

**DISASTER RISK REDUCTION FOR FREQUENT
OCCURRENCE OF CYCLONES AND FLOODS – A CASE OF
JAGATSingHPUR, ODISHA**

MASTER OF ENVIRONMENTAL PLANNING

KASTURI MANDAL
2016MEP001



**SCHOOL OF PLANNING AND ARCHITECTURE, BHOPAL
NEELBAD ROAD, BHAURI, BHOPAL (MP)-462 030**

May 2018

DISASTER RISK REDUCTION FOR FREQUENT OCCURRENCE OF CYCLONE AND FLOODS – A CASE OF JAGATSINGHPUR, ODISHA

*Thesis submitted in partial fulfillment of the requirements for
the award of the degree of*

Master of Environmental Planning

By
Kasturi Mandal
2016MEP001



**SCHOOL OF PLANNING AND ARCHITECTURE, BHOPAL
NEELBAD ROAD, BHOURI BHOPAL (MP)-462 030**

May, 2018

Declaration

I **Kasturi Mandal**, Scholar No. **2016MEP001** hereby declare that the thesis titled **Disaster Risk Reduction for frequent occurrence of cyclones and floods – A case of Jagatsinghpur, Odisha** submitted by me in partial fulfilment for the award of **Master of Environmental Planning**, at School of Planning and Architecture, Bhopal, India, is a record of bonafide work carried out by me. The matter/result embodied in this thesis has not been submitted to any other University or Institute for the award of any degree or diploma.

Signature of the Student

Date: _____

Certificate

This is to certify that the declaration of Kasturi Mandal is true to the best of my knowledge and that the student has worked under my guidance in preparing this thesis.

RECOMMENDED

Prof. Dr. N. Sridharan

ACCEPTED

Prof. Dr. Sheuli Mitra
Head, Department of Environmental Planning

May, 2018, Bhopal

ACKNOWLEDGEMENT

The thesis journey which started at the onset of the starting of third semester has reached its last lap and it had not been possible to complete the journey without the guidance and valuable suggestions and inputs from my guide **Prof. Dr. N. Sridharan**, who had always advised me through the thick and thin, particularly in choosing the correct literature for the thesis project.

Second, I would also like to thank our thesis co-ordinators, **Prof. Dr. Amit Chaterjee, Prof. Dr. Kshama Puntambekar and Prof. Dr. Rama Pandey** and HOD of Department of Environmental Planning, **Prof. Dr. Sheuli Mitra** for their extended support since the beginning of this journey. Also, I would like to thank all other faculties who have given their inputs for making the thesis better.

I am grateful to the officials of **Odisha State disaster management Authority, Ministry of Forests and Environemnt, Odisha, ICZMP, Odisha, District Collectorate, Jagatsinghpur and Fisheries Department, Odisha** for providing me with all the necessary data required for the project.

I convey my gratitude to my friend **Pritam Patnaik** and his family members for their kindness and aid without which the primary survey and data collecteion would not have been possible. The inhabitants of my study area and all the people who helped me with my primary survey must be thanked for their helping hands they had extended to me willingly.

I would also take the pleasure of thanking two of my very good friends **Satadal Sengupta** and **Hillol Samanta** who even staying miles away had their faith embedded on me always.

I am particularly thankful to my friends **Ipsita, Zinnia, Praseeda, Pratishtha, Prachi, Nilesh, Udit and Souvick** for standing by me like a pillar in all the ups and downs and my parents, **Mr. Nikhil Kumar Mandal and Mrs. Sobha Mandal** without whose blessings I would not have been able to come so far.

Last, I thank the Almighty for what I am today and showing me the path of light in future.

Thank you,

Kasturi Mandal

ABSTRACT

Floods and cyclones are regular occurrences in coastal regions of Odisha. Despite having a long history of disasters and after much efforts from Odisha State Disaster Management Authority and several NGOs, the ground reality is something different and there lies a gap which yearns to be mended at the earliest. Jagatsinghpur is one of the coastal districts which gets affected by floods and cyclones regularly but is overshadowed by the adjoining Puri and Kendrapara districts due to their attractive tourist locations. The reality is that the study area comprises of critical eco-sensitive zone and also it falls in the direct path of cyclonic storms over Bay of Bengal.

The aim is to suggest interventions which might bring down the vulnerability level of the study area. For the same, it is important to find out how vulnerable the coastline of Jagatsinghpur is, which is done by applying the Coastal Vulnerability Index method on basis of few identified parameters. The probable causes and impacts of frequent disasters on the study area from a socio-economic and environmental viewpoint is also a determining factor in the interventions which is analysed through primary surveys, stakeholder interviews and accounts of previous disasters and documents obtained from the secondary sources. The coast of Jagatsinghpur is not a stable coast and is found to be undergoing fast rates of erosion as well as accretion. Human-environment interaction, especially disaster inducing human interaction needs to be considered in planning as observed from the study.

Attention should be given towards both the proactive and reactive approaches, strong stakeholder participation, community-based disaster reducing techniques, private-public partnership in managing the disasters, as well as alternative methods of land use planning and strengthening of infrastructural facilities which will go a long way in controlling the vulnerability levels before, during and after the disaster, and also enhancing the adaptive capacity and coping mechanisms amongst the inhabitants of the coastal areas of the district.

Kasturi Mandal

2016MEP001

सार

ओडिशा के तटीय क्षेत्रों में बाढ़ और चक्रवात नियमित घटनाएं हैं। आपदाओं का लंबा इतिहास होने के बावजूद और ओडिशा राज्य आपदा प्रबंधन प्राधिकरण और कई गैर सरकारी संगठनों के बहुत से प्रयासों के बाद, वास्तविकता कुछ अलग है और जल्द ही एक अंतर है जो जल्द से जल्द मिश्रित होना चाहता है। जगत्सिंहपुर तटीय जिलों में से एक है जो नियमित रूप से बाढ़ और चक्रवात से प्रभावित होता है लेकिन आस-पास के पुरी और केेंदराड़ा जिलों द्वारा उनके आकर्षक पर्यटक स्थानों के कारण प्रभावित होता है। हकीकत यह है कि अध्ययन क्षेत्र में महत्वपूर्ण पर्यावरण-संवेदनशील क्षेत्र शामिल है और यह बंगाल की खाड़ी पर चक्रवात तूफान के सीधे रास्ते में भी पड़ता है।

इसका उद्देश्य उन हस्तक्षेपों का सुझाव देना है जो अध्ययन क्षेत्र की भेद्यता स्तर को कम कर सकते हैं। इसके लिए, यह जानना महत्वपूर्ण है कि जगत्सिंहपुर की तट रेखा कितनी कमजोर है, जो कुछ पहचाने गए मानकों के आधार पर तटीय भेद्यता सूचकांक विधि को लागू करके किया जाता है। एक सामाजिक-आर्थिक और पर्यावरणीय दृष्टिकोण से अध्ययन क्षेत्र पर लगातार आपदाओं के संभावित कारण और प्रभाव हस्तक्षेपों में भी एक निर्धारण कारक है जिसका प्राथमिक सर्वेक्षण, हितधारक साक्षात्कार और पिछली आपदाओं के खातों और माध्यमिक स्रोतों से प्राप्त दस्तावेजों के माध्यम से विश्लेषण किया जाता है। जगत्सिंहपुर का तट एक स्थिर तट नहीं है और यह क्षरण और साथ ही साथ वृद्धि की तेज दर से गुजर रहा है। मानव पर्यावरण की बातचीत, विशेष रूप से आपदा से प्रेरित मानव आपदा को अध्ययन से मनाए जाने की योजना में विचार किया जाना चाहिए।

सक्रिय और प्रतिक्रियाशील दृष्टिकोण, मजबूत हितधारक भागीदारी, समुदाय-आधारित आपदा घटाने की तकनीक, आपदाओं के प्रबंधन में निजी-सार्वजनिक भागीदारी के साथ-साथ भूमि उपयोग योजना के वैकल्पिक तरीकों और आधारभूत सुविधाओं को सुदृढ़ करने के लिए ध्यान दिया जाना चाहिए जो एक आपदा के पहले, उसके दौरान और उसके बाद भेद्यता के स्तर को नियंत्रित करने में लंबा रास्ता, और जिले के तटीय क्षेत्रों के निवासियों के बीच अनुकूल क्षमता को बढ़ाने और तंत्र को मुकाबला करने में भी लंबा रास्ता है।

कस्तुरी मंडल
2016MEP001

CONTENTS

List of Figures	iv
List of Graphs	iv
List of Maps	v
List of Tables	vi
List of Abbreviations	vii
CHAPTER 1: INTRODUCTION	1
1.1 Background study	1
1.1.1 1971 cyclone	3
1.1.2 1999 Odisha super cyclone	4
1.1.3 Cyclone Phailin	6
1.1.4 Floods	7
1.2 Need of the study	10
1.2.1 Vulnerability on the eastern coast of India	14
1.3 Aim, Objectives, Scope and Limitations	15
1.3.1 Aim	15
1.3.2 Objectives	15
1.3.3 Scope	15
1.3.4 Limitations	16
1.4 Understanding the worldwide frameworks for disaster risk reduction	16
1.4.1 Hyogo Framework	17
1.4.2 Sendai Framework	18
1.5 Institutional framework for DRR in India	19
1.5.1 National level	20
1.5.1.1 National Disaster Management Authority	21
1.5.1.2 National Institute of Disaster Management	21
1.5.1.3 National Disaster Response Force	22
1.5.1.4 National Executive Committee	22
1.5.1.5 National Crisis Management Committee	22
1.5.1.6 Cabinet Committee on Security	22
1.5.2 State level	23
1.5.2.1 State Disaster Management Authority	23
1.5.2.2 District Disaster Management Authority	23
1.6 Organization of thesis and chapter outlines	24
1.7 Conclusion	26

CHAPTER 2: DISASTER RESPONSE, PREPAREDNESS AND RECOVERY: LITERATURE REVIEW	27
2.1 Introduction	27
2.2 Risk perception	27
2.2.1 Heuristic v/s cognitive approach	27
2.2.2 Cultural approach	28
2.3 Risk communication	29
2.4 Risk management	30
2.5 Key findings	30
2.5.1 Concept based literature	31
2.5.2 Approach based literature	32
2.5.3 Methodology based literature	33
2.5.4 Case studies	39
2.6 Conclusion	42
CHAPTER 3: EMPIRICAL CONTEXT	43
3.1 Introduction	43
3.2 CRZ regulations in Odisha	43
3.2.1 Mangroves	45
3.2.2 Olive Ridley Turtles	46
3.3 Fishing and agrarian communities in coastal Odisha	49
3.4 Environmental ethics and conflicts in coastal Odisha	55
3.5 The case study of perished village: Satbhaya	57
3.6 Conclusion	60
CHAPTER 4: INTRODUCTION TO THE STUDY AREA	61
4.1 Introduction	61
4.1.1 Physical settings of the district	61
4.1.2 Political boundaries of the district	65
4.2 Erasama block	68
4.3 Balikuda block	70
4.4 Conclusion	72
CHAPTER 5: METHODS AND METHODOLOGY	73
5.1 Introduction	73
5.1.1 Vulnerability Analysis	73
5.2 Methodology	73
5.3 Challenges faced during the site visit	78
5.4 Methods	79

5.4.1 Coastal Vulnerability Index	79
5.4.2 Parameters used	80
5.4.3 Method of doing the CVI	80
5.4.4 Evaluation of various parameters	81
5.4.4.1 Shore-line change rate (m/year)	82
5.4.4.2 Barrier type	82
5.4.4.3 Coastal slope (degrees)	83
5.4.4.4 Significant wave height (metres)	83
5.4.4.5 Shoreline exposure	83
5.4.4.6 Regional elevation (metres)	84
5.4.4.7 Coastal geomorphology	86
5.4.4.8 Surge Height (metres)	86
5.4.5 Socio-economic Vulnerability Index	87
5.4.5.1 Analysis of few socio-economic parameters	88
5.4.6 A tiff between the ideal and real time scenarios	91
5.4.7 Documentation of stakeholder interviews	92
5.5 Conclusion	94
CHAPTER 6: POSSIBLE INTERVENTIONS	95
6.1 Introduction	95
6.2 Relating the possible interventions with the stakeholder interviews	95
6.4 Possible interventions in CRZ I areas	97
6.4.1 Timber groynes	97
6.4.2 Mangrove culture	97
6.4.3 Natural fish drying yards and hatcheries	98
6.5 Possible interventions in CRZ III areas	99
6.5.1 Infrastructure services	99
6.5.2 Alternative scope for livelihood	101
6.5.3 Rehabilitation of inhabitants of Tarasahi under Marichpur Gram Panchayat	102
6.6 Other interventions	103
6.7 Future research areas	103
6.8 Conclusion	105
References	108
ANNEXURES	114
SURVEY QUESTIONNAIRE	114

List of Figures

Figure 1 Coastal erosion near Satabhaya village.....	4
Figure 2 Flood in one of the coastal Odisha villages after Cyclone Phailin.....	6
Figure 3 Devastation and flooding caused by previous cyclones in Odisha	11
Figure 4 Changes in coastline of the coastal districts of Odisha.....	13
Figure 5 Vulnerability of eastern coast of India on basis of cyclone hazards	14
Figure 6 Disaster management cycle	20
Figure 7 Basic institutional framework of national level disaster management	21
Figure 8 Basic institutional framework for disaster management at state level	24
Figure 9 The cycle of risk communication and management	30
Figure 10 Denotation of the four zones as described in CRZ Act.....	33
Figure 11 Location of Sunset Beach	34
Figure 12 Workspace for calculating CVI in InVEST	35
Figure 13 The study area in Odisha	36
Figure 14 Coastal Vulnerability Map of Puri-Gopalpur coast.....	37
Figure 15 Barguna district of Bangladesh.....	38
Figure 16 Study area of three districts of Odisha	39
Figure 17 Location of Mekong Delta.....	40
Figure 18 Forecast verification of source of Cyclone Phailin.....	41
Figure 19 Numerical Weather Predictor based Objective Cyclone Prediction System	41
Figure 20 National parks of coastal Odisha.....	44
Figure 21 Mangrove covers in coastal Odisha.....	44
Figure 22 CRZ boundaries near Balukhand in Puri	45
Figure 23 CRZ areas near Devi river mouth	46
Figure 24 Areas showing the breeding ground of Olive Ridley turtles	47
Figure 25 Brackish water prawn farming areas in Sahadabedi.....	50
Figure 26 Motor used typically to move the pond water in circular movements	50
Figure 27 Catch ready to go to the agricultural market in the block headquarter.....	51
Figure 28 The village in Odisha to be engulfed completely by the sea.....	58
Figure 29 Type of coast in the coastal districts.....	63
Figure 30 Rate of change of coastline in Jagatsinghpur	63

List of Graphs

Graph 1 Marine fish production in Odisha	56
Graph 2 Variation of education awareness amongst the social classes.....	88
Graph 3 Availability of temporary shelters for various social classes.....	90

List of Maps

Map 1 Location of Odisha on eastern coast of India.....	2
Map 2 Six coastal districts of Odisha and the lengths of coastline	3
Map 3 Cyclone prone zones of India	8
Map 4 Flood prone zones of India	9
Map 5 Cyclone prone zones of Odisha	12
Map 6 Flood plains of Odisha	12
Map 7 CRZ boundaries in the study area	48
Map 8 Water logged areas during floods	53
Map 9 Saline water intrusion in the study area	54
Map 10 Base map of Jagatsinghpur district	62
Map 11 Land use land cover map of Jagatsinghpur	62
Map 12 Major rivers and waterbodies in the district.....	64
Map 13 Soil typology of Jagatsinghpur district.....	64
Map 14 Major roads, railway line and important places	66
Map 15 The tsunami prone villages of the district	66
Map 16 Land use map of the coastal areas of the two blocks.....	67
Map 17 Erasama block	68
Map 18 Land use of study areas in Erasama.....	69
Map 19 Balikuda block.....	70
Map 20 Land use map of the study area in Balikuda	71
Map 21 Types of barriers along the coastline	83
Map 22 Coastal slope variation in the coastal stretch	84
Map 23 Shoreline exposure in the coastal stretch	85
Map 24 Elevation profile of the area	85
Map 25 Coastal geomorphology of the stretch	86
Map 26 The overall CVI of the stretch.....	87
Map 27 Possible interventions in CRZI areas.....	98
Map 28 Location of proposed mangroves near Devi river mouth	98
Map 29 Location of cyclone shelters	100
Map 30 Location of other infrastructural services.....	101
Map 31 Possible interventions in CRZIII areas.....	102

List of Tables

Table 1 Nodal ministry for management/ mitigation of different disasters.....	22
Table 2 Parameters used and their ranking system for coastal ecosystem.....	36
Table 3 CVI values for various stretches of the study area	37
Table 4 Marine Fisheries Resources, 2013-2014.....	49
Table 5 The points of conflict between the two communities	55
Table 6 Timeline of submergence of Satabhaya village.....	58
Table 7 Details of shifted households of Satabhaya cluster	59
Table 8 Land utilisation	59
Table 9 Methods applied for the two objectives.....	78
Table 10 Parameters used in CVI method.....	80
Table 11 Risk rating for all the parameters.....	81
Table 12 Contrasting ideal and real scenario.....	91
Table 13 Socio-economic profile of interviewees	92
Table 14 Current and required number of infrastructural services	99
Table 15 Inferences from the analysis and their causes	104
Table 16 Possible interventions for reducing socio-economic and environmental vulnerability.....	105

List of Abbreviations

SC	Super Cyclone
SCS	Super Cyclonic Storm
VSCS	Very Severe Cyclonic Storm
CS	Cyclone Shelter
MCS	Multipurpose Cyclone Shelter
PDS	Public Distribution System
IMD	Indian Meteorological Department
OSDMA	Odisha State Disaster Management Authority
NDMA	National Disaster Management Authority
CVI	Coastal vulnerability Index
SeVI	Socio-economic Vulnerability Index
DM	Disaster Management
DRM	Disaster Risk Management
MoEFCC	Ministry of Environment Forest and Climate Change
HQ	Headquarters
AWC	All Weather Centre
CRZ	Coastal Zone Regulation
CZMP	Coastal Zone Management Plan

CHAPTER 1: INTRODUCTION

1.1 Background study

Odisha is located on the eastern coast of India with an area of 1,55,707 sq.km. and a population of 4.37 crores. Bounded by West Bengal on the north-east, Chattisgarh on west and north-west, Jharkhand to the north, and Andhra Pradesh on the south, Odisha is the 9th largest state of India with a long coastline of 485 kilometres, stretching from Balasore to Ganjam. The coastal areas of India have been subject to remarkable pressure from population and developmental activities, over the last few decades. The coastal areas which are part of the Indian state of Odisha, have shown signs of vulnerability towards accelerated levels of coastal erosion. The coastline includes various establishments such as fishing villages, large and small towns, hotels and tourism centers, is already witnessing frequent storms accompanied with floods, and severe erosion. Some of the celebrated coastal habitats in the state have not been spared as well; those include Asia's largest brackish water lagoon, called Chilika, the sandy beaches in Rushikulya and Gahirmatha, which comprise the largest rookeries in the world for the Olive Ridley sea turtles, and the wildlife sanctuary of Bhitarkanika, which is an extensive mangrove cover hosting a variety of flora and fauna. Besides, the deltaic plains of Odisha, and the large estuarine systems, have also not been spared from the hazards of coastal erosion.

The rivers have inland water channels with slope towards the landward side of the state and as a result, flood in the rivers submerges vast stretches of lands along both the banks of the rivers. Also, due to lack of marginal embankment on the rivers, flood water overflows the plains and is released into the Bay of Bengal with low depth of submergence. As Odisha falls directly in the path of cyclonic storms originating in the Bay of Bengal, the runoff concentration in the rivers increase heavily due to the torrential downpour caused by the same and it has been witnessed that the storms cause flood in more than one river at a time.



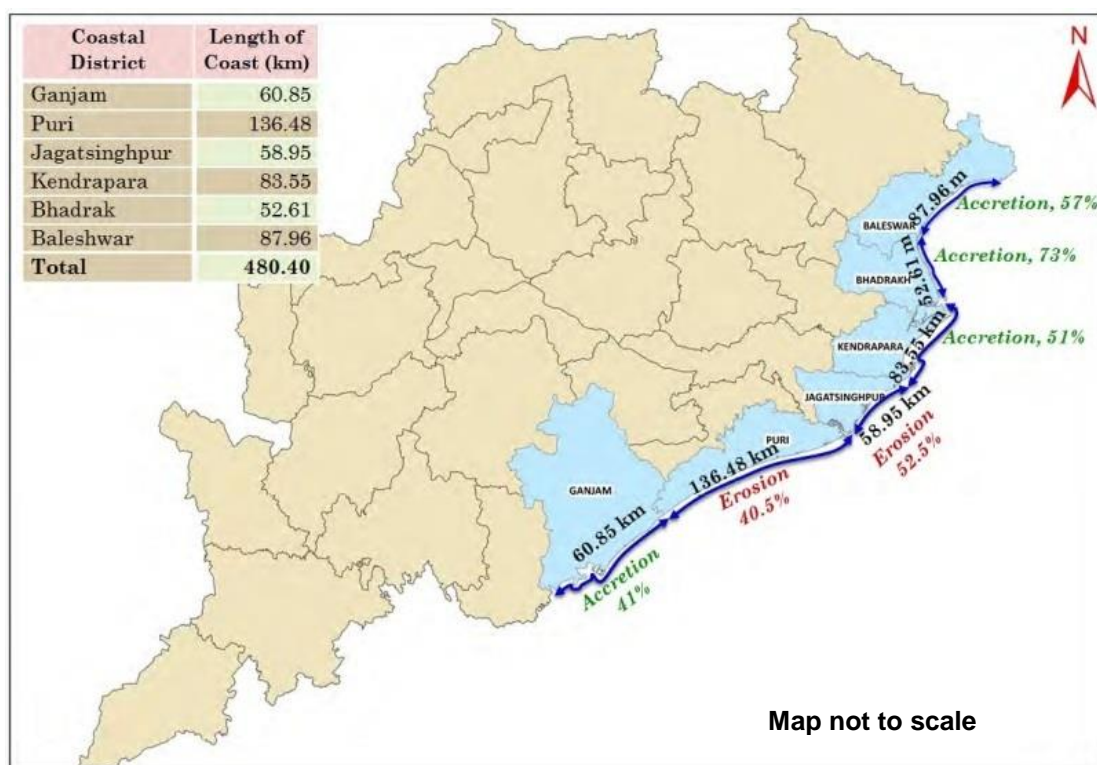
Map 1 Location of Odisha on eastern coast of India

Source: *mapsofindia.com*

Odisha has six coastal districts out of which Jagatsinghpur is the smallest in area but having the greatest concentration of rivers and other waterbodies. It consists of the great Mahanadi delta, three estuaries and a portion of the Bhitarkanika mangrove ecosystem. One of the most important ports of India, Paradip is located in this district near the mouth of Hukitola Bay.

With a coastline of almost 60 kms., it is one of the districts which frequently devastated due to cyclones and floods.

It is also one of the leading districts in rice production, the staple crop of the state which gets thoroughly affected due to the salt water intrusion during flooding of the rivers in the coastal region. The coastline of Jagatsinghpur is highly unstable with high rates of changes in erosion or accretion which makes it more vulnerable to cyclones. With a long record of cyclonic storms and floods, the people living in the rural areas of coastal Jagatsinghpur struggle to live amidst uncertainty of life, livelihood, liveability and food security.



Map 2 Six coastal districts of Odisha and the lengths of coastline

Source: Centre for Coastal Zone Management and Coastal Shelter Belt

1.1.1 1971 cyclone

Considered to be the first Very Severe Super Cyclonic Storm to have affected the Odisha coast in 201th century, it made its landfall near Paradip recording wind speed till 185 km/hr. Originating down south near Malacca Strait, it travelled northwards towards Andaman Sea and ultimately strengthened over Bay of Bengal before hitting the Odisha cost.

Lacking any policy framework or concerning body or any infrastructural facilities, Odisha faced the wrath of this natural calamity as it wreaked havoc by wiping out a large chunk of coastal settlements. Official records put forward a death toll of 10,000 whereas, **the village of Satabhaya (the seven-village cluster) in Kendrapara district suffered the maximum loss as five out of seven villages were completely submerged due to high storm surges and heavy coastal erosion.** The picture below depicts the present-day condition of the situation of the last two hamlets, where the inhabitants live in such a risky condition that the sea can engulf the region anytime.



Figure 1 Coastal erosion near Satabhaya village

Source: Odisha Sun Times

1.1.2 1999 Odisha super cyclone

1999 super cyclone which crossed near Paradip in Odisha was the strongest tropical cyclone ever recorded in 20th century over Bay of Bengal and also the most destructive of its kind. It all started as a depression in the Andaman Sea dated 25th October even though the origin was traced back to a region of storms over Sulu sea four days before. The Sulu Sea is a waterbody in the southwestern area of the Philippines, separated from the South China Sea in

the northwest by Palawa and from the Celebes Sea in the southeast by the Sulu Archipelago. Borneo is found to the southwest and Visayas to the northeast. It gradually followed a west to north-western part, thus attaining the rage of cyclonic storm the next. As it proceeded further, it received all the favourable conditions of developing into super cyclonic storm and finally made its landfall on 29th October, bringing devastation to 14 districts of Odisha, especially Jagatsinghpur. It steadily weakened after continuous land interaction and after coming in contact of dry air and finally subsided after two days on 1st November, 1999.

Owing to high storm surges, powerful winds and heavy downpour, water entered up till 35kms towards the land, along with coastal debris. Saline water inundation occurred in the agriculture fields destroying the sugarcane and other rabi crops, as well as making the fields unfit for agriculture in the years to come. High waves instantly sank almost 15,000 fishing boats due to due to lack of communication and warning signals. Widespread flooding led to the damage of many flood embankments, leaving about 2.5 million people homeless in the affected areas. The official death toll reached approximately 10,000 amongst which 8,000 was recorded alone in the blocks of Erasama and Kujang of Jagatsinghpur district. 18,420 sq. km. cropland was destroyed whereas 444,000 livestock fatalities were reported. Odisha was cut off from rest of the world for over 48 hours due to mass destruction of electric poles which were uprooted due to the high speed of winds and there were massive power outages. Infrastructural services were heavily damaged as electric water pumps were totally destroyed and the roads leading to the district headquarters and other major cities were filled with debris.

