargram district to move (approx. 95% of families) to safer locations.

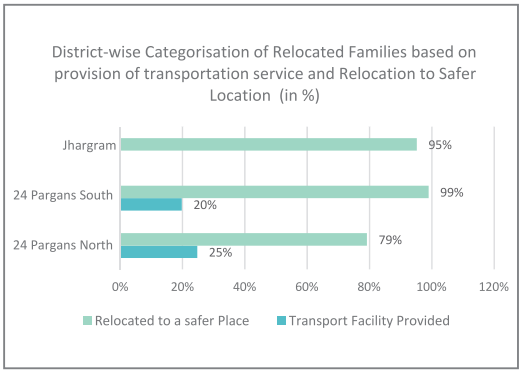


Figure 108: District-wise Categorisation of Relocated Families based on provision of transportation service in West Bengal

Though a large proportion of the families affected did relocate to safer places, yet a cumulative for all the sampled districts of West Bengal suggests that 9% of the families did not relocate to safer locations. When these families were asked about the reasons for them to not relocate, 73% of the families responded that the houses in which they are living were pucca houses and built at elevated levels. For few others, it was seen that they did not believe that cyclone could actually cause damage to their lives and homes. People portrayed lack of confidence in the services or arrangements made by the authorities and hence preferred taking the risk & stayed back in their houses located at the disaster-prone areas.

5.3.2 Damage and Loss of Livelihoods

Damage and loss to livelihood category under the Household Survey was incorporated to analyse the impact of cyclone over the three economic sectors, i.e., the primary sector, the secondary and the tertiary sector.

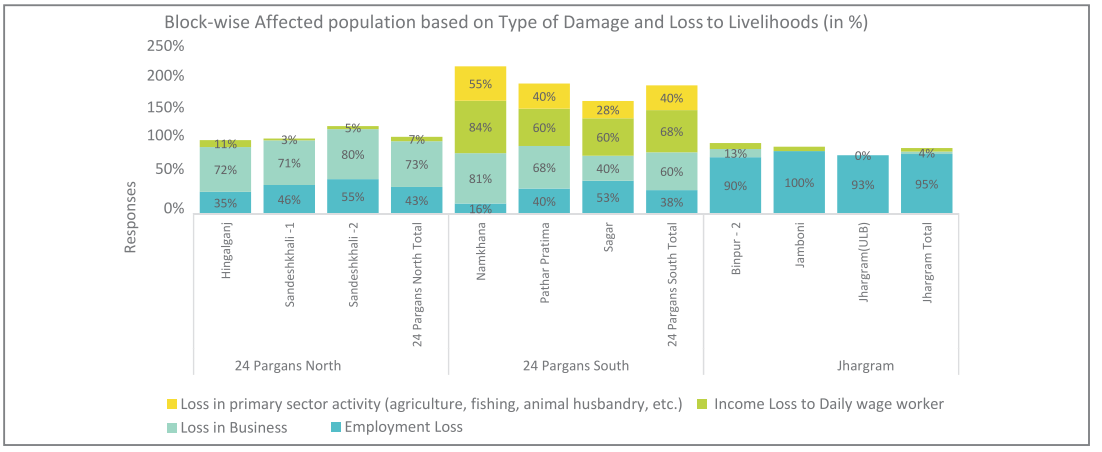


Figure 109: Block-wise Affected population based on Type of Damage and Loss to Livelihoods in West Bengal

The block wise impact assessment of cyclone on livelihoods of people states that, for 24 Parganas South, proportional damage had been witnessed across all three economic sectors. However, for 24 Parganas North and Jhargram, maximum losses were incurred in businesses and employments.

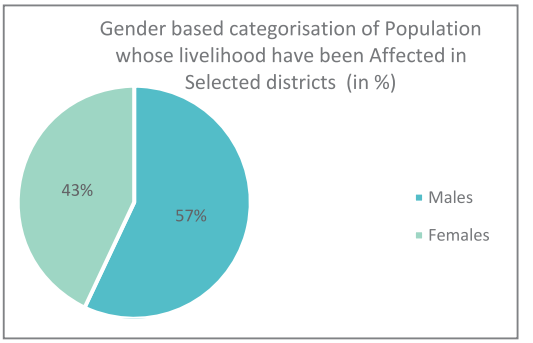


Figure 110: Gender based categorisation of Population whose livelihood have been Affected in West Bengal

Families Whose Livelihoods have been Affected

When families whose livelihoods were affected were analysed based on gender, it was seen that 57% of the population whose livelihood were affected were males, indicating that maximum damage at a cumulative district level was witnessed by male members of the families affected. 43% of the those whose livelihood was affected were females.

Families whose livelihoods had been affected, the majority of them were engaged in farming. Approximately, 70% of families at cumulative district level in west Bengal were engaged in farming (refer figure 111). The next most common occupation that was affected by the cyclone was fishing & animal husbandry that was constituted of migrant workers. 19% of the population whose livelihoods were affected in sampled district of West Bengal were migrant workers. While less than 1% were engaged as unregistered self-employees.

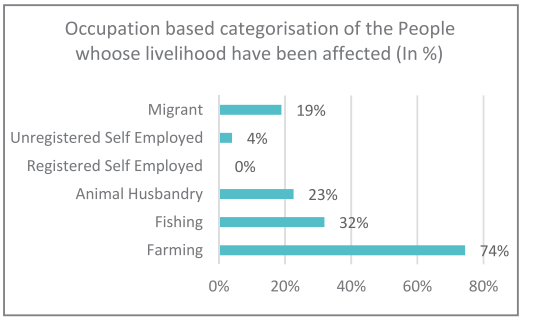


Figure 111: Occupation based categorisation of families whose livelihoods have been affected in West Bengal

Economic Sector specific damage analysis.

The district level analysis depicts that primary sector was least affected in Jhargram compared to other two districts. This, when correlated to the fact that Jhargram had least number of people affected by cyclone, it suggests that the reasons for loss of livelihoods in secondary & tertiary sectors of Jhargram was largely due to damages to physical & social infrastructures.

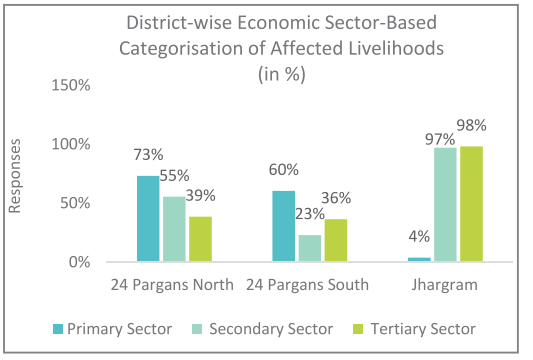


Figure 112: Economic Sector-Based Categorisation of Affected Livelihoods in West Bengal

1. Primary Sector

When primary sector was further analysed specifically, there had been a 100% loss in agriculture for all the three districts whereas no common pattern can be gathered for losses in animal husbandry & fishing for all the three districts.

Animal husbandry was the least affected in 24 Parganas North while 88% animal husbandry was affected in 24 Parganas South. In Jhargram, 75% of families engaged in animal husbandry were affected while no data regarding the impact on families engaged in fishing was witnessed in Jhargram.

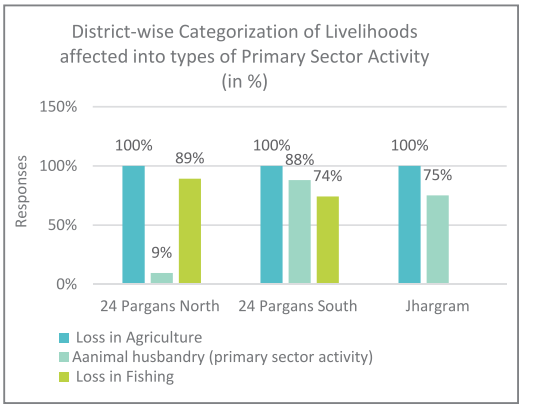


Figure 113: District-wise Categorization of Livelihoods affected into types of Primary Sector Activity

Cost of losses for different types of primary sector activities were sourced from the memorandum on very severe cyclone Yaas which states that Jhargram suffered least losses, whereas, a proportional loss had been witnessed for the remaining two districts. 24 Parganas North incurred maximum losses in agriculture sector (refer figure 114) while 24 Parganas South incurred maximum cost of damage in animal husbandry.

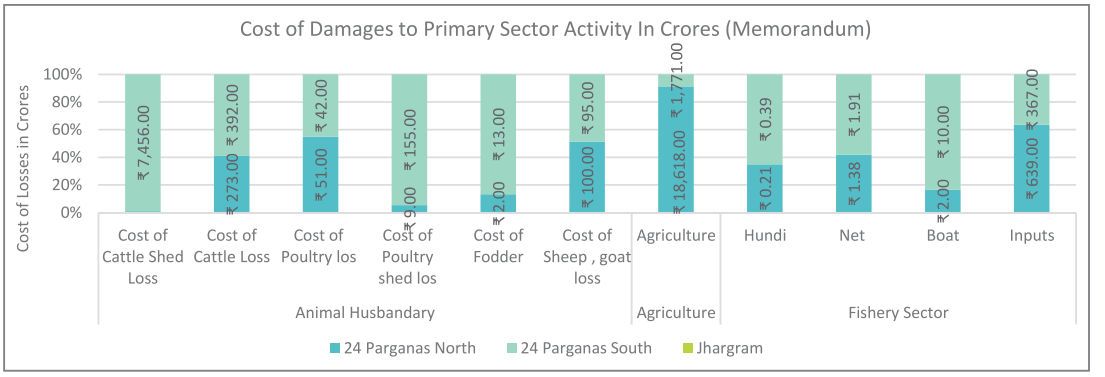


Figure 114: Cost of Damages to Primary Sector Activity in West Bengal

2. Secondary Sector

When losses in secondary sector were analysed for all three districts, it was witnessed that losses in revenue was the most crucial reason for losses in this sector of economy. However, for secondary sector, disruptions to power and water supply were a crucial factor culminating losses for 24 parganas North. For Jhargram, losses in revenue hadcaused major hinderances, resulting inoverall losses in secondary sector for the state.

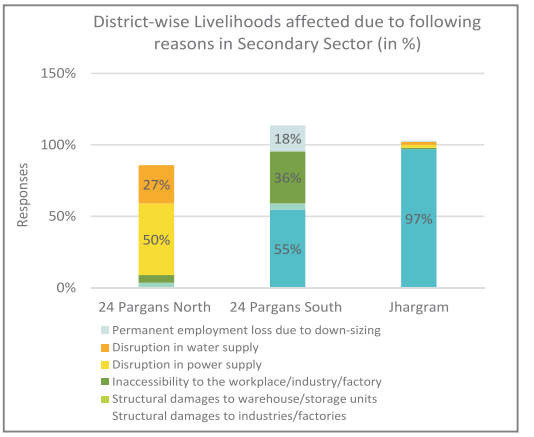


Figure 115: District-wise Livelihoods affected due to certain reasons in Secondary Sector in West Bengal

3. Tertiary Sector

For 24 Parganas North, 77% families engaged in tertiary sector were affected by losses because of structural damages to workplaces. In 24 Parganas South, it was seen that multiple reasons caused losses to tertiary sector. The main reasons were losses in revenue and inaccessibility to workplace.

In Jhargram, losses in revenue were the main reason that brought losses in tertiary sector of the state.

The overall livelihood losses at household level were then analysed. For 24 Parganas South and Jhargram, the average income loss was highest at Rs. 65K. However, for 24 Parganas North, the proportion was less than 10K and for Jhargram, it was the least at Rs. 900 (refer figure 117).

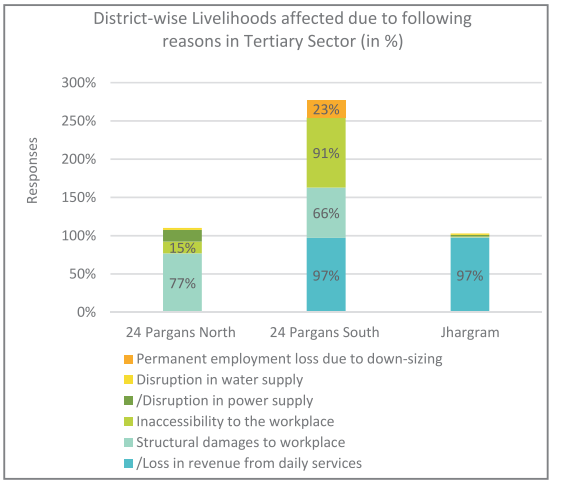


Figure 116: District-wise Livelihoods affected due to certain reasons in Tertiary Sector in West Bengal

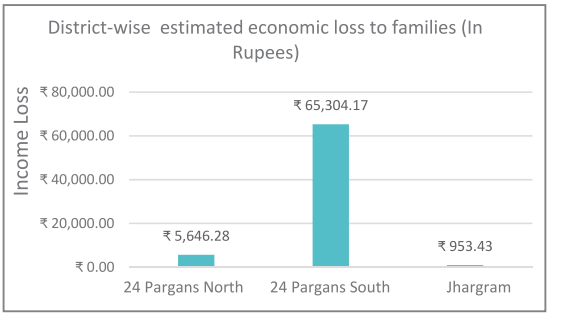


Figure 117: District-wise estimated economic loss to families in West Bengal

Livelihood Practices:

The cause assessment done to analyse whether disaster resilient livelihood practices are being followed within the state or not. For West Bengal, it was found that multi crop practice and Eco-DRR based solutions were the only resilient livelihood practice followed by both the 24 Parganas districts. However, the only resilient livelihood practices followed in Jhargram was the resilient structures for milk/cattle sheds. Similarly, for both of the 24 Parganas districts, over 75% of livelihoods were not diversified. Of instances where livelihood was diversified, only primary and secondary sectors were incorporated, excluding tertiary sector completely.

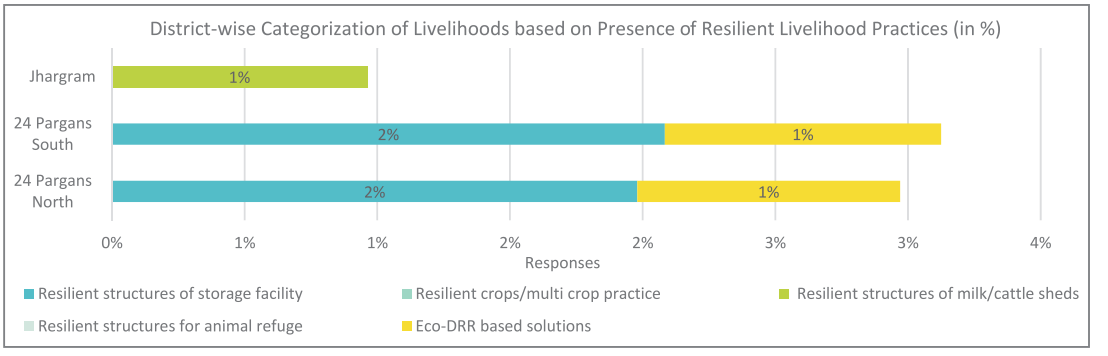


Figure 118: District-wise Categorization of Livelihoods based on Presence of Resilient Livelihood Practices in West Bengal

It is to the best of interest for the state and districts to incorporate diversified livelihood practices. However, for West Bengal, it was seen that over 90% of livelihood practices in 24 Parganas South were not diversified (refer figure 119), 14% of livelihood practices in Jhargram and 76% for 24 Parganas North were not diversified. In cases where livelihoods were diversified, secondary sector was seen as the most dominant sector followed by primary sector.

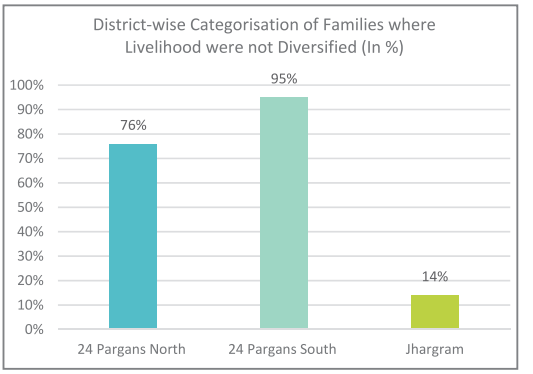


Figure 119: District-wise Categorisation of Families where Livelihood were not Diversified in West Bengal

5.3.3 Damage to Housing Structures

Aftera detailed analysis of the people and their livelihoods being affected, under this domain, we are going to assess the damage caused to housing structures within the sampled districts of West Bengal. Approximately, 1,145,00 houses had been damaged in 24 Parganas South, 37,201 houses in 24 Parganas North and 681 in Jhargram district. The ownership of these houses varied from owned, rented to mortgage on loan. The extent of damage ranged from fully, severely or partially damages structures.



Image 12: Damaged Huts in Flooded regions of West Bengal
Source: Primary Survey Field Coordinator, 2021

A cumulative district level analysis for West Bengal depicted that of the total number of houses surveyed, 77% were kutcha houses, suggesting it to be the most crucial reasons for the quantum of damage caused to the housing structures. Half of the total houses surveyed were found to be partially damaged while 34% of these were fully damaged. Both these parameters can be associated, since number of pucca structures could possibly be inversely proportional to the extent of damage (refer figure 120 & 121).

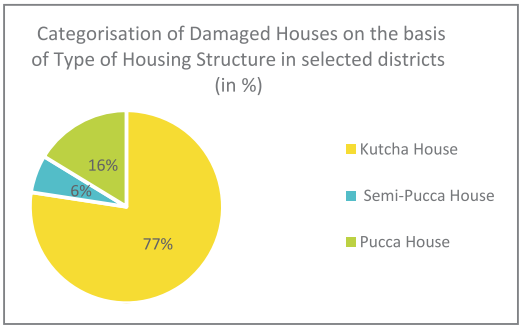


Figure 120: Categorisation of Damaged Houses on the basis of Type of Housing Structure in West Bengal

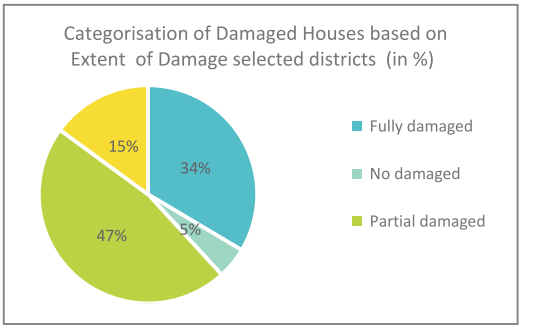


Figure 121: Categorisation of Damaged Houses based on Extent of Damagein West Bengal

A detailed analysis at district level states that 35-50% of houses in 24 parganas North were either fully or partially damaged, whereas 98% of housing structures of Jhargram were partially damaged (refer figure 122). In 24 Parganas South, 68% structures were fully damaged. Also, it should be brought into concern that almost all the sampled houses were damaged in one form or the other.

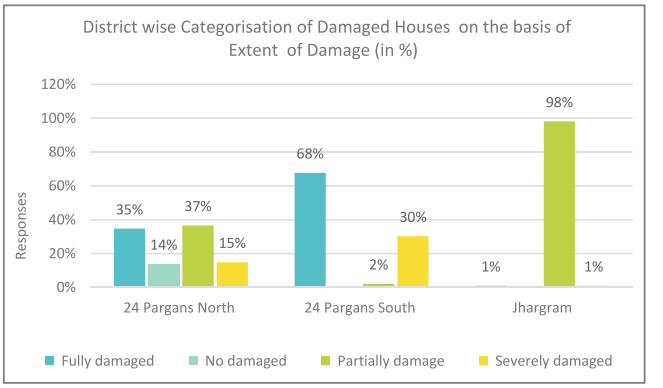


Figure 122: District wise Categorisation of Damaged Houses on the basis of Extent of Damage in West Bengal

A district level relation analysis was done between extent of damage and type of housing structures. This assessment found on the reasons of 98% of houses being partially damaged since all of these were kutcha houses. Pucca houses of 24 parganas north were either not at all damaged or partially damaged. Kutcha houses of both the remaining districts were majorly found to be fully damaged (refer figure 123). However, 98% Kutcha houses of Jhargram were partially damaged. It was noted that in majority cases, irrespective of the type of houses, the sampled houses were either partially or fully damaged.