As an aftermath of the cyclone, there was outbreak of many communicable diseases like diarrhea, cholera, and measles and the cases reported continued to increase for days. The condition could be normalized only by February, 2000. The affected districts ceased to have a normal livelihood for almost six months. **The notable development which took place as the immediate result of the super cyclone was the formation of Odisha State Disaster Management Authority in December the same year.**

1.1.3 Cyclone Phailin

Phailin was recorded to be the strongest tropical cyclone since the 1999 super cyclone which made its landfall near Gopalpur coast of Odisha. It was first recorded as a depression over the Gulf of Thailand, and started moving towards the west as it passed over Malay peninsula. It finally emerged into the Andaman Sea and followed the same path as 1999 SC before crashing on 10th October, 2013 as SCS. It weakened for the next few days as contact with land caused friction and finally subsided on 14th October, 2013.

The important thing which took place was the biggest evacuation in the twenty-five years' history of India, when 5,50,000 people were shifted from the coastline to high grounds to cyclone shelters and other buildings which were being temporarily used as CS. The stilt floors were used as shelters for cattle and other livestock.

The coastal district of Ganjam was hit hardest by the cyclone with losses in form of 2.4 lakhs damaged houses and livelihood of over 5 lakhs of people. Roads in other adjoining districts were blocked due to uprooting of trees, whereas the slum dwellers in Paradip seemed to witness the worst damage as many huts were damaged, either partially or completely.

Mangroves near the Kendrapara-Jagatsinghpur border were uprooted for stretches and sea water intrusion had left the areas unsuitable for growth of several types of plant species. India's largest coastal lagoon and a highly eco-sensitive zone, Chilka was affected which may take years to overcome the loss.

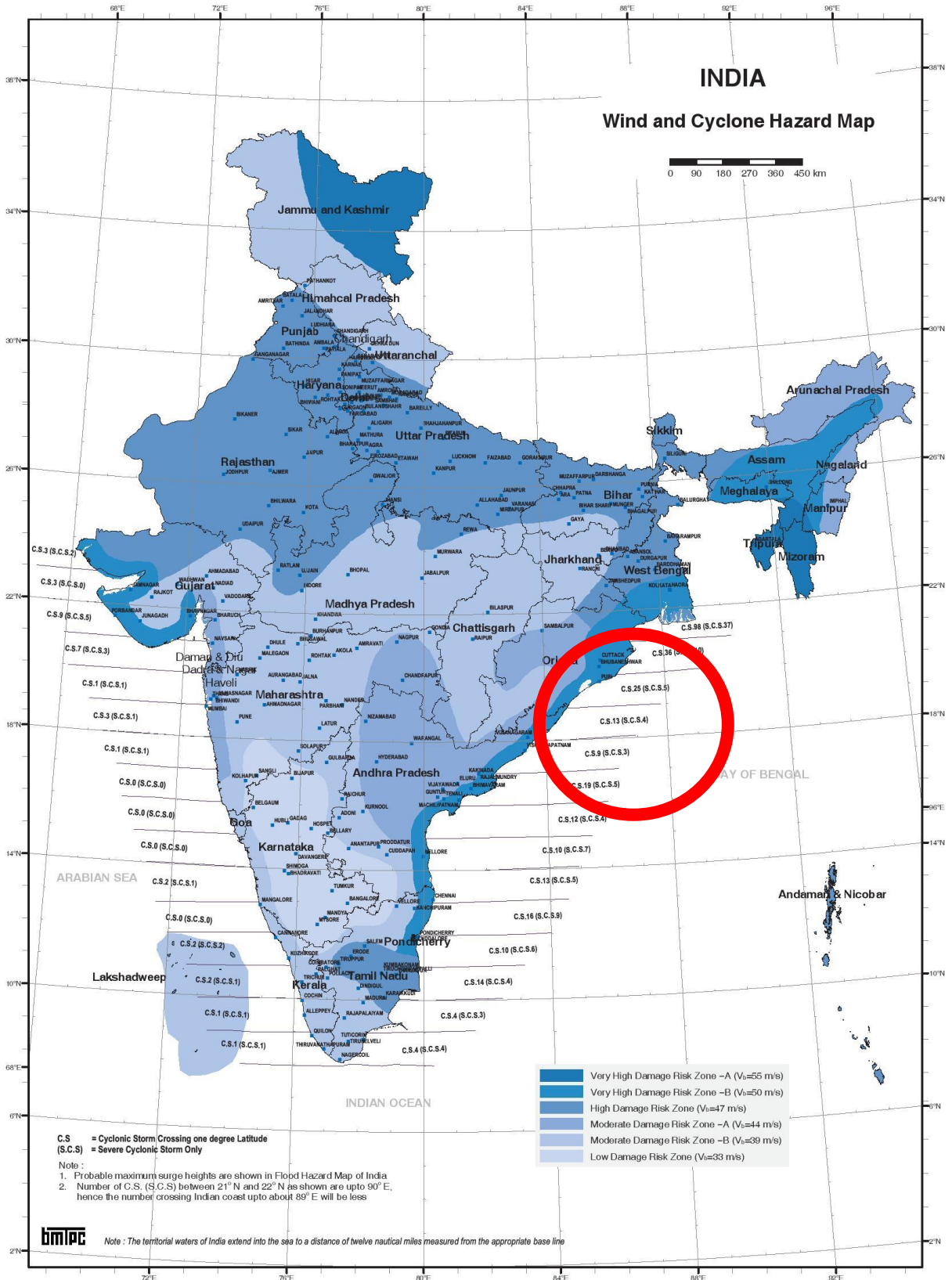


Figure 2 Flood in one of the coastal Odisha villages after Cyclone Phailin

Source: Times of India

1.1.4 Floods

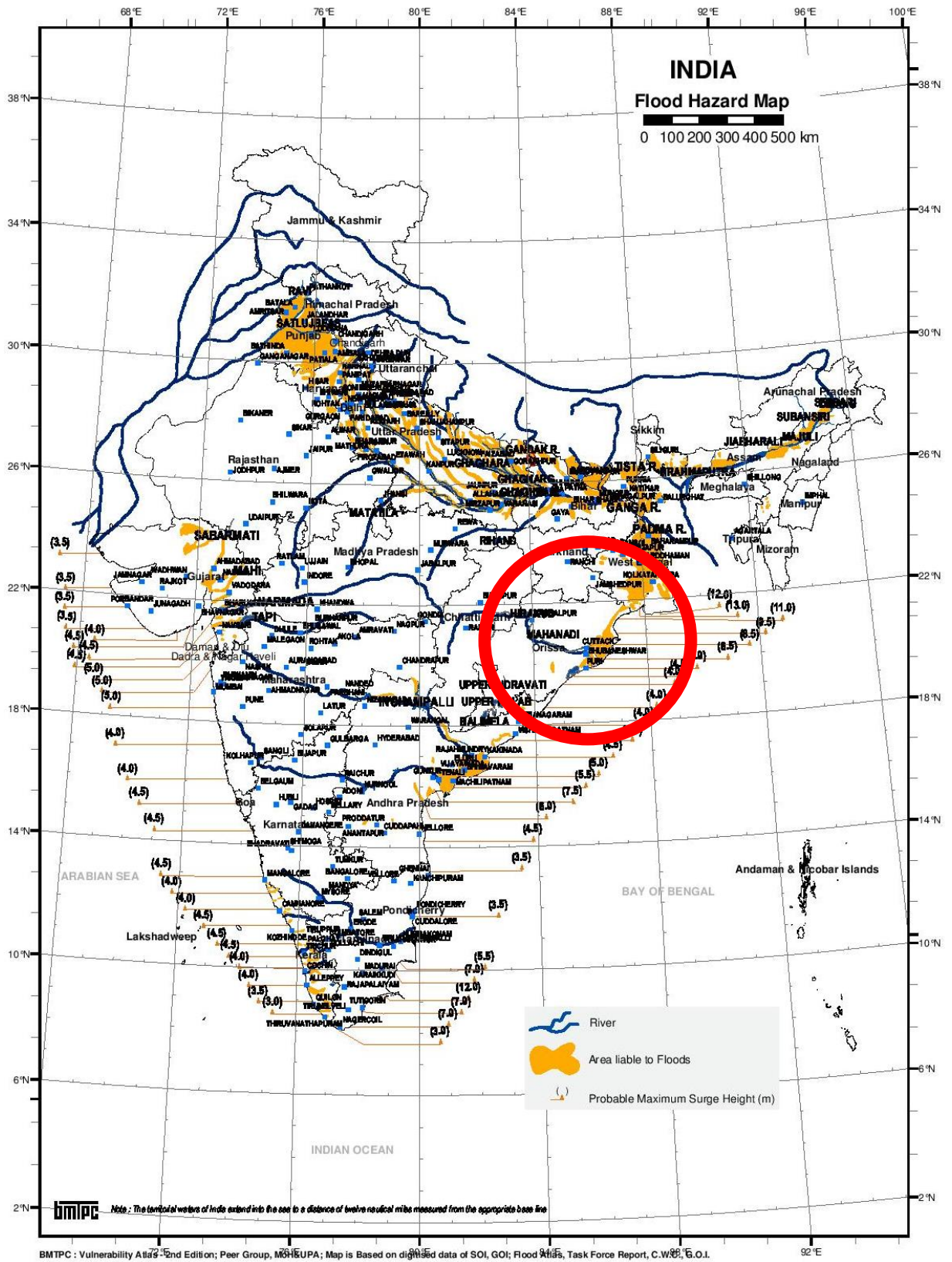
In Odisha, floods mainly occur in the Mahanadi, Brahmani and Baitarani rivers as these three share a common delta, the flood plain being the eastern part of the district of Jagatsinghpur where flood water overflow and intermingle submerging the areas near the rivers. Impacts of flooding is enhanced due to flow of water from adjoining states of Jharkhand and Chattisgarh. The coastal areas almost are flat with very low value of slope, poor drainage, soil erosion, and high degree of siltation in the river basins and delta areas. The problem become even more grave when high tides further coincide with the floods. Moreover, the entire coastal region is highly prone to storm surges making the coast vulnerable to both seasonal and cyclonic floods causing severe damage to life, livestock, houses, crops and infrastructure.



BMTPC : Vulnerability Atlas –2nd Edition: Peer Group. MoH&UPA: Map is Based on digitised data of SOI. GOI : Basic Wind Speed Map. IS 875(3) –1987: Cyclone Data. 1877-2005. IMD. GOI

Map 3 Cyclone prone zones of India

Source: Vulnerability Atlas of India



Map 4 Flood prone zones of India

Source: Vulnerability Atlas of India

1.2 Need of the study

It is clear from the previous records that Odisha coastline is vulnerable to multiple disasters such as, floods, storm surges, tropical cyclones and tsunamis. The threat due to such disasters have increased manifold with an increase in human population. The economy of the state had experienced tremendous setbacks as floods and cyclones have become regular phenomenon.

In one of the studies it is stated that the last few decades have witnessed an unprecedented pressure on the coastal areas for establishment of fisheries, ports, aquaculture centres, harbours, residential areas, and tourist resorts; the collective effect of such rampant developmental activities have led to environmental changes which are largely irreversible. As a result, these vulnerabilities have grabbed attention of the common citizens, as well as the state governmental agencies. Examples of some of the most devastating changes include tropical cyclones and associated storms and floods, reduction in the coverage of mangrove forests, trans-formation of the coastal estuarine system, and acceleration in changes along the shores. These environmental changes affect the economic status of the region, along with loss to life and property.

According to a report by the Planning Commission of India on Salinity control, there exists around 7 million hectares of coastal area in India, which are salt-affected. Estimates compiled by the Central Soil Salinity Research Institute in Karnal reveals that Odisha accounts for 0.4 million hectares of saline soil. The affected areas generally occur in the river deltas, forming a narrow strip of land close to the sea coast. These range in size from a few kilometers to around fifty kilometers, and can be found along low-lying regions, estuaries, and inland depressions. The soil salinity is due to intrusion of sea water into the land during high tides, and along several estuaries and creeks around the areas.

Apart from the direct effect of mixing of saline water into the soil, the underground water-table is also present at a small depth, and is rendered rich with saline water. As a result of capillary rise of salt water during dry spells in the region, this groundwater rises and occupies most of the land areas which are used for agriculture. A topographical feature of the regions where such a

phenomenon happens, is that these are low lying areas, and are characterized with elevations not more than ten meters from the mean sea level.

The saline water affected lands are however, not uniform in terms of characteristics. In most regions, however, the soil is found to have a moderate to heavy texture, and obviously shows high salt content. The most heavily occurring component is sodium chloride, and the soil is slightly acidic to neutral when tested for acidic content. Also, the salinity level of the soil varies from region to region, and with seasons.

Another study states that the Mahanadi river system around the state of Odisha is the third largest in the Indian peninsula, and is spread with a spread across a drainage area of 1132,000 sq. km. The source of the river is in the Bastar hills of Madhya Pradesh, and it flows along a distance of 860 kilometers, until it joins the Bay of Bengal, along the coastline surrounding the districts of Puri and Cuttack in Odisha. The river system discharges heavily into the coastal plains through a large system of distributaries and sub-distributaries, forming a delta system. The primary tributary rivers constitute the Birupa, the Mahanadi – Chitralla – Kathjhorī – Devi, and the Kuyakhai – Daya – Kushbhadra – Bhargavi. From these sources, several tidal inlets intrude into interior regions of land, where agriculture takes place. As a result, these regions often experience floods and cyclones, and sustain heavy damages to crops, property, and life. The study thus underlines the requirement to systematically study the various ingress processes of saline water into cultivable land, and proceeds to outline the interface structure between saline and freshwater sources.



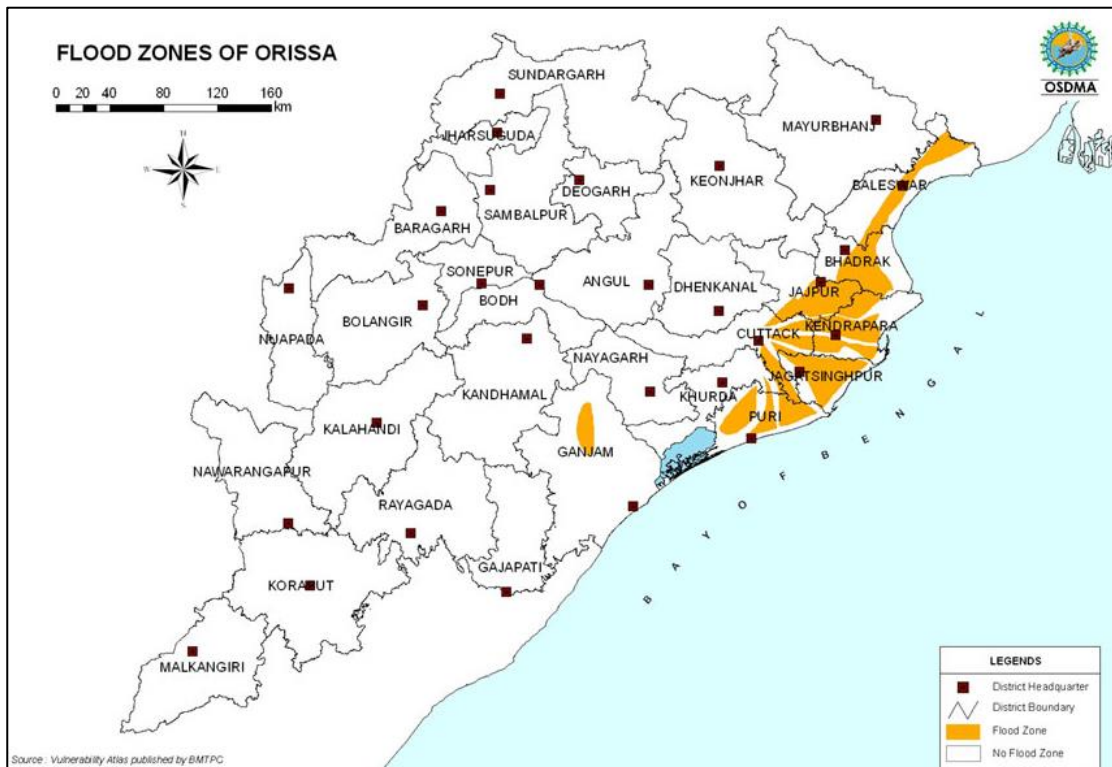
Figure 3 Devastation and flooding caused by previous cyclones in Odisha

Source: Odia Darpan



Map 5 Cyclone prone zones of Odisha

Source: Vulnerability Atlas of India



Map 6 Flood plains of Odisha

Source: Vulnerability Atlas of India

The paper also proposes guidelines for constructing proper well fields, and other developmental programs keeping in mind the drinking water and irrigation needs of the people living around the Mahanadi delta in Odisha.

One of the reports states the rise and fall of tourist visits to different parts of Odisha, including the coastal regions around the various sea beaches. The study makes certain recommendations to any agencies targeting better revenue from the tourism industry in Odisha. These recommendations include attempts to conserve the culture of ethnic communities through empowerment and participation, crackdown on illegal activities on heritage sites and restricted permission for construction on vulnerable pieces of land, encouraging ethnic communities to come up with attractive products for consumption of tourists, and a structured approach through which tourism is not merely viewed as a source of income, but as a means of elevating honour of the entire region.

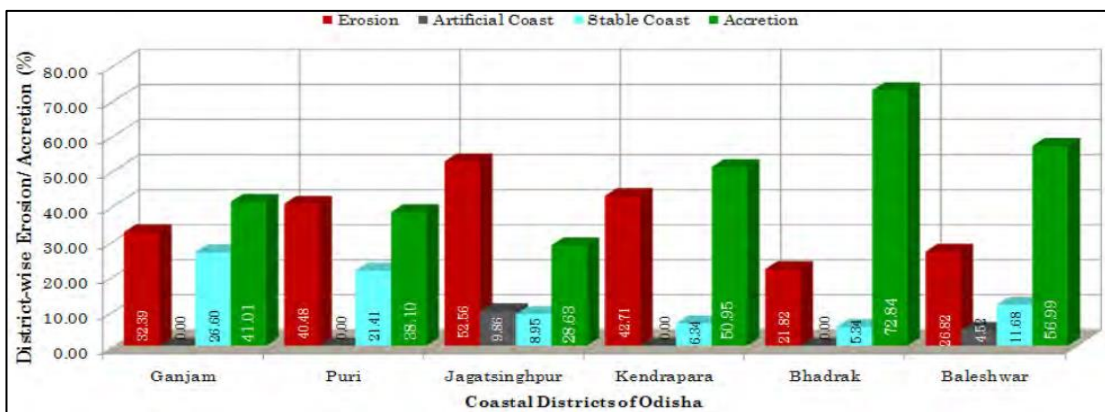


Figure 4 Changes in coastline of the coastal districts of Odisha

Source: Odisha State Disaster Management Authority

According to the state government’s Human Development Report 2004, “property loss has been steadily growing every year over the past few decades due to climate change and disasters”.

As per Global Environmental Negotiation journal, “if sea level rises 1 meter from the current level, 1,70,000 hectares of cultivable land in Odisha will be submerged”.

As per DDMA of Jagatsinghpur, “Sahadabedi gram panchayat in Erasama block is one of the worst affected areas due to cyclonic storms with degradation in natural vegetation along the beach. The Sahadabedi village currently

dominated by the fisherfolk community is at a distance of 450mts. only from the Siyali Sea Beach”.

1.2.1 Vulnerability on the eastern coast of India

Amongst all the SCs and VSCSs recorded since 18th century, most of them had occurred on the eastern coast of India. The reason behind this is that Bay of Bengal is hotter than the Arabian sea due to its compactness and the landmasses surrounding it closely. Also, in addition to the cyclones originating in BoB, the typhoons which originate down south near Malay peninsula, Sulu Sea and Japan Sea move northwards intensifying into cyclones getting all the favourable conditions. Moreover, cyclones building up over Arabian Sea tend to move towards north-west, away from the Indian coast.

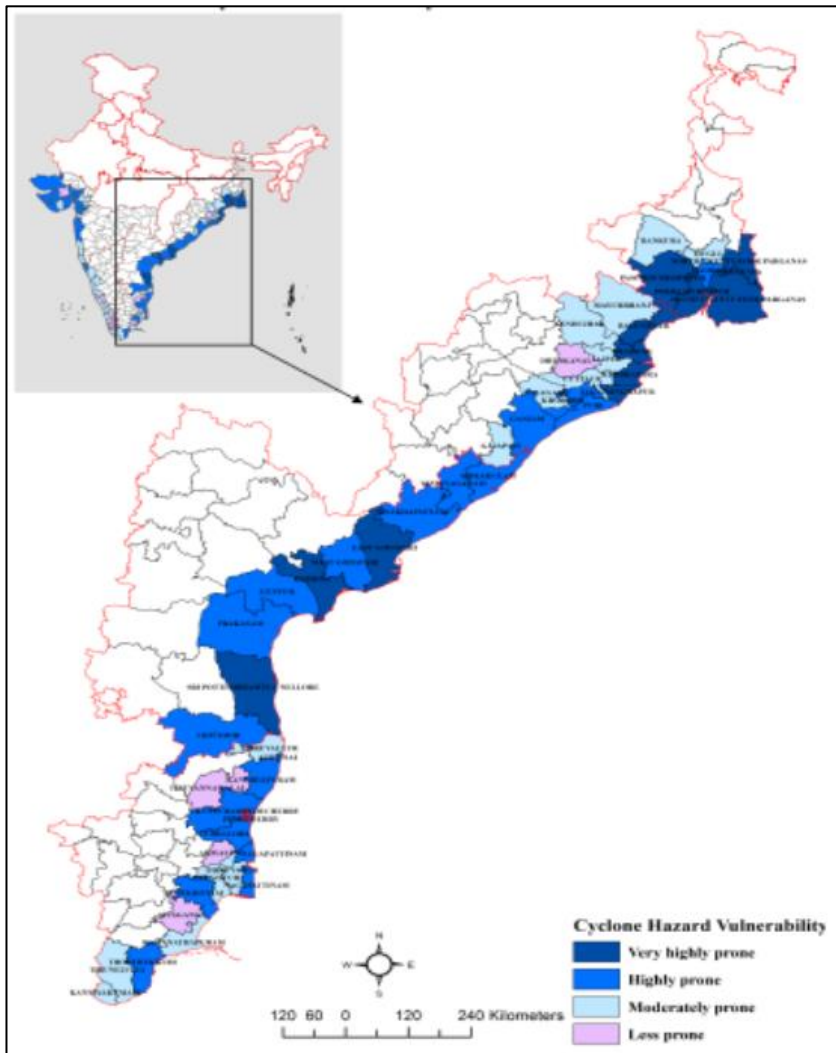


Figure 5 Vulnerability of eastern coast of India on basis of cyclone hazards

Source: Indian Meteorological Department

1.3 Aim, Objectives, Scope and Limitations

Each project has certain aim (goal) which is the final step to be achieved and which defines the viability of the study done. The target is defined by a set of objectives which need to be followed to reach the same and each objective is to be analyzed separately for the ultimate goal.

Now each objective is guided by certain number of expected outcomes or, scope as we can say which are steps to accomplish the objectives. And lastly, there are limitations to the study which mean that they are important for the study but to certain external factors and obligations could not be accomplished at the moment.

1.3.1 Aim

The aim is to reduce the vulnerability due to frequent occurrence of floods and cyclones by means of an integrated approach of Disaster Risk Reduction and Management in Jagatsinghpur district of Odisha.

1.3.2 Objectives

The various objectives pertaining to the thesis are:

- To analyse the vulnerability of CRZ areas within the study area and various influencing factors through literature studies and spatial analysis tools.
- To analyse the vulnerability of CRZ areas within the study area and various influencing factors through literature studies and spatial analysis tools.
- To improve risk reduction and mitigation approaches so as to make the study area and the inhabitants resilient to disasters.

1.3.3 Scope

Each objective has its own set of scope/ expected outcomes as an accomplishment of the project.

Expected outcomes for the first objective are:

- To identify the shoreline changes and understanding the concepts of erosion and accretion through various literature sources.
- Identifying the critical areas using GIS tools and various strategies implemented to mark the same.
- Coastal construction practices and other spatial planning techniques affecting the changes.
- Mapping the loss in vegetation of the study area.

- Mapping the sea water intrusion in the settlements along the coast.
- Identifying the loss in natural habitat of various species from secondary data sources.

Expected outcomes for the second objective are:

- To identify the changes in livelihood of the inhabitants in the study area from detailed primary survey.
- To identify the driving factors of seasonal migration and shifting of settlements frequently.
- To identify the challenges faced by the marginalized sections of the society.
- To identify the gap in the study area with respect to provision for basic infrastructure and housing.

Expected outcomes for the third objective are:

- To encourage community-based participation in mitigating the impacts of disasters in the study area.
- To implement resilient structures and ensure proper maintenance of temporary shelters.
- To provide alternate means of livelihood through spatial planning implementations.
- To enhance the warning strategies before the occurrence of disasters.

1.3.4 Limitations

- The surveys conducted cannot be performed at various seasons or at the time when the disaster has struck.
- Due to limited period of time, surveys cannot be conducted at every village of the affected blocks.

1.4 Understanding the worldwide frameworks for disaster risk reduction

In December, 1999, Un General Assembly adopted the International Strategy for Disaster Reduction and founded UNISDR, the governing body to ensure its implementation and working. Its mandate was further expanded in 2001 to function as the major part of United Nations system in order to build collaborations and coordinate in disaster risk reducing activities, particularly in

socio-economic and humanitarian fields. The scope of its work ranges from DRR in association to climate change, increasing funds for DRR, to developing disaster-resilient cities and infrastructure and strengthening the global concern and strategy for DRR.

Its vision is based on the four aspects laid down in Sendai framework of perceiving the disaster risk, strengthening the governance to properly manage the risk, making investments in disaster resilience strategies and increasing preparedness for optimum response post disaster.

The preparation and follow-up of the Global Platform for Disaster Risk Reduction established in 2006 is led by UNISDR. The Global Platform has become the major international forum for DRR and for the delivery of calculated and comprehensible guidance for the application of the Sendai Framework and lastly, to gather experience from the stakeholders. Other functions of UNISDR includes delivering the Global Assessment Report on DRR after every two years, aiding nations in monitoring vulnerability trends and the implementation of the Sendai Framework for the same, and sponsoring global campaigns on DRR for safer cities and infrastructure.