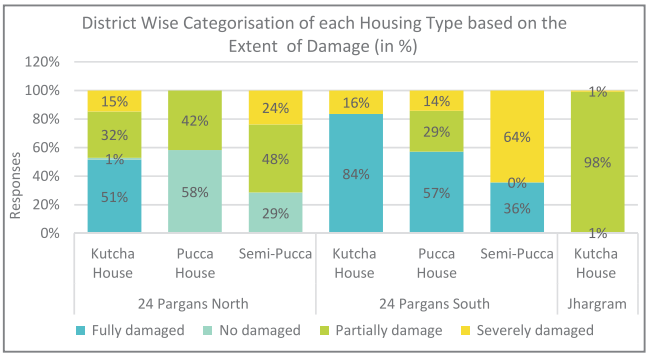


Figure 123: District Wise Categorisation of each Housing Type based on the Extent of Damage

Damages to houses were then assessed based upon the component damaged, i.e., the foundation, the roof or the walls and columns. These component for each district were only partially damaged but the component damaged differed for each district (refer figure 124). For 24 parganas north 100% roof and foundation (the type of damage seen was cracks, scouring and settlements) were partially & severely damaged. When talking about roof, the type damage that was seen were either

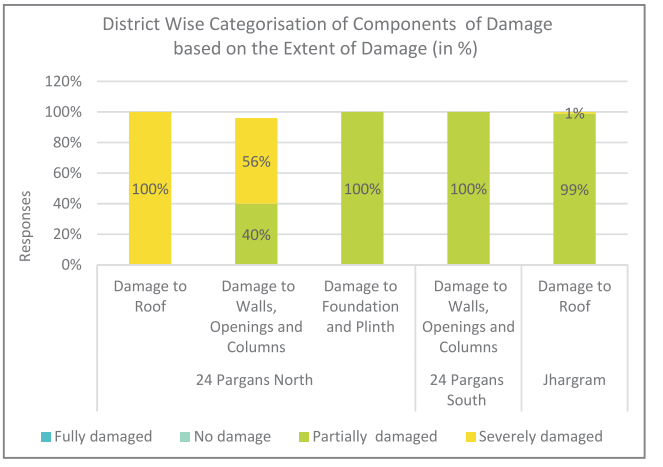


Figure 124: District Wise Categorisation of Components of Damage based on the Extent of Damage

cracks, total or partial destruction. For 24 Parganas south, only walls were damaged i.e., vertical cracks, wall tilting, corner separation, bulging, diagonal cracks near openings, cracks at beam-column junction and buckling of columns were the visible kinds of damage type witnessed. For Jhargram,98% house-roofs were damaged.

Talking about the repair status, less than 1% of damage to foundation and plinth were repairable.In case of damage to walls, columns and openings, only 9% were of repairable status while in case of damage to roofs, 35% were of repairable status.

The estimated cost of damages incurred district wise was averaged the least at Rs. 3,000 for Jhargram while it was the maximum for 24 Parganas North at Rs. 2,00,000. It was averaged somewhere between Rs. 30,000-35,000 for 24 Parganas South. Since houses of 24 parganas North had suffered almost all the types of damages, it received the maximum percentage of government support. On a contrary, Jhargram received the least. The proportions of compensation given by the government to the affected families were however very less and reached only to 10-15% of the families whose houses were affected because of the cyclone.

After the disaster subdued and with the compensation received by the households of 24 Parganas North, the entire reconstruction of the damaged houses was completed in approximately 20-25 days. For the other two districts, since monetary compensations were not provided in maximum cases, the reconstruction period varied, to as low as 2 days to as high as 210days.

An approximate estimate of assistance sought for restoration and reconstruction of these structures had been around Rs. 73,000 Lakhs.

Cause Identification:

Talking about the causes of damages to the housing structures, it was found that over 90% of the houses in all the three districts of West Bengal were constructed without following any disaster risk reduction norms and safety standards. Almost all of them were either non-engineered or semi-engineered. Except Jaggar, almost all the houses sampled and affected were built on hazard prone areas.

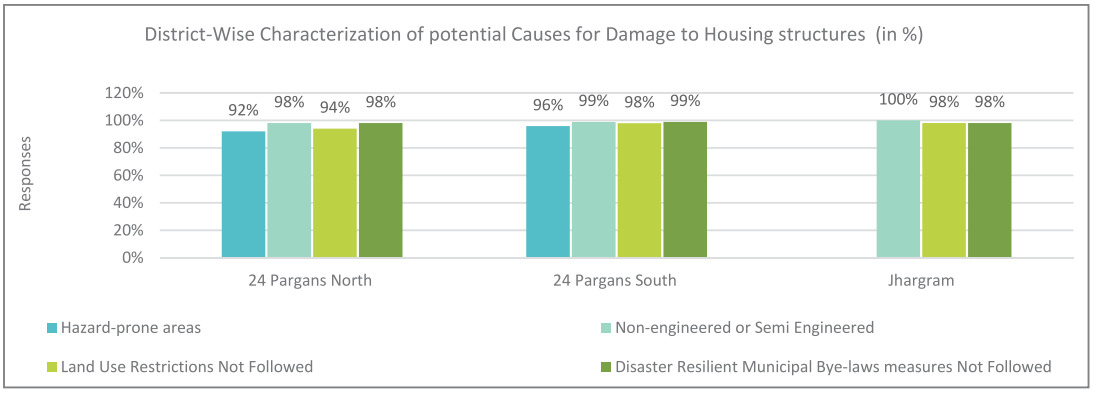


Figure 125: Characterization of potential Causes for Damage to Housing structuresin West Bengal

5.3.4 Damage to Physical Infrastructure

The cyclone caused a major service disruption to the physical infrastructural elements like water supply, sewerage, drainage network, road network, electricity and communication. The damage assessment analysis states that over 90% of families surveyed in 24 parganas south faced service disruptions to water supply, electricity and road network. Jhargram, again, suffered least service disruptions to physical infrastructures while moderate impact was seen in 24 Parganas North, with the highest service disruptions to road network and transportation services.

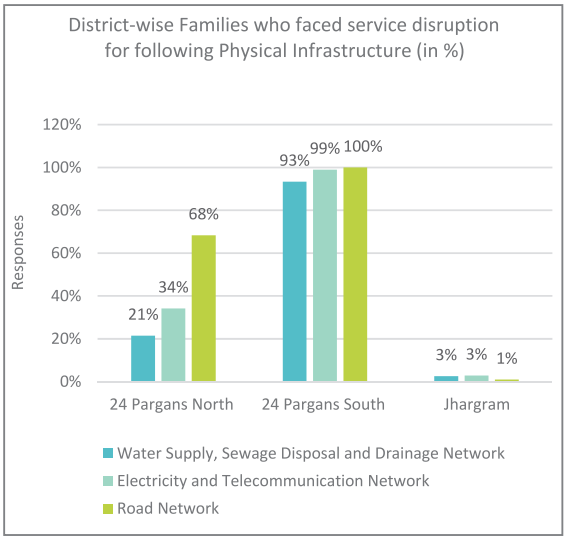


Figure 126: District-wise Families who faced service disruption (Physical Infrastructure) in West Bengal

The most common type of service disruptions witness was inaccessibility, non-availability, blockage, waterlogging or damages to the service. A total road length of 49 kms in 24 Parganas North, 78 kms in 24 Parganas South and 0.7kms of road length in Jhargram was damaged.

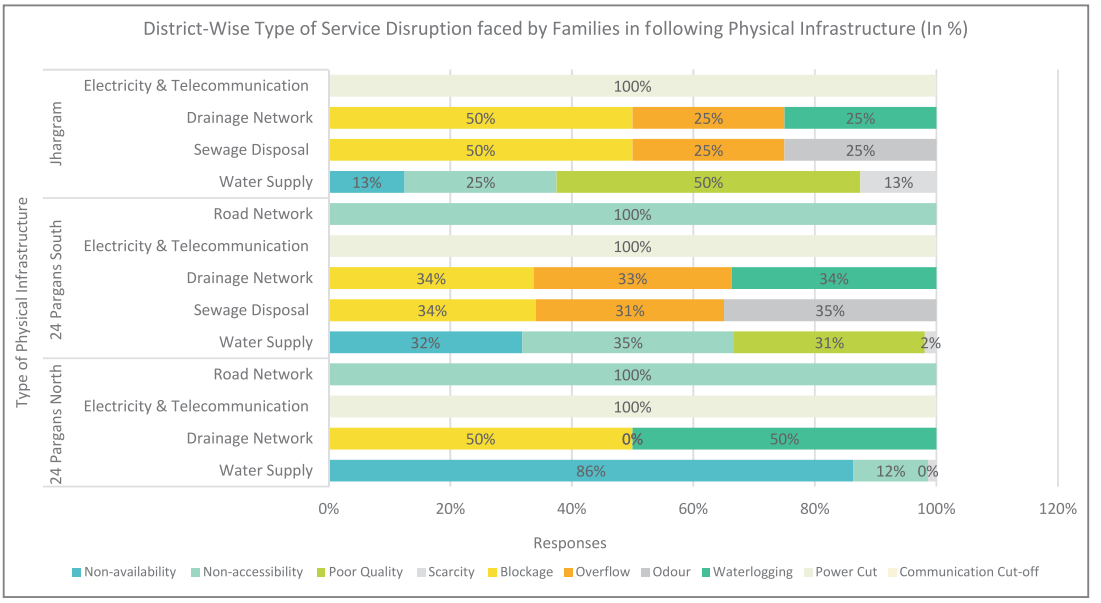


Figure 127: District-Wise Type of Service Disruption faced by Families (Physical Infrastructure) in West Bengal

50% of the water supply in 24 parganas North were perceived to be of poor quality (refer figure 127). Families faced issues of blockage of sewerage & drainage while 25% of families witnessed

overflowing drainage & sewerage within the district. Almost all the families faced issues of power cut. Although, disruptions to road network were not known in 24 Parganas South, majority families faced issues of non-availability and accessibility to water supply while 31% families reported the water supply to be of poor quality. Moderate percentages of family reported blockage & overflowing sewerage & drainage and almost all the families of this district reported power cuts and accessibility issues in road network. In Jhargram, 86% families reported non-availability of water supply while cases of drainage blockage and waterlogging were also reported. Almost all families reported power cuts and inaccessibility to road networks.

The damage at household level were analysed and stated that 97% of the road networks of 24 Parganas South had been damaged at household level. Further to this, maximum damages at household level were witnessed at electricity & telecommunication infrastructures. Jhargram had the least physical infrastructural damages at household level.

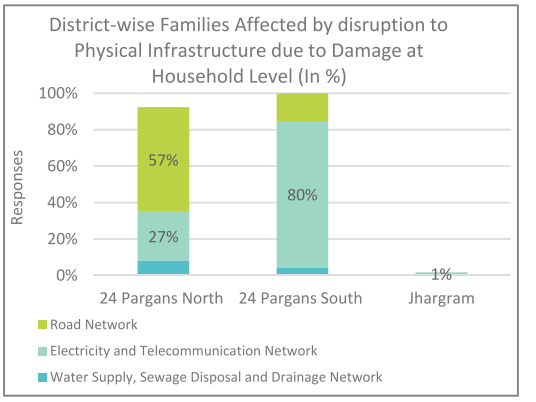


Figure 128: District-wise Families Affected by disruption to Physical Infrastructure due to Damage at Household Level in West Bengal

Cost of damages to water supply infrastructure was sourced from memorandum of very severe cyclone Yaas that stated Rs. 4500 crores of damages in 24 Parganas North, Rs. 1625 crores damages in 24 Parganas South and Rs.1.65 crore damages to water supply in Jhargram.

Marginalised Families

Families had been analysed on the basis of income factor. Analysing the impact of service disruptions to physical infrastructures over economically marginalised families, it was seen that approximately, 30% of families belonged to low-income groups and faced service disruptions to water supply, electricity and road network. An equal proportion of families whose monthly earned family income was below Rs. 5000, faced multiple service disruptions.

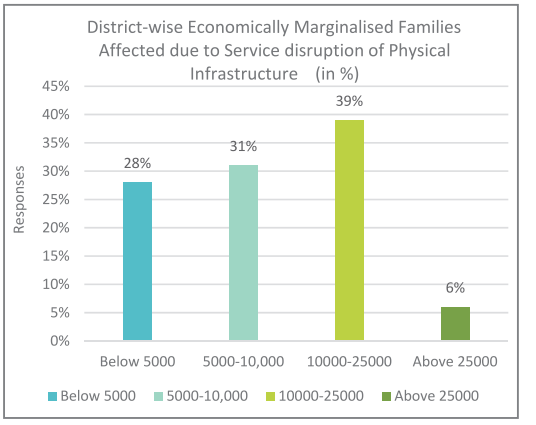


Figure 129: District-wise Economically Marginalised Families Affected due to Service disruption of Physical Infrastructure in West Bengal

Talking about the impact of service disruptions to physical infrastructures on socially marginalised families, it was seen that maximum service disruptions were faced by the OBC community, with 30-40% of families belonging to OBC community faced service disruptions. This was followed by SC category. However, the proportions were low, with 5-7% of families from SC community facing service disruptions. ST was the least impacted social group in West Bengal due to damages to physical infrastructures.

Cause Identification

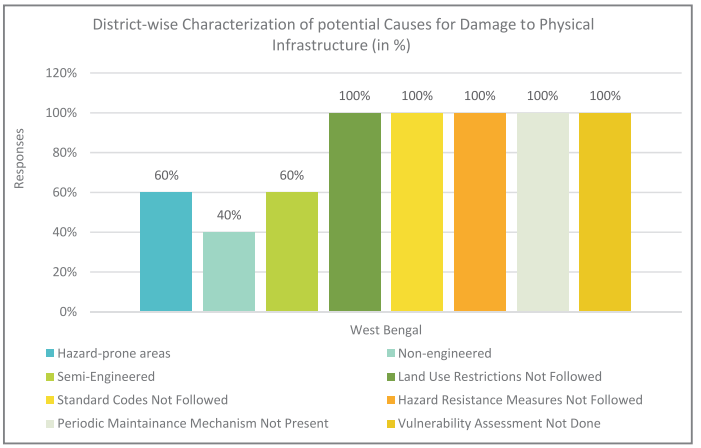


Figure 130: District-wise Characterization of potential Causes for Damage to Physical Infrastructure in West Bengal

Based on the previously-described parameters, it was assessed that out of 60% of the physical infrastructures within the sampled district area, 40% were constructed at hazard prone areas. These were non-engineered building structures. Almost all these structures did not follow land use restriction norms neither the standard codes and these structures did not follow any hazard resistance measures as well. Almost all of these structures did not have any periodic maintenance mechanism nor undertaken vulnerability assessments.

5.3.5 Damage to Social Infrastructure

Cyclone had an adverse effect over the social infrastructural components of the society which are health facilities, education facilities, institutions, religious and community and caused hinderances.

Maximum service disruptions to social infrastructures were witnessed in 24 Parganas South districts with 67% of health facilities and 95% of educational facilities being damaged (refer figure 131). A district wise data had been sourced from the Memorandum of very severe cyclone Yaasthat stated that 24 Parganas South had the maximum number of educational facilities damaged and to have incurred an approximate cost of damage of Rs. 2700 lakhs.

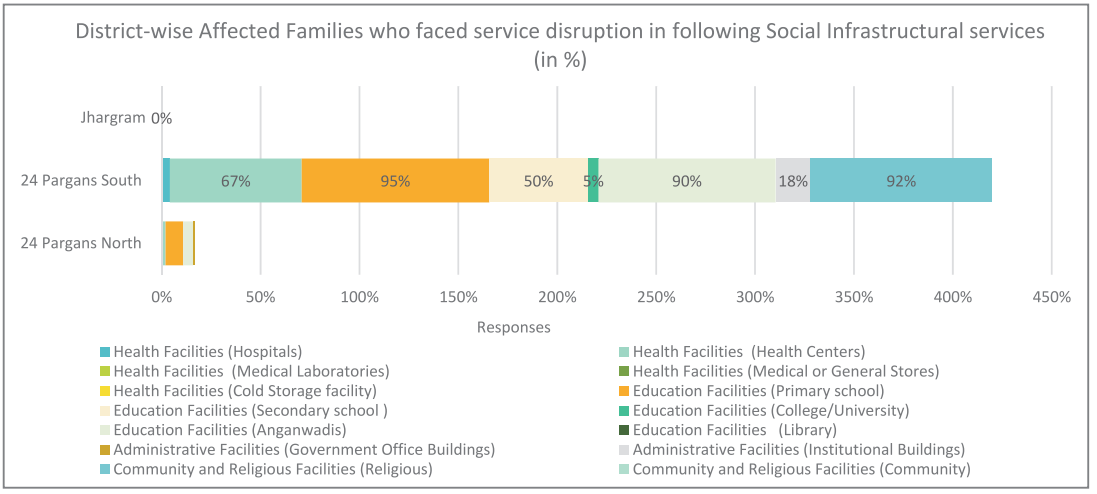


Figure 131: District-wise Affected Families who faced service disruption in following Social Infrastructural services in West Bengal

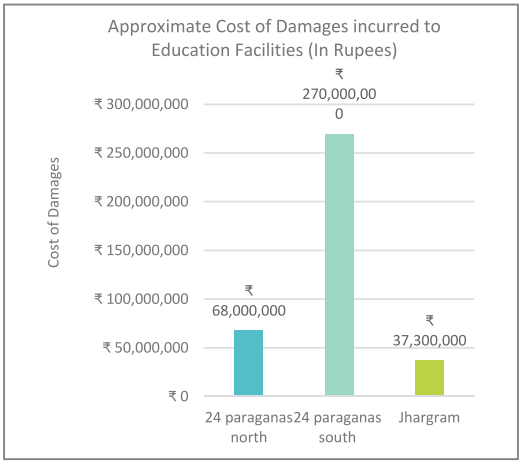


Figure 132: Approximate Cost of Damages incurred to Education Facilities in West Bengal

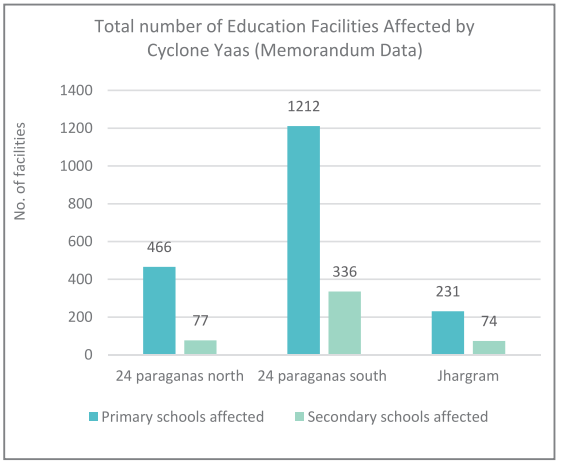


Figure 133: Total number of Education Facilities Affected by Cyclone Yaas in West Bengal

Evidently, 24 Parganas South was the only sampled district of West Bengal that had witnessed major service interruptions to social infrastructure services with equal proportions of health, educational and administrative services being affected and damaged. The duration of disruption varied according to the districts. Jhargram had no major service interruptions. There was negligible duration of inconvenience to the population. However, the average days of disruption of each service of the social infrastructure damaged ranged between 10-15 days for 24 Parganas North and South (refer figure 134).

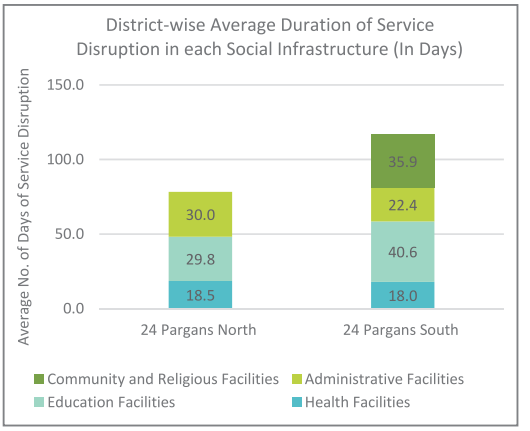


Figure 134: District-wise Average Duration of Service Disruption in each Social Infrastructure in West Bengal
Note: Very few data available for Jhargram

Cause Identification

Based on certain identified parameters, it was found that 60-65% of the social infrastructures within the sampled district area were constructed at hazard prone areas and were non-engineered building structures. 80% of these did not follow land use restriction and municipal by-laws. Most importantly, all of these structures did not undertake vulnerability assessments to adjudge the safety elements.