1.4.1 Hyogo Framework

The first ever plan by UNISDR was the Hyogo Framework for Action which remained in effect from 2005 to 2015. It was formed to have a thorough explanation, description and details of any work required in any sector to minimize losses caused by the disasters. The HFA has mainly five priorities for acting to a crisis situation and they are:

Priority Action 1: Ensure that disaster risk reduction is a national and a local priority with a strong institutional basis for implementation.

As location and physical settings of each country is different and not all countries are affected by similar kind of disaster, it is easier for those countries to tackle with disaster situations which have some kind of DRR policy or institutional frameworks of their own. Also, by having the same, the countries can expect much widespread consensus for aids in DRR measures for and from people of all the sectors of society.

Priority Action 2: Identify, assess and monitor disaster risks and enhance early warning.

The secret to success in case of handling a disaster situation lies in the identifying the economic, social, physical and environmental vulnerabilities the society gets exposed to due to a particular type of disaster and the impacts, both long-term and short-term it will have and then act as per the knowledge acquired.

Priority Action 3: Use knowledge, innovation and education to build a culture of safety and resilience at all levels.

Risk due to disasters can be reduced to a large extent if people are made aware about the benefits of disaster prevention and resilience beforehand, which again requires optimum knowledge about the disasters, its causes and ability to cause destruction.

Priority Action 4: Reduce the underlying risk factors.

While planning for particular area, the disaster risks related to each sector and due to change in land use plans, socio-economic and environmental conditions should be kept in mind and also the effects of global changes like climate change, geological events etc. so that risk related to each sector can be dealt with separately.

Priority Action 5: Strengthen disaster preparedness for effective response at all levels.

At all the three levels of disaster i.e. before, during and after the situation, the losses and affects can be reduced greatly if concerned authorities, stakeholders, and affected communities are well versed with the pros and cons of the disaster and well prepared with measures for effective DM.

1.4.2 Sendai Framework

The Sendai framework came up as the successor of HFA for a period of 15 years which laid down the fact that the State will play the pivotal role in DRR but the responsibility will be followed in collaboration with other stakeholders like local government, PPPs, and communities. The final outcome will be: **“The substantial reduction of disaster risk and losses in lives, livelihoods and health and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries”**.

Priority 1. Understanding disaster risk

DRR should be as per the understanding of a disaster and all its aspects of vulnerability, ability to affect lives and livelihood, capacity and effects on the environment.

Priority 2. Strengthening disaster risk governance to manage disaster risk

Disaster risk governance is extremely important as it fosters collaboration amongst various concerned authorities, both Government and NGOs and public and private enterprises.

Priority 3. Investing in disaster risk reduction for resilience

Investment from both public and private sectors in form of structural and non-structural measures are crucial for enhancing the overall resilience of communities and their resources.

Priority 4. Enhancing disaster preparedness for effective response and to “Build Back Better” in recovery, rehabilitation and reconstruction

Aiming at the proactive approaches of taking precautions in anticipation of any such situation and ensuring capacities are available at all levels for prompt response and recovery are good signs of integrated DRR measures.

1.5 Institutional framework for DRR in India

A crucial step was taken by Government of India when the Disaster Management Act came into force on 23rd December, 2005 which triggered the formation of NDMA, the head being the Prime Minister, SDMA, heads being the chief Ministers of the respective states and DDMA which are headed by District Collector, District Magistrate or Deputy Commissioner, whichever is applicable so as to adopt and implement a holistic and collective approach at all the levels for DRR. It was a paradigm shift from the previous relief-centric approach in which attention was paid only after the disaster had occurred. The new approach aimed towards a proactive approach of “Prevention is better than cure” consisting of preparedness and mitigation measures so as to conserve developmental gains and reduce loss and harm to life, livestock, livelihood and property.

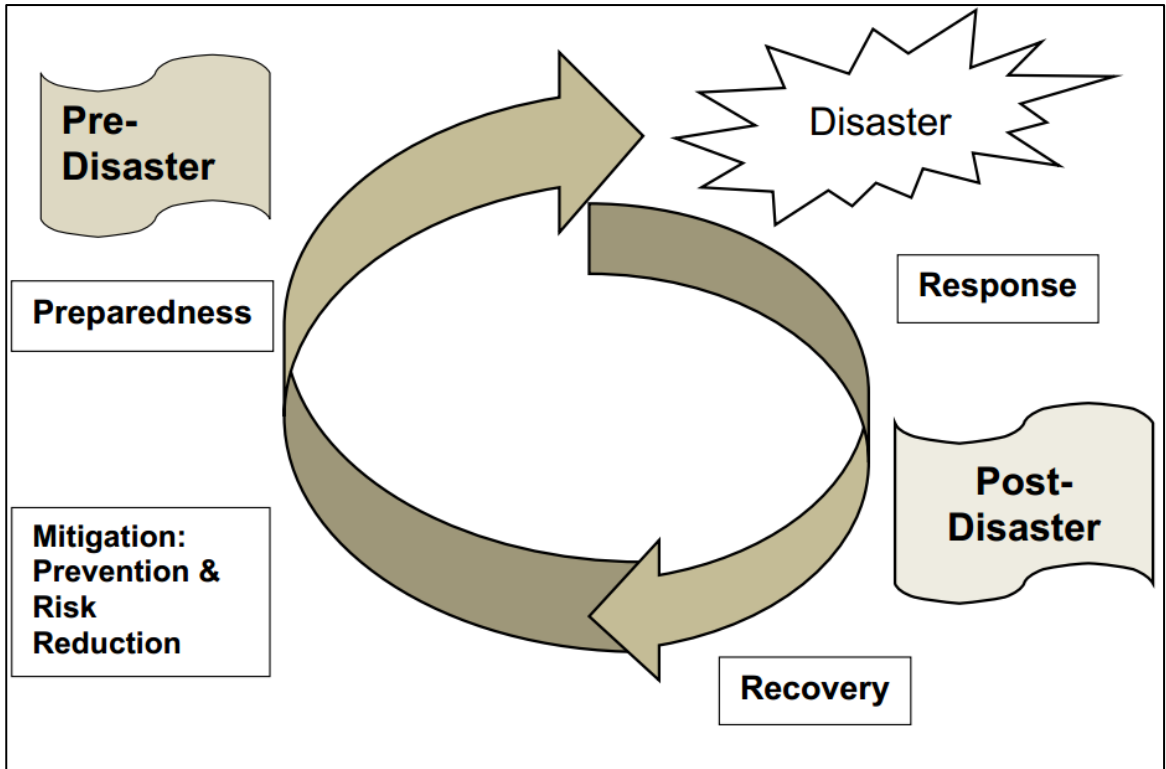


Figure 6 Disaster management cycle

Source: National Disaster Management Authority

1.5.1 National level

Ministry of Home Affairs is responsible for the overall process of DM. The CCS and NCMC are the core committees who take the crucial decisions regarding DM whereas, NDMA is the lead agency which takes the responsibility for making and executing the plans for DM at national level. Usually, it is the responsibility of the State Authorities to act to crisis situations with support from the Central Authorities. The aid provided is dependent on the scale, type of disaster and administrative boundary where it has taken place. Normally, NDMA takes action on request of the State bodies, but if direct support is required, it might extend its assistance regardless the typology of the disaster.

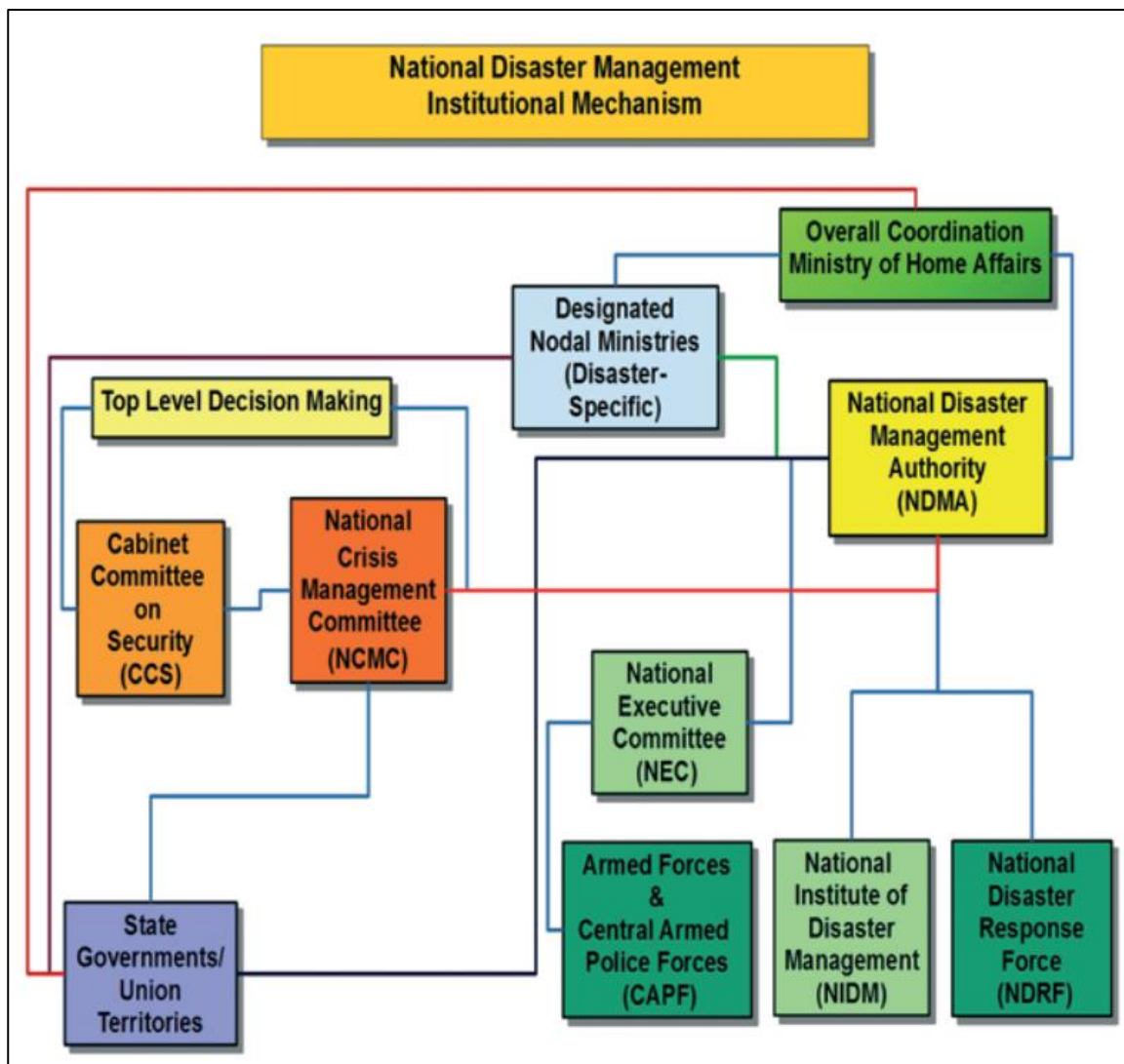


Figure 7 Basic institutional framework of national level disaster management

Source: NDMA

1.5.1.1 National Disaster Management Authority

The major functions are to lay down and implement policies and guidelines regarding DM, control the State Authorities and Central Ministries handling various disasters and is the body responsible for approving NDMP and other DM plans of respective Ministries of GoI.

1.5.1.2 National Institute of Disaster Management

Its major activities include research regarding various aspects of disasters, and conducting the social aspect of a DM programme that is, to spread awareness, provide training facilities to various institutes with specialisation in handling disasters, conducting training programmes in affected areas and enhancing

human resource development by promoting capacity building within the affected communities.

1.5.1.3 National Disaster Response Force

NDRF's duty is to provide immediate assistance to State and District authorities during breakthrough of any disaster following the aftermath as well.

1.5.1.4 National Executive Committee

The key functions of NEC can be divided into monitoring and coordinating. It is responsible for assisting the NDMA while formulating the guidelines, coordinating with heads of DM authorities at various levels, NDRF during crisis situations and IMD personnel for early warning and disseminations system.

1.5.1.5 National Crisis Management Committee

NCMC oversees the monitoring and coordinating functions, controls the Crisis Management Group and gives suggestions during crisis situations as required.

1.5.1.6 Cabinet Committee on Security

CCS conducts the evaluation of security level from national perspective, oversees all the aspects of DM for CBRN emergencies and updates direction for mitigating risks time to time.

Table 1 Nodal ministry for management/ mitigation of different disasters

Sl No.	Type of Disaster	Nodal Ministry/ Development
1	Biological	Ministry of Health and Welfare
2	Chemical & Industrial	Ministry of Environment Forest and Climate Change
3	Civil Aviation Accidents	Ministry of Civil Aviation
4	Cyclone/ Tornado	Ministry of Earth Sciences
5	Tsunami	Ministry of Earth Sciences
6	Drought/ Hailstorm/ Cold wave/ Frost/ Pest Attack	Ministry of Agriculture and Farmers' Welfare
7	Earthquake	Ministry of Earth Sciences
8	Flood	Ministry of Water Resources
9	Forest Fire	Ministry of Environment Forest and Climate Change
10	Landslides	Ministry of Mines

11	Avalanche	Ministry of Defence
12	Nuclear and radiological emergencies	Ministry of Atomic Energy
13	Rail accidents	Ministry of Railways
14	Road accidents	Ministry of Road Transport and Highways
15	Urban accidents	Ministry of Urban Design

Source: NDMA

1.5.2 State level

According to the DM Act enforced in 2005, it is mandatory for all the states to have an institutional framework of their own for DM which will be responsible for preparations of SDMPs, allocation of funds for the same and establish EWS. During times of need, State Governments shall also assist Central agencies in various sectors of DM.

1.5.2.1 State Disaster Management Authority

Every state should have a SDMA or equivalent body headed by the Chief Minister of the states whereas, in case of UTs, it will be headed by Lieutenant Governors and in case of Delhi, the Lieutenant Governor and the Chief Minister will be Chairperson and Vice-chairperson respectively. The State Government shall create a State Executive Committee (SEC) to support the SDMA in performing the functions. The SEC head will be the Chief Secretary to the State Government. Monitoring and coordination of the National Policy, the National Plan, and the State Plan will be done by the SEC.

1.5.2.2 District Disaster Management Authority

Every State Government shall form DDMA for every district which will be headed by Deputy Commissioner, District Collector or Magistrate, whereas the co-chairperson shall be the elected representative by the local authorities. An officer not beyond the rank of Additional Collector, Additional District Magistrate or Additional District Collector shall be chosen to serve as the Chief Executive Officer of the DDMA. It works in association SDMA and NDMA in handling a disaster situation and in planning, implementing and monitoring of DM within the district.

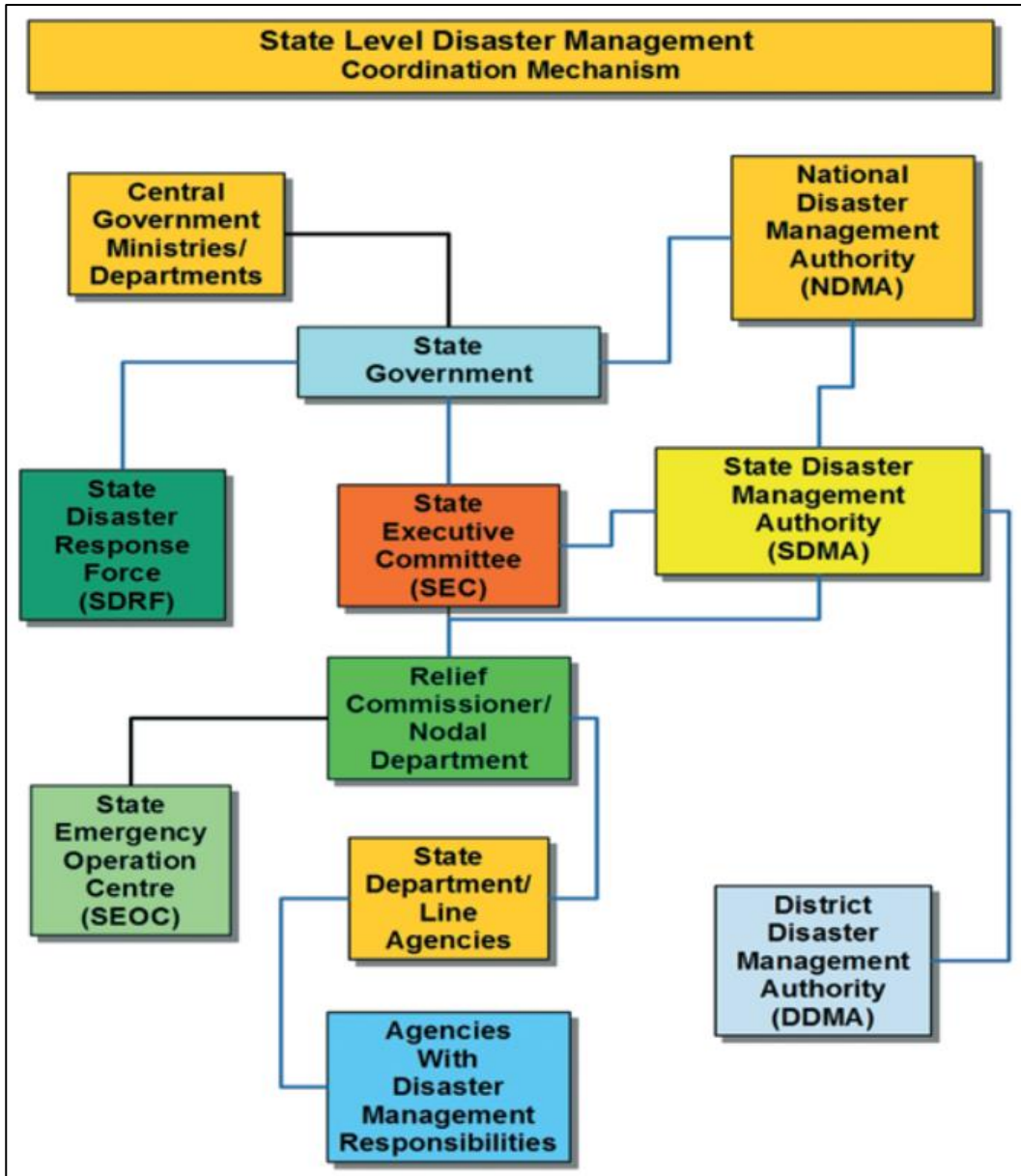


Figure 8 Basic institutional framework for disaster management at state level

Source: NDMA

1.6 Organization of thesis and chapter outlines

The thesis is built up on studies done on different levels, global, national, local and household. It covers the perception of disaster and DRR techniques as perceived by various levels and ranging stakeholders. The chapters are organized as per the development of the study and the defined set of objectives.

In Chapter 2, I have done the literature review on disasters, various approaches to face a disaster situation and the four types of study i.e. concept based,

approach based, methodology based and case specific. The main motto of this chapter is to understand the various underlying concepts and document the key findings so that they can be used as further interventions in the upcoming study.

In Chapter 3, I have discussed the empirical context of the study area which portrays a picture of the current scenario and the vulnerabilities due to the disasters which had been documented and observed from previous studies. The real situation of the fishing and the agrarian communities, their daily struggles have been upheld in the chapter which will aid in identifying the parameters on which the questionnaire will be framed for the primary survey and determining the tools for analysing the survey data collected during the site visit.

In Chapter 4, the location and physical settings of the study area has been discussed in two levels: micro and macro. Macro level aims towards the situation of the entire district, its land use, the existing physical infrastructure and the water bodies draining the entire area. Micro level pinpoints the specific locations which have been chosen on basis of particular parameters and zooms up to the minute details particularly land use, vegetation and geomorphological features.

In Chapter 5, I have documented the method followed to achieve each objective step by step. Details about each of the tools, their parameters, gap identification for each aspect is discussed. Also, the amount of data collected, and the issues while collecting the data have been discussed in the chapter.

In Chapter 6, possible interventions to overcome the issue/ challenge identified in the beginning of the study have been discussed. The different structural and non-structural approaches to reduce the risk of floods and cyclones in the study area are covered in this chapter. The last part contains the research areas which is beyond the scope of my study but are relatable. Few aspects could not be incorporated in the study due to various constraints and those can be the subjects of study in line of the study done by me.

1.7 Conclusion

This chapter is an overview of the previous scenario in the study area regarding the notable disasters which had a long-lasting impact and how the people and concerned authorities had acted to the same. The viability of the study is then established through various identifiable parameters from economic, social and environmental viewpoint. I have also covered the final aim, objectives, scope of each objective and certain limitations for conducting this particular study. Lastly, I have tried to show what is going on worldwide aspiring to reach the goal of the study. This chapter forms the base of the next chapter that is, the literature review which is done in light of the defined aim and objectives.

CHAPTER 2: DISASTER RESPONSE, PREPAREDNESS AND RECOVERY: LITERATURE REVIEW

2.1 Introduction

Before proceeding further, it is important to have an idea about the various aspects of a risk or hazard. Any natural hazard becomes a disaster only when it comes in contact with human beings and settlements. Living organisms have the ability to perceive something as a “risk” and then act on it. The first part of the review deals with the ideas and methods of perceiving, acting to and managing a risk situation.

The second part deals with the various approaches regarding how such a situation can be dealt with. There can be either ad hoc solutions or planned ones which are implemented after studying each and every aspect of the disaster and the affected communities.

The last part consists of the various studies required for progressing further with the analysis and interventions. It can be divided into four types of studies namely, concept-based, approach-based, methodology-based and case studies. In a way, the literature review is the amalgamation of whatever analytical methods I have used and the possible interventions suggested.

2.2 Risk perception

Perceiving risk is the subjective judgemental quality people are endowed with to measure the severity or ability to cause harm by a natural hazard. Normally, this term is used in case of grave problems like environmental impacts, health, climate change etc. There are several theories which are used by different people as per the situations to get an idea about the seriousness of a hazard. Mainly three theories exist in determining how deadly a hazard can become and convert to a disaster to the affected community on basis of their psychological approach (heuristic and cognitive), cultural (sociological and anthropological approach) and interdisciplinary approach which involves the thought process of experts from all fields.

2.2.1 Heuristic v/s cognitive approach

The earliest known psychological approach was given by Daniel Kahneman and Amos Tversky who after a series of experiments gave the conclusion that people use quite a number of heuristics while perceiving a risk, which enable

them to rule out all other factors except one, and act accordingly. Even though it works most of the time, often the solutions lack logic as they are taken in moments rather than after a steady thinking process. Heuristic approaches can be useful when there is a lack of early warning system and the disaster strikes unexpectedly.

Cognitive approaches on the other hand require calculative thinking, extensive research and scientific methods to act to a risk situation. However, people tend to give more importance to immediate hazards rather than something which has a gradual but deadly effect on long term basis like environmental degradation or climate change. As all the people are not directly affected by the same on a regular basis, they fail to realise the importance of taking measures to mend the situation even after repeated studies and appraisals given by the experts. In case of disaster situation also, the long-term planning therefore, needs to be done by concerned authorities with help from few interested community members who understand the gravity of the situation and value of required actions taken to mitigate the disaster.

2.2.2 Cultural approach

These include extensive studies by social scientists and anthropologists and the approaches are community and region specific as various people possess various constraints regarding perception of the risk. The socio-economic and the cultural setup of a community determine the exposure level towards a risk. A very good example is the social stratification in which people from various classes of the society get exposed to the risk but the levels vary. In a country like India where caste system is predominant, often the lower caste people fail to avail the infrastructure provided to overcome the disaster. Such situation demands separate approaches for separate group of people. Also, gender bias is an example of cultural approach. The vulnerability of women increases manifold before, during and after disaster due to the estranged gender role they

have to play. Depending on the community one is planning for, hierarchical¹, individualist², egalitarian³, and fatalist approaches should be chosen.

2.2.3 Interdisciplinary approach

SARF or Social Amplification of Risk Framework adds up studies from various social science and applied science branches and tends to find linkages in the same. The framework tries to explain why, when and which risk will be amplified, how people will take it and whether it will receive public attention.

These ripple effects triggered by the intensification of risk include long-lasting mental perceptions, influences on business sales, and variations in residential property values, changes in education, training and awareness or social disorders. These secondary impacts are again seen as risk by the people and they react to it causing third order problems. As the chain goes on, the order gets higher and ripples to other locations and parties.

2.3 Risk communication

Risk communication is the way one behaves or acts in a crisis situation. This behaviour is crucial as it involves the process of letting other people know about the disaster and making them aware of the same. Experts believe it to be a scientific approach as it requires nerve to behave in a matured way during situations of high crisis, stress and controversy.

Its motto is to help people understand how to understand and manage a risk and thus, proper and valid perceptions are created about a hazard which lets people take decisions more strategically. Risk communication approaches can be verbal, written or visual documents containing integrities about the risk.

The ideal way to communicate is to keep a particular risk in context, compare it with other kinds of risks, making the people aware and encouraging them to communicate with the concerned authorities. It is a two-way line where both the message giver and receiver should speak for effectively managing the situation.

1 Approach as per priorities or level of importance

2 Approach where decisions are taken interests of a single person taking into consideration that other people will be of the same views.

3 Approach considering all people to be equal despite their social, economic or cultural background



Figure 9 The cycle of risk communication and management

Source: United States – Environmental Protection Agency

2.4 Risk management

Risk management involves identification, calculation and prioritization of the “fateful” events and then take necessary steps as per the social and physical settings and economic resources to lower the fatalities involved with the risk or find some way to benefit from the event afterwards. For example, if a cyclone occurs, it has to be decided what is the priority, whether it is to evacuate the people to safer places or rebuild the houses. Similarly, in case of floods, after the water has subsided, the area becomes rich in silt which is extremely useful for agriculture.

2.5 Key findings

Concept based/ Theoretical background – past, present or future from where the various definitions have been derived and the history of the study area in respect to the topic is done.

Approach based - Previous findings and Rationale and/or relevance of the current study majorly help in the scope if relevant measures which can be taken to ease out the problems and can be multi-dimensional, given the type of intervention one intends to use in his/ her study.

Methodology and/or research methods give a clear picture regarding how the various tools for analysis have been use before in other cases and help us to build our own set of parameters for further evaluation of the collected data.

Case studies/ Best practices – previous or contemporary is a documentation of all works done till date to tackle the same kind of issues faced in similar kind of situation, in this case the major parameters being geographical settings and climate.

2.5.1 Concept based literature

The various definitions obtained from literature review are:

Climate change is a global change in the climate for over a long period of time. It is a gradual but steady change and can be witnessed in the increase in temperature, changing patterns of rainfall, untimely monsoon and increase in natural hazards. There are a number of anthropogenic factors which give rise to climate change. Paris Agreement made an effort to combine all the participating nations to combat against the odds of climate change and find out means to get adapted to the changes brought by climate change so far.

Disaster is a situation where life, livelihood, livestock and properties are in stake in large scale. According to UNISDR, there is nothing called “disaster”. There are natural or man-made hazards which when come in contact with the human beings and settlements turn into “disaster”. The impacts can be perceived only when it affects people and their assets.

Cyclone can be defined as a large mass of air moving in spirals with an extremely low-pressure zone as the centre. Cyclogenesis is the procedure of formation and strengthening of cyclone in favourable conditions like warmer surface temperature, location of landmasses etc. The low-pressure point is commonly called the eye of the cyclone and we know, wind flow from high pressure to zone to low pressure zone, strong winds start making spiral formation and come gushing towards the eye. As the cyclone traverses its way over the massive waterbodies and finally reached the coast, it wreaks havoc as it enters the settlement areas in the coast. As the eye now gets shifted on the land, that area is called the landfall. This is the lowest pressure area on the land and suffers the maximum losses.

Flood is usually defined as submergence of lands which normally remain dry. It normally happens in waterbodies due to heavy precipitation, usually which is a seasonal phenomenon but can be triggered by other hazards like tsunamis and cyclones as well. It is characterized by overflow of water from the banks of

rivers and streams and more the concentration of rivers in an area, the greater is the risk. Floods are more common in delta forming rivers as in the lower course of the stream rivers either break into distributaries or are joined by tributaries and during rainy season become full and flood the banks.

Flood plains are the areas lying between and surrounding the main rivers and their distributaries. These are the areas which gets flooded and affected the most.

Vulnerability is the extent of helplessness of individual, individuals or communities in case of natural hazard and it depends on the physical settings of the place, socio-economic and cultural constraints of the affected people and the condition of the environmental factors in that area.⁴

Mitigation is the way to reduce the impact of natural hazards on the communities and is done by embracing both proactive and reactive measures. It will involve preparedness, response and recovery. Proactive measures are required as if we are not prepared for it, the penalties can be fatal

2.5.2 Approach based literature

As India has a history of getting affected by various types of disasters, various documentation had been done before as well. The efforts to combat against the disasters have changed over due course of time. It was required that we have some guidelines or framework which can be followed to reduce the impacts. Gol took a celebrated step when Disaster Management Act came into being in 2005.

Even before that India has the record of having the oldest policy code for disaster dated back in 1880, just after the Great Famine broke out 1876. India had been following the Five Year National Plans although they were not there on a rolling basis.

The Tenth Plan from 2002 to 2007 had a detailed chapter regarding Disaster Management It came a long way after then and when the 1984 Bhopal Gas Tragedy shook the people, Environment Protection Act was passed in 1986.

⁴ Environment tries to put a check always as it has defence mechanism of its own but if the factors only are degraded they will tend to work against the humankind.

Environment Impact Assessment is included in a section under EPA only and it was again revised in 2006, which include the assessment of any upcoming or existing project on the environmental factors of that area.

1991 saw the emergence of Coastal Zone Regulation Act with a view to protect the eco-sensitive areas along the coast. It covers the guidelines for the development of any kind of infrastructure, livelihood and industries along the coast. It has been notified from time to time and the recent notification came in 2018.

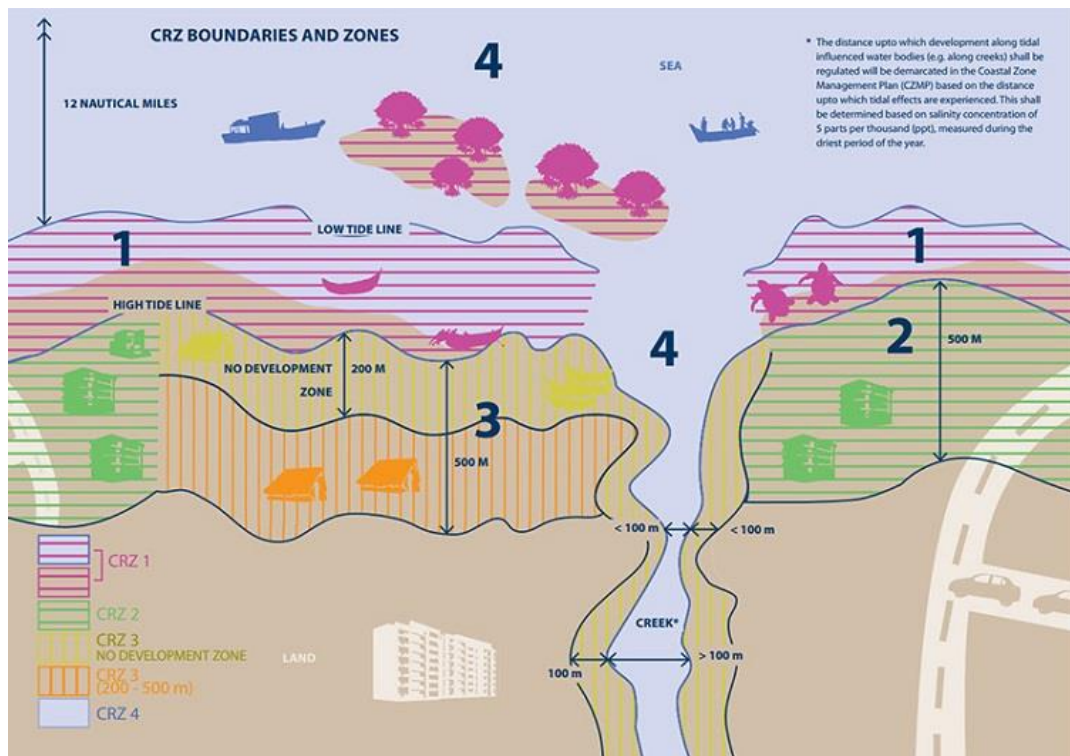


Figure 10 Denotation of the four zones as described in CRZ Act

Public Liability Insurance Act was enforced by Gol in 1991 which enables a person to have provision of immediate relief who are engaged in activities involving direct handling of hazardous substances.

The paradigm shift was the DM Act in 2005 which provides the legal institutional framework for management of disasters. The various levels, their functions, inter-linkages and sphere of work had already been discussed in the previous chapter.

2.5.3 Methodology based literature

Mainly documents covering the calculation of CVI for various coastal parts of Odisha and India and how the parameters have been taken into consideration

are the ones which have proved useful in determining the set of parameters for my study area and topic. CVI had been involved for the past few decades and in the very first go, only a set of six parameters were used. The formula is derived from a complex model and numerical process which allows any set of parameters, let's say "n" and assign ratings of low, medium or high vulnerability as per the location and settings of the concerned area. Another important finding from these literature sources is having an idea about the sources of the data regarding the various geomorphological and bathymetric parameters.

The process is also explained clearly and it can be done in two ways: either manually by feeding data for each division of the study area and then calculating the overall rating of the same or feeding data to the software InVEST, under which there is a Coastal Vulnerability section which calculates the CVI for any particular area in one click.

Two cases have been studied in detail for having a proper understanding of this method. One is the application of CVI in the island of Oahu involving a total of six parameters. The data had been obtained from various sources which are fed into the software designed to calculate the CVI i.e. InVEST.

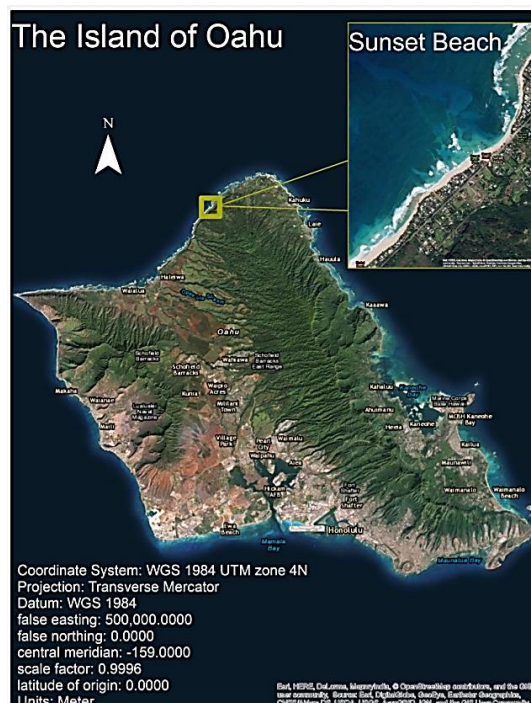


Figure 11 Location of Sunset Beach

Source: Report by Mark Marchant, 2017

The model used in this study comprises of the following input parameters: Output area, Workspace location, Area of interest (AOI), Polygon shapefile of the land, Bathymetric data, Relief data (in metres), Vertical datum (MSL in metres), Model resolution (in metres), Effect of oceans (distance in metres), Geomorphological features, Sea level rise (in metres), Contour level depth (in metres), Population data, and exposure to the sea (distance in metres). The spatial resolution of the model will be equal to or greater than 250 metres.

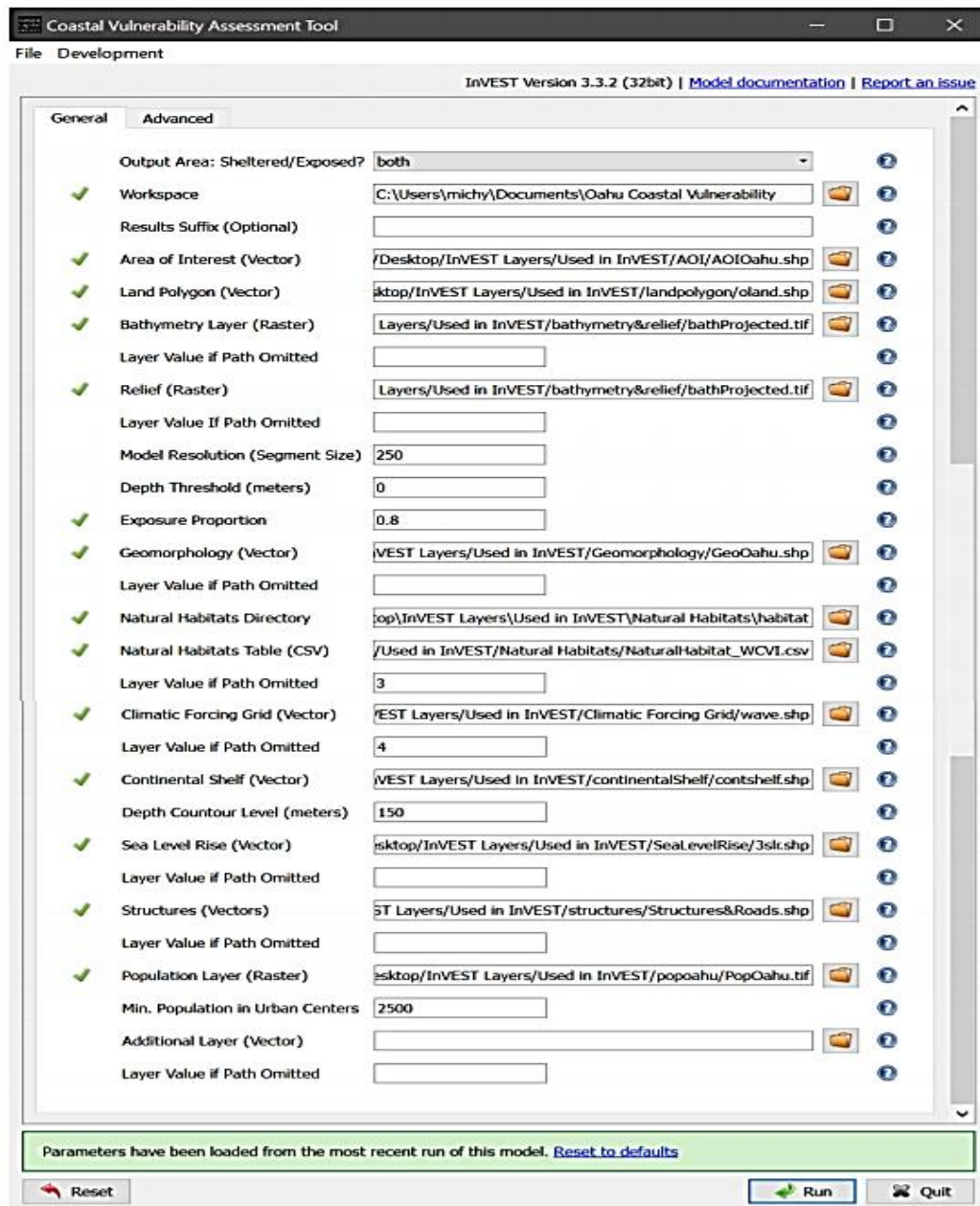


Figure 12 Workspace for calculating CVI in InVEST

Source: Report by Mark Marchant, 2017

Table 2 Parameters used and their ranking system for coastal ecosystem

Rank	Very low	Low	Moderate	High	Very high
Variable	1	2	3	4	5
Geomorphology	Rocky, high cliffs, fjords, seawalls	Medium cliff, indented coast, bulk heads	Low cliff, glacial drift, alluvial plains, rip-rap walls	Cobble beach, estuary, lagoon, bluff	Barrier beach, sand beach, mudflat, delta
Relief	0-20 percentile	21-40 percentile	41-60 percentile	61-80 percentile	81-100 percentile
Natural habitats	Coral reef, mangrove, coastal forest	High dune, marsh	Low dune	Sea grass, kelp	No habitat
Sea level change	0-20 percentile	21-40 percentile	41-60 percentile	61-80 percentile	81-100 percentile
Wave exposure	0-20 percentile	21-40 percentile	41-60 percentile	61-80 percentile	81-100 percentile
Surge Potential	0-20 percentile	21-40 percentile	41-60 percentile	61-80 percentile	81-100 percentile

Source: Report by Mark Marchant, 2017

The second study was from Odisha, India and the CVI had been calculated manually in this case without the use of software. The area selected was the coastal stretch between Puri and Gopalpur mainly for the safety of fisherfolk community of the area.

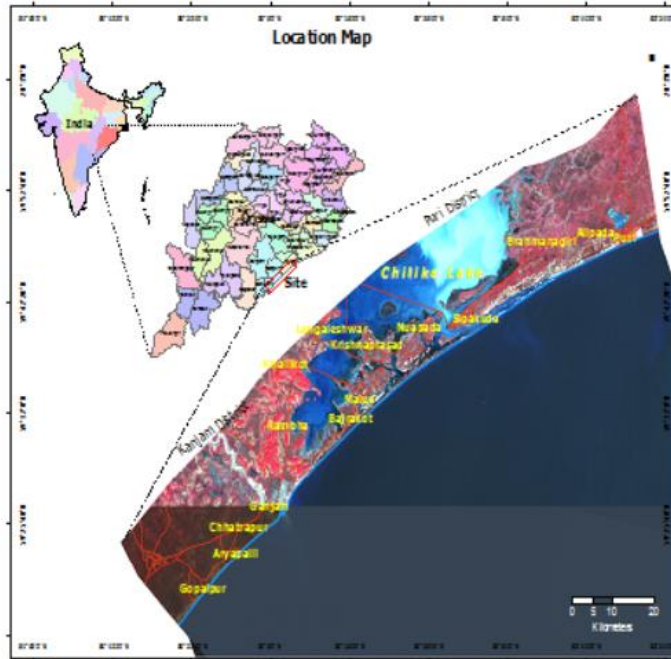


Figure 13 The study area in Odisha

Source: Journal paper by International Journal of Engineering and Research, 2015

Nine variables were selected and rated into five categories. The entire area was divided into grids of 1kmx1km and then values for each square was given as per the parameters. After adding up the values, the result was divided by the number of parameters. The square root of the obtained result is the CVI for that particular grid.

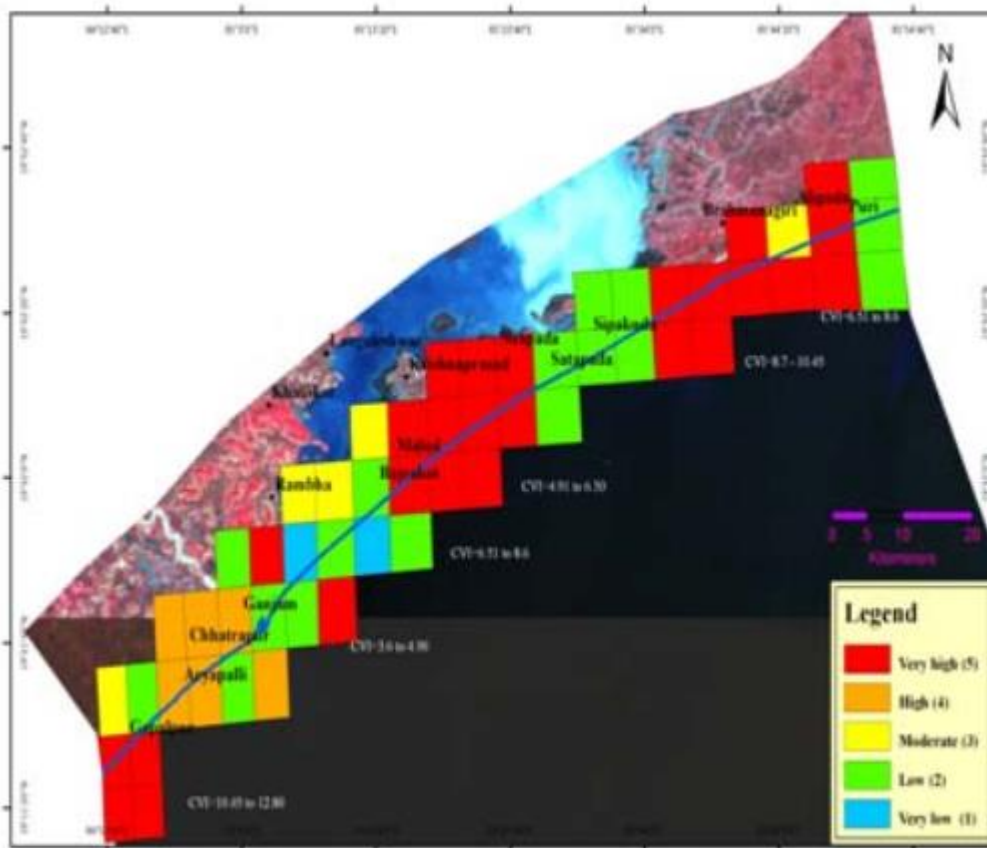


Figure 14 Coastal Vulnerability Map of Puri-Gopalpur coast

Source: Journal paper by International Journal of Engineering and Research, 2015

Table 3 CVI values for various stretches of the study area

CVI Index	Station	Category	Length of the coastline
10.46-12.80	Gopalpur, Aryapalli, Alipada, Puri	Very high	41.25kms
8.7-10.45	Chatrapur, Rambha, Brahmangiri	High	19.45kms
6.51-8.6	Malud, Ganjam	Medium	39.26kms
4.91-6.05	Satpada, Nuapada	Low	13.74kms

3.6-4.90	Krishnaprasad, Bajrakol	Very low	14.35kms
----------	----------------------------	----------	----------

Source: Journal paper by International Journal of Engineering and Research, 2015

Now, for the analysis of the socio-economic variables, two papers were followed, one study was done for Brguna district of Bangladesh and the other one for six blocks of Balasore, Bhadrak and Ganjam districts of Odisha, India. SEVI or Socio-economic Vulnerability Index have been used to analyse the parameters. The data have been acquired from secondary sources and Primary survey of sample households for which questionnaire was prepared. Analysis is done by Microsoft Excel 2010 and Statistical Package for Social Sciences, version 20. After much discussion with disaster management experts, a list of 29 parameters were shortlisted and rated as per different research papers. As per IPCC’s definition of vulnerability these parameters were categorised into three classes: sensitivity, risk exposure and adaptive capacity. The values for all the parameters were fed into the work file of Excel and then the final value was calculated for the study areas.

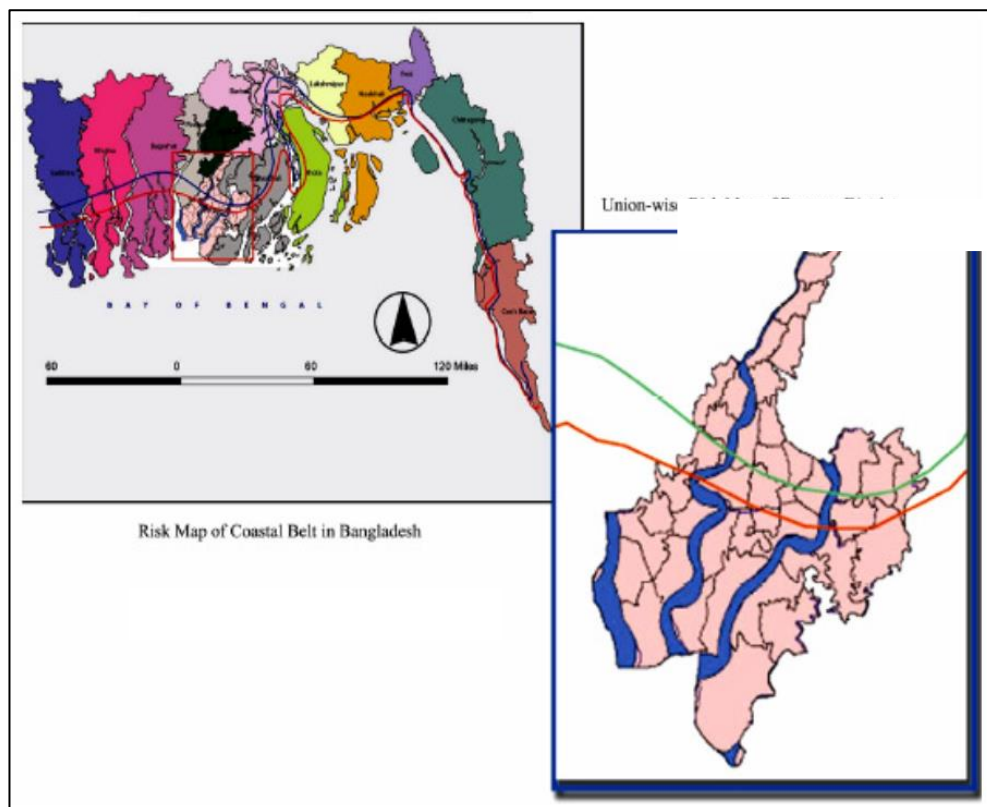


Figure 15 Barguna district of Bangladesh

Source: Journal paper, Bangladesh Institute of Planners, 2009

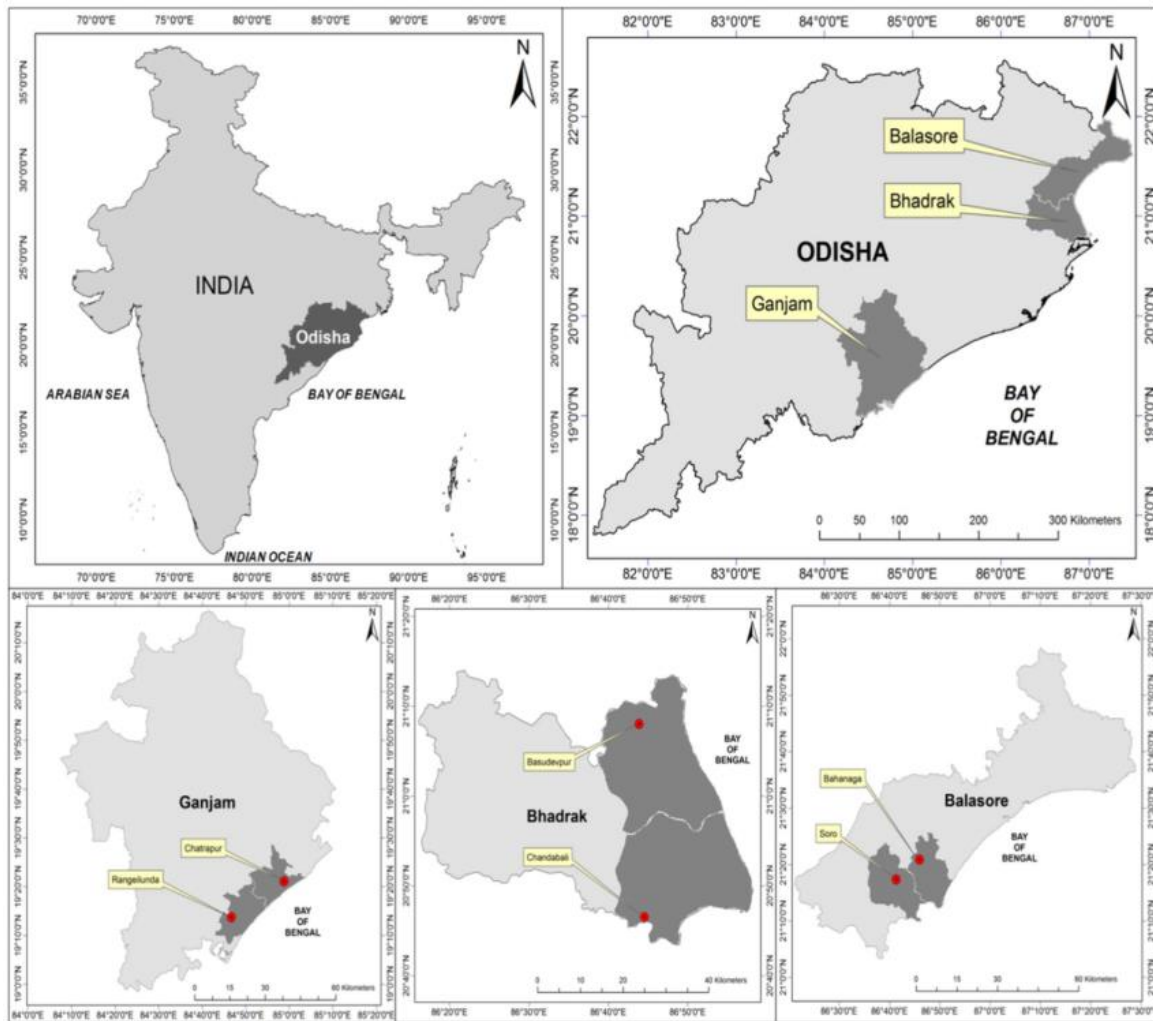


Figure 16 Study area of three districts of Odisha

Source: Journal Paper, *International Journal for Disaster Risk Reduction*, 2017

2.5.4 Case studies

In case of the Mekong Delta, they have discussed the outburst of floods on an annual basis in the Mekong river, and how it has become an integral part of their living. As it goes “Necessity is the mother of invention”, the frequent floods have taught them how to “live with the floods”, which counts for how to use the impacts of floods to their own benefits for example, the rich alluvial soil for agriculture. Opting alternative means of livelihood, other varieties of crops and structural measures like embankments and dykes, whereas holding the community at a very important position had helped them to come a long way in tackling with the issues. Embankments, seawalls, implementation of man-made sand features and artificial coasts area some of the structural features induced in the area.