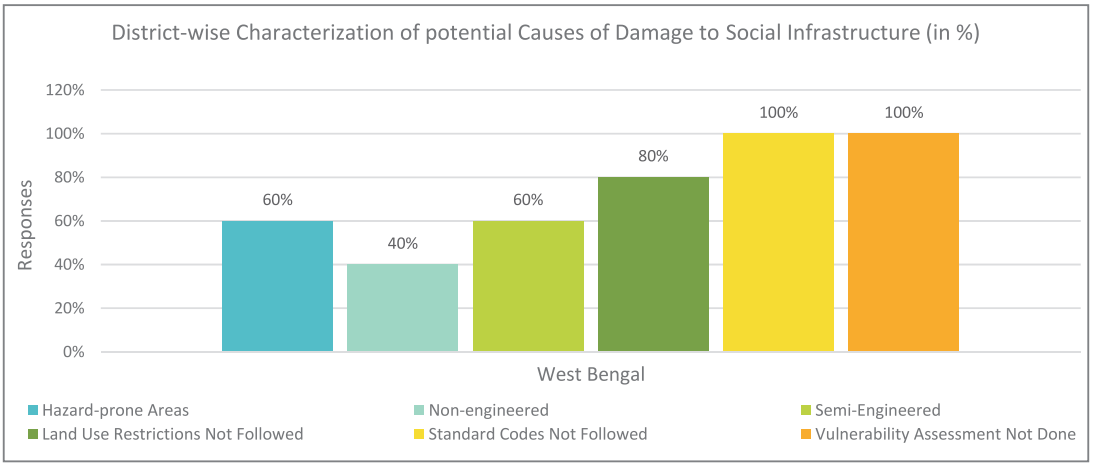


Figure 135: Characterization of potential Causes of Damage to Social Infrastructure in West Bengal

5.3.6 Damage to Environment

The Environment domain has been specifically incorporated to identify the impact and extent of damage the cyclone has caused to various components of environment. The components of environment that has been analysed are:

1. Water sources which specifically constitutes ground water, lake, rivers and canals. At a cumulative district level analysis, it was seen that many rivers in West Bengal were affected and damaged because of the cyclone. Talking about the families that were affected because of the damage caused to water sources, it was seen that not many families were affected by the damage caused to water source. When respondents were asked about the type of damage, it was seen that area around these water sources were damaged and broken, polluting the water sources.

2. Land constitutes agricultural land, forest, wetland, mines, mangroves and wastelands. An approximate 27% of the families surveyed were affected by the damage caused to different components of land (refer figure 136). 80 families



Image 13: Water Sources in West Bengal polluted disrupted by the Cyclone
Source: Primary Survey Field Coordinator, 2021

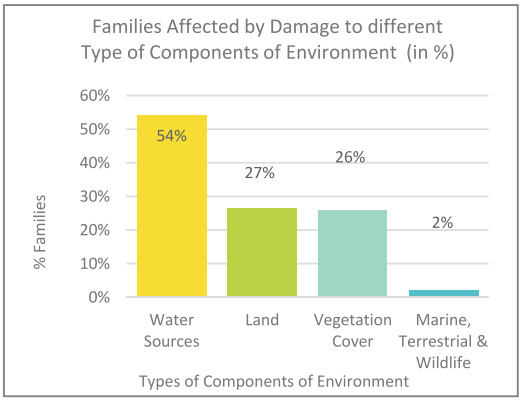


Figure 136: Families Affected by Damage to different Type of Components of Environment in West Bengal

were affected by damage to agricultural lands while 32 families were affected by the damage caused to wetlands. Damage to land critically impacted families by destroying their agricultural lands, causing losses in production and livelihoods.

3. Vegetation Cover constitutes grass, bamboo, timber trees, plantation and aquatic plants. Cumulative district level analysis states that 26% of the families surveyed were affected by the damage caused to vegetation cover. The most important conclusion here was 68 families were affected because of the damage caused specifically to plantation and 20 families were affected by damage caused to timber trees.

4. Marine, Terrestrial and Wildlife. The cumulative district level analysis for WB shows that negligible proportions of families were affected by the damage caused to this component of environment. This suggests that not many families surveyed were dependent on this component for livelihood. However, of the families that had responded, the most common form of damage witnessed by them was drowning of animals because of the increased water levels.



Image 14: Damaged huts in affected districts of West Bengal
Source: Primary Survey Field Coordinators, 2021

5.4 Odisha – Damage and Cause Assessment

In Odisha, 87.42 Lakh people were affected. 12 districts were rammed (Balasore, Bhadrak, Cuttack, Dhenkanal, Jagatsinghpur, Keonjhar, Khorda, Kendrapara, Mayurbhanj, Jajpur, Puri and Sundergarh) by Cyclone Yaas.

Table 19: General Details of Sampled State of Odisha

	Odisha
Population Affected	87.42 Lakh
Villages Affected	13,541
Persons Evacuated	7,03,058
Houses Damaged	18,094
Human Lives Lost	3
Crop affected	5672.99 Ha
Maximum Wind Speed	30-140 gusting to 155 kmph
Rainfall	Heavy to extremely heavy rainfall at isolated places over coastal Odisha on 25th May and heavy to very heavy rainfall at a few places and extremely heavy rains at isolated places on 26th May over North Odisha.

Balasore	Most Affected
Bhadrak	Most Affected
Mayurbhanj	Moderately Affected

Source: Primary Source through State Coordinator, 2021

For the purpose of undertaking the Damage Assessment Study, we conducted Household and Key Informant surveys across the state of Odisha to make a comprehensive analysis of the damage at state, district, block and village level. The three districts that were surveyed are Balasore (most affected), Bhadrak (most affected) and Mayurbhanj (moderately affected). Three blocks/wards undereach district were surveyed with a minimum of 3 villages per block.

Sample Survey Findings

5.4.1 Damage and Loss to Human Lives

For Odisha, no deaths were reported in the sampled districts.

The assessment analysis of damages to human lives in the three surveyed districts and its blocks infers to have affected Mayurbhanj the most. It has been stated through the survey responses that people of Balasore and Bhadrak were least/ not affected by the cyclone.

Talking about the type of damages, the most common and the only type of damage witnessed at the state level was health issues. As per the responses collated, it will be easy to infer that there were no casualties in Odisha because of the cyclone. At district level, an approximate of 19% of people surveyed in Mayurbhanj were

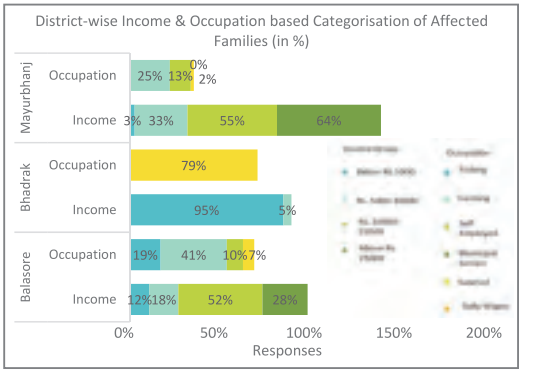


Figure 137: District-wise Income & Occupation based Categorisation of Affected Families in Odisha

found to be affected by cyclone had been developing health issues. As highlighted previously, there had been no causalities across the state.

When characteristics of the population affected was analysed, it was seen that 8% of the affected population were male while a similar proportion of population were female. Approximately 4-8% of children were affected. For Balasore and Mayurbhanj, farming and self-employed occupations appears to be the most common occupation for greater part of the affected families, which also concludes that families belonging to low-income groups have been the most affected category of the population.

Monetary Compensation:

Mayurbhanj was the only district to receive monetary compensations for the damages and loss to human lives caused by the cyclone. Both the other districts witnessed least or no damages hence no compensation were disbursed. Approximately, 19% of the families affected by cyclone in Odisha received compensations from the government.

Early Warning Information Dissemination:

The Early Warning information dissemination analysis for all the three districts shows that over 75% of surveyed families of Mayurbhanj received the early warnings, understood the meaning and relocated to a safer place (refer figure 139). However, this pattern for Balasore was comparatively low while for Bhadrak, it was negligible. Only 2% of the families surveyed in Bhadrak received and understood the early warning information but none of them moved to safer locations. This represents the requirement of building a robust early warning awareness system within the district.

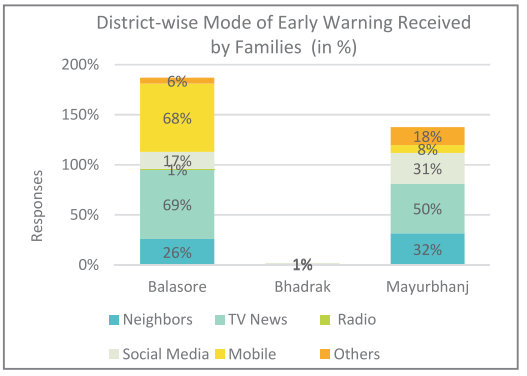


Figure 138: Mode of Early Warning Received by affected Families in Odisha

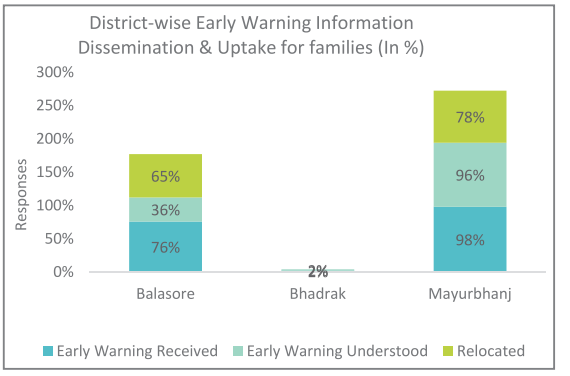


Figure 139: District-wise Early Warning Information Dissemination & Uptake for families in Odisha

The most common mode through which the families received Early Warnings were through TV news for both Balasore and Mayurbhanj (refer figure 138). Since in Bhadrak, only 2% of the population received early warnings, no strong trend could be extracted. Mobile phones and neighbourhood interactions were also very common source of spreading or receiving early warnings.

After understanding the Early Warning information, the average evacuation lead time was between 2.5-4 hours for Balasore and Mayurbhanj (refer figure 140). (Very low percentages of families in Bhadrak received early warning. The evacuation lead time and relocation data couldn't be extracted). Of people who relocated to safer places in Balasore and Mayurbhanj, the average days of stay was between 0-4 days. Very few families in Balasore stayed for more than 6 days (refer figure 141).

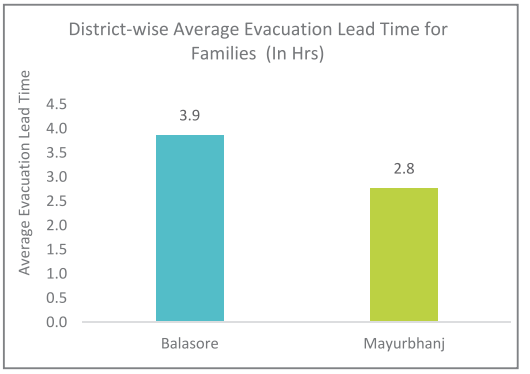


Figure 140: Average Evacuation Lead Time for affected Families in Odisha
Note: Data not available for Bhadrak

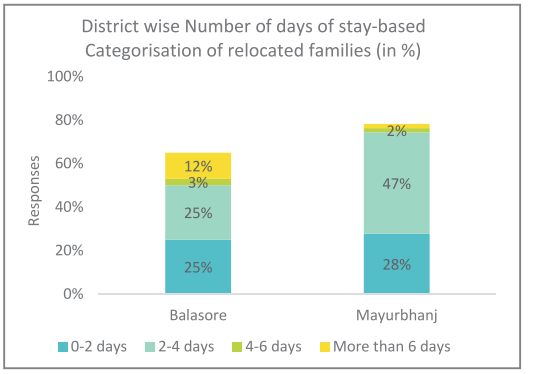


Figure 141: District wise Number of days of stays for relocated families in Odisha
Note: Data not available for Bhadrak

5.4.2 Damage and Loss of Livelihoods

Damage and loss to livelihood category under the Household Survey was incorporated to analyse the impact of cyclone over the three economic sectors, i.e., the primary sector, the secondary and the tertiary sector. The block wise impact assessment of cyclone on livelihoods of people states that for Mayurbhanj, over 70% of damage had been witnessed as employment loss. However, for Balasore, primary sector activities and loss in business were the most evident loss of livelihood. The district level analysis depicts that primary sector was majorly impacted for Balasore and secondary sector was the most affected for Mayurbhanj. (Bhadrak had no evident impact on the livelihood of people).

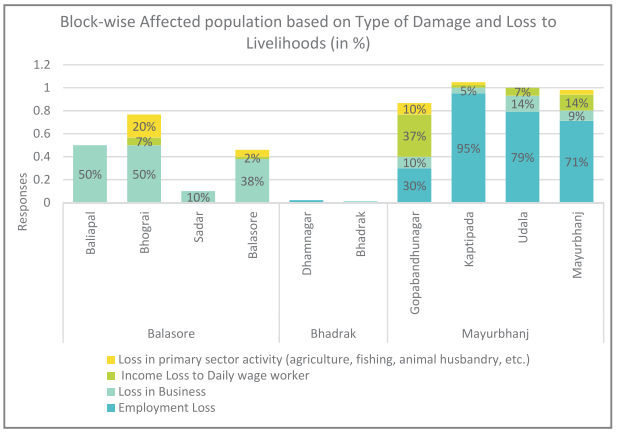


Figure 142 (a): Block-wise Affected population based on Type of Damage and Loss to Livelihoods in Odisha

1. Primary Sector

When primary sector was further analysed specifically, it was witnessed that 66% losses in primary sector livelihood belonged to agriculture for Balasore. No specific pattern could be gathered for losses in primary sector activity in Bhadrak district.

For a better understanding regarding the components of each primary sector activity, an in-depth analysis was made with respect to the impacts caused by the cyclone specific to the components. For Agriculture, 77% crop production was affected while 23% losses were made. 90% of the storage facility for agriculture was damaged and 52% of stored grains were submerged. Additionally, 51% of the agricultural land was damaged.

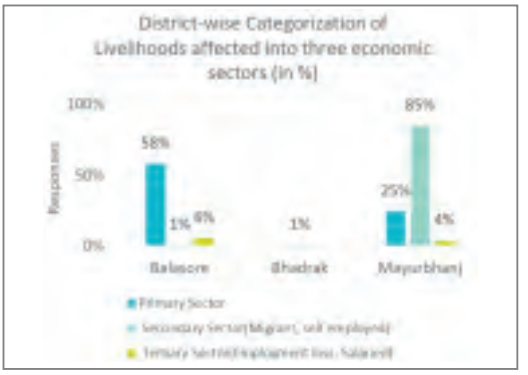


Figure 142(b): District-wise Categorization of Livelihoods affected

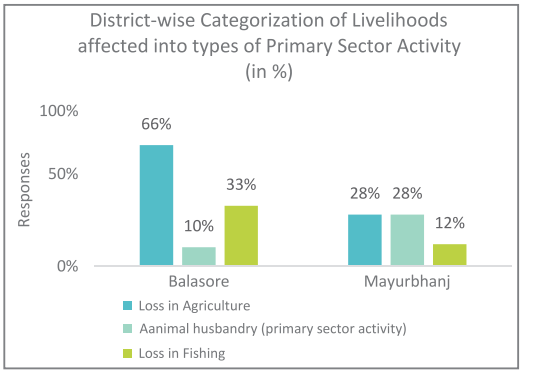


Figure 143: District-wise Categorization of Livelihoods affected into types of Primary Sector Activity in Odisha
Note: No data available for Bhadrak

For Fishing, 100% production was affected, 50% of fish farms were damaged while the other 50% were submerged. Almost all the fishing nets and boats were damaged (refer figure 144).

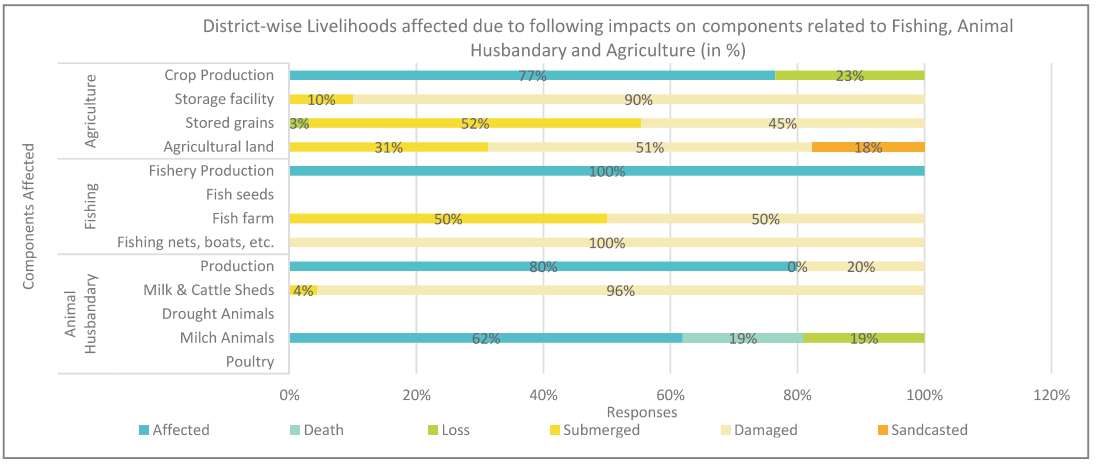


Figure 144:District-wise Livelihoods affected due to following impacts on components related to primary sector

For Animal Husbandry, 80% of the production was affected while 96% of the milk/cattle sheds were damaged. 62% of the Milch animals were affected while a minute portion died.

It was eventually observed that for Odisha, almost all the components of primary sector activities were hit in one form or the other. However, the number of components (Animal

Husbandry/Fishery) that died was negligible. The minimum losses scaled were minimum, which implies that the amount of damage that happened to primary sector activities were recovered quickly.

2. Secondary Sector

Losses in secondary sector were analysed for all three districts. It was witnessed that losses in revenue was the most crucial reason for losses for all the three districts. For Balasore, structural damages to warehouse contributed to major losses. In Mayurbhanj, the losses were related to revenue losses, inaccessibility to workplace and disruptions to power supply.

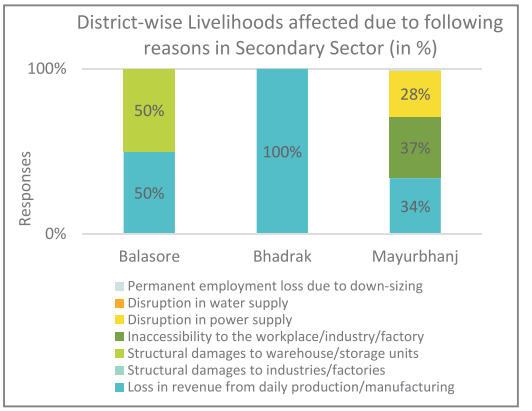


Figure 145: District-wise Livelihoods affected due to certain reasons in Secondary Sector in Odisha

3. Tertiary Sector

In tertiary sector, workplace damage, inaccessibility and losses in revenues were the most common reasons for losses in Balasore and Mayurbhanj. The main causes for losses in Balasore were mainly workplace related while structural damages and losses in revenue were important reasons for losses in Mayurbhanj. (No relevant responses received for Bhadrak).

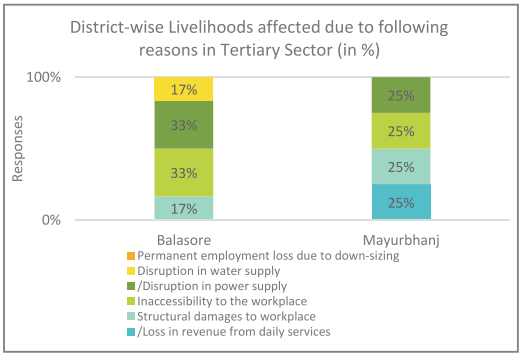


Figure 146: District-wise Livelihoods affected due to certain reasons in Tertiary Sector in Odisha
Note: No data available for Bhadrak

The overall livelihood losses at household level were analysed. The estimated average economic losses for Balasore were the highest for families whose livelihood had been affected. The average estimated losses for the days when cyclone affected the livelihoods of people were approximately 14k for Balasore, while it amounted to less than 5K for Bhadrak and Mayurbhanj.

Livelihood Practices:

The cause assessment was done to analyse whether disaster resilient livelihood practices were being followed within the state or not. For Odisha, it was seen that multi crop practices, resilient structures for animal refuge and Eco-DRR based solutions were the resilient livelihood practiced and mostly followed in both Balasore and Mayurbhanj. No particular resilient livelihood practices were witnessed in Bhadrak.

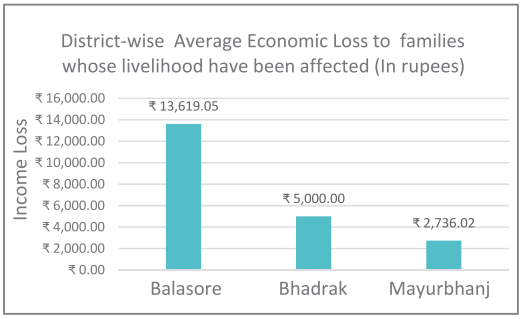


Figure 147: District-wise average Economic Loss to families whose livelihood have been a affected in Odisha

On a similar line, 70% livelihood in Balasore and 40% of livelihood in Mayurbhanj were not diversified, primary sector activities were the most dominant. No evidences of livelihood diversification were seen in Bhadrak.

5.4.3 Damage to Housing Structures

After a detailed analysis of the people and their livelihoods being affected, under this domain we are going to assess the damage caused to housing structures within the sampled districts of Odisha. The ownership of these houses varies from owned, rented to mortgage on loan. The extent of damage ranged from fully, severely or partially damages structures.

A state level analysis for Odisha depicted that of the total number of houses surveyed, 77% were kutcha houses, suggesting it to be the most crucial reasons for the quantum of damage caused to the housing structures (refer figure 150). Half of the total houses surveyed were found to be partially damaged while 24% of these were fully damaged (refer figure 151). Both these parameters can be associated since number of pucca structures could possibly be inversely proportional to the extent of damage. A detailed analysis at district level states that 60-70% of houses in Balasore and Mayurbhanj were partially damaged, 40-48 % of housing structures of Bhadrak were partially or severely damaged (refer figure 152). A district level correlation analysis was done between extent of damage and

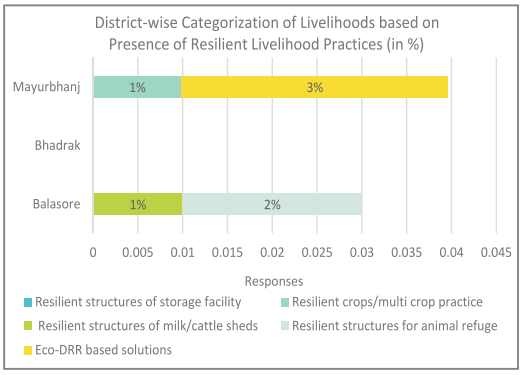


Figure 148: District-wise Categorization of Livelihoods based on Presence of Resilient Livelihood Practices in Odisha

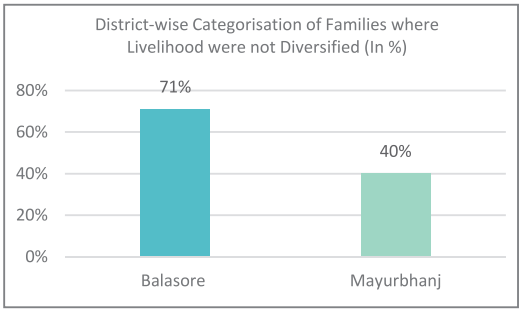


Figure 149: District-wise Categorisation of Families where Livelihood were not Diversified in Odisha
Note: Data not available for Bhadrak

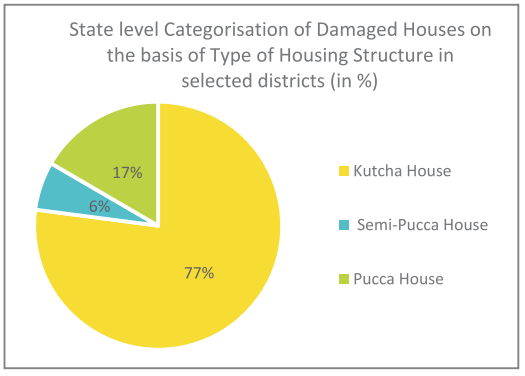


Figure 150: State level Categorisation of Damaged Houses on the basis of Type of Housing Structure in Odisha

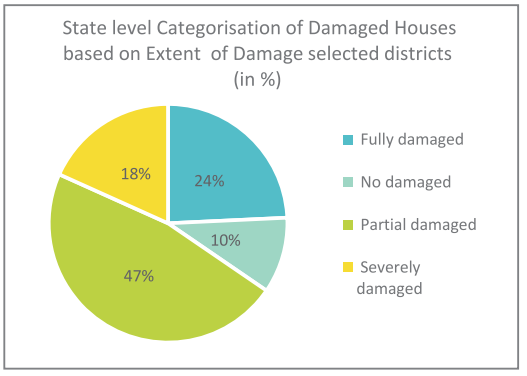


Figure 151: State level Categorisation of Damaged Houses based on Extent of Damage in Odisha

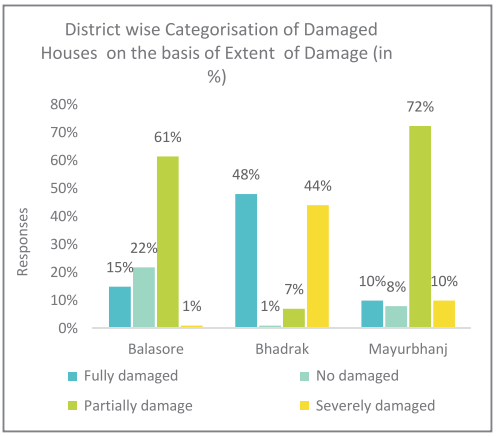


Figure 152: District wise Categorisation of Damaged Houses on the basis of Extent of Damage

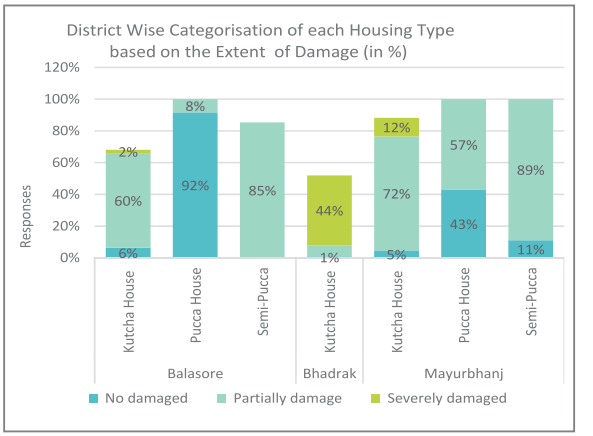


Figure 153: District Wise Categorisation of each Housing Type based on the Extent of Damage

type of housing structures. This assessment documented on the reasons of houses being severely to fully damaged. Pucca houses of Balasore and Mayurbhanj, mostly witnessed no damage while kutcha houses of both these districts were mostly partially damaged. Over 40% of Kutcha houses of Bhadrak were severely damaged (refer figure 153).

Talking of the Damages to houses based upon the component damaged, i.e., the foundation, the roof or the walls and columns. All the components for both districts were mostly partially damaged. 100% walls and foundation component of Mayurbhanj were partially damaged and over 80 % of the components of Balasore district were partially damaged. Only few instances of fully damage and severely damaged houses were seen in both the districts. (No specific information regarding damages to components of Bhadrak was received).



Image 15 Damaged Huts in Bhadrak District of Odisha

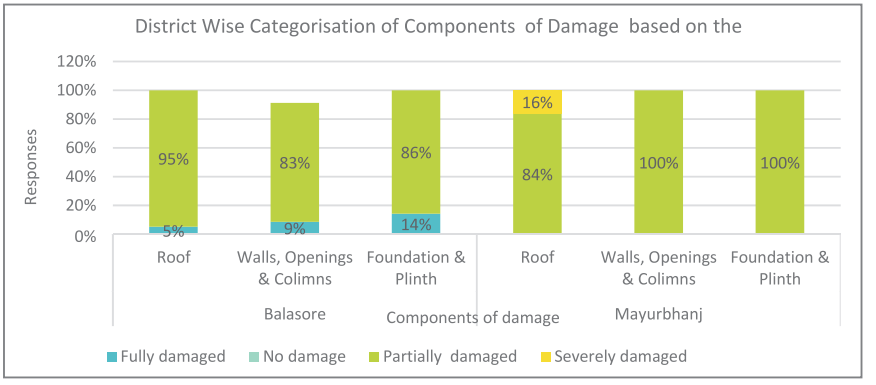


Figure 154: District Wise Categorisation of Components of Damage based on the Extent of Damage
Note: Data not available for Bhadrak

Since houses of Balasore and Mayurbhanj suffered most of damages, it received the maximum percentage of government support. On a contrary, Bhadrak received the least.

Cause Analysis:

Talking about the causes of damages to the housing structures, it was found thatover 90% of the houses in all the three districts of Odisha were constructed without following any disaster risk reduction norms and safety standards. Almost all of them were either non-engineered or semi-engineered. Except Bhadrak, almost all the houses sampled and affected did not follow land use restrictions.

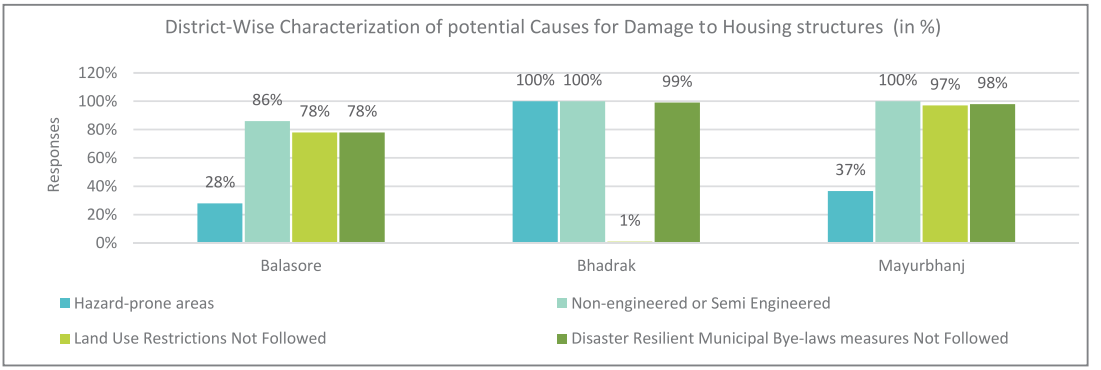


Figure 155: Characterization of potential Causes for Damage to Housing structures in Odisha

5.4.4 Damage to Physical Infrastructure

The cyclone caused a major service disruption to the physical infrastructural elements like water supply, sewerage, drainage network, road network, electricity and communication. The most common type of service disruptions witness was inaccessibility, non-availability, blockage, waterlogging or damages to the service. The damage assessment analysis states that over 70% of families surveyed in Balasore and Mayurbhanj faced service disruptions for electricity and communication. Bhadrak, again suffered least service disruptions to physical infrastructures, with maximum propotion of disruptions to electricity & telecommunications.

The most common type of service disruptions for water supply was in-accessibility, non-availability, poor quality and scarcity (refer figure 166). At a cumulative district level, it was seen that 60% of families couldn't access the water supply services. 15% of the families faces issues of water scarcity and non-availability of water supply. Service disruptions for

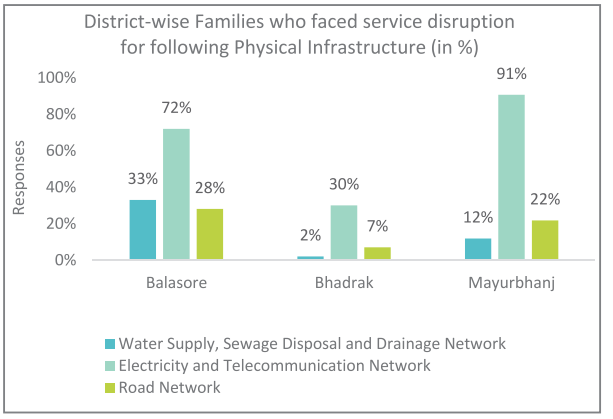


Figure 156: District-wise Families who faced service disruption (Physical Infrastructure) in Odisha

sewage disposal constituted, blockage, odour and overflow. For all the sampled districts, it was seen that 31% of the families' faced issues of sewer blockage while 5-7% families faced odour and overflow issues. Service disruptions for drainage network were blockage, overflow and waterlogging, of which maximum families faced issues of blockage and water logging.

The damage at household level were analysed and stated that over 60% of the electricity service of Bhadrak & Mayurbhanj had been damaged at household level. Further to this, negligible damages at household level were witnessed at water supply in all the sampled districts. Moderate impact was seen on families due to damage to road network.

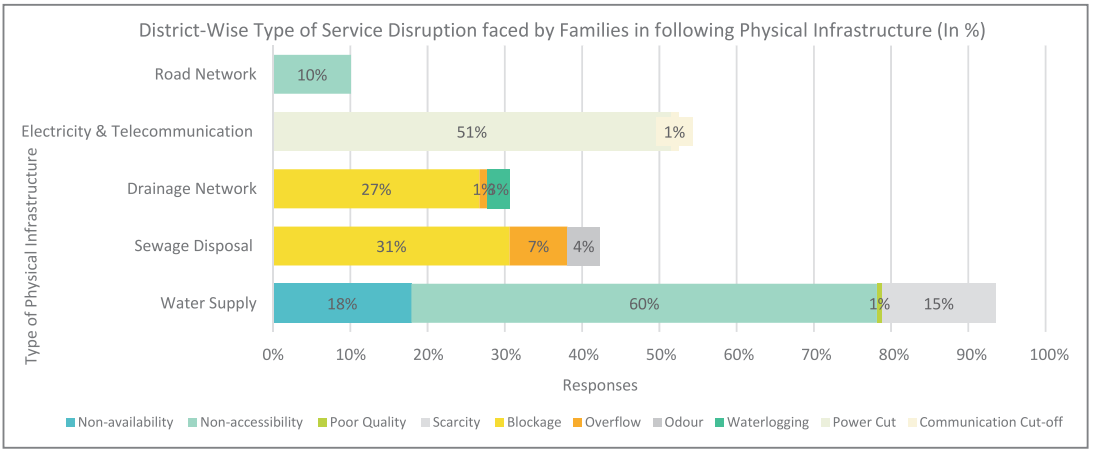


Figure 157: Type of Service Disruption faced by Families (Physical Infrastructure) in Odisha

Marginalised Families

In order to analyse the impact of service disruptions to physical infrastructures on marginalised families, we have analysed this parameter in two ways. One is by analysing the impact over economically marginalised families. Approximately, 20-30% of economically marginalised families faced service disruptions to water supply, electricity and road network. Families whose monthly earned family income is below Rs. 5000, mainly faced physical infrastructure service disruptions. Here, it is highly possible that they may have limited accessibility to these infrastructures in the first place (refer figure 159).

Talking about the impact of service disruptions to physical infrastructures on socially marginalised families (refer figure 160), it was seen that maximum service disruptions were faced by the OBC community, with 40-60% of families.

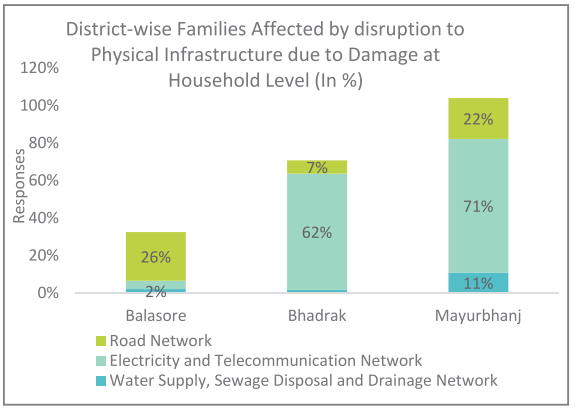


Figure 158: District-wise Families Affected by disruption to Physical Infrastructure due to Damage at Household Level in Odisha

This was followed by SC category. However, the proportions were low, with 10-12% of families from SC community facing service disruptions. ST were the least impacted social group in Odisha due to damages to physical infrastructures.

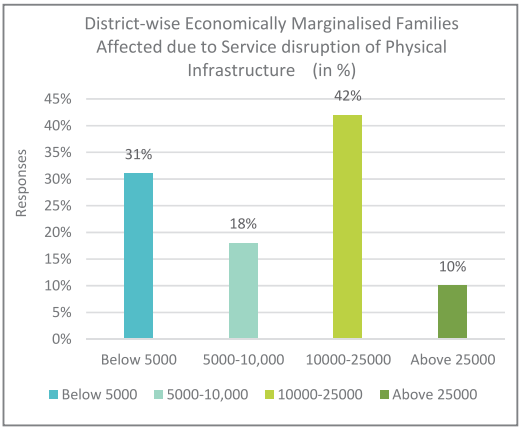


Figure 159: District-wise Economically Marginalised Families Affecteddue to Service disruption of Physical Infrastructure

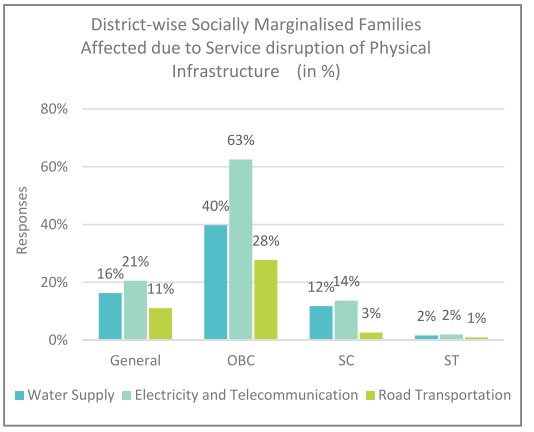


Figure 160: District-wise Socially Marginalised Families Affecteddue to Service disruption of Physical Infrastructure

Cause Identification:

Based on the previously-described parameters, it was observed that 30% of the physical infrastructures within the sampled district, were constructed at hazard prone areas. 100% of these were non-engineered building structures, 100% of these did not follow land use restriction norms nor the standard codes and neither of these structures followed any hazard resistance measures. Almost all of these structures did not have any periodic maintenance mechanism nor undertaken vulnerability assessments.

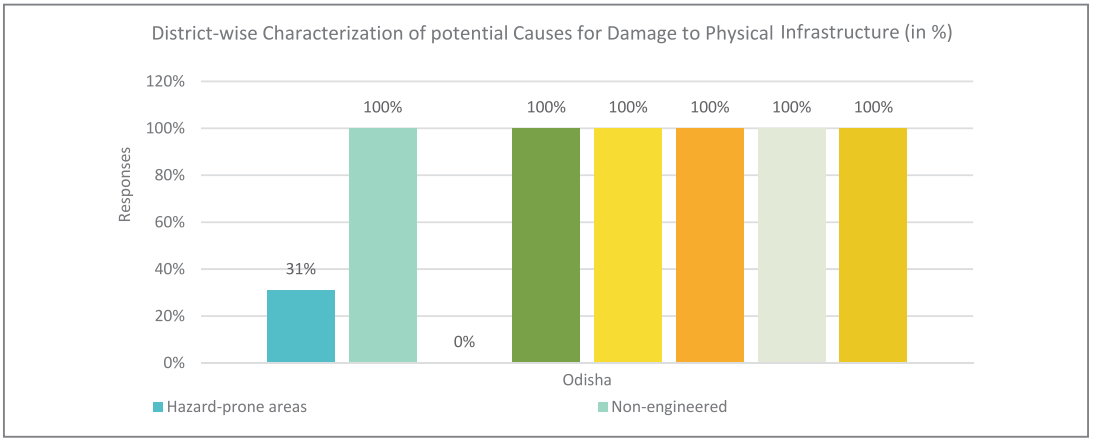


Figure 161: District-wise Characterization of potential Causes for Damage to Physical Infrastructure in Odisha

5.4.5 Damage to Social Infrastructure

Cyclone takes an adverse effect and cause hindrances over the social infrastructural components of the society that are health facilities, education facilities, institutions, religious and community.

Maximum service disruptions to social infrastructures were witnessed in Mayurbhanj district with almost all social infrastructure facilities being damaged (refer figure 171). Bhadrak had least percentage of social infrastructure disruptions of the two districts with maximum interruptions. Hospitals and colleges were the most damaged facilities under social infrastructures.

Evidently, Balasore and Mayurbhanj were the sampled district of Odisha thatwitnessed major service interruptions to social infrastructure services with equal proportions of health, educational and administrative services being affected & damaged. The duration of disruption varied according to the districts. Bhadrak had no major service interruptions. There was negligible duration of inconvenience to the population. However, the average days of disruption of each service of the social infrastructure damaged ranged between 10-20 days for both the districts (refer figure 162).

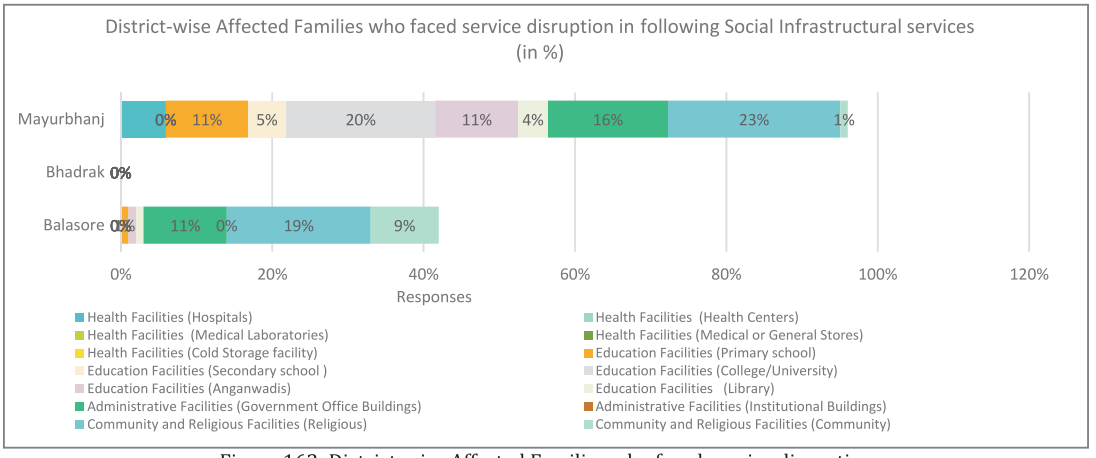


Figure 162: District-wise Affected Families who faced service disruption in following Social Infrastructural service in Odisha

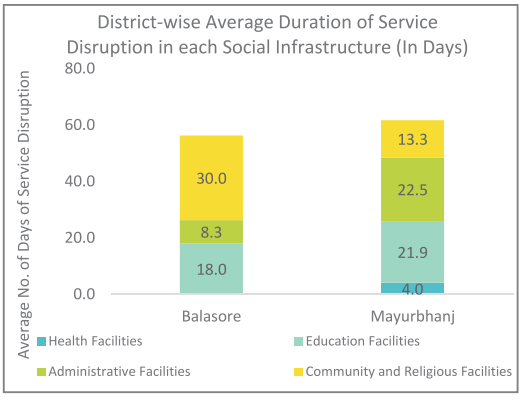


Figure 163: District-wise Average Duration of Service Disruption in Odisha
Note: Data not available for Bhadrak

Marginalised Families

In order to analyse the impact of service disruptions to social infrastructures on marginalised families, we have analysed this parameter in two ways. One is by analysing the impact over economically marginalised families (analysing the income factor). Approximately, 32% of families who faced service disruptions to social infrastructural facilities belonged to Rs. 5000-10,000 income groups while families earning below Rs. 5000 were not affected by service disruptions to social Infrastructures.