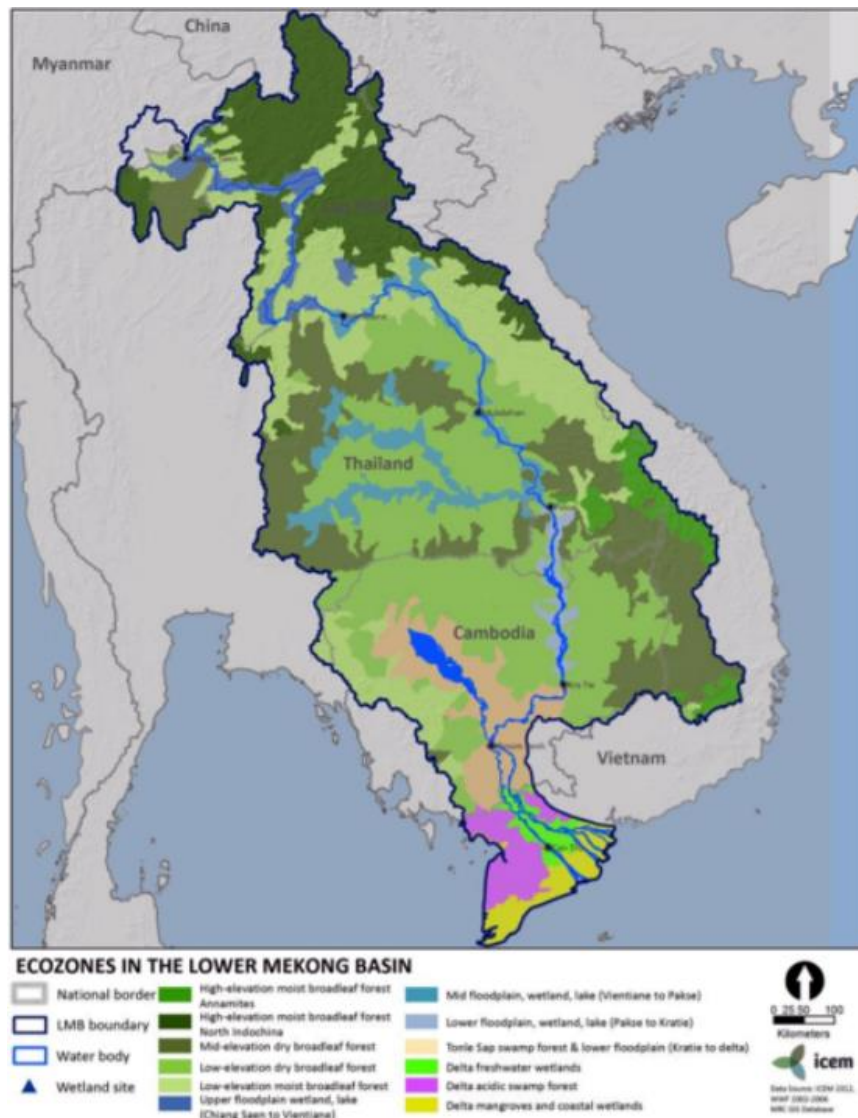


Figure 17 Location of Mekong Delta

Source: Project Report, Stockholm Environmental Institute, 2017

India also had made notable progress in the field of disaster management after DM Act came into being. For example, in case of Phailin only, millions of people were evacuated to high grounds and even though it had the same intensity as the 1999 super cyclone, the death toll were much less as compared. A commendable job was done by IMD in tracking the cyclogenesis beforehand and early warning to the fisherfolk communities of Gopalpur, where it made its landfall. India lacked cyclone shelters back in 1999, which had affected the relief work post disaster recovery. Moreover, communication is a huge issue which had been mended over the time in form of mobile towers, internet facilities, and All-Weather Information Centres along the coast. As Rushikulya beach in Gopalpur emerged out as one of the

leading tourist centres in Odisha owing to the breeding of endangered Olive Ridley turtles, special attention was given to upgrade the disaster management issues.

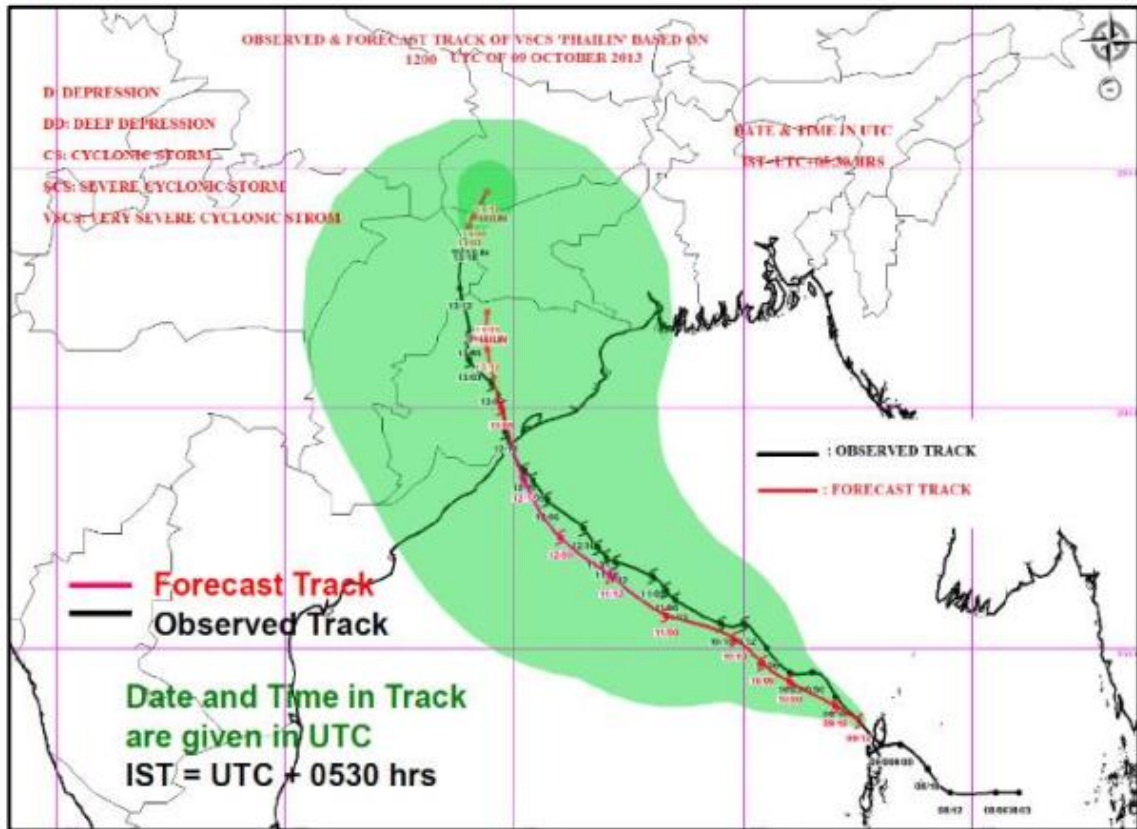


Figure 18 Forecast verification of source of Cyclone Phailin

Source: Report, UNISDR, 2017

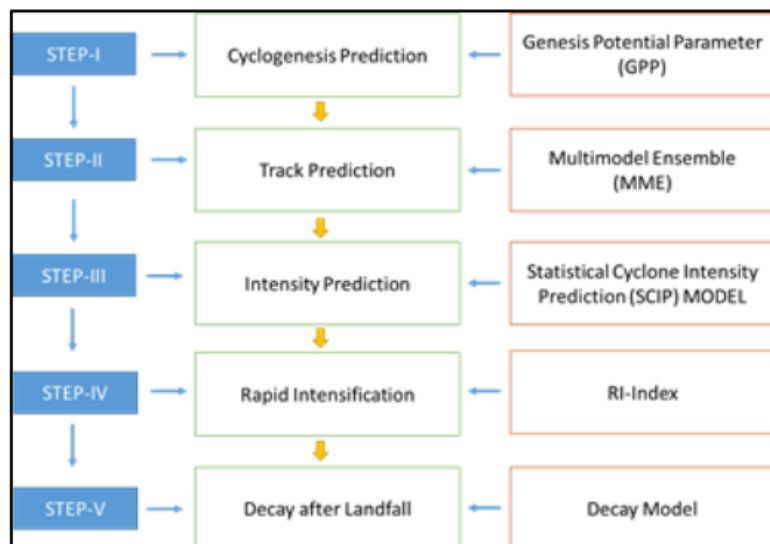


Figure 19 Numerical Weather Predictor based Objective Cyclone Prediction System

Source: Report, UNISDR, 2017

2.6 Conclusion

The final conclusion derived from all the sets of literature is that many parts of the world are experiencing similar kind of situations and that are not totally impossible to prevent, at least the catastrophic impacts can be reduced to a large extent if the methods are followed strategically and equal importance is given to the suggestions of stakeholders at each level. Before that, creating a solid database is extremely important without which it is impossible to measure the risk factor of any area and act accordingly.

CHAPTER 3: EMPIRICAL CONTEXT

3.1 Introduction

The study is contextualised in this chapter as it provides the background of the power and conflicts of environmental justice prevailing in the areas. CRZ regulations came into being later in 1991 but the rural settlements had been existing before that. Special attention should be given while making any development in these villages as many of them fall in the eco-sensitive zones. Also, the important role the agrarian and fishing communities play and how their livelihoods have change over due course of time has been discussed. The power that the heads of fishing committees and village panchayats hold and the conflict with the State is important while discussing the environmental degradation of the area. The issue of environmental ethics and the evils of Prisoner's mentality also comes into play, particularly in case of fisheries.

3.2 CRZ regulations in Odisha

Odisha has a coastline of almost 480kms and shared by six of the districts namely, Balasore, Bhadrak, Kendrapara, Jagatsinghpur, Puri and Ganjam. The entire coast consists of many eco-sensitive areas like Hukitola Bay-Bhitarkanika mangrove ecosystem, exposed sand beaches (casuarina vegetation), Mahanadi delta, Jatadharmohan and Devi river estuary (numerous coastal features like mudflats, creeks and sandbars). Gahirmatha also serves as the largest breeding ground for Olive Ridley turtles whereas the Bhitarkanika mangrove ecosystem is home to largest salt water crocodiles and horse-shoe crabs. All these eco-sensitive areas come under CRZ I along with the entire stretch which is 500mts from HTL. Few urban agglomerations are there along the coast like Puri Sadar, Paradip Port Area, Dhamra Port Area and Brahmapur Sadar where regulated developments are allowed and they come under CRZ II. Most of the areas beyond 500mts of HTL fall under CRZ III areas which comprises of small fishing and agrarian villages. Towards the seaward side, there are few deserted islands which come under the CRZ IV category. CRZ recently passed new notification in 2018, which divides CRZ III areas further into two sub-categories CRZ III-A and CRZ III-B on basis of population density of the villages and imposed new regulations for making any new

development in the same. These notifications will be enforced once the ICZMPs have been updated and they have complied with the new notifications.

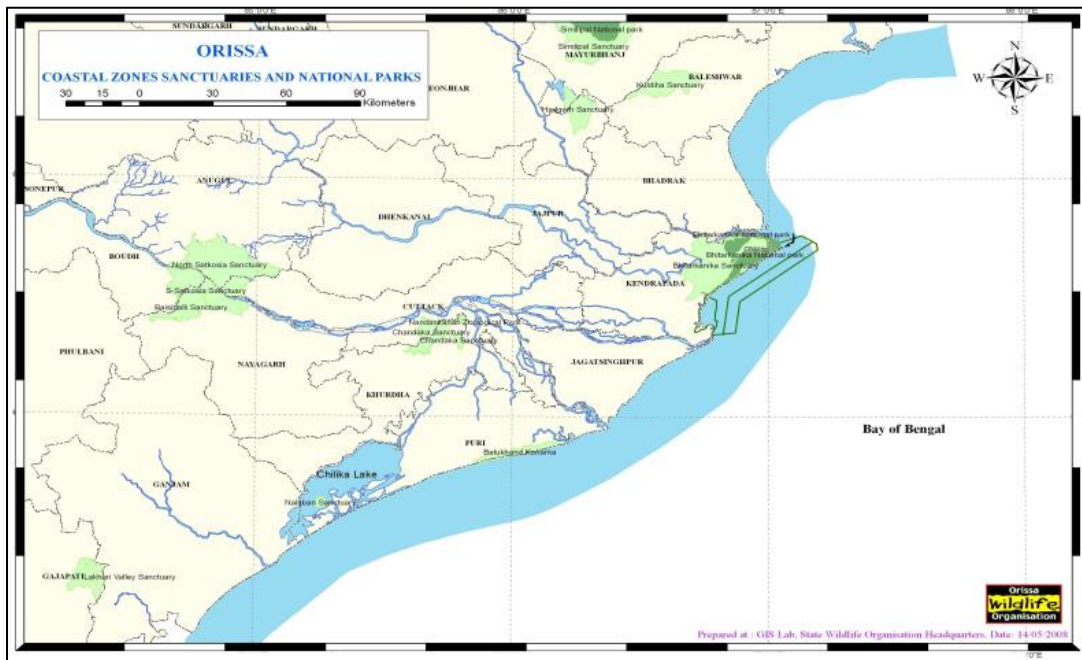


Figure 20 National parks of coastal Odisha

Source: Project report, SCZMP, Odisha, 2012

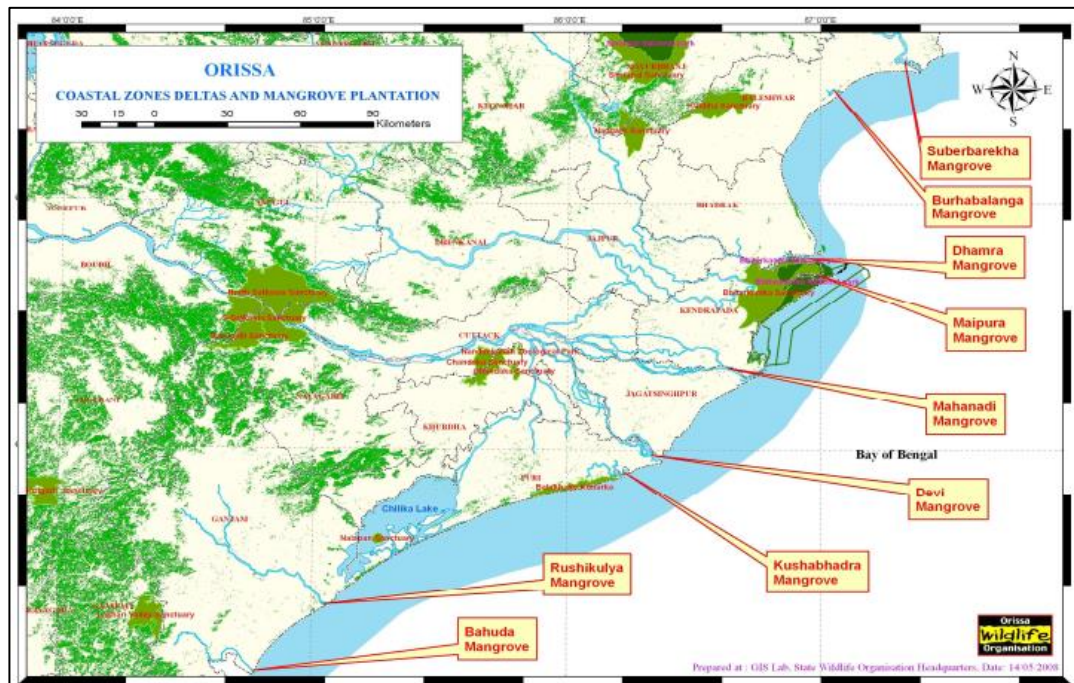


Figure 21 Mangrove covers in coastal Odisha

Source: Project report, SCZMP, Odisha, 2012

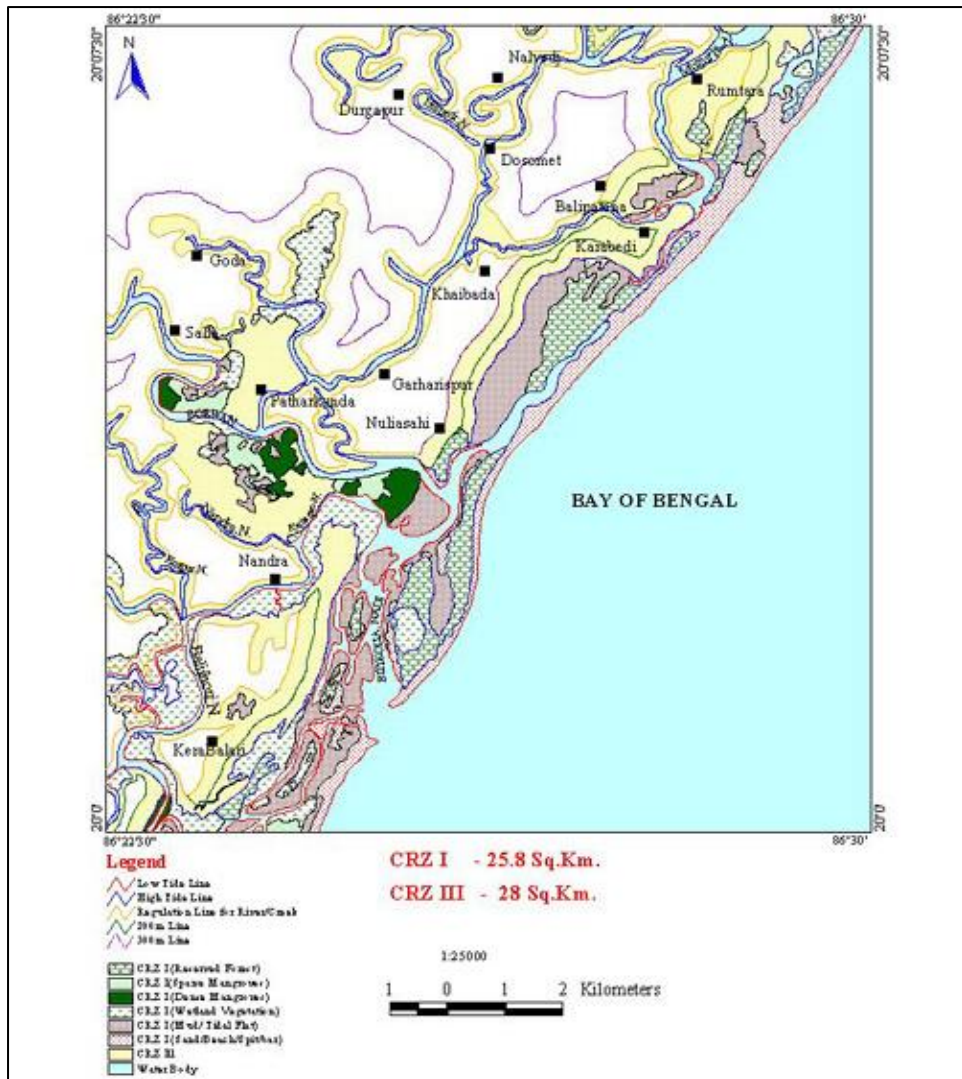


Figure 22 CRZ boundaries near Balukhand in Puri

Source: Anna University, 2013

3.2.1 Mangroves

Mangrove ecosystem is an important feature in coastal areas which is beneficial for safeguarding the coast from getting eroded, acting as the rookery for various kinds of prawns and fishes and as barriers to tidal storm surges. As the storm surges can go up till 9mts. in the coastal areas of Odisha, it gets exposed to the vulnerability of natural hazards like cyclones and tsunamis. Odisha has 203 sq. kms. of mangroves, the largest being the Kendrapara (175sq. kms.), followed by Bhadrak (20 sq. kms.) and then Jagatsinghpur and Balasore (4 sq. kms. each). These mangrove ecosystems are seen to be degraded by various

anthropological factors, mainly due to coming up of brackish water ponds for prawn farming.

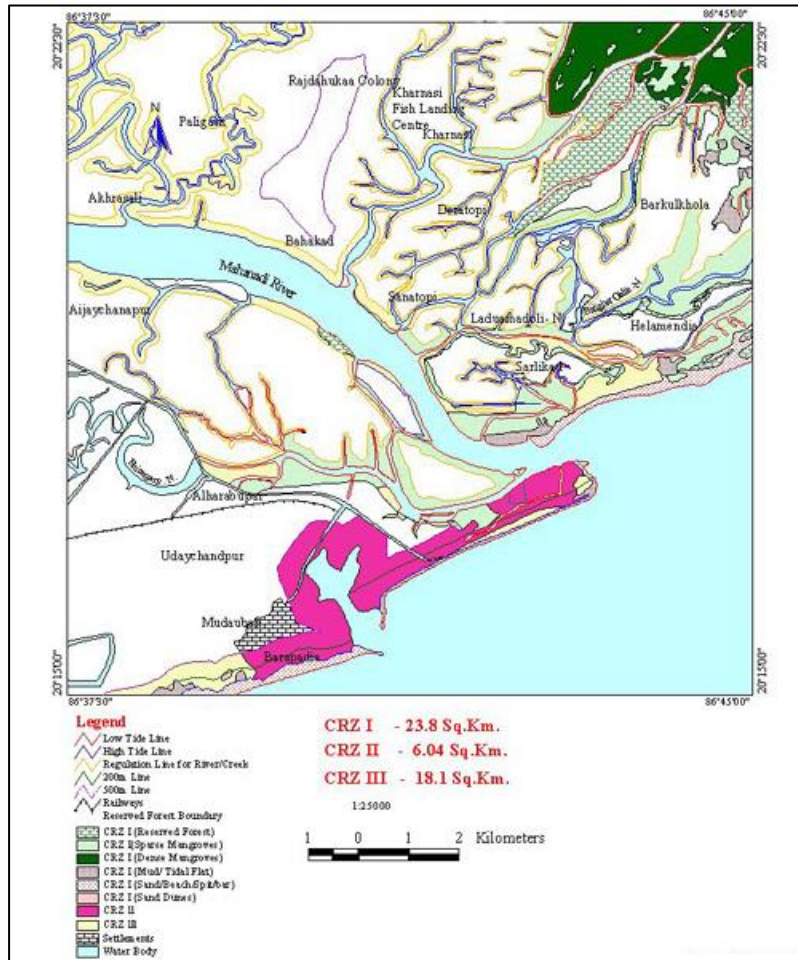


Figure 23 CRZ areas near Devi river mouth

Source: Anna University, 2013

3.2.2 Olive Ridley Turtles

The Olive Ridley (*Lepidochelys olivacea*) is one of the endangered turtle species, well-known for mass nesting during a particular time of the year near three stretches in Odisha coast. These are:

- The Gahirmatha rookery near Dhamra river mouth.
- The rookery near Devi river mouth.
- Rushikulya river mouth

These three nesting grounds were discovered during mid-1970s, 1981 and 1994 respectively. The Gahirmatha rookery is the largest breeding ground in the world with annual nesting of thousands of turtles during peak time of January and sometimes, during April-May. Mass nesting at Gahirmatha has considerably

decreased since 1997 apparently due to reduction in size of the beach availability, frequent occurrence of tropical cyclonic storms and beach erosion being responsible for the same.

The mass nesting at the ground near Devi river mouth has been changed because of casuarina plantation. Ever since the discovery of the Rushikulya nesting area in 1994, Olive Ridleys are nesting in large numbers but there are fluctuations every year.

The following factors can be held responsible for the reduction in breeding of turtles:

- Interventions in turtle habitats for food, mineral requirements, shelter, oil drilling etc.
- Poaching during or after nesting or accidental catches while marine fishing with trawlers and motorised boats.
- Predation by predators like jungle cats, feral dogs, hyena etc.
- The nesting grounds which mainly comprise of the sand bars and islands in the estuarine mouths undergo fragmentation due to regular coastal erosion.

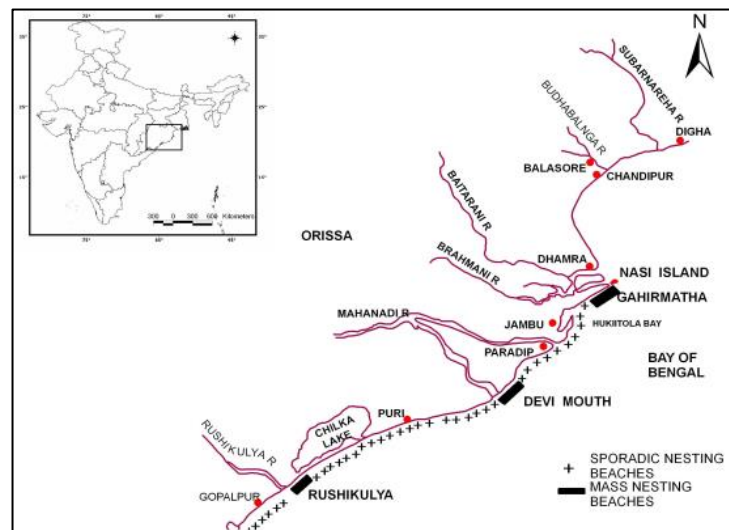
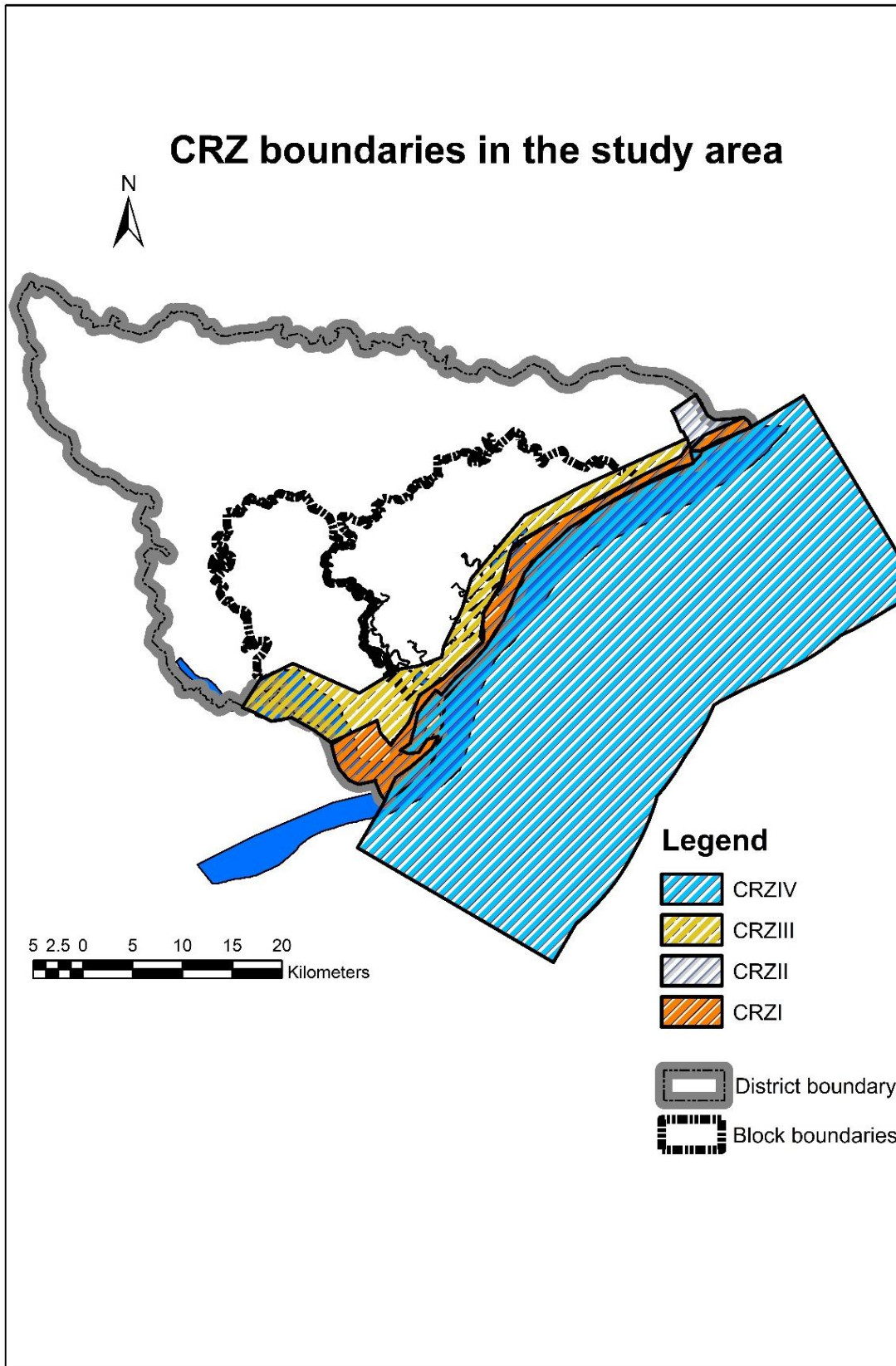


Figure 24 Areas showing the breeding ground of Olive Ridley turtles

Source: Project report, SCZMP, Odisha, 2012



Map 7 CRZ boundaries in the study area

Source: Generated by author

3.3 Fishing and agrarian communities in coastal Odisha

Fishing and fish farming are the major sources of livelihood in many rural settlements of Odisha. Previously fisherfolk communities mainly depended on estuarine fishing or river fishing using traditional boats. These people were normally the local or indigenous people who are original inhabitants of Odisha. As time went by, due to depletion of mangroves and degradation of coastal ecosystem, natural fishing grounds started to degrade, paving way for the artificial fish and prawn farming in man-made brackish water ponds. Also, people opted for marine fishing using mechanised trawlers. Also, the updated notifications made in CZMPs have barred the fishermen to fish during certain times of the year and also control brackish water fishing in prohibited zones that is, in the CRZ I and CRZ III No Development Zones. In fact, the fisherfolk⁵ communities are the largest groups which make maximum use of the Common Property Resources.⁶

Table 4 Marine Fisheries Resources, 2013-2014

State/ UTs	Approx. length of coastline (kms)	Continental shelf area (sq. kms.)	Number of landing centres	Number of fishing villages	Number of fishermen families	Number of people using fishing as livelihood
Andhra Pradesh	974	33	353	555	163427	605428
Goa	104	10	33	39	2189	10545
Gujarat	1600	184	121	247	62231	336181
Karnataka	300	27	96	144	30713	167429
Kerala	590	40	187	222	118937	610165
Maharashtra	720	112	152	456	81492	386259
Odisha	480	26	73	813	114238	605514
Tamil Nadu	1076	41	407	573	192697	802912
West Bengal	158	17	59	188	76981	380138
A & N	1912	35	16	134	4861	22188
Daman & Diu	27		5	11	7374	40016
Lakshadweep	132	4	10	10	5338	34811
Pondicherry	45	1	25	40	14271	54627
Total	8118	530	1537	3432	874749	4056213

Source: Annual Report, Department of Animal Husbandry, Dairying and Fisheries, MA, Govt

1 Protection of Rights Act, 2009 An Act to recognize and vest the traditional rights and the occupation of fishing through traditional means in fisherfolk who have been residing in coastal areas for generations and carry on regular fishing activity in coastal and marine areas and to provide a framework for protecting the rights so vested.

2 A good or resource (e.g. bandwidth, pasture, oceans) whose characteristics make it difficult to fully enclose and partition, making it possible for the non-owners to enjoy resource benefits and owners to sustain costs from the actions of others, typically necessitating some form of creative institutional management.



Figure 25 Brackish water prawn farming areas in Sahadabedi

Source: Captured by author



Figure 26 Motor used typically to move the pond water in circular movements

Source: Captured by author



Figure 27 Catch ready to go to the agricultural market in the block headquarter

Source: Captured by author

A report from TERI had stated “one metre sea-level rise could put as many as 7.1 million people including all the coastal communities whose livelihood is directly linked to the sea- at the risk of displacement. In other words, the coastal fishing communities stand the risk of being worst affected”.

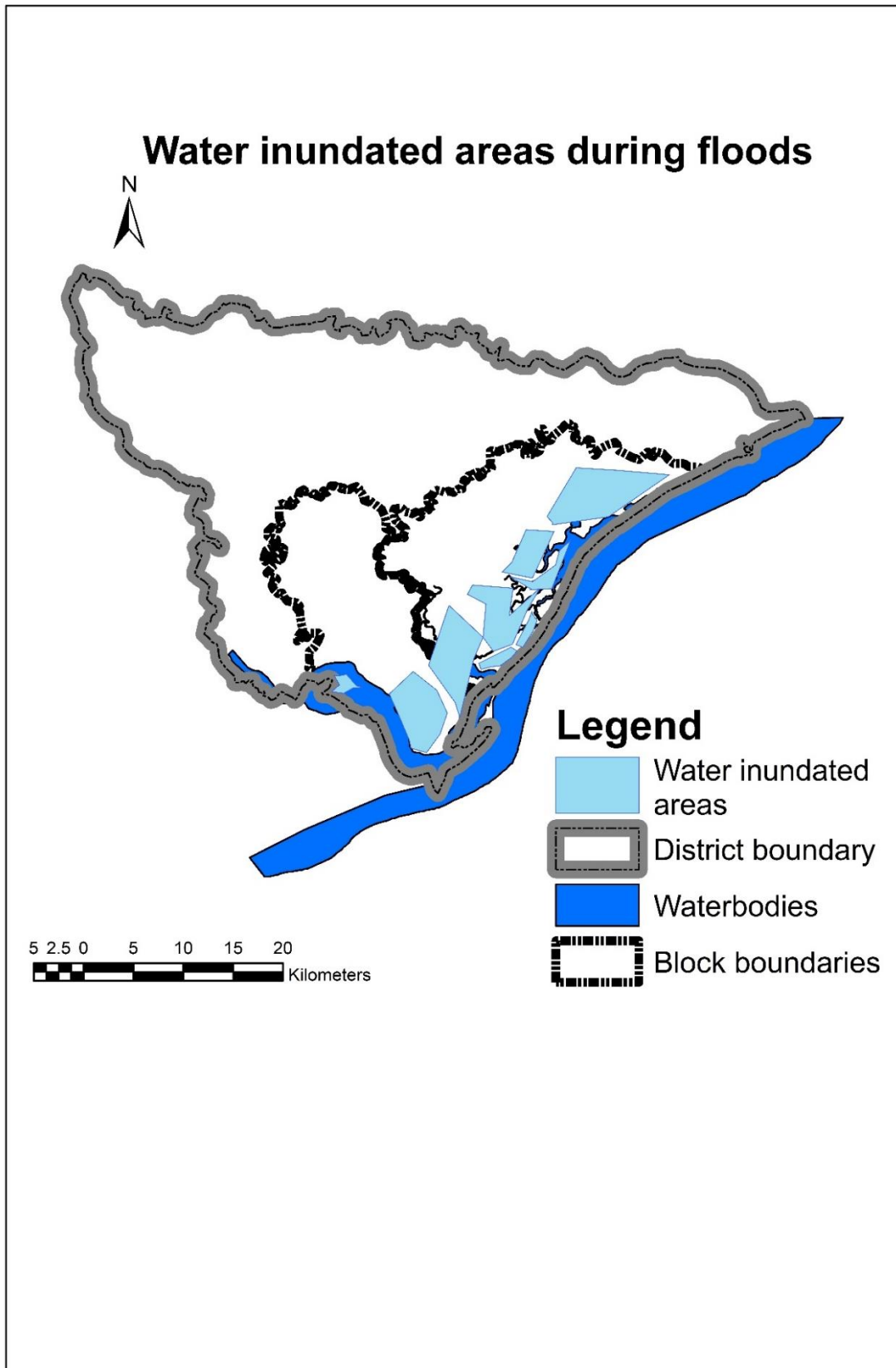
The major problem with the fishing communities in coastal Odisha is food insecurity, vulnerability and uncertainty. It is easier for the large-scale fish traders which deal in export quality fish and own boats and trawlers. They do not face problems during the lean period. On the other hand, the small fishermen usually go for fishing in groups, and it is a pre-decided thing whatever catch they get will be divided equally amongst all after keeping a portion for their respective families. Now, the amount of catch for each day is totally uncertain and also, it deploys them off their earning opportunities as well, the reason being they are local sellers who are engaged in selling the fish maximum, at the nearest block headquarter.

Paddy is the most important crop of Odisha, followed by moong, during summer time whereas during winter, sugarcane and turmeric are the major crops. Jagatsinghpur, even though the smallest district accounts for the maximum production of rice as it consists of fertile plain lands and a concentration of major rivers and their tributaries and distributaries. Moreover, these rivers experience floods on a regular basis during monsoon as well as during cyclone surges which

leads to maximum deposition after the flood water has subsided. This deposition is rich in alluvium or, silt and extremely good paddy cultivation.

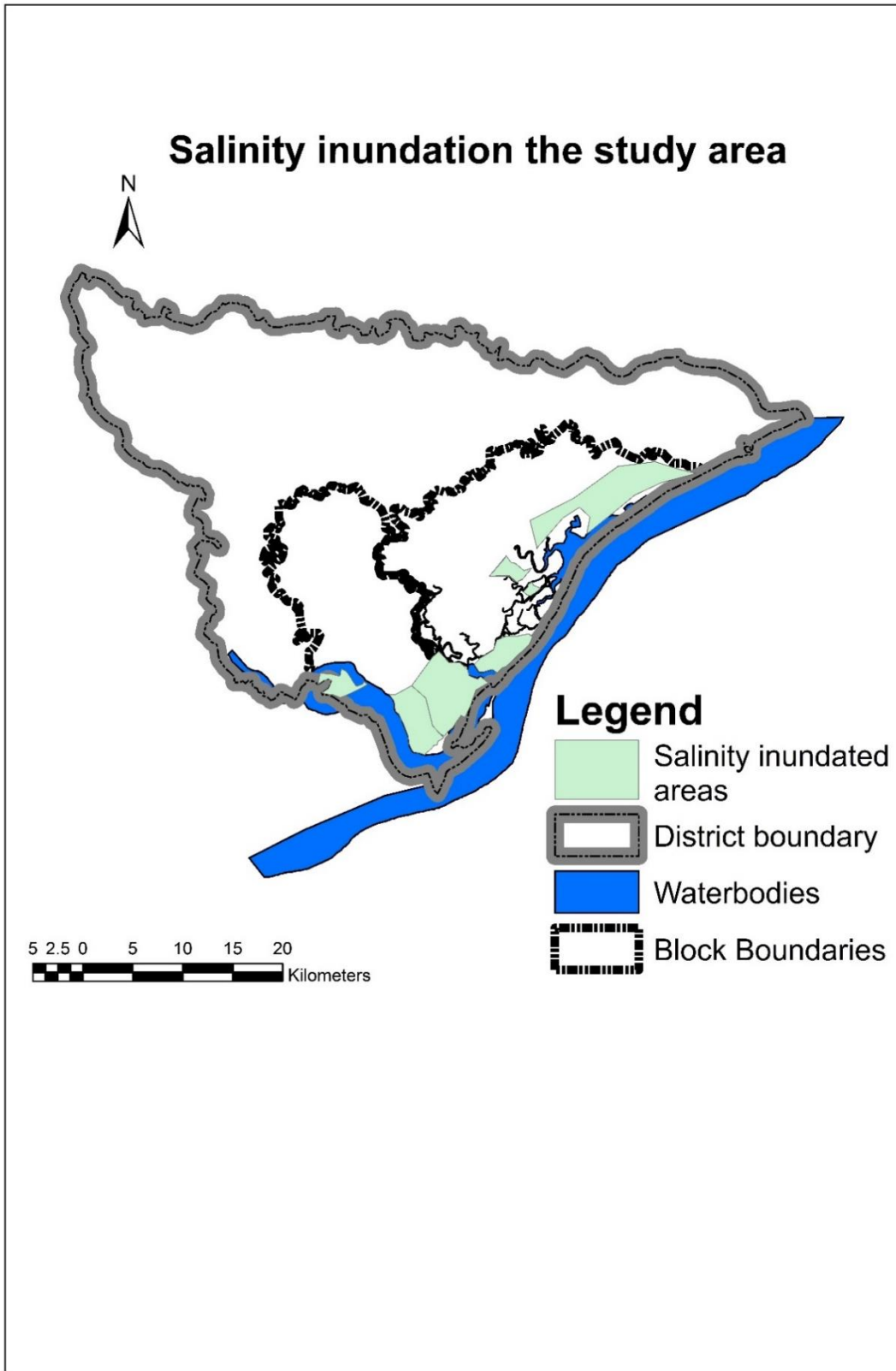
But, in the past few years, due to climatic change, rainfall pattern had been erratic (monsoon is changing time), and also there had been scarcity or excess of rainfall in certain areas. With rise in sea level, the coastal ecosystems will experience augmented levels of inundation and storm water flooding, accelerated rate of coastal erosion, encroachment of tidal water into river channels and sea water intrusion into the fresh ground water. Saline water intrusion within 10 kms of the coastline had led to complete loss in cultivation in those areas. And, due to erratic rainfall pattern, water logging occurs in many areas near the coast.

People are almost deprived of their once upon a time livelihood, that is, agriculture due to excessive salinity in the soil. Land use also shows that percentage of fallow land had increased in the past decade, and the families which entirely used to depend on agriculture for a living now have succumbed to odd jobs like daily labour in the urban areas, seasonally employing sectors or even, ultimate conditions of being unemployed.



Map 8 Water logged areas during floods

Source: Generated by author as per Bhuvan data



Map 9 Saline water intrusion in the study area

Source: Generated by author as per Bhuvan data

3.4 Environmental ethics and conflicts in coastal Odisha

A fight had been going on over a long period of time regarding the fishing rights in the coastal areas. It all started with the incoming of immigrants from the neighbouring state of West Bengal, the then undivided Pakistan during partition. Due to religious indifferences, they had tried to settle in the neighbouring states of Tripura, Assam, Bihar and Odisha. Arriving in other states by means of waterways would have been easier as it was connected. As it is the same stretch of waterbody running throughout and Indian coastline on the eastern has no such big indentations, people automatically got the superb idea to get settled in a state which was comparatively hassle-free and start a new life.

Livelihood was never an issue for them as these adjoining states share the same social and economic backgrounds. They took to fishing as the most reliable and beneficial option. What ensued the fight was that the original inhabitants of Odisha that is, the Odias claimed themselves to be indigenous and the rightful and only owners of the fishing rights within the state boundary and hailed the Bengali immigrants as outsiders.

Two major opinion from two different communities hovering in the area regarding this particular context are:

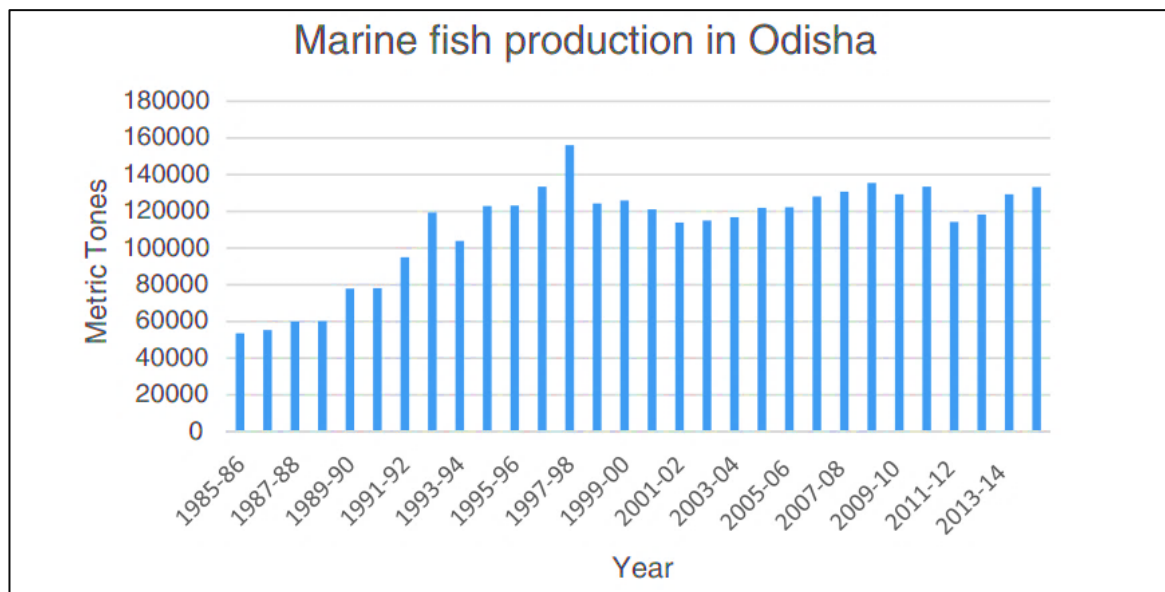
Table 5 The points of conflict between the two communities

Odias	Bengalis
They claim to be the local residents of the area and therefore, they claim more right in the area.	They were supposedly the immigrants or the outsiders and the local residents were least bothered about their prevailing conditions.
They mainly practiced river and estuarine fishing using traditional nets.	They were forced to go for marine fishing for their livelihoods and introduced gill nets and hilsa nets.
They use non-motorised techniques of fishing	They came up with the ideas of using motors in fishing for increasing the yield.
They claim that they lost their indigenous methods to the Bengalis because of the marine fishing techniques.	They claim they were forced to go to the seas for fishing as they were forced to settle in the areas just adjacent to sea.

Source: Generated by author

Both the parties became busy in blaming each other and finding faults. The Odias claimed that the Bengali immigrants have no regards for the background and biodiversity and physical settings of the area so they started practicing marine

fishing using motorised boats. According to them, many marine species like Olive Ridley turtles get caught accidentally in the nets while fishing is going on and get perished, which is hampering the coastal ecosystem of the area. On the other hand, the immigrants argue that they were forced to get into marine fishing as they were pushed down towards the sea coast and barred from getting within the Odia territory and practice fishing in the estuaries and the main rivers. So, it was out of compulsion they started using updated tools and nets for more and expensive catch.



Graph 1 Marine fish production in Odisha

Source: Journal paper, Vasudha Chhotray, 2016

During Focus Group Discussions with the head of fishing committee of two villages and one personnel from Directorate of Fisheries, two interesting things can be inferred. One of the village, Sahadabedi is inhabited entirely by Bengali immigrants accepted the fact that if seen from the context of environmental ethics⁷, that has indeed been violated by both the communities are to be blamed for the same. The other village, Ambiki is inhabited by people both communities and the fishing committee heads are also from both. They jointly gave a statement that “It cannot be denied what the Bengalis did was in a way good in uplifting the economy of the

³ A principle as well as a body of thought and research, stressing the need for equitable distribution of environmental goods (parks, open spaces, waterbodies) and bads (pollution, hazard, waste) between people, no matter their race, ethnicity or gender. Ethics is the branch of philosophy dealing with morality or, questions of right or wrong human actions in this world.

state as they had brought newer techniques and invented innovative ways of catching fish. But at the same time, if they had tried to maintain some co-operation and lived in harmony, the scenario could have been better and the result could be a better environment.

Both followed the path of Prisoner's Dilemma⁸ and only thought of their own betterment and ultimately faced the harsh outcome in the form of ban in fishing for both communities at certain times of the year. There is ban during December as well, when it is not the breeding time of the Olive Ridges. Also, even if there is a good catch, many times the forest officials and guards get into illegal practices of seizing them, extracting money or illegally export them separately. The fight continues to stay as India offers single citizenship and not according to states. Also, these people had immigrated even before independence when India did not become a Republic officially. So, as per domicile they are also a part of the state where they are staying at present. Indian states anyways, offer domicile either as per birth place of the individual or if his/ her parents are born in a particular state.

The only thing which can be inferred is that the roots of this problem that is, the partition was a sensitive issue and it could have been handled with more care and rationally, failing so, the scenario of Tragedy of Commons⁹, as we witness exists today.

3.5 The case study of perished village: Satbhaya

The fatal consequences of coastal erosion are portrayed through the study of Satbhaya, literally meaning seven brothers. This village is a cluster of seven villages in the Rajnagar district of Kendrapara. It is located very near to the Kendrapara-Jagatsinghpur border. Satabhaya and Kanhapur villages are amongst the villages on the verge of being wiped off the map. The village has shifted its

4 An allegorical description of a game theoretical situation in which multiple individuals or groups of individuals making decisions in pursuit of their own interests tend to create collective outcomes that are non-optimal for everyone.

9 The Tragedy of Commons is a form of economic issue in which every other individual or group of individuals tries to derive the maximum benefit from a fixed given resource. As the demand for the resource exceeds the supply, every individual or group of individuals who consumes an extra portion directly harms the other beneficiaries who no longer can derive the benefits at the same extent. Usually, the concerned resource is readily available to all, the condition of Tragedy of Commons occurs when no longer an individual gives a thought about the well-being of entire society.

original location three times since 1970s which was some 1 km inside Bay of Bengal.

Present day Kahnapur is hardly 50 metres from the shore. Besides Satabhaya and Kanhapur, about twenty other villages along the coast are at risk. Most of the villages have faced submergence of more than sixty percent of lands in the sea. People started migrating after the cyclone of 1971 only and relocated to Bagapatia village of Gupti Panchayat, which is 8kms from the sea in the present time. The village lacks a cyclone warning centre even now. Many human and animal casualties occurred and many lives and properties have been washed away from 1971 onwards. There is constant fear looming large over these two left out villages by cyclonic tides.



Figure 28 The village in Odisha to be engulfed completely by the sea

Source: Captured by author

Table 6 Timeline of submergence of Satabhaya village

1930 land records	Cluster of seven villages having an area of 320 sq.kms.
1980s	Three villages were wiped off namely Govindpur, Mahnipur, Kuanrora.
Mid 1990s	Two more villages submerged i.e. Kharikula and Sarpada.
2000 land records	Area reduced to 155 sq. km. (only two remaining i.e. Kanhapur and Satabhaya)

Source: Generated by author

The enumeration of families to be rehabilitated at Bagapatia was done during the year 2010 where in 571 households were identified and the detail are provided as below:

Table 7 Details of shifted households of Satabhaya cluster

Sl. No.	Mouza	Total households	S.T.	S.C.	General	Total population
1	Kanhapur	16		4	12	109
2	Satabhaya	220	4	15	201	1177
3	Barahipur	93	15	7	71	552
4	Rabindrapalli	26		17	9	153
5	Magarakanda	216		110	106	1252
6	Total	571	19	153	392	3243

Source: *The Response, Annual Magazine, Volume-XVII, OSDMA*

An area extent of Ac. 187.50 dec. consisting of 75 plots were allocated at Bagapatia for the rehabilitation project with provision of all urban facilities. The Tahsildar, Rajnagar block prepared a rural township plan giving connectivity to each plot in a square shape with an area of Ac. 0.10 dec. for 571 beneficiary households selected in the 1st phase and other 250 additional families of Charigharia and Satabhaya under this project. Sufficient free land has been kept for all communal purposes like primary/ high school, anganwadi centre, MPCs, community halls, playground, new panchayat office with godown, market complex, cremation ground etc.

Table 8 Land utilisation

House site for 818 families @ Ac. 0.10 dec. per families	Ac. 81.80 dec.
Govt. office	Ac 3.10 dec.
Educational institution	Ac. 10.00 dec.
Community based utility	Ac. 92.60 dec.

Source: *The Response, Annual Magazine, Volume-XVII, OSDMA*

Since Satabhaya cluster is located within the area of Bhitarkanika National Park, it will help in protecting the local environment if the rehabilitation occurs successfully. The wild animals like crocodiles, deer, birds etc will avail free habitat due to shifting of human habitat. The mangrove ecosystem will also be free from destruction which will be useful from ecological point of view and it might also help in the mass breeding of turtles.

3.6 Conclusion

The chapter gives us an idea about the existing scenario which has been either observed while the site visit or, collected from various study sources. It is important to have a knowhow of the trending situation and analysing, or at least associating it with further analysis for making further interventions. The effect of political power, community conflicts, degrading trend of biodiversity will eventually play an important role in the proposals. As primary survey could be conducted only in a few selected villages that too, for a certain percentage of households, it is relevant to have an idea what is going on at macro level. Also, ideas can also be derived from the already implemented solutions in other areas along the coastline of Odisha by the Government and NGOs which are running successfully.