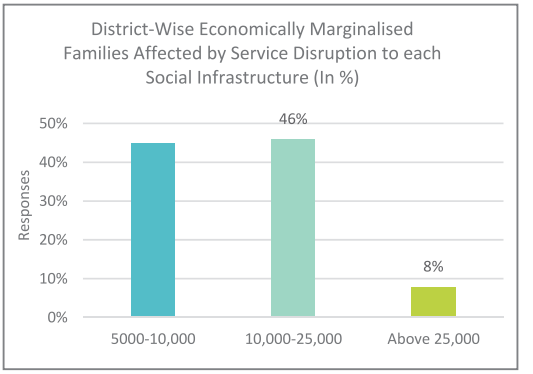


Figure 164: District-Wise Marginalised Families Affected by Service Disruption to each Social Infrastructure in Odisha

Cause Identification

Based on the above-described parameters, it was noticed that 38% of the social infrastructures within the sampled district area were constructed at hazard prone areas and 85% were non-engineered building structures. 85% of these did not follow any standard codes. Most importantly, majority of these structures did not undertake vulnerability assessments to adjudge the safety elements.

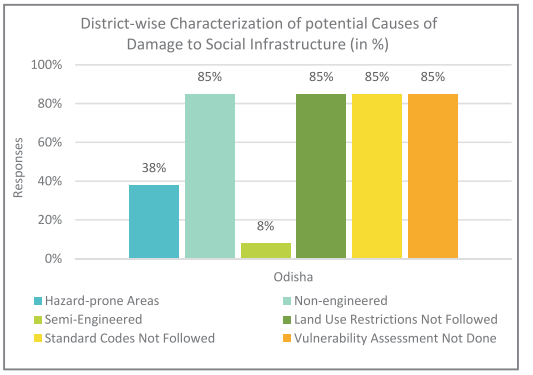


Figure 165: District-wise Characterization of potential Causes of Damage to Social Infrastructure in Odisha

5.4.6 Damage to Environment

The Environment domain has been specifically incorporated to identify the impact and extent of damage the cyclone has caused to various components of environment. The components of environment that has been analysed are:

1. Water sources which specifically constitutes, ground water, lake, rivers and canals. At a cumulative district level analysis, it was seen that one lake in Odisha was affected and damaged because of the cyclone. Talking about the families who were affected because of the damage caused to water sources, it was seen that not many families were disturbed by the damage caused to water sources. When respondents were asked about the type of damage, it was seen that the area around these water sources were damaged and broken, polluting the water sources.
2. Land constitutes agricultural land, forest, wetland, mines, mangroves and wastelands. An approximate 17% of the families surveyed were affected by the damage caused to different components of land (refer figure 166). 49 families were affected by damage to agricultural lands while 26 families were affected by the damage caused to wetlands. Damage to land critically impacted families by destroying their agricultural lands, causing losses in production and livelihoods.

3. Vegetation Cover constitutes grass, bamboo, timber trees, plantation and aquatic plants. Cumulative district level analysis states that 35% of the families surveyed were affected by the damage caused to vegetation cover. The most important conclusion here was, 110 families were affected because of the damage caused specifically to plantation and 20 families were affected by damage caused to timber trees.

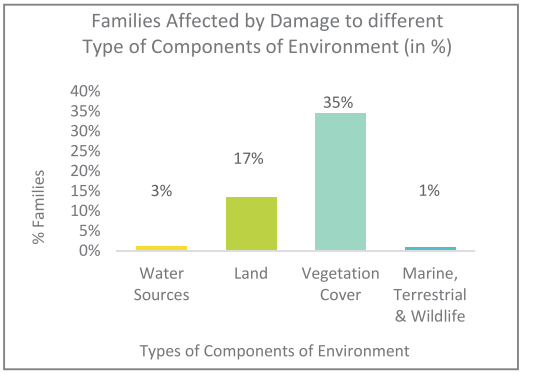


Figure 166: Families Affected by Damage to different Type of Components of Environment in Odisha

4. Marine, Terrestrial and Wildlife. The cumulative district level analysis for Odisha shows that negligible proportions of families were affected by the damage caused to this component of environment. This suggests that not many families surveyed were dependent on this component for livelihood. However, of the families that have responded, the most common form of damage witnessed by them was drowning of animals because of the increased water levels.



Reasoning the variations in Damages and Causes across states

Reasoning the variations in Damages and Causes across states

6

6.1 Geographical and Sectoral Variations - DAMAGES

6.1.1 Assessing Cost of Damages across States and Domains of damages

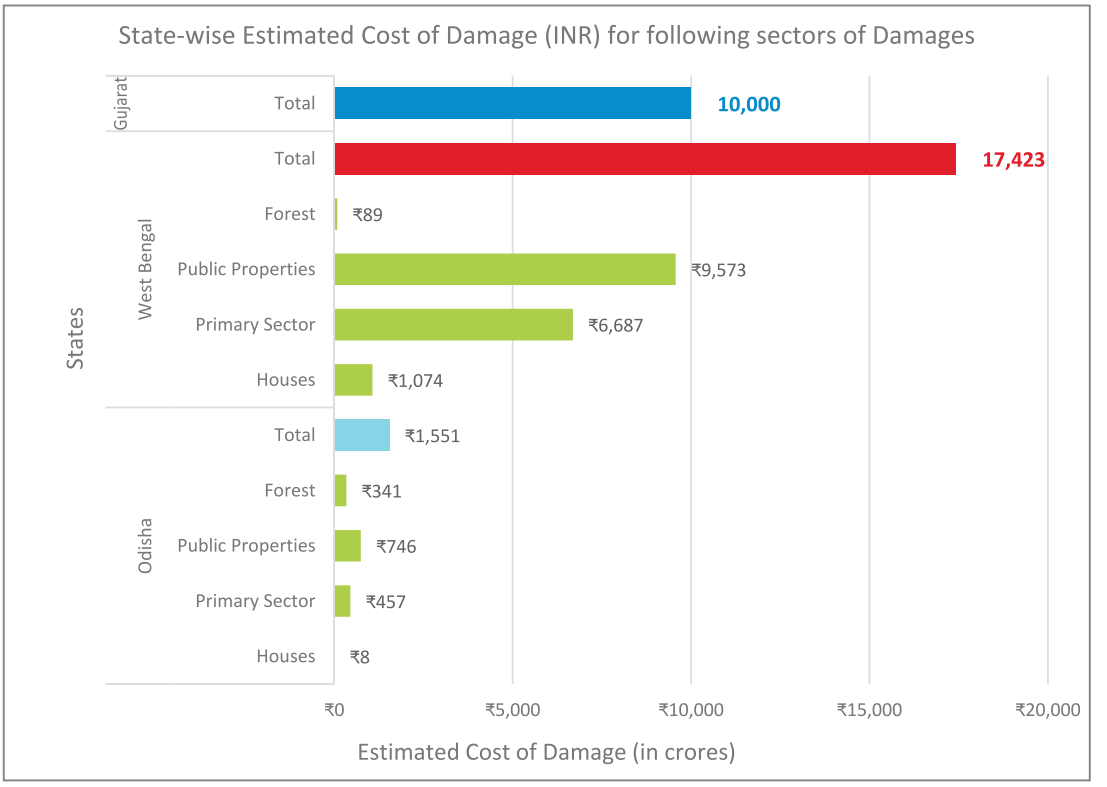


Figure 167: State-wise Estimated Cost of Damage (INR) for following sectors of Damages
Source: Times of India, 2021; India TV, 2021; Govt. of W. Bengal, 2021;
Revenue and Disaster Management Department, 2021

As per The Times of India article dated 27th May, 2021 (Times of India, 2021), the total estimated damage in Gujarat due to cyclone Tauktae is Rs. 10,000 crores. Based on the memorandum prepared by states (Govt. of W. Bengal, 2021; Revenue and Disaster Management Department, 2021)of West Bengal and Odisha, the total estimated damages due to cyclone Yaas in each state is Rs.17,423 crores and Rs.1,551 crores respectively. As per an India TV report (India TV, 2021), the total housing damage in Maharashtra is estimated as Rs.1.27 crore and the total damage to crops/cattle sheds is computed around Rs.65 lakhs.

The monetary valuation of damages clearly indicates the devastating impacts of cyclone Tauktae highest on Gujarat state followed by Maharashtra and other states (which have not been included in the study scope). Similarly, West Bengal faced a severe economic damage amounting to highest amongst the states on eastern coastline affected due to cyclone Yaas.

6.1.2 Assessing the Housing Damage across States

Sample survey on households reveal that out of the 4 states, West Bengal accounted for the maximum percentage of fully damaged houses followed by Odisha and then Gujarat, Gujarat suffers the maximum housing damage (54% approx.) in terms of fully and severely damaged houses, followed by West Bengal (with 50% approx. housing damage) in fully and severely damaged category.

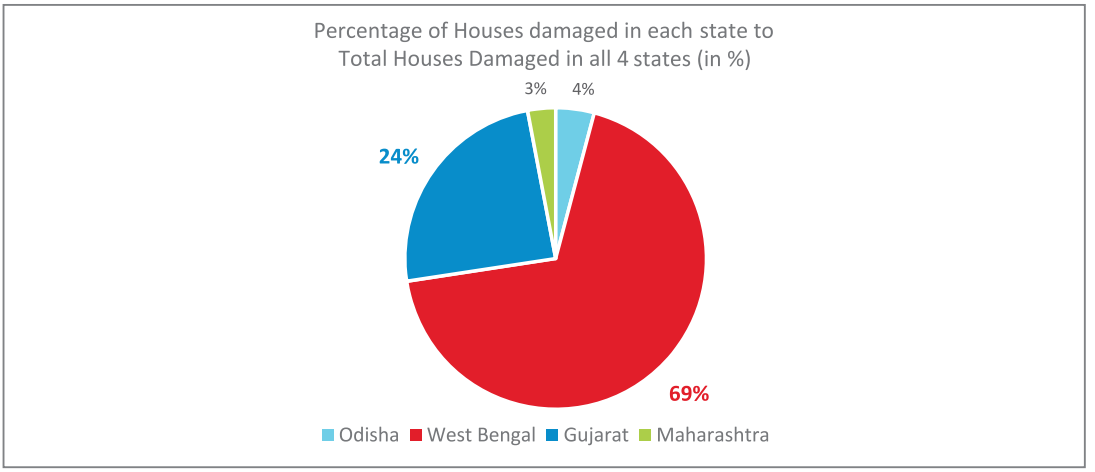


Figure 168: Percentage of Houses damaged in each state to Total Houses Damaged in all 4 states (in%)

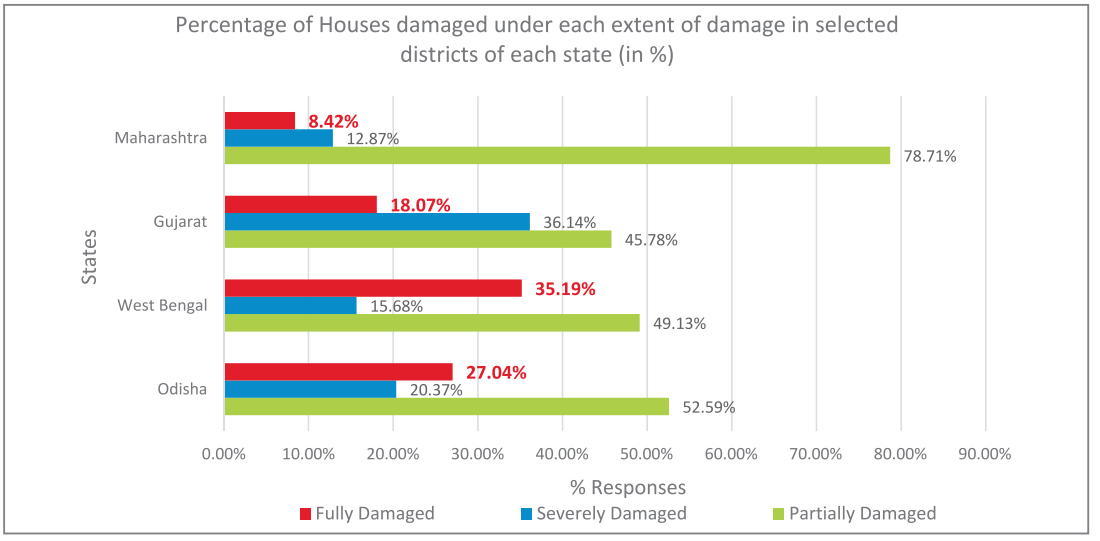


Figure 169: Percentage of Houses damaged under each extent of damage in selected districts of each state (in %)

6.1.3 Assessing Impact of Damages on economically marginalised families across States and Domains of Damages

When analysing the impacts of damages due to cyclonic events on economically marginalised families, the sample household survey results indicate the variations in the most affected income class when compared across states. For instance, in West Bengal and Gujarat the families with average HH income below 10k were the most impacted due to damage/disruption to lives, livelihood, housing, physical and social infrastructure and environment.

However, in Odisha it was the families with average income range between 10k to 25k who were most affected due to cyclone Yaas due to damage to various identified domains.

It is important to note that these trends are specific to the criteria of district selection (2 most and 1 moderate) and criteria of HH selection. It appropriately highlights the vulnerability levels of varying economic classes across 4 states due to impacts of cyclone on human lives, livelihoods of people, housing structures, environmental components, physical and social infrastructure.

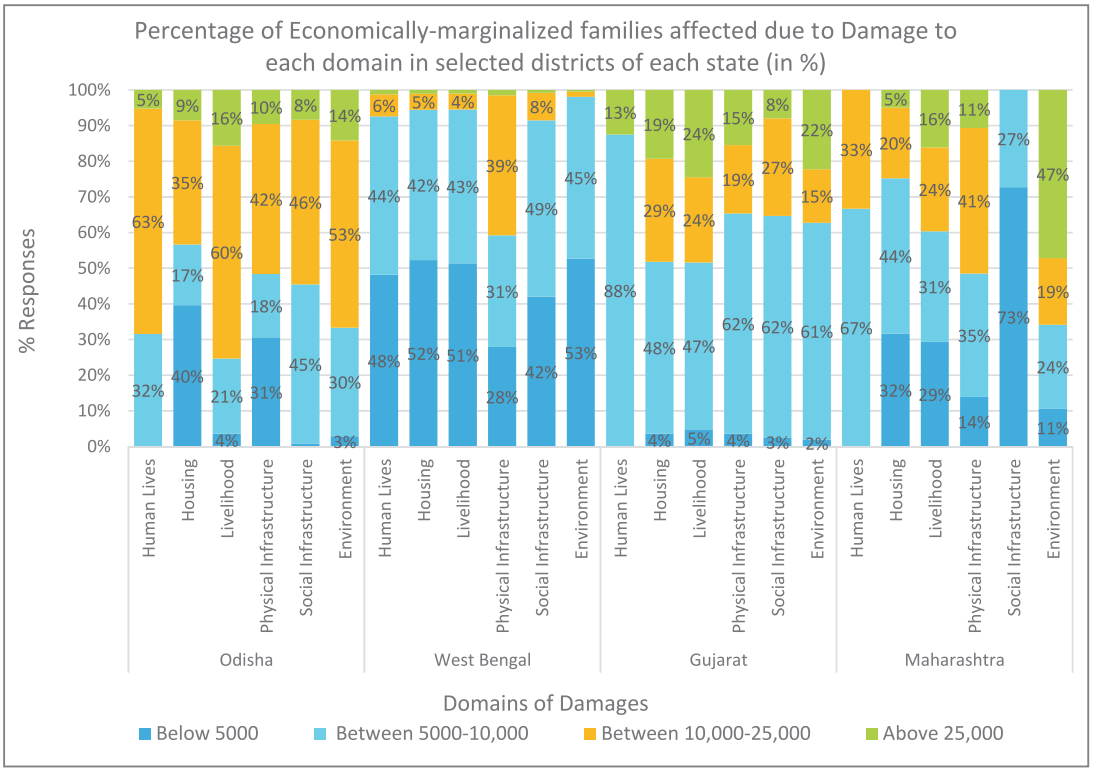


Figure 170: Percentage of Economically-marginalized families affected due to Damage to each domain in selected districts of each state (in %)

6.1.4 Assessing Livelihood Damages in intra-state (district-wise) and inter-states

Sample survey results show that the affected families in the states of West Bengal and Gujarat have suffered highest financial loss due to the cyclonic events during the peak days of impact. On the

other hand, the affected families in the state of Odisha have suffered lowest financial loss due to the cyclonic events compared to the remaining 3 states.

In West 65k approx.Bengal, the affected families in 24 Pargans South districts were hit financially the most (INR 65 k approx..), higher than the state average (INR 23k approx.). In Gujarat, the affected families in Amreli district were hit financially the most (INR 43k approx..), higher than the state average (INR 18.5k approx.)

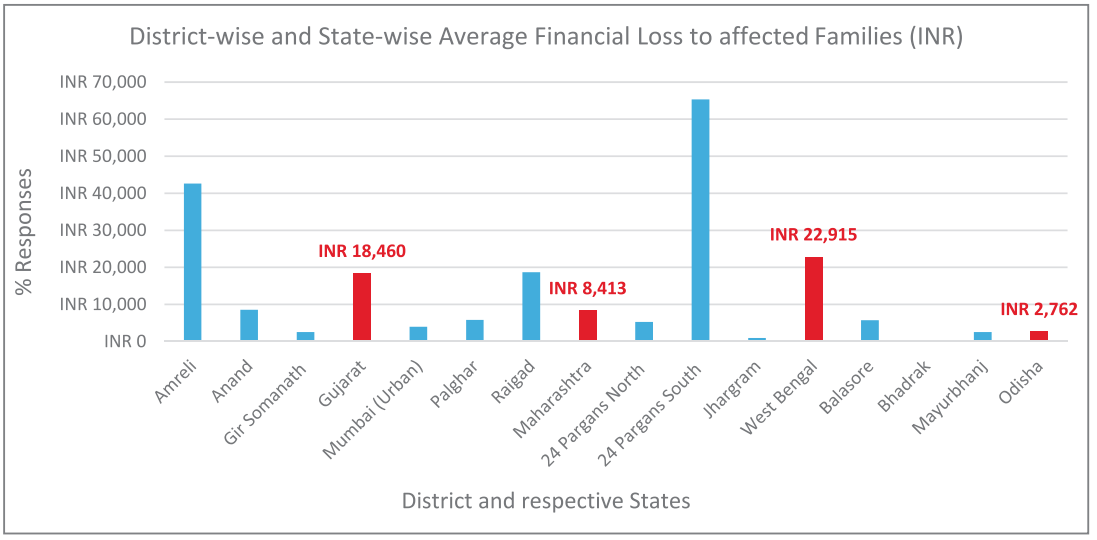


Figure 171:District-wise and State-wise Average Financial Loss to affected Families (INR)

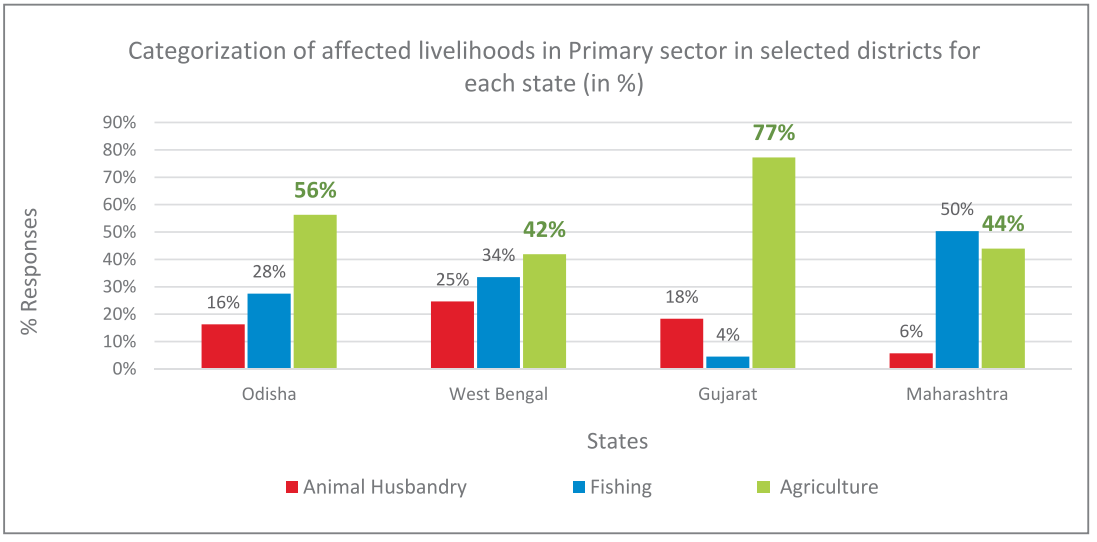


Figure 172: Categorization of affected livelihoods in Primary sector in selected districts for each state (in %)

Within the Primary sector, the sample survey results reveal that agriculture is the livelihood predominantly affected across all 4 states due to several reasons like damage to crops, damage to cropland, damage to storage sheds and stored grains, etc. Particularly in Gujarat, 77% of the affected livelihoods in primary sector were from agricultural type. In Maharashtra, 50% of the livelihoods affected in primary sector belonged to fishing.