CHAPTER 4: INTRODUCTION TO THE STUDY AREA

4.1 Introduction

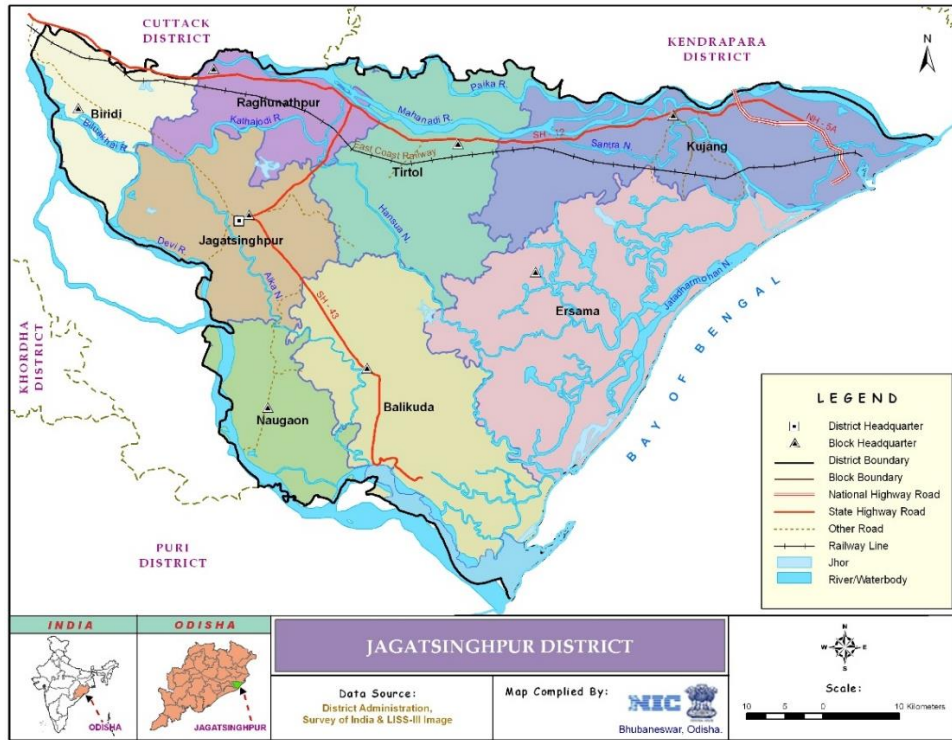
In this chapter, a detailed description about the site has been given. I have divided the chapter into two levels, the first one comprises of a general description about the physical features, waterbodies, land use and demography of Jagatsinghpur, in the second one I have zoomed down to the two blocks which I have taken up for further analysis and future interventions. This chapter basically serves the purpose of setting up the linkages between these two levels. It further tells us about the nature and socio-economic and political background and the information also used to prepare the base map using which the next stage that is, analysis will be done and future interventions can be marked, without we cannot have the spatial assumption of the study area.

4.1.1 Physical settings of the district

The district is located on the eastern side of Odisha with one side entirely facing the Bay of Bengal. The district boasts of the presence of numerous rivers and its tributaries. The Mahanadi river flows into the Bay of Bengal after forming a delta along with its major tributaries like Santra river, Biluakhai river, Jatadharmohan River and Hansua river. The major distributary of Mahanadi is Devi river which flows in the southern part of the district and forms a wide mouthed estuary before falling into the Bay of Bengal. The natural features formed by the rivers are sandbars, spits, mudflats (jhors) and bays. Mahanadi obviously is the largest river and forms a delta along with its tributaries and distributaries which spans over an area of 1,41,600 sq. kms. with rich deposition of alluvium. Jagatsinghpur is the most fertile district of the state as most of the rivers pass through the district before falling into the Bay of Bengal. As the rivers are in their lower course, the debris they carry throughout the course is deposited in the river basins.

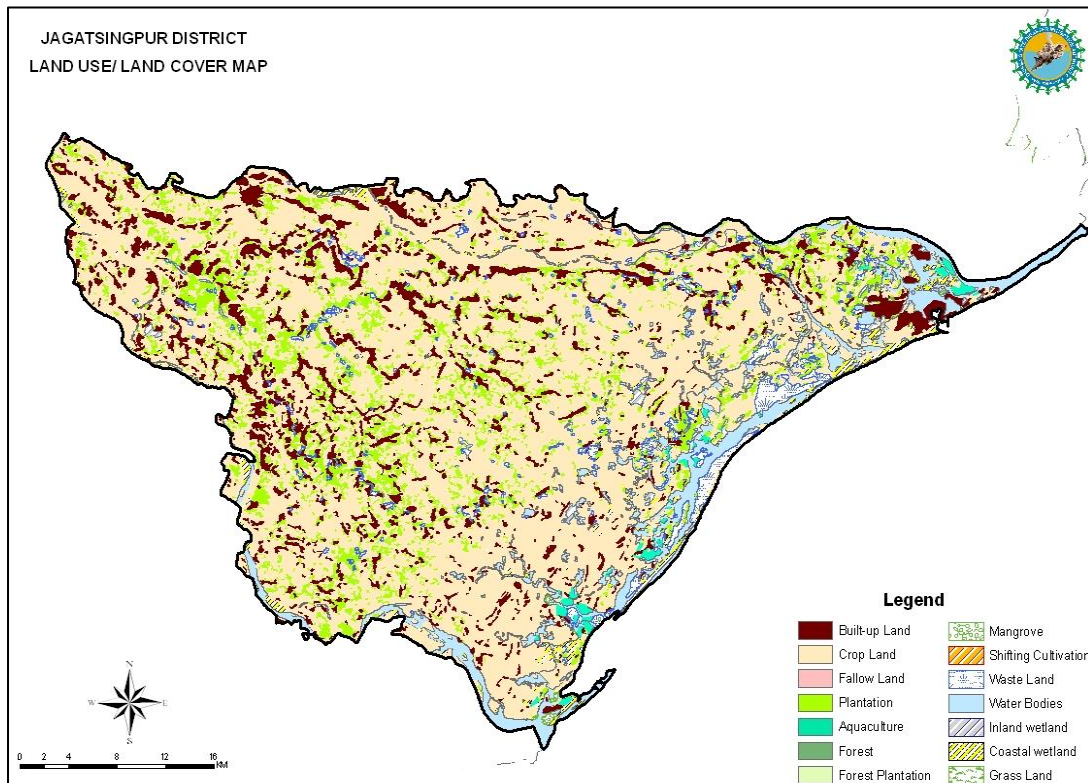
The district has more or less a gentle slope with variation not more than six degrees which enhances the paddy cultivation. It also consists of biodiversity hotspots like the Devi river mouth estuary, the home to Olive Ridley turtles, mangrove ecosystem and virgin sea beaches with high potential for growth of tourism. The soil type found over here is a mixture of sandy and clayey loam, which is considered to be the best for paddy cultivation.

Chapter 4: Introduction to the study area



Map 10 Base map of Jagatsinghpur district

Source: Odisha GIS portal



Map 11 Land use land cover map of Jagatsinghpur

Source: OSDMA

Coming to the climatic conditions, the district enjoys a moderate type of climate with temperature not going above 35 degrees during summer and not below 15 degrees during winter. Rainfall is erratic, and is normally excess in alternate years.

Even after having so much of rich physical features, Jagatsinghpur is extremely prone to natural disasters, especially cyclones and floods due to erratic rainfall, presence of so many deltaic rivers, excessive coastal erosion, anthropological interventions, degradation of mangrove ecosystem and engulfing the eco-sensitive zones for anthropological usages. With a coastline of almost 60 kms. and too, an unstable one, the district faces the wrath of tropical cyclones and seasonal floods frequently.

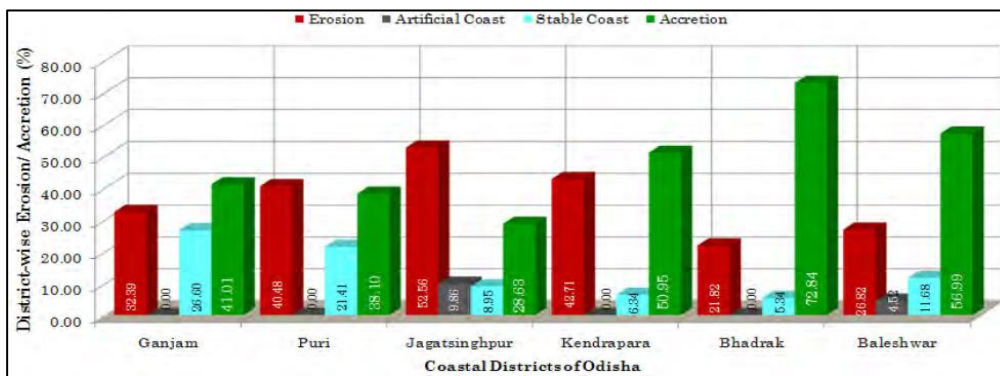


Figure 29 Type of coast in the coastal districts

Source: OSDMA

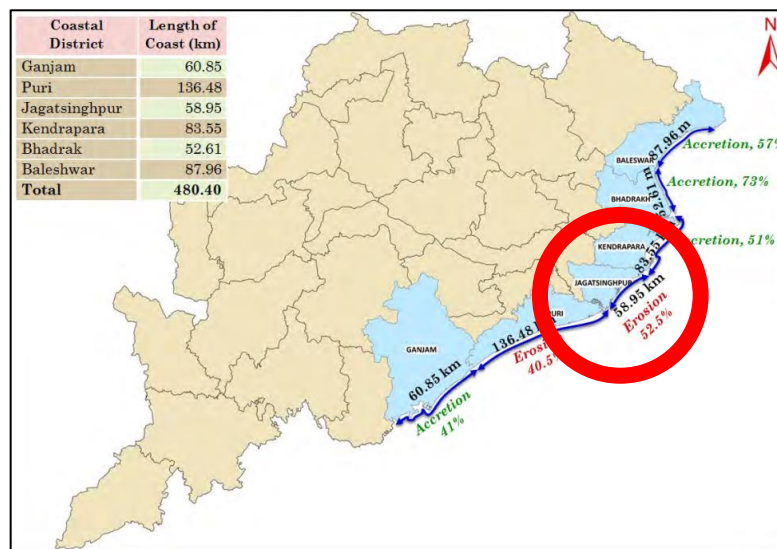
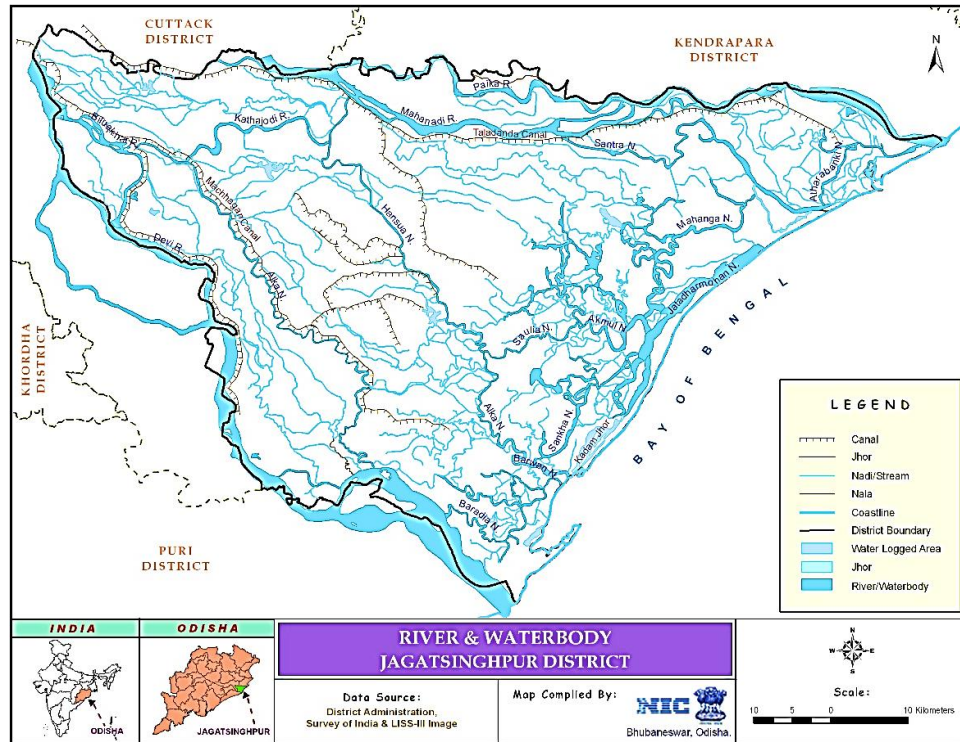


Figure 30 Rate of change of coastline in Jagatsinghpur

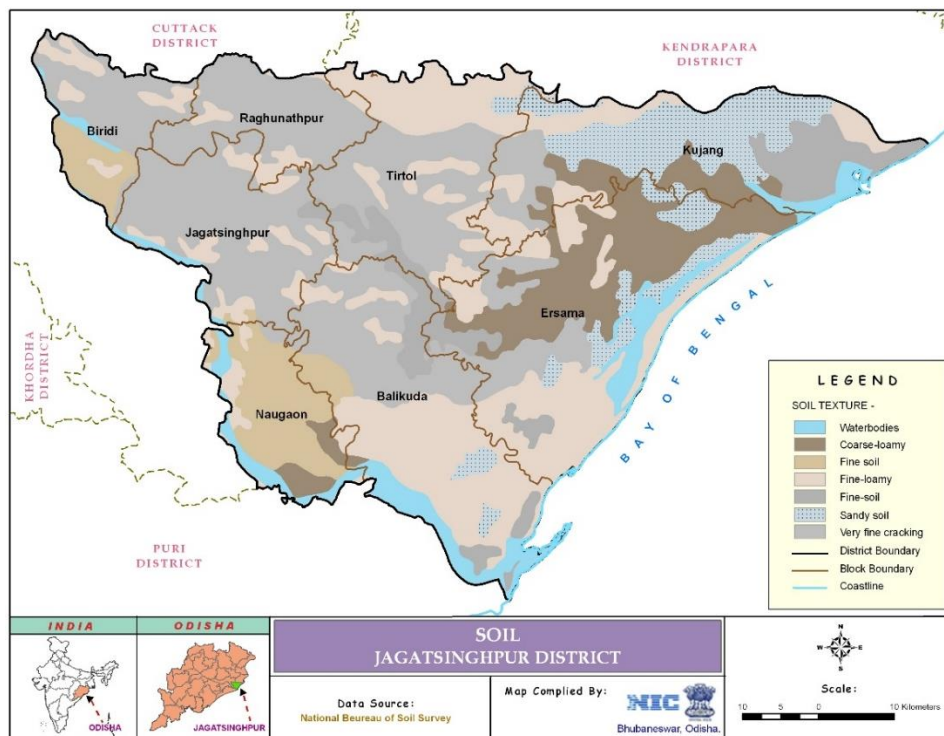
Source: OSDMA

Chapter 4: Introduction to the study area



Map 12 Major rivers and waterbodies in the district

Source: Odisha GIS portal



Map 13 Soil typology of Jagatsinghpur district

Source: Odisha GIS portal

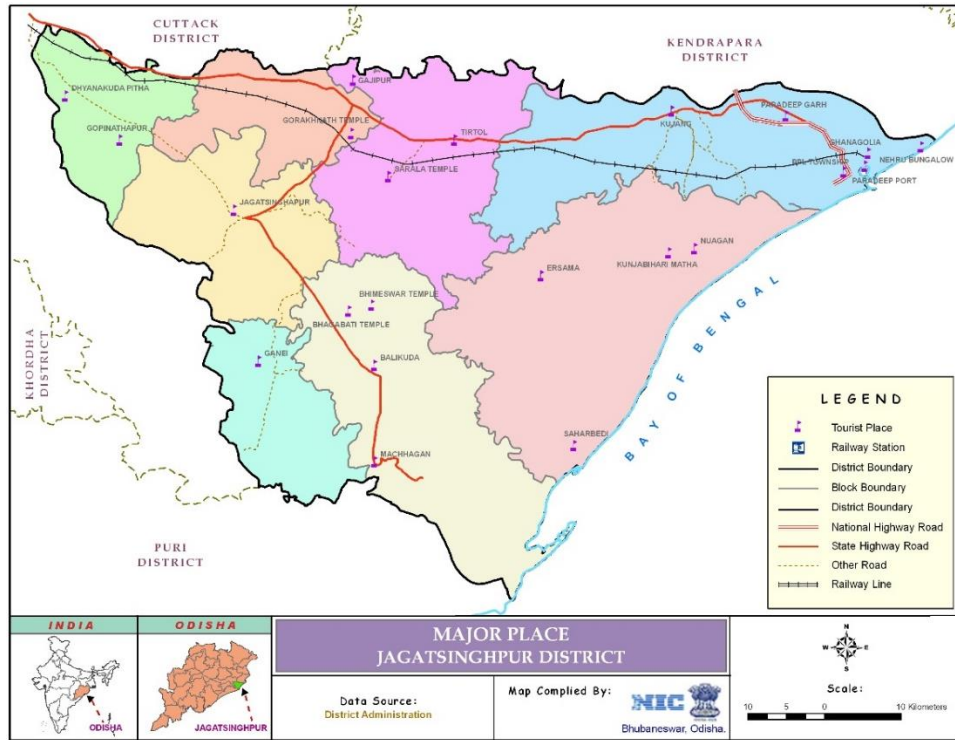
4.1.2 Political boundaries of the district

Jagatsinghpur is composed of eight blocks namely, Jagatsinghpur Sadar (which also serves as the district headquarters), Raghunathpur, Biridi, Tirtol, Naugaon, Kujang, Erasama and Balikuda. Out of these, the last three are bounded by sea on one side, Erasama having the longest coastline. Area wise, this is the smallest district with an area of only 1,759 sq. kms. It was carved out of the Cuttack district in 1993 and is the last of the 30 districts of Odisha. It comes within 20 degrees 87 minutes north latitude and 86 degrees 17 minutes east longitude.

It is well connected by roads with other places of importance. The capital city, Bhubaneswar is situated at a distance of 60 kms. from the district headquarters whereas, Cuttack is at a distance of 40 kms. Two state highways, SH 43 and SH 12 pass through the district, the former one connecting the Sadar and the later one connects Paradip to Cuttack. Railways are not so developed in the district. It is connected by a link route via Cuttack, with a single train plying from Puri to Paradip. The nearest station to the district headquarters is at Gorakhnathpur, located at a distance of 10 kms. There are major arterial roads connecting the Sadar to each of the block headquarters, and then sub-arterial and village roads connect the major rural settlements of the blocks.

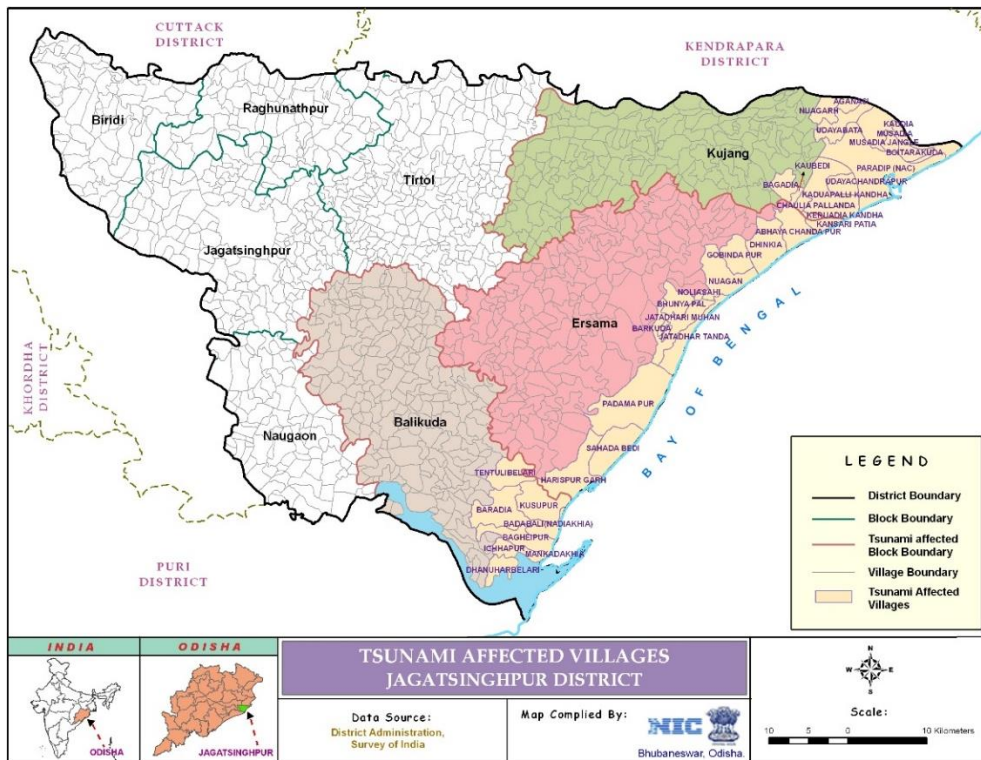
The district mainly portrays rural settlements (90 percent) of the land use of the entire area, whereas only 10 percent is of urban nature, the major towns being Jagatsinghpur district headquarters and the port town of Paradip. Mangrove ecosystem extend from the neighbouring district of Kendrapara and can be found in the northern part of Paradip near Hukitola Bay. A large portion of the coastal blocks of Erasama and Balikuda is shown to have aquaculture and prawn farming areas. Forestation is encouraged in demarcated patches of land all throughout the district. Just above the mouth of Devi river, a reserved forest is coming up by the name of Jagatsinghpur reserved forest.

Chapter 4: Introduction to the study area



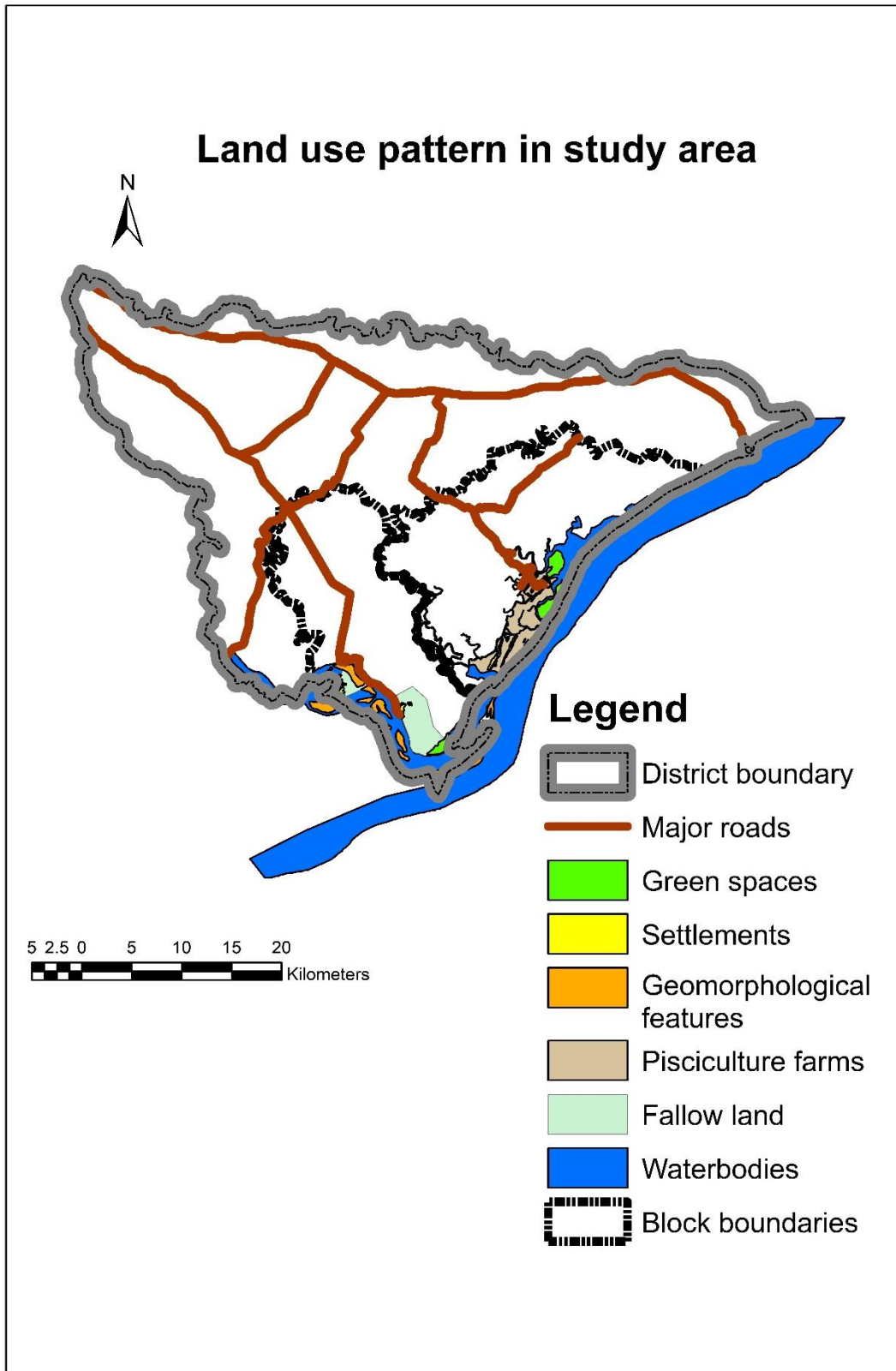
Map 14 Major roads, railway line and important places

Source: Odisha GIS portal



Map 15 The tsunami prone villages of the district

Source: Odisha GIS portal



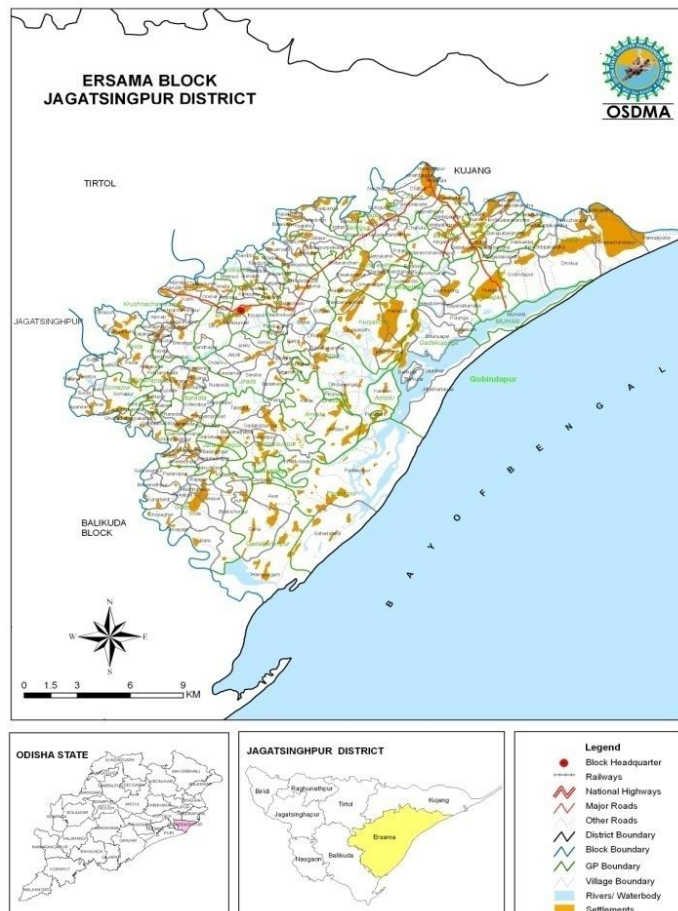
Map 16 Land use map of the coastal areas of the two blocks