6.2 Geographical and Sectoral Variations – CAUSES

6.2.1 Identifying the potential Exposure to Hazard-related Causes of Damages across States

Based on the secondary sources, it is observed that the intensity (highest wind speed) of the cyclonic events considered for this study was highest in Gujarat followed by West Bengal, Odisha and then Maharashtra. Increase in the exposure of regions to cyclonic impacts attributed as a causative factor of damages observed in all domains. The previous section 6.1, evidently supports the statement. It clearly highlights that Gujarat and Maharashtra experienced highest extent of damages considering monetary loss at state level, housing damages, livelihood damages, financial loss at family level, etc.

Table 20- Cyclone Intensity comparison across states

S.No.	State	Maximum Wind Speed (kmph)	Ranking
1	Gujarat	185 160-170 kmph gusting to 185 kmph	Highest (1st)
2	West Bengal	130 155-165 kmph gusting to 185 kmph	Second Highest (2nd)
3	Odisha	155 130 -140 kmph gusting to 155 Kmph	Moderately Highest (3rd)
4	Maharashtra	114 kmph	Lowest (4th)

Source: Govt. of W. Bengal, 2021; Revenue and Disaster Management Department, 2021; Indian Express,

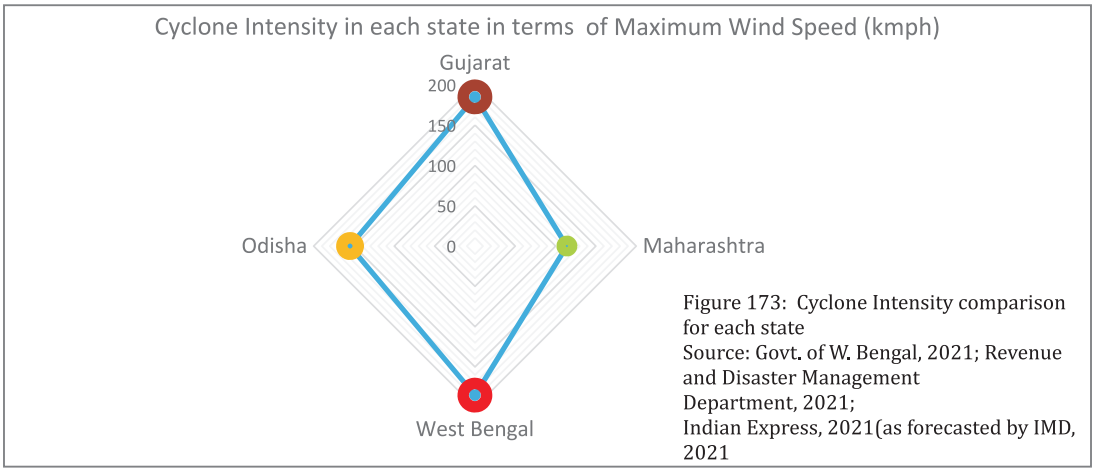


Figure 173: Cyclone Intensity comparison for each state
Source: Govt. of W. Bengal, 2021; Revenue and Disaster Management Department, 2021;
Indian Express, 2021(as forecasted by IMD, 2021

6.2.2 Identifying the potential Development-related Causes of Damages to Housing Structures, Physical and Social Infrastructures across States

Gujarat –

The state of Gujarat suffered severe damage to housing structures with around 86,455 Kutcha houses damaged and 20,562 Pucca houses damaged due to cyclone Tauktae(MHA Situation Reports, 2021). Based on the mapping of DRR relevant developmental policies, guidelines, regulations, codes, etc. from secondary sources, the following have been identified as the key pointers for causing destruction to housing structures, social and physical infrastructure to the extent seen in Gujarat.

1. Comprehensive DCR by State Government does not consider DRR component in any form while preparing codes and regulations governing building structures and their planning.
2. Absence of dedicated codes and guidelines for developing physical infrastructure resilient to cyclonic events in coastal regions.
3. Strict Enforcement of policies and norms considering multi-hazard DRR approach in land-use planning and framing DCR is absent.
4. 100% enforcement and implementation of the above-mentioned DRR provisions in SDMP is challenging as the pointers in SDMP appears general and lacks application-level policies/regulations w.r.t cyclones.
5. Guidelines for Cyclone-resilient building structures by GSDMA do not hold any regulatory base for mandatory implementation in coastal districts of Gujarat.

Maharashtra –

The state of Maharashtra experienced a total of 13,102 housing damages with 81 houses fully damaged and 13,021 partially damaged (MHA Situation Reports, 2021). Based on the mapping of DRR relevant developmental policies, guidelines, regulations, codes, etc. from secondary sources, the following have been identified as the key pointers for causing destruction to housing structures, social and physical infrastructure to the extent seen in Maharashtra.

1. Development Control and Promotion Regulations by Urban Development Department does not consider DRR component in any form while preparing codes and regulations governing building structures and their planning.
2. Absence of dedicated codes and guidelines for developing physical infrastructure resilient to cyclonic events in coastal regions.
3. Strict Enforcement of policies and norms considering multi-hazard DRR approach in land-use planning and framing DCR is absent.
4. 100% enforcement and implementation of the above-mentioned DRR provisions in SDMP is challenging as the pointers in SDMP appears general and lacks application-level policies/regulations w.r.t cyclones

West Bengal –

Approximately, 3 Lakh houses have been damaged in West Bengal due to cyclone Yaas(MHA Situation Reports, 2021). Based on the mapping of DRR relevant developmental policies,

guidelines, regulations, codes, etc. from secondary sources, the following have been identified as the key pointers for causing destruction to housing structures, social and physical infrastructure to the extent seen in West Bengal.

1. Building Regulations for Industrial Growth Centres & Parks of WBIIDC in West Bengal does not consider DRR component in any form while preparing codes and regulations governing building structures and their planning.
2. Absence of dedicated codes and guidelines for developing physical infrastructure resilient to cyclonic events in coastal regions.
3. Strict Enforcement of policies and norms considering multi-hazard DRR approach in land-use planning and framing DCR is absent.
4. 100% enforcement and implementation of the above-mentioned DRR provisions in SDMP is challenging as the pointers in SDMP appears general and lacks application-level policies/regulations w.r.t cyclones.

Odisha –

Odisha experienced a damage to 18,094 housing structures in total due to cyclone Yaas (MHA Situation Reports, 2021). Based on the mapping of DRR relevant developmental policies, guidelines, regulations, codes, etc. from secondary sources, the following have been identified as the key pointers for causing destruction to housing structures, social and physical infrastructure to the extent seen in Odisha.

1. Planning and Building Standard Rules by Housing & Urban Development Department, Govt. of Odisha does not consider DRR component in any form while preparing codes and regulations governing building structures and their planning.
2. Absence of dedicated codes and guidelines for developing physical infrastructure resilient to cyclonic events in coastal regions.
3. 100% enforcement and implementation of Odisha state Land Use policy in demarcated coastal districts is still a distant objective yet to be achieved.
4. Odisha state Land Use policy does not describe the detailed DCR relevant to achieving DRR in identified vulnerable coastal districts.
5. 100% enforcement and implementation of the above-mentioned DRR and CCA provisions in SDMP is challenging as the pointers in SDMP appears general and lacks application-level policies/regulations w.r.t cyclones.

Further, the potential causes of damage to housing structures, social and physical infrastructure are also attempted to be identified from primary sources, mainly Key Informant Surveys. Following graphs shows the derived results and trends of probable causes of physical damage across all 4 states. It is important to note that the Key Informant Interviews include responses from concerned personnel at all levels of administration (district, block and village/ward).

Also, the questions asked from KII to identify the potential causes of damages concerning DRR-relevant developmental mechanisms include following key aspects –

1. Hazard-prone areas refer to the coastal regions vulnerable to cyclonic events and sub-

divided based on the extent of vulnerability which is identified by the Disaster Management Authorities and technical institutions.

2. Semi-engineered buildings refer to buildings made from intuitively structural materials like burnt bricks, laid in cement or lime mortar with RC slab/roofs without proper design or supervision and offer some resistance to cyclonic damage.

Non-Engineered buildings are constructed using non-standard materials like Agri-waste and local construction practices and are highly unsafe and vulnerable to cyclonic damage.

3. DRR-oriented Planning and Land Use Restrictions refer to Zoning and Development Control Regulations (DCR) which specifically cater to the vulnerability of the area to disasters (cyclone here) and offer resilience and adaptative mechanisms.

4. Municipal Bye-laws/Buildings Codes and Guidelines refer to structural standards laid out for buildings to foster cyclone-resilient construction.

5. Vulnerability Assessment refer to identifying and quantifying vulnerabilities of buildings and other structures specific to type and intensity of vulnerability to hazards (cyclone).

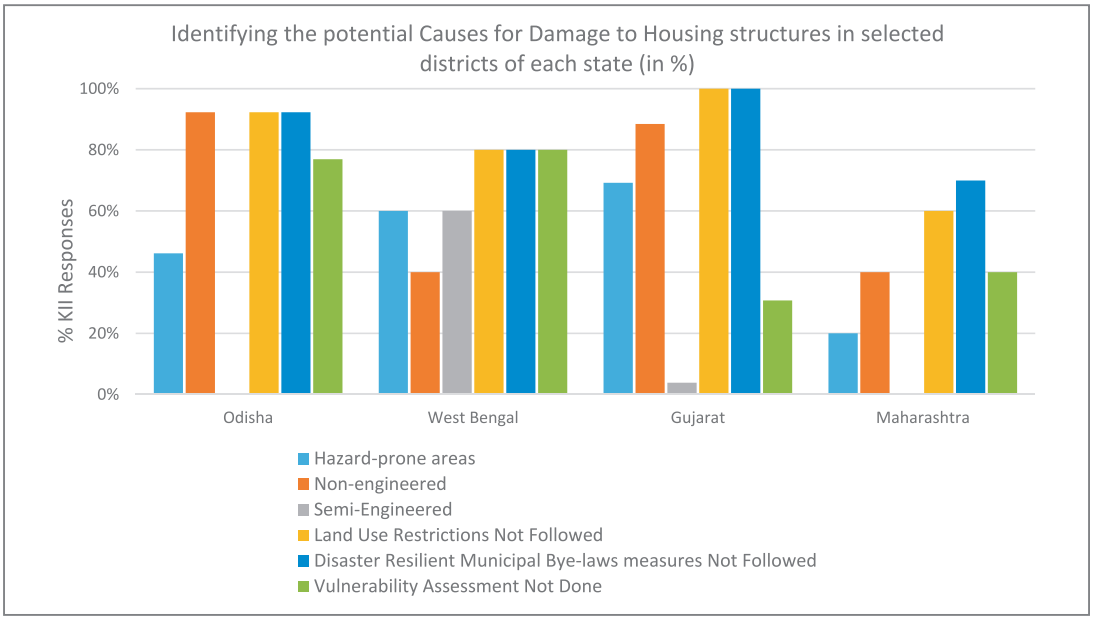


Figure 174: Identifying the potential Causes for Damage to Housing structures in selected districts of each state (in %)

Housing Structures - The responses collected from Key Informant Interviews clearly highlights the absence of disaster risk reduction and disaster resilient measures in structural and planning mechanism of each state. All the states showcase similar kind of results indicating critical lack of engineered housing structures, adherence to land use and zoning regulations, adherence to buildings bye-laws and periodic assessments of vulnerability of housing structures specific to regions.

Around 90% responses say that the houses damaged in Odisha and Gujarat were non-engineeredwhile 80% in West Bengal indicates non-adherence to Land Use development & control regulations and Building bye-laws & codes.

Physical Infrastructure- The responses collected from Key Informant Interviews clearly highlights the absence of disaster risk reduction and disaster resilient measures in structural and planning mechanism of each state. All the states showcase similar kind of results indicating critical lack of engineered physical infrastructures, adherence to land use and zoning regulations, adherence to standard codes & hazard resistance guidelines and periodic maintenance & assessments of vulnerability of infrastructures specific to regions.

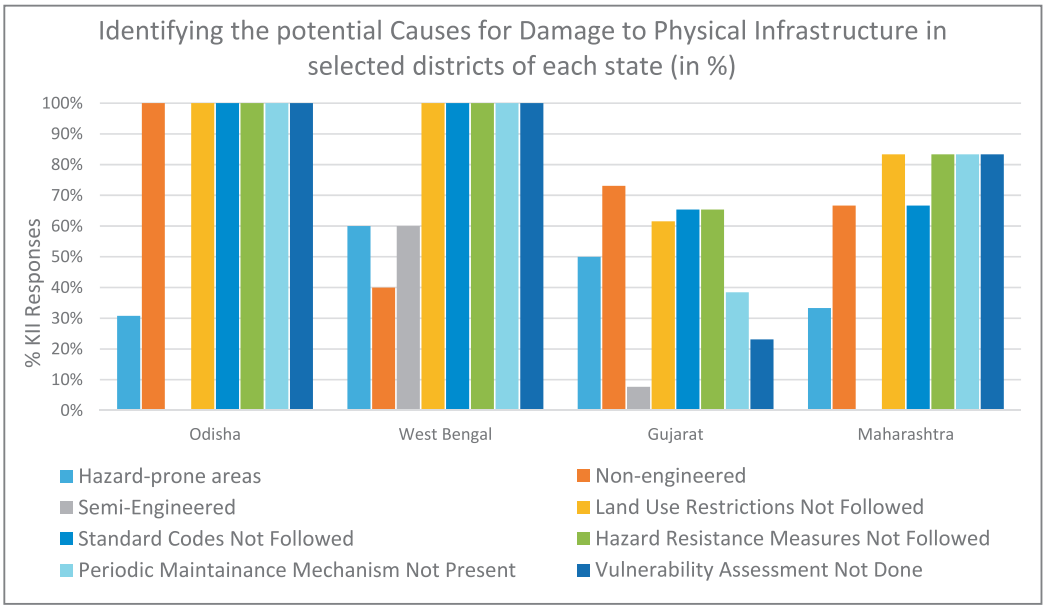


Figure 175: Identifying the potential Causes for Damage to Physical Infrastructure in selected districts of each state (in %)

100% of KII responses in Odisha and West Bengal while around 80% in Maharashtra and 60% in Gujarat say that the state, especially the affected districts do not have engineered physical infrastructure, construction and development do not follow land use regulations, standard codes and hazard resistance measures& there is absence of periodic maintenance and vulnerability assessments of physical infrastructure.

Social Infrastructure - The responses collected from Key Informant Interviews clearly highlights the absence of disaster risk reduction and disaster resilient measures in structural and planning mechanism of each state. All the states showcase similar kind of results indicating critical lack of engineered social infrastructures, adherence to land use and zoning regulations, adherence to standard codes & hazard resistance guidelines and assessments of vulnerability of infrastructures specific to regions.

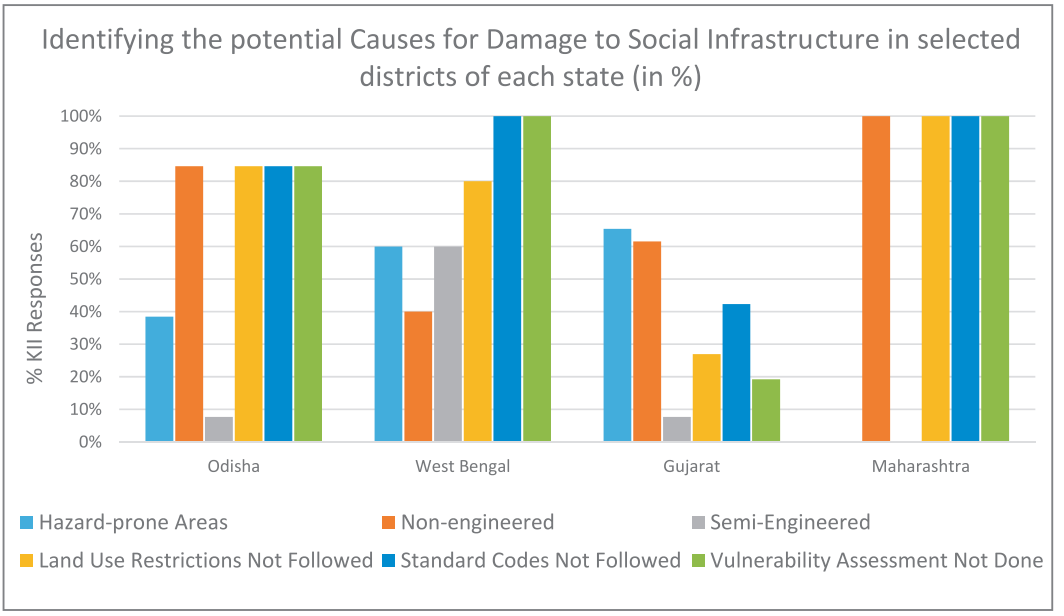


Figure 176: Identifying the potential Causes for Damage to Social Infrastructure in selected districts of each state (in %)

100% of KII responses in Maharashtra while more than 60% in West Bengal and Odisha say that the state, especially the affected districts do not have engineered social infrastructure, construction & development do not follow land use regulations & standard codes and there is absence of periodic vulnerability assessments of social infrastructure.

6.2.3 Identifying the potential Disaster Management-related Causes of Damages across States

Gujarat –

Based on the qualitative primary data collected from the Key Informant Interviews of concerned disaster management professionals in each state, the following points have been identified as the key causes of damages experienced in Gujarat –

1. Lack of existing mechanisms in place for periodic mapping, vulnerability and risk assessment of cyclone-prone areas.
2. Low Literacy and Digital divide scenario are not effectively considered in early warning dissemination systems, thus increasing the vulnerability of illiterate and digitally unequipped people in remote locations.
3. At grassroot level, there are no area-specific, geography-specific or social diversity-specific evacuation plans.
4. Inefficient and delayed response measures like assessments, immediate relief, governmental support, etc.
5. Mechanisms in place tending to inclusivity of specially-abled, aged, women/children,

marginalized communities, etc. during the planning and operation of the entire system of disaster management is crucially missing.

6. Lack of community-based preparedness and response approaches, community training, knowledge building, etc.
7. Adequate funding and financial arrangements are unavailable.

West Bengal –

Based on the qualitative primary data collected from the Key Informant Interviews of concerned disaster management professionals in each state, the following points have been identified as the key causes of damages experienced in West Bengal –

1. Local organizations have Village Disaster Management Committee (VDMC) and Task Force to conduct periodic mapping of risk and capacity in vulnerable areas of Sundarbans. However, at state level, there is a lack of existing mechanisms in place for periodic mapping, vulnerability and risk assessment of cyclone-prone areas.
2. Low Literacy and Digital divide scenario are not effectively considered in early warning dissemination systems, thus increasing the vulnerability of illiterate and digitally unequipped people in remote locations.
3. Village Disaster Management Plan are developed along with evacuation map with defined roles and responsibilities for the camp management. However, effective implementation of the plan is a constant issue.
4. Il-maintained response measures like services to evacuated people, shelter maintenance and ignorance of problems faced by women, children and aged people along with no arrangement for treatment & fodder for cow, goat and others livestock.
5. Mechanisms in place tending to inclusivity of specially-abled, aged, women/children, marginalized communities, etc. during the planning and operation of the entire system of disaster management is crucially missing.
6. Lack of community-based preparedness and response approaches, community training, knowledge building, etc.
7. No realistic preparedness plan contextual to local self-governments and blocks as plans are prepared only district or higher level, creating havoc during implementation.
8. Lack of convergence among all the departments as well as between government and CSOs.
9. Adequate funding and financial arrangements are unavailable.

Odisha –

Based on the qualitative primary data collected from the Key Informant Interviews of concerned disaster management professionals in each state, the following points have been identified as the key causes of damages experienced in Odisha –

1. Lack of existing mechanisms in place for periodic mapping, vulnerability and risk assessment of cyclone-prone areas.
2. Low Literacy and Digital divide scenario are not effectively considered in early warning

dissemination systems, thus increasing the vulnerability of illiterate and digitally unequipped people in remote locations.

3. Mechanisms in place tending to inclusivity of specially-abled, aged, women/children, marginalized communities, etc. during the planning and operation of the entire system of disaster management is crucially missing.
4. Lack of community-based preparedness and response approaches, community training, knowledge building, etc.
5. Adequate funding and financial arrangements are unavailable.

Further, the potential causes of damage due to inefficient and insufficient disaster management measures are also attempted to be identified from primary sources, mainly household surveys. Following graph shows the derived results and trends of probable causes of impact on human lives across all 4 states.

From the results of sample survey of households in selected districts, it is observed that the mechanism for Early Warning were well in place with timely dissemination and relocation of families in the states of West Bengal and Gujarat. However, in Maharashtra less than 10% of households received Early Warnings and relocated to safer location.

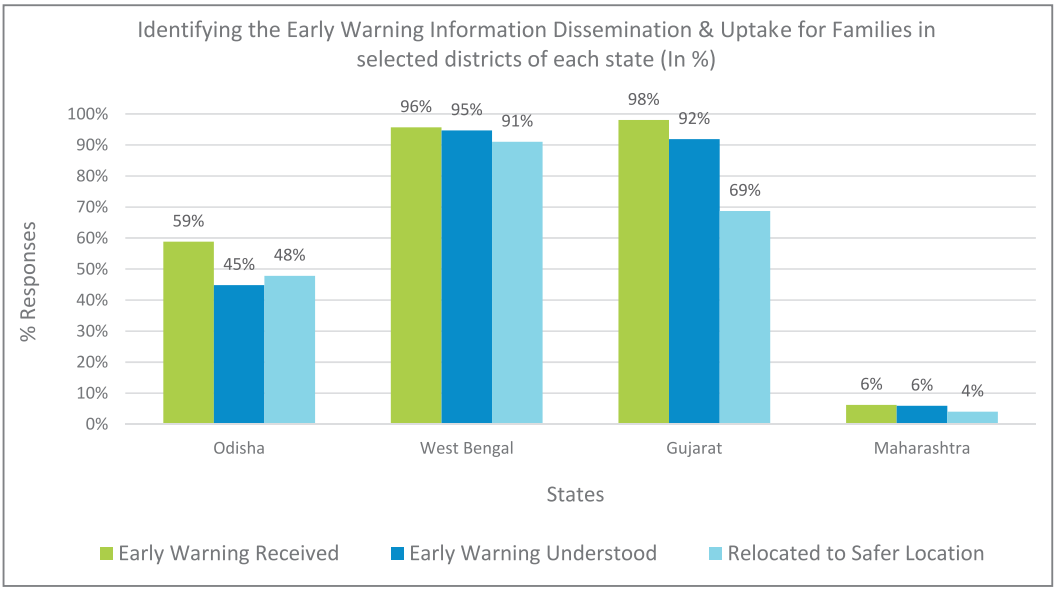


Figure 177: Identifying the Early Warning Information Dissemination & Uptake for Families in selected districts of each state (In %)



Recommendations and Strategies

Recommendations and Strategies

7

It is evident from the results of state-level analysis that there are multiple and diverse factors contributing to damages and causes of those damages in the selected states (Gujarat, Maharashtra, West Bengal and Odisha) due to cyclonic events Tauktae and Yaas. The extent of damages is mainly defined by two possible causes i.e., exposure to hazards and level of risk/vulnerability. Further, the comparative study of variations in damages and causes amongst all 4 states is conducted as a part of Chapter 6.

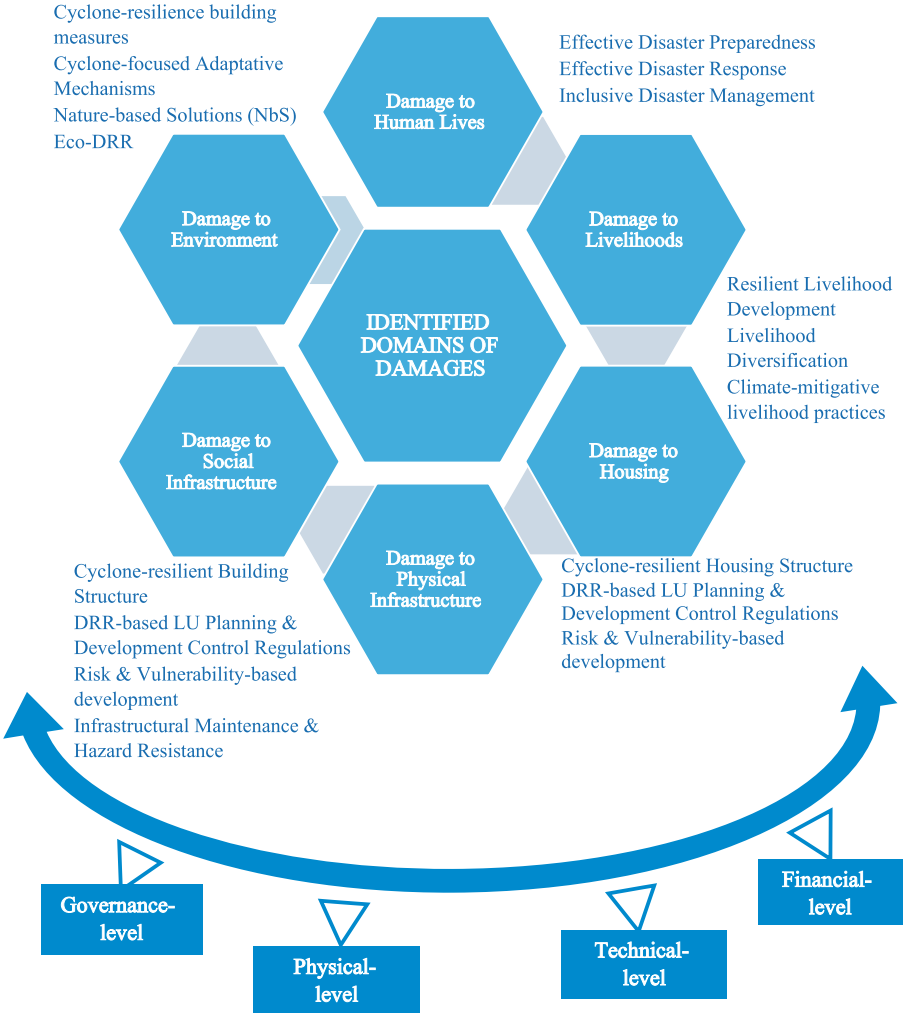


Figure 178: Concept Evolution for formulating proposals
Source: Generated by Author, 2021

Through this chapter, the aim is to draw specific and contextual recommendations and strategies for all the identified causes and challenges during cyclones in the selected states for the study. Before starting, it is beneficial to understand the four major levels of recommendations and strategies to achieve efficient DRR and DM in the state. The four levels of interventions include –

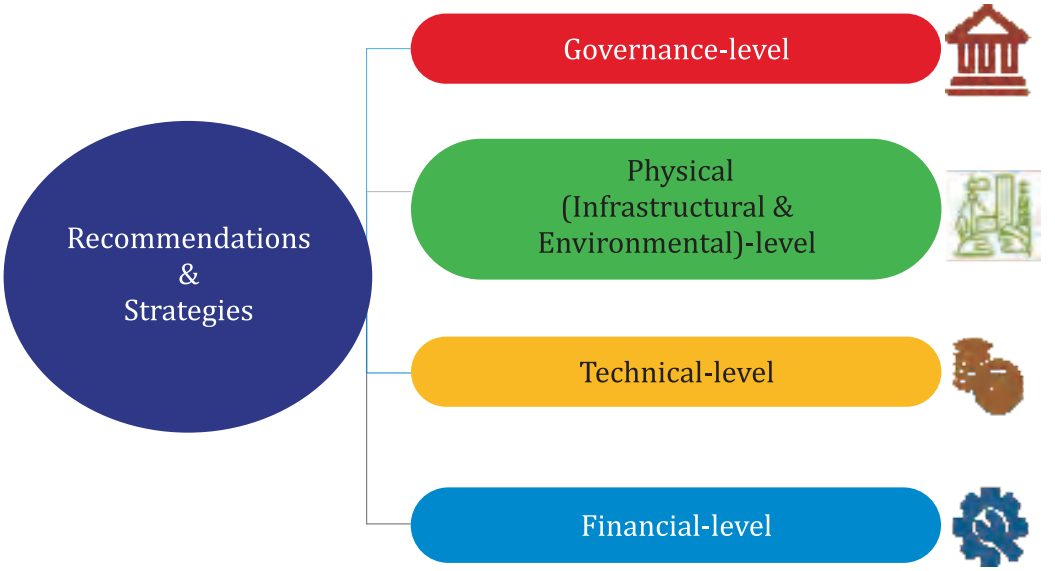


Figure 179: Various levels of Recommendations and Strategies
Source: Generated by Author, 2021

1. **Governance-level -** Strengthening institutional framework, organizational structure, policy-making form the major components of effective governance and is the most crucial of all. Various institutions, governmental or non-governmental act as the empowering, decision-making body transferring technical know-how to the communities.
2. **Technical-level-** Technology-based approaches and technical equipment help institutions and communities in multiple stages of DRR and disaster management.
3. **Financial-level -** Funding and finance mechanisms play a vital role in the implementation and monitoring of all the other domains of interventions. Mobilization of resources is a crucial aspect in systems strengthening for disaster management.
4. **Physical/Infrastructural and Environmental-level-** Disaster Risk Reduction and Resilience to Disaster can be achieved through mitigation and adaptation techniques when incorporated in physical and environmental planning.

All the recommendations and strategies made under the scope of this study identify themselves with either of these levels. It is important to mention that the approach to define and propose recommendations is objective i.e., the interventions are grouped under the varying phases of disaster i.e., pre-disaster, during disaster and post-disaster. Following are the proposed interventions as recommendations and strategies specified under different (but connected) phases of disaster and levels of interventions.

Consolidation of Proposed Recommendations and Strategies under defined levels and phases:

Table 21: Consolidation of Proposed Recommendations and Strategies under defined levels and phases

S.No.	Proposed Recommendations and Strategies	Pre-Disaster	During Disaster	Post-Disaster
Governance-level				
1	Fostering Grassroots level Governance	✓	✓	✓
2	Periodic strengthening of Institutional Capacities and Technical Expertise	✓	✓	✓
3	Composition and Accountability to Approval/ Clearance, Regulatory and Monitoring Team	✓		✓
4	Strategically decentralized Early Warning Systems	✓		
5	Community- level Preparedness	✓	✓	
6	Ethical enforcement of Risk and Vulnerability Assessment tools	✓		✓
7	Consideration of "Inclusivity" in all stages of Disaster Management	✓	✓	✓
Physical (Infrastructural & Environmental)-level				
8	Formulation & Strict Enforcement of Codes and Guidelines to make infrastructural system cyclone-resilient	✓		
9	Periodic Maintenance of the essential infrastructural systems	✓		
10	Development and Strict Enforcement of cyclone-resilient building construction practices in building Bye-Laws, Codes and Development Control Regulations (DCR)	✓		
11	Retrofitting of Existing Building Structures	✓		✓
12	Vulnerability Assessment of Buildings and Structures	✓		✓
13	Mandatory Enforcement of Land Use (Coastal) Zoning Regulationsand Restrictions	✓		
14	Resilient Livelihood Development	✓		
15	Policymaking for effective implementation and periodic tracking of Nature-based Solutions (NbS)	✓		
16	Logical demarcation and enforcement of eco-sensitive zones	✓		
17	Innovative Mechanisms to protect Eco-sensitive zones	✓		

S.No.	Proposed Recommendations and Strategies	Pre-Disaster	During Disaster	Post-Disaster
Technical-level				
18	Leveraging "Technology" in Disaster Management	✓	✓	✓
19	Introducing Digital Governance	✓	✓	✓
Financial-level				
20	Business-oriented Financing Mechanism	✓		
21	Resilient Community-level Business Models	✓		
22	Increase in budgetary allocation for Disaster Preparedness	✓		
23	Financing for Research and Development	✓		

Source: Generated by Author, 2021

1. Governance-level Recommendations & Strategies:

a. Fostering Grassroots level Governance:

The local government is always at the frontline and considered to be the direct respondent when any disaster strikes. A local government level statutory authority dedicated to disaster risk reduction and management extends autonomy and decision-making powers at the local level. To be implemented, provision of this should be mandated under a policy or an act. This local-level authority must compulsorily have members from local communities who are completely aware of the localized disaster paradigm.

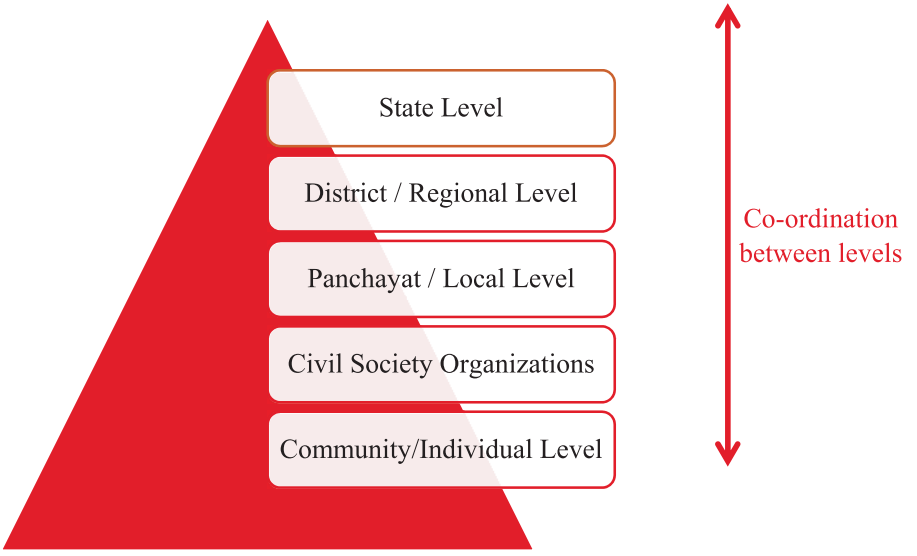


Figure 180: Coordination Between Levels
Source: Generated by Author, 2021

Not only at the governmental level but at the local organizations and community level also, disaster-related governance must be extended. Civil Society Organizations play an important role in advocating for people and the environment. For instance, CSOs can advocate lessons learnt from past tragedies to attain people-centric development agenda. Such organizations can advocate for issues like green, sustainable and inclusive developmental approaches, restoring ownership & control of natural resources to local communities, delineation of eco-sensitive areas & strict regulations, development of funds for the ecological services and channelization of the fund to the communities who forego their resources, etc. They need to be identified as active partners in DRR and disaster management. Again, to be implemented, provision of this should be mandated under a policy or an act.

Community-level adaptation and community-level preparedness are the most crucial aspect of empowering local people and promoting a bottoms-up approach (discussed in other sections).

b. Periodic strengthening of Institutional Capacities and Technical Expertise:

The government authorities at all levels must undergo rigorous training and capacity building to facilitate DRR and DM. Strengthening and empowering the institutional mechanism at the state level (SDMA, SDRF, SEC, others), district level (DDMA, DDRF, others) and local level with domain experts as members is highly recommended. The respective members must be sufficiently equipped with the requisite knowledge and experience to discharge the assigned roles and responsibilities. Doing this will ensure strong implementation of DRR and DM policies, plans and mechanisms. It will lead to informed and accurate decision making based on the correct understanding of risk and vulnerability assessments.

At the local level, capacity building, skill development and technical knowledge sharing should not be limited to local government, but to the local organizations, volunteers and local communities too.

All levels of institutions should be technically oriented to the new practices and equipment which can be used in multiple stages of disaster management. To avoid ignorance and relaxations, periodic capacity assessment and capacity building practices with updated and latest mechanisms must exist.

c. Composition and Accountability to Approval/Clearance, Regulatory and Monitoring Team:

The approval/clearance, regulatory and monitoring committees for the developing cyclone-resilient infrastructural projects and building structures should be mandated under a policy/act to be comprised of technical experts and institutions, organizations, community representatives, local government authority along with regional/state-level government authority. This minimizes the illegal autonomy and profit-seeking approaches thus reducing the level of ignorance. The team composed must be accountable at all levels for each project and sanctioning.

d. Strategically decentralised Early Warning Systems:

Early Warning Systems must be strategically located based on the detailed vulnerability assessments conductedincyclone prone areas. Mandatory installation of automatic weather stations and real-time forecasting systems at all levels of spatial units is the prior step in strengthening the state's early warning capacities.

e. Community-level Preparedness:

As a disaster preparedness measure, localized warning systems distributed with communities play an important management role. Leveraging technology for mobilizing an early warning system developed, managed and maintained by the community itself to reduce the possibility of personal injury, loss of life, damage to property, environment and loss of livelihood. This requires training of community by local organizations and volunteers to orient them about the disaster risk and early warning system to ensure warning mechanisms, resulting in desired action or response.

As a disaster response measure,ensuring community awareness on evacuation and mapping of areas, that are safe for evacuation and pre-positioning & identifying safe shelters in public buildings, on forecast and warnings, is imperative.

Because communities are at the frontline of disasters, their awareness, skill development and capacity building are the most important part in achieving an effective disaster management system with minimal losses. For instance, when all means of communication breakdown, a trained force of locals can save lives. Mainstreaming disaster management courses as a part of school-level education and provision of sufficient training to students is an effective to train common people from the young age itself.

f. Ethical enforcement of Risk and Vulnerability Assessment tools:

Although risk and vulnerability assessment due to cyclonic events in coastal regions is a well-established mechanism, its effective conduction and utilization is hardly concrete and ethical. The inclusion of multi-hazard vulnerability, social vulnerability and climate change, impact assessment should be given most importance in all disaster management and development-related practices.

g. Consideration of "Inclusivity" in all stages of Disaster Management:

All the stages of Disaster Management from Prevention/Mitigation, Preparedness, Response, Relief, Recovery and Reconstruction must mandatorily include inclusive mechanism catering to gender-specific, age-specific, disability-specific, etc. vulnerabilities. The enforcement through the way of policies and standards must be institutionalized across all states and across all administrative levels.

CASE STUDY on Disaster Management in Odisha: Success Story

In the last 3 years, Odisha has faced as many as six cyclones but the death toll has never exceeded a single digit. Over the years, the OSDMA has gone from strength to strength and in the process,

Odisha has carved out a standalone identity as the best-equipped state to manage disasters. It's considered as a role model, in India and internationally as well, for efficient preparedness and swift response to disasters.

Cyclone Yaas made landfall in Odisha on May 26 between the north of Dhamra coast in Bhadrak district and Bahanga coast in Balasore district. Two of the major USPs of Odisha's way of fighting natural disasters are massive evacuations, both targeted and blanket, and inter-department coordination.

Preparedness: As soon as weather experts predicted the approaching of Cyclone Yaas, the state disaster management department was activated immediately and undertook all precautionary measures, including evacuation of people to meet the zero-causality target set by Chief Minister Naveen Patnaik. Odisha government managed to evacuate at least 710,000 people so far from the low-lying and seaside areas with the help of response forces on the ground.

Besides the disaster response team, the state has also deployed several teams for the redevelopment of cyclone-affected areas. At least 10,000 members from the energy department were pre-deployed in strategic locations such as hospitals and other important places to help the administration in faster restoration.

Evacuation: Evacuating people from the probable cyclone-affected areas was a challenging task due to the Covid-19 pandemic. In the first phase, the administration opted for targeted evacuation by moving people from kutcha houses and low-lying areas to a safe place. In the second phase, the administration routed for blanket evacuation of villages falling on 4 meters line and as a result, not a single injury or death happened in over 150 villages where heavy waterlogging was reported.

Covid management during cyclone: Facing a dual challenge due to the cyclone and Covid-19 pandemic, the restoration teams fortified doors and windows of Covid designated hospitals; adequate drugs, injections, consumables were stocked in hospitals. Adequate oxygen cylinders and buffer stock were maintained. Food was arranged for patients, doctors and paramedics inside the hospital. As a result, none of the Covid hospitals in the cyclone-affected districts reported any untoward incidents.

Odisha facilitated unhindered transportation of medical oxygen to the Covid-affected states. Besides coordinating the interstate movement of oxygen tankers, the state police also ensured the oxygen supply reached the local hospitals.

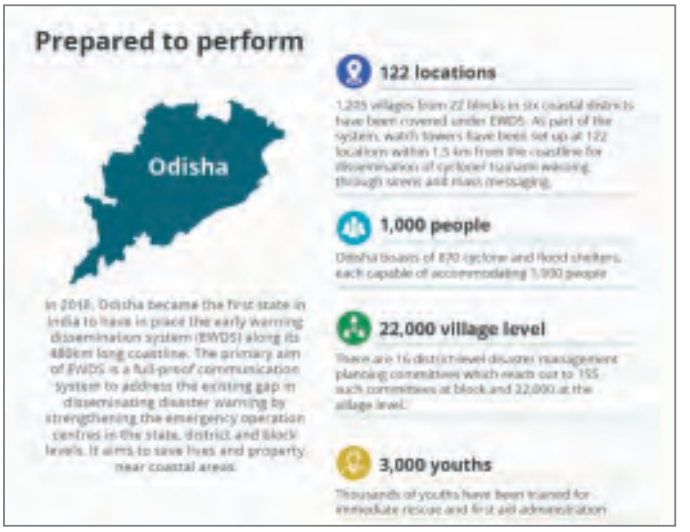


Figure 181: Odisha- Prepared to perform
Source- The Federal

2. **Physical (Infrastructural and Environmental)-level Recommendations & Strategies:**

a. **Formulation & Strict Enforcement of Codes and Guidelines to make infrastructural system cyclone-resilient:**

The essential services like fire stations, hospitals, water supply systems, electric supplies, communication systems, etc. are the critical infrastructure requiring maximum contextual resilience to cyclones. The related buildings, structures and systems of these services must be designed and constructed according to hazard resistant principles and details. The constructed structures should have adequate hazard resistance complying to the Standard Codes and Guidelines.

b. **Periodic Maintenance of the essential infrastructural systems:**

Appropriate maintenance is necessary to keep the infrastructural system/service continuously safe at the time of unforeseen future events. Maintenance can be ensured through a system of check list and ensuring accountability by making specific personnel responsible for the same. It is vital to check the safety, verify the available resistance and improve resistance of the existing structures and systems to the level required.

c. **Development and Strict Enforcement of cyclone-resilient building construction practices in Building Bye-Laws, Codes and Development Control Regulations (DCR):**

Standards specific for cyclone safety of building structures (new and existing) in hazard prone areas with varying levels of exposure must be formulated for all building types.There is an urgent need to enact appropriate legislation for the bye-laws and DCRs for mandatory use of hazard (cyclone) resisting measures in the construction of all new buildings.

d. **Retrofitting of Existing Building Structures:**

Proactive measures to improve the cyclone resistance of existing deficient houses/buildings by carrying out suitable retrofitting measures is an important intervention. General retrofitting measures can be carried out in low or medium vulnerable areas to cyclones.

In case of highly vulnerable areas, a detailed survey to get the details of the building typology and the sizes of the structural members must be employed. Further, the collected data must be used to determine the deficiency in the various elements by carrying out structural safety analysis and the corresponding minimum required element sizes for safety can be ascertained. Deficient members in the buildings must be replaced with the ones of minimum sizes obtained from analysis.

It is also necessary either through law or by a mix of incentives and disincentives to implement strengthening of existing unsafe buildings and structures by retrofitting methodologies. Initially, it may be done selectively in most vulnerable areas considering cost-benefit point of view.

e. **Vulnerability Assessment of Buildings and Structures:**

The proper understanding of vulnerability of buildings and structures to various

intensities of hazards in a systematic way can prove to be a real mitigative strategy to reduce impacts of cyclones. A proper method is to develop representation of vulnerability versus hazard intensity showing vulnerability functions. Vulnerability Atlas of India has categorized the risk to the buildings under cyclonic events in a qualitative way (very high, high, etc.). Thus, it is an imperative need to conduct an intensive assessment in developing the vulnerability functions for various types of buildings, both existing and being constructed versus the probable cyclonic wind speeds.

f. Mandatory Enforcement of Land Use (Coastal) Zoning Regulations and Restrictions:

Disaster-resilient, especially cyclone-resilient (coastal areas) land use restrictions are either unavailable in many towns and country, planning laws and master plan regulations, or they aren't strict/punishable enough to be implemented and monitored, thus expanding development occupying hazard prone areas. Contextual and well-defined land use zoning regulations pertaining to risk and vulnerability of coastal areas to varying intensities of cyclonic events must be mandated at policy level and its fair incorporation should be monitored under formal governance framework.

g. Resilient Livelihood Development:

Resilient Livelihood Development is the most prominent recommendation and strategy to secure the economic base of local communities which is likely to be affected due to climate change impacts or climate change-induced disasters. E.g., for a local community in rural areas is dependent on agriculture, development of integrated farming systems for different agro-ecological conditions, revitalization of rain-fed agriculture, diversifying crops, insurance coverage and greater awareness on climate adaptation to strengthen community's capacities. Business development at the community level using local resources with financial and technical assistance can not only help affected people recover but also develop a sense of independence amongst them, thus making them resilient to future scenarios. Although typically livelihoods restoration policies attend to men, encouraging women into employment or business opportunities can boost the resilience at the individual, family and community level.

Capacity Building, Knowledge Management, Training and Skill Development norms and courses should be frequently provided to the communities. Focus on economic recovery, which is resilient, should be given.

h. Policymaking for effective implementation and periodic tracking of Nature-based Solutions (NbS):

The most crucial point is to allow easy implementation of NbS through the way of legal policies. Evidence-based approaches, where the implemented examples are used as references and are encouraged to be replicated with contextual variations at multiple locations is the best way to mainstream nature-based solutions into policies for disaster risk reduction and risk management. This can help to formulate policies that favour protection, management and restoration of natural elements as a resilience development mechanism against disasters, instead of unapologetically allowing continued overexploitation and deterioration.

Standard monitoring methods, tools and indicators are effective ways to track the performance of NbS, thus enhancing its applicability and reproducibility by reducing scepticism. NbS Assessment is important to convince policy-makers and practitioners to uptake NbS for ecologic, socio-economic and monetary benefits, pre and post disasters. Regulatory and monitory assessments not only help to make the decision-makers understand the benefits of NbS by appeasing existing hesitation of using NbS over grey-engineered solutions, but such assessments help improve the loopholes and quality of NbS measures.

One such assessment tool is Cost-Benefit Analysis that can help compare the cost incurred and benefits attained with and without NbS, thus allowing easy decision-making.

i. Logical demarcation and enforcement of eco-sensitive zones:

Protection and restoration of eco-sensitive zones fail due to blanket ban on the demarcated areas. Demarcation of sub-zones within the eco-sensitive zones, based on their fragility as restricted, semi-restricted or low will provide a more sound and detailed insight while management of such zones. Feasible and practical activity prohibition, regulation and monitoring (based on the sub-zones) in the eco-sensitive zones like catchment areas, water bodies (lakes, rivers, streams), flood plains, coastal habitats/plantation, etc. is the next step to be considered. Enforcement of prohibitory and regulatory rules should be cohesively instrumented by government, scientific institutions and organizations, thus avoiding unreasonable clearance and illegal development of projects and construction activities.

j. Innovative Mechanisms to protect Eco-sensitive zones:

Ecological entrepreneurship, i.e., renumerating locals to protect and restore natural systems using their traditional knowledge and external expertise, is an effective instrument that safeguards fragile landscapes, provides autonomy and a sense of belongingness to local people. Natural resource management through activities like afforestation, soil conservation, rainwater harvesting, etc. is the potential employment opportunity for local communities apart from regulating and monitoring these ecologically sensitive areas.

3. Technical-levelRecommendations & Strategies:

a. Leveraging "Technology" in Disaster Management:

Advanced technological mechanisms like Remote sensing-based studies, simulation and modelling to provide scenarios of cyclonic impacts in vulnerable regions, scientific investigation, artificial intelligence, robotics and ICT to be utilized to observe, analyze, process, communicate, classify and document observations.

'Common alerting protocol', a centralized system of information and warning dissemination by collecting data from various government bodies and sources need to be put in place. The information should not just be sent personally to individuals but also broadcasted and communicated at a larger scale.

b. Introducing Digital Governance:

A common digital platform for data management, data analytics and information sharing seem to be a not-so-necessary intervention, but is the most effective means of information and knowledge sharing. ICT can be used as a tool in the process to generate and disseminate real-time information to the communities through technology at the fingertips (mobile phones). It supports timely access to information like alerts, SOPs and ensure the flow of information to concerned stakeholders.

The digital platform is not only important during and post-disaster stages, but also is highly crucial to share beneficial knowledge, best practices, awareness and skill development programmes, etc. with local government, volunteers and communities.

4. Financial-level Recommendations & Strategies:

a. Business-oriented Financing Mechanism:

Instead of conventional budgeting or fund allocation by the government for disaster mitigation and adaptation, which in most instances fails to be implemented, the more practical solution is to develop an encouraging environment for business models based on investments and revenue generation. Profitable investment in resilient & green infrastructure reduces the dependency solely on government.

Similarly, business models in micro and macro scale adaptation must be encouraged. Private investors and semi-public investors provide immense opportunity through varying modes of PPP models. Attractive techniques like incentives (monetary or non-monetary) must be incorporated and regulated to boost up the disaster mitigation and adaptation efforts.

b. Innovative Fund Pooling Techniques:

Multiple tools and techniques can be introduced and regulated by the governing authority to raise funds for DRR initiatives. Payment for the ecosystem services of the natural resources is an effective way for the state and regional level government to raise funds from the national level authorities. A mechanism like taxation, penalties and fees to those violating DRR norms at community, regional and state level for several activities and projects benefits in collecting funds for DRR.

c. Resilient Community-level Business Models:

Development and promotion of community-level business models contributing to mitigation and adaptation, while generating profitable revenue for the communities through eco-friendly approaches. The business models should be shock-proof to the impacts of disasters and must be able to continue the livelihoods of locals, post-disaster.

d. Increase in budgetary allocation for Disaster Preparedness:

The governments should immediately extend the budgetary approach towards risk reduction measures like mitigation, adaptation and preparedness. E.g., Investments in

preparedness-related equipment like advanced warning systems, monitoring systems, dissemination systems, etc. needs to be understood as the priority of the hour.

e. Financing for Research and Development:

Funds should be levied to encourage and carry out progressive research in the field of disaster management and disaster mitigation/adaptation with the contextual focus on issues in coastal areas due to cyclonic events. This will help to develop greater insights and future proof techniques.

Recommendations for Policy-makers: Key pointers

1. Formulation of policies ensuring Periodic strengthening of Institutional Capacities and Technical Expertise: at the state level, district level and local level with domain experts as members. To avoid ignorance and relaxations, periodic capacity assessment and capacity building practices with updated and latest mechanisms must exist.
2. The approval/clearance, regulatory and monitoring committees for the developing cyclone-resilient infrastructural projects and building structures should be mandated under a policy to be comprised of technical experts and institutions, organizations, community representatives, local government authority along with regional/state-level government authority.
3. Rigid policy development for ethical enforcement of risk and vulnerability assessment tools considering inclusion of multi-hazard vulnerability, social vulnerability and climate changeimpact assessment.
4. All the stages of Disaster Management must mandatorily include inclusive mechanism catering to gender-specific, age-specific, disability-specific, etc. vulnerabilities. The enforcement through the way of policies and standards must be institutionalized across all states and across all administrative levels.
5. Policymaking for effective implementation and periodic tracking of Nature-based Solutions (NbS) backed by Evidence-based approaches, where the implemented examples are used as references and replicated with contextual variations at multiple locations. This can help to favour protection, management and restoration of natural elements as a resilience development mechanism against disasters, instead of unapologetically allowing continued overexploitation and deterioration.
6. Business friendly policies to develop an encouraging environment for business models based on investments and revenue generation. Profitable investment in resilient & green infrastructure and business models in micro and macro scale adaptation by Private investors and semi-public investors provide immense opportunity through varying modes of PPP models. Attractive techniques like incentives (monetary or non-monetary) must be incorporated and regulated through stringent policies to boost up the disaster mitigation and adaptation efforts.

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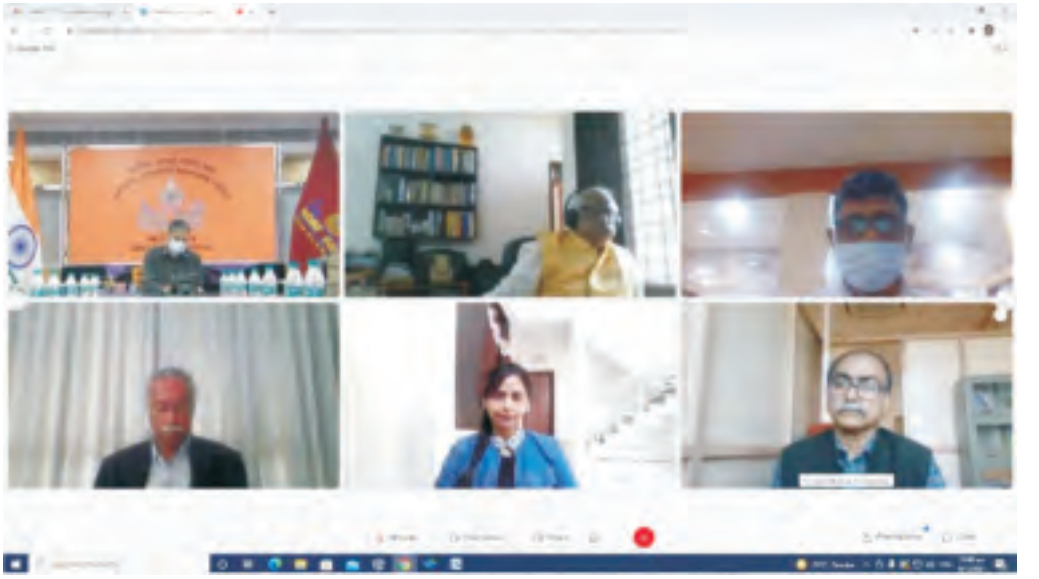
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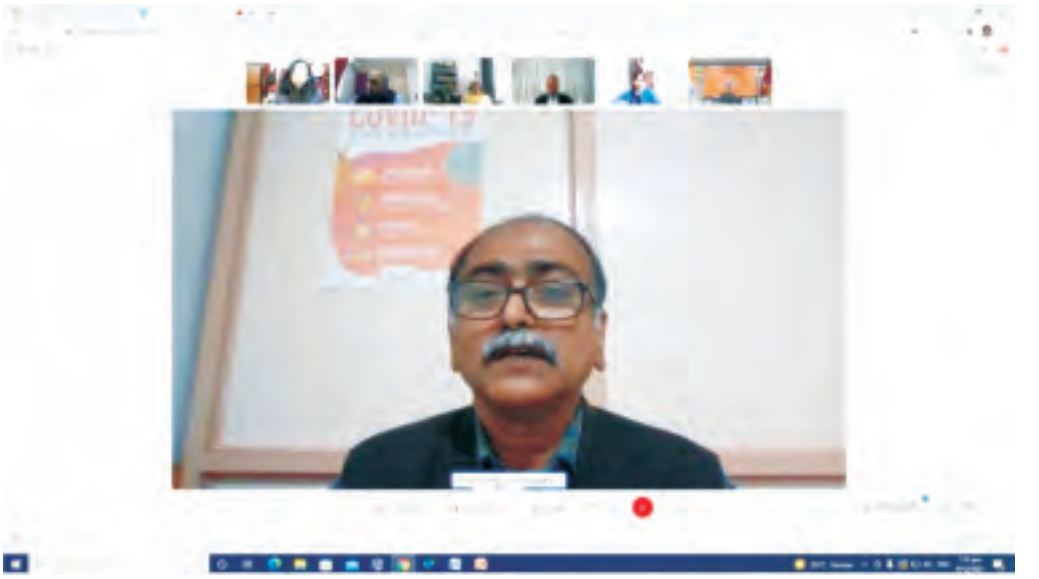
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Annexure

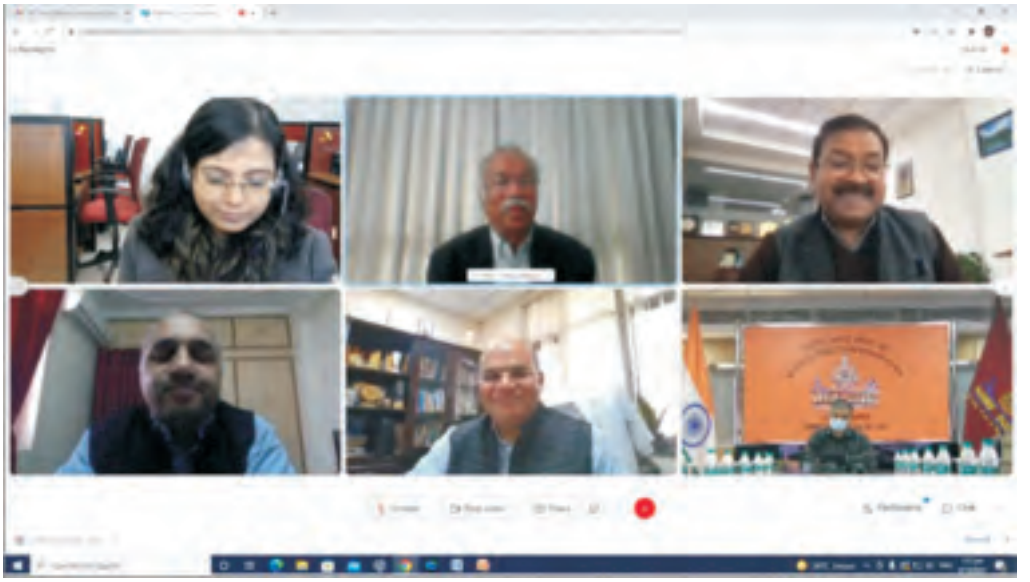
A consultancy meeting was organized on 9th December with participants from various State Disaster Management Authority, National Disaster Response Force, etc. The meeting was intended to invite inputs and comments from the esteemed panelists and disseminate the ongoing study to all.

Few captures from the consultation meeting

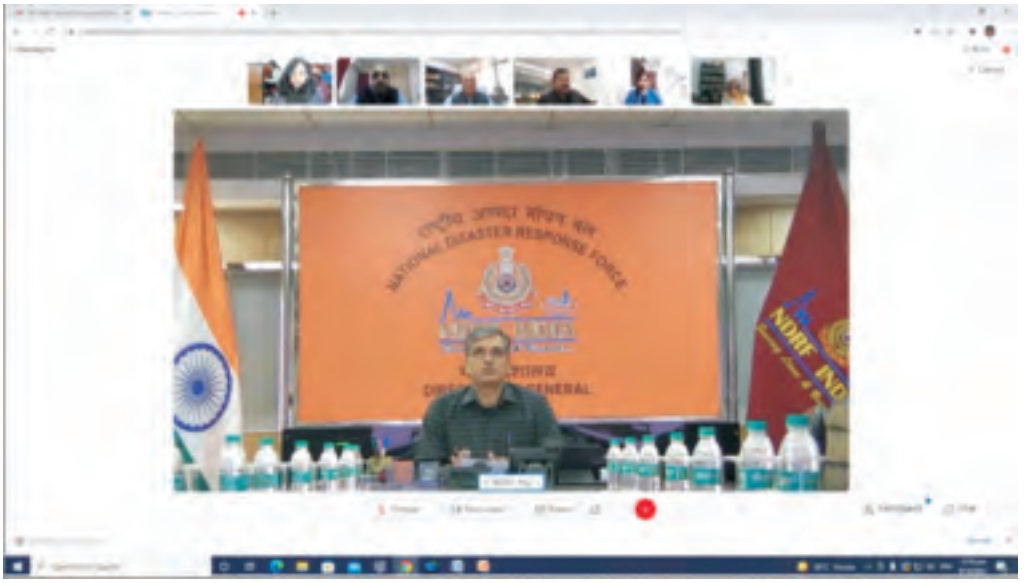











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About the Institute

National Institute of Disaster Management (NIDM) was constituted under an Act of Parliament with a vision to play the role of a premier institute for capacity development in India and the region. The efforts in this direction that began with the formation of the National Centre for Disaster Management (NCDM) in 1995 gained impetus with its redesignation as the National Institute of Disaster Management (NIDM) for training and capacity development. Under the Disaster Management Act 2005, NIDM has been assigned nodal responsibilities for human resource development, capacity building, training, research, documentation and policy advocacy in the field of disaster management.

NIDM is proud to have a multi-disciplinary core team of professionals working in various aspects of disaster management. In its endeavour to facilitate training and capacity development, the Institute has state-of-the-art facilities like class rooms, seminar hall and video-conferencing facilities etc. The Institute has a well-stocked library exclusively on the theme of disaster management and mitigation. The Institute provides training in face-to-face, on-line and self-learning mode as well as satellite based training. In-house and off-campus face-to-face training to the officials of the state governments is provided free of charge including modest boarding and lodging facilities.

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