Source: Generated by author

4.2 Erasama block

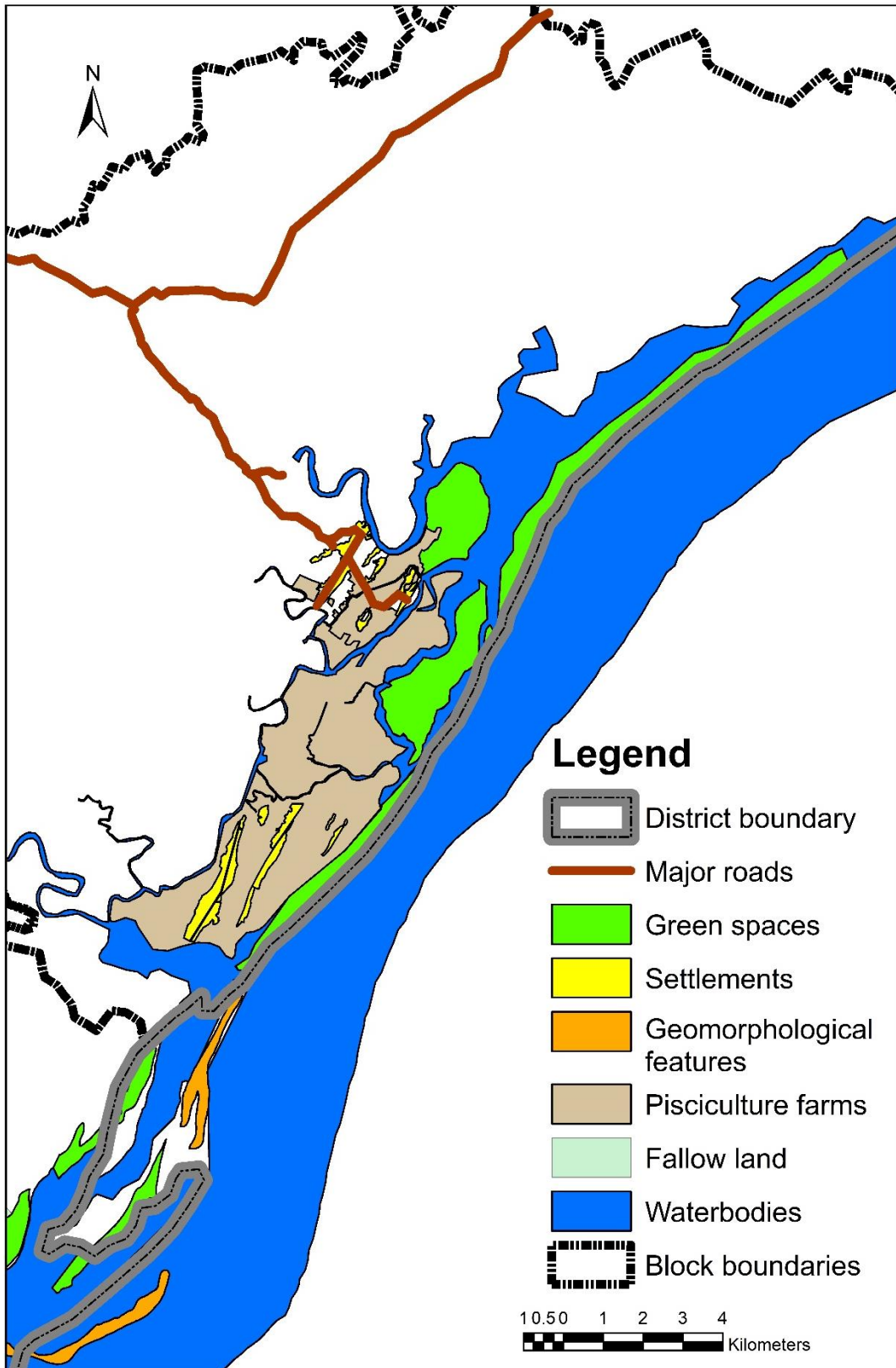
This is one of the blocks in the study area which comprises of entirely rural settlements. The major rivers flowing through the block are Hanshua and Jatadharmohan, the later forming an estuary before falling into the Bay of Bengal. Ambiki village lies by the side of Hanshua river and falls prey to annual floods and water inundation by the former. The other village Sahadabedi is at a mere distance of 1kms from the sea. The virgin sea beach, Siyali which is yet to fall prey to the tourists have extensive casuarina vegetation and a lighthouse as the only building footprint.

Erasama block was the worst affected block during super cyclone of 1999. The Mahanadi delta spans in this block only. It has a coverage of 371 sq. kms. and is located at a distance of 53 kms. form the district headquarters. Boats operate from the Hanshua river ghat for communication to many villages.



Map 17 Erasama block

Source: OSDMA

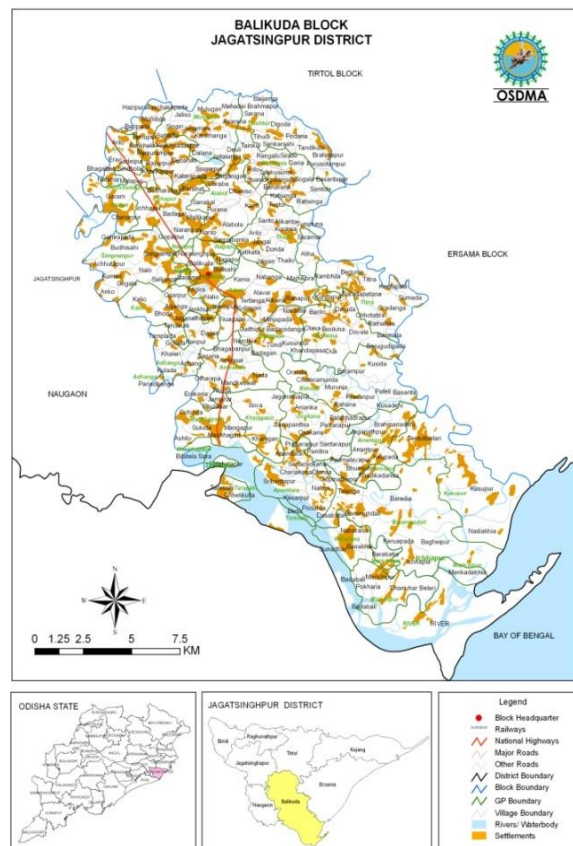


Map 18 Land use of study areas in Erasama

Source: Generated by author

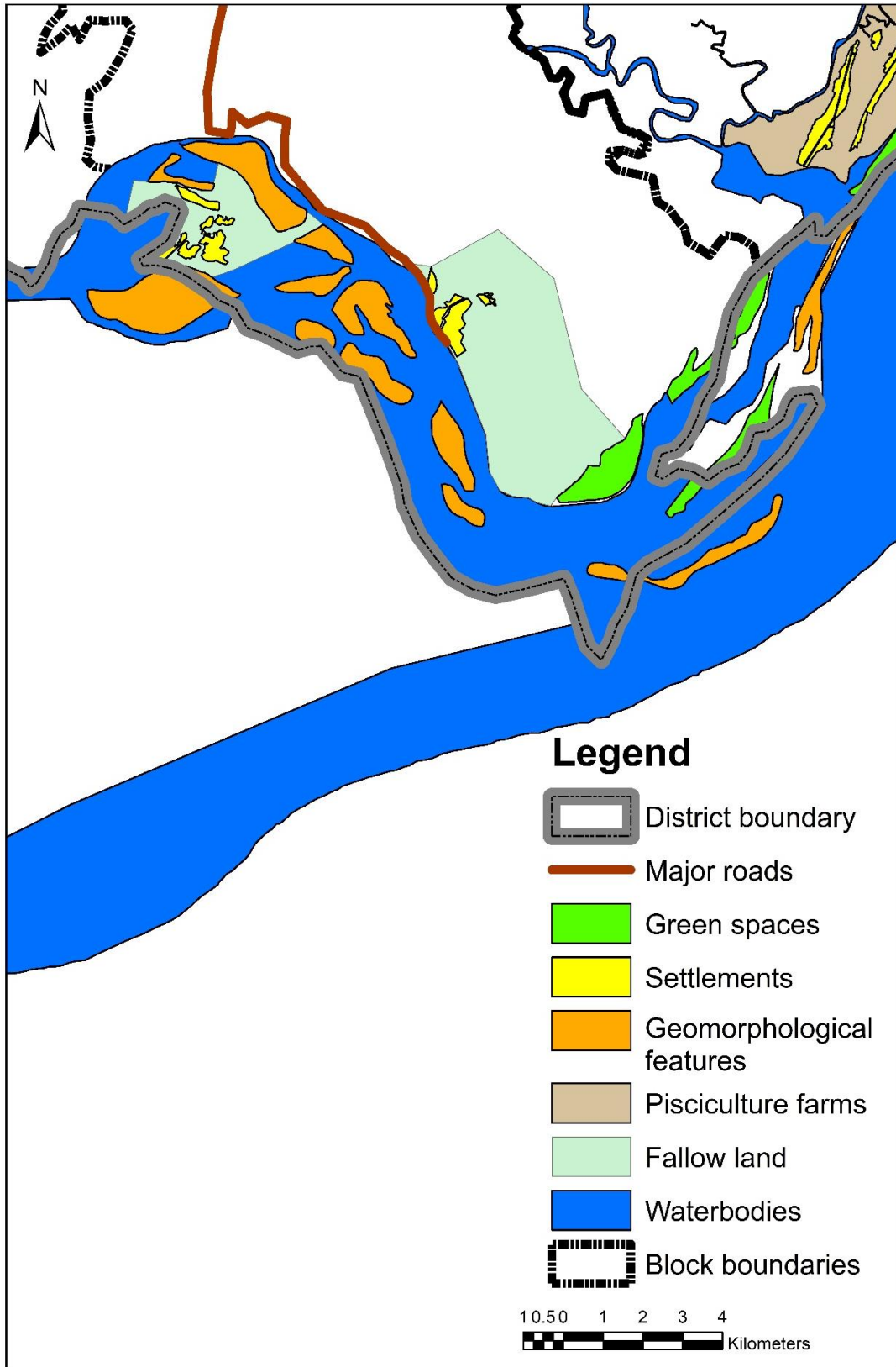
4.3 Balikuda block

This is the second block and it is not totally exposed to the sea as the previous one. The major river found in this block is the Devi river and its distributaries which forms an estuary and a number of coastal geomorphological features before falling into the sea. Tarasahi, one of the study villages lies in the jhor (mudflat) formed by the river and is enclosed by water on all sides, accessible only by means of country boat, via Machhgaon and Talada Ghats. The other village, Balipatna-Bandara lies in the estuarine mouth of the Devi river and extensively practices estuarine river fishing. Covering an area of 285 sq. kms. and located at a distance of 16 kms. from the district headquarters, it is the block which has highly eco-sensitive zones, including the rookery for breeding of turtles. Traditional boats ferry from a number ghats on Devi river, such as, Talada ghat and Machhgaon ghat. Near the estuary, where fishing is practiced is characterised by man-made rip-rap features, which also act as a barrier for flood waters.



Map 19 Balikuda block

Source: OSDMA



Map 20 Land use map of the study area in Balikuda

Source: Generated by author

Primary records regarding loss of assets during occurrence of previous disasters show that Erasama had witnessed more damages in respect to human life, livestock, and houses. The natural barriers present in Balikuda form a shield for the cyclones making it vulnerable mostly to the floods caused by Devi river. Salinity of the soil though has affected the livelihood of people of both the blocks as there was loss of agricultural fields during previous cyclones and floods.

4.4 Conclusion

Predominantly agrarian in nature, the district has started to lose its scope of producing more food grains owing to high rates coastal erosion. The more features an area has, the more difficult it becomes to maintain them. It had every resource to enhance various sectors like agriculture, industries and tourism. But all of these had been suffering a setback due to the vulnerability due to natural disasters, which are in turn, induced by human beings only. Moving towards the next chapter, which is extremely important for the study as because, the analysis of human-environment interactions will be done in that chapter on basis of the settings of the study area, which is the most crucial step in suggesting the probable measures to solve the identified issue.

CHAPTER 5: METHODS AND METHODOLOGY

5.1 Introduction

In this chapter, the methodology adopted from the very beginning of the study has been discussed. The first part consists of the type of approaches for each of the objectives and a brief description of parameters used has been given. The next part of the chapter comprises of the particular tools or techniques which had been implemented in similar kind of situations to evaluate the various degrees of vulnerability of the study area.

5.1.1 Vulnerability Analysis

Vulnerability, as we had seen of now, is the degree of “helplessness” or the internal factor of risk when exposed to a “disaster” situation. Even though understandable empirically, or from description from somebody, to express something with respect to certain standards, we need mathematical formulas or models to evaluate the level of vulnerability of a subject or group of subjects in case of similar situation. A particular disaster might be governed by certain set of parameters which might pose a different level of threat. So, a easy way of providing ranking is selected as per expert discussions and comments, looking at the availability of certain set of components. The analysis will help us to act differently in a calculated manner that is, a cognitive approach can be taken up afterwards for solving a issue.

5.2 Methodology

Issue Identification involves picking up a certain topic which has considerable environmental concern. This is done by going through a number of literary sources, previous records and documents. The topic selected must be a sensitive issue, affecting a considerable amount of people, and has degrading or distressful effects on the components of the ecosystem. In this case, the issue identified had been there as old records in India, but the current human-environment interaction and that interaction-induced effects were the one which prompted me to choose the topic.

Area Identification is done on basis of various records, literature and history of disasters and it shows relevant information about the eastern coast of India getting regularly affected by tropical cyclones, with Odisha ranking the highest

in the occurrence of cyclones. The scenario gets worse when storm surges cause floods as well due to heavy rainfall and overflow of delta-forming rivers. Data used: Indian Meteorological Department, Vulnerability Atlas of India, Odisha State Disaster Management Authority

Framing aim, objectives, scope and limitations gives me the scope to focus into a particular target. The scope of the entire topic can be so vast that it will not be possible to tackle the issue single-handedly in such a short period of time. So, focussing on a particular aspect of the issue, then deciding upon what necessary measures can be taken to achieve that goal is important. Scope gives us to assume certain set of expected outcomes in the end which will drive me in finding suitable measures so as to achieve those. Time and in this case, unavailability of real-life situations while undertaking the site visit area the two main constraints.

Need of the Study talks about the viability of the topic, and mainly is about convincing others my own understanding of the topic or rather, say, making others realise its gravity. Strong witnesses are required so that so that it can be proved that a detailed study on the selected topic is the need of the hour.

- Supported by literature studies
- Vulnerability analysis of the coastal areas of Jagatsinghpur, using CVI index method and eight parameters used for the Integrated Coastal Zone Management Plan.
- Data sources required for the various parameters are obtained from Landsat imagery, GEBCO data, GLOSS data and INCOIS data.
- Primary and secondary data from various sources to check the condition various parameters of SeVI (Socio-economic Vulnerability Index)

Literature Review (in two phases) is done for the above point and the detailed methods of doing literature review had been discussed before in Chapter 2.

i) Before the site visit

- Conceptual – To have an idea about the background, terms, definitions and theories in practice.

- Case Studies – To have an idea of strategies and development measures in similar scenarios.
- Approach based studies – To have a know-how regarding current approaches and strategies.

ii) After the site visit

- Perception based studies – To acquire detailed ideas about various social stigmas after primary surveys.
- Materials available from various concerned secondary sources.
 - a) OSDMA
 - b) Ministry of Forestry, Odisha.
 - c) Department of Fisheries Handbook, Odisha.
 - d) District Collectorate, Jagatsinghpur, Odisha
 - e) Census data of India.

Selection of Site is done after the area has been finalized. It is done in the following manner:

- District highly affected by cyclones and floods
 - a) Presence of numerous rivers and formation of flood-plains.
 - b) Holding high records of getting devastated by frequent cyclones.
 - c) High migration profile.
 - d) Decrease in crop production (rice, moong)
- Macro level selection

Three coastal blocks in the district, out of which two completely portray rural characteristics.

Presence of flood plain and ecologically sensitive areas.

Erasama and Balikuda selected on basis of vulnerability analysis.

- Micro level selection.
 - a) 3 villages selected from each block.

Distance from the shoreline.

Proximity to the estuary.

Proximity to river.

Condition of road connecting the village to the block headquarters.

Names of the villages

a) Erasama

Ambiki (located by the side of Hanshua river)

Padmapur (located near the estuary of Jatadharmohan river)

Sahadabedi (located at a distance of 450 mts from the sea)

b) Balikuda

Tarasahi (located by the Devi river)

Marichipur/ Balipatana (located near the estuary of Devi river)

Bandara (located at a distance of 800 mts. from the sea)

All the settlements come under the CRZ- III category as per the Coastal Zone Notification.

Data Collection is again done in two ways:

Primary Survey based on questionnaire on the following topics:

General topics such as household size, housing typology and conditions, livelihood pattern, change in livelihood pattern and migration status.

Cropping pattern and usage of fertilizers.

Infrastructural facilities.

Impact of previous disasters and aids from the concerned authorities.

Preparedness and awareness.

Availability and condition of cyclone/ flood shelters.

Secondary data was readily available for the study area from various sources like Odisha State Disaster Management Authority, Indian Meteorological Department, State Coastal Zone Management Authority, Directorate of Fisheries in Jagatsinghpur and various reports published by local and international NGOs from time to time.

Data Analysis can be either qualitative or quantitative in nature:

a) Qualitative analysis is done by taking personal interviews of stakeholders at various levels. It was a bottom to top approach and in total fifteen interviews were recorded. Each interviewee enumerated their previous experiences during disasters, how they managed to cope up with the situation. Three people were chosen from each village, preferably from different social background and strata. There is at least one female respondent. Two officials were interviewed at Jagatsinghpur Collectorate, Emergency Office handling the disaster section. One of them is directly associated with DC and have contribution in framing the latest DDMP of Jagatsinghpur. The other one is the official from an NGO who is working in collaboration with the officials of DDMA. The third one was some personnel from Fisheries Department of Odisha.

All the interviews were documented and the aim was to get a picture of the scenario and to understand the disparities in understanding and perception of a disaster situation and how the various aspects change due to a change in the receiving end.

b) Quantitative analysis is done by analyst tools and software for finding the critical areas and finding out the suitable areas for development. It is again in two parts:

The first part comprises of the vulnerability analysis of the study areas by Coastal Vulnerability Index method using eight parameters and assigning risk factor to each parameter. (Suitability analysis of areas for development as per CRZ notifications.)

The second part is done to understand the gap in social and economic infrastructure by feeding the collected primary data and then analysing that with the help of pie charts and bar graphs and other graphical methods. This

is helpful in finding the relationship of a particular parameter, for example, housing condition with other parameters such as income groups or availability to PMAY scheme.

Gap identification is calculated by the above process for the countable infrastructural facilities. A comparative analysis is given showing the required number of infrastructure entities for a particular population, the current population of the villages, the present number of facilities present and how much more is required to meet the shortage.

Visual survey is also useful in gap analysis as condition of certain facilities like roads, cyclone shelters, PDS are documentable and also helps in determining the future interventions that can be suggested for making the condition better.

Development Concept and implementation strategies will be based on the overall analysis of the two objectives and can be divided into structural and non-structural measures in this study. Structural measures will have infrastructural development and special design strategies adopted for areas affected by cyclones. Non-structural measures include economic and social upgradation solutions like spreading awareness and enabling the people to avail insurance or monetary help from the concerned authorities.

Table 9 Methods applied for the two objectives

Objective	Method used	Data sources
Calculating the Coastal Vulnerability Index for the Coastline of Jagatsinghpur in Odisha	CVI method. The manual form of evaluation.	AsterDEM, INCOIS, visual survey, GEBCO data, Bhuvan maps.
Calculating the Socio-economic Vulnerability Index for my exact site areas that is, the villages selected for future implementations	SeVI method. Done using Microsoft Excel 2016.	Primary survey data, Secondary sources

Source: Generated by author

5.3 Challenges faced during the site visit

The major problem I faced was the location of the villages. Communication facilities gave me the toughest time as the district really lacks railway facilities. As a non-native and non-Odia speaker and also as a female,

accommodating and communicating was also the challenges I had to face often. Jagatsinghpur lacks the facilities of a proper town so there are no good places to put up for a lone female.

I had been to my site twice. First time, I went for an overview, preliminary study, gathering data, secondary mainly and I had to put up at Bhubaneswar, which is at a distance of 60 kms. There are no direct buses as well. The travel that I used to follow was to travel to Cuttack from Bhubaneswar by bus, and then take another bus to Jagatsinghpur Sadar. From there, buses ply to the block headquarters and after that, one has to tick to para-transit modes like autos, rickshaws etc. to go to the particular villages. Time management posed as a problem in between these long journeys. Safety is another real time issue if one female is going alone for the study, partly because I am not a native and partly, because of the social background of most of the inhabitants and partly, because of the communication facilities.

Second time, I went mainly for the primary survey in all the villages. This time I had put up with one of my friend's relatives who are natives of Mandasahi village in Jagatsinghpur Sadar. All I could to manage my time, was to hire a car and travel the respective places. Even though it costed a lot, it was worth the shot as all the relevant survey data I required was available. Condition of roads, rather unavailability of All Weather Condition roads is noteworthy. The last problem I faced this time while doing primary survey was the language constraint. I can understand Odia, and manage to speak fair. But my target groups were mainly rural folk and they lacked complete knowledge in English or Hindi. Expressing myself emotionally, which is very much required in these kinds of scenarios was very difficult. My previous experiences of staying in Odisha for my studies and job helped me to get over the problem to a great extent.

5.4 Methods

5.4.1 Coastal Vulnerability Index

CVI method is a statistical method by which the risk factor and vulnerability of coastal areas can be determined. It is the same method used by Theiler and Koshler in calculating the CVI of Polynesian Islands. Previously six

parameters were used, but a set of any number of parameters is allowed while computing the CVI of any area. In my study a total of eight parameters have been taken into consideration and risk factor assigned has been divided into three categories namely, least vulnerable, medium vulnerable and highly vulnerable.

5.4.2 Parameters used

The eight parameters used are shoreline change rate, barrier type, coastal slope, significant wave height, shoreline exposure, regional elevation, coastal geomorphology and storm surges. These parameters have been considered looking at the background of the study area, documented data by various departments and location and physical features of the area. The data sources used are INCOIS, GLOSS, SRTM data, visual survey, GEBCO data and documents from OSDMA and Vulnerability Atlas of India. The various procedures by help of which these data are analysed are with the help of various spatial analysis tools of GIS, manual documentation, mapping and secondary data analysis.

Table 10 Parameters used in CVI method

Parameters	Data used (sources)	Procedure
Shore-line change rate	Landsat data	GIS algebraic procedure and mapping
Barrier type	Google earth imagery/ visual survey	Mapping/ Visual survey
Coastal slope	Aster DEM	Spatial analyst tool
Significant wave height	INCOIS data	Image taken at an interval of 6hrs in a day
Shoreline exposure	Google earth imagery/ visual survey	Mapping/ Visual survey
Regional elevation	SRTM DEM file	GIS tools
Coastal geomorphology	Google earth imagery/ visual survey	Mapping/ Visual survey
Surge Height	OSDMA data/ vulnerability atlas	documented

Source: Generated by author from various sources

5.4.3 Method of doing the CVI

At first, the study area is divided into grids of 1km X 1km. Then for each grid, risk factor is assigned for each parameter, the lowest being 1, medium 2 and the highest being 3. The reason behind doing this is to build a common platform for comparison. The various factors themselves possess different

units and they cannot be compared keeping their original values intact. So, a rating system is made for making the task hassle-free. After the risk values have been assigned, the product of all the factors for each grid is calculated. Then the obtained value is divided by the number of parameters to obtain a mean value for each grid. Then the square root of the mean value is taken to be the CVI for each grid. In this respect, the highest value which can be obtained can be the square root of 91.25 i.e. 9.59 whereas the lowest value obtained can be 0.35, in case, there is one such grid which has the lowest weightage in all the parameters. So, the results are again divided into three categories i.e. if it is 0.35 – 3.1, then the vulnerability is low, if it is 3.2 – 6.5, then it is medium and above 6.5 is termed as highly vulnerable.

Table 11 Risk rating for all the parameters

Parameters	Low Risk	Medium Risk	High Risk
Shore-line change rate (m/year)	>0 (accretion)	≥ -10 and ≤ 0 (erosion)	< -10 (severe erosion)
Barrier type	Sand dunes, sand mounds	Mainland beach barriers	No land use features
Coastal slope (degrees)	>1.0	>0.2 and ≤ 1.0	≥ 0 and ≤ 0.2
Significant wave height (metres)	Below 1.25	1.25 – 1.40	Above 1.40
Shoreline exposure	Sheltered	Semi-exposed	Exposed
Regional elevation (metres)	> 6.0	> 3.0 and ≤ 6.0	≥ 0 and ≤ 3.0
Coastal geomorphology	Inundated coasts, cliffs	Estuaries, vegetated coasts (other than mangroves)	Sandy beaches, deltas, sand-bars, mud flat
Surge Height (metres)	< 3.0	≥ 3.0 and ≤ 5.0	>5.0

Source: Generated by author from various sources

5.4.4 Evaluation of various parameters

Evaluation of each factor separately is required for proper understanding of the role each of them has to play in affecting the vulnerability of the entire area. It is often seen that even if a certain area is vulnerable because of some factor, the vulnerability is overshadowed by the positive rating of any other factor. Also, it helps us determining the future interventions which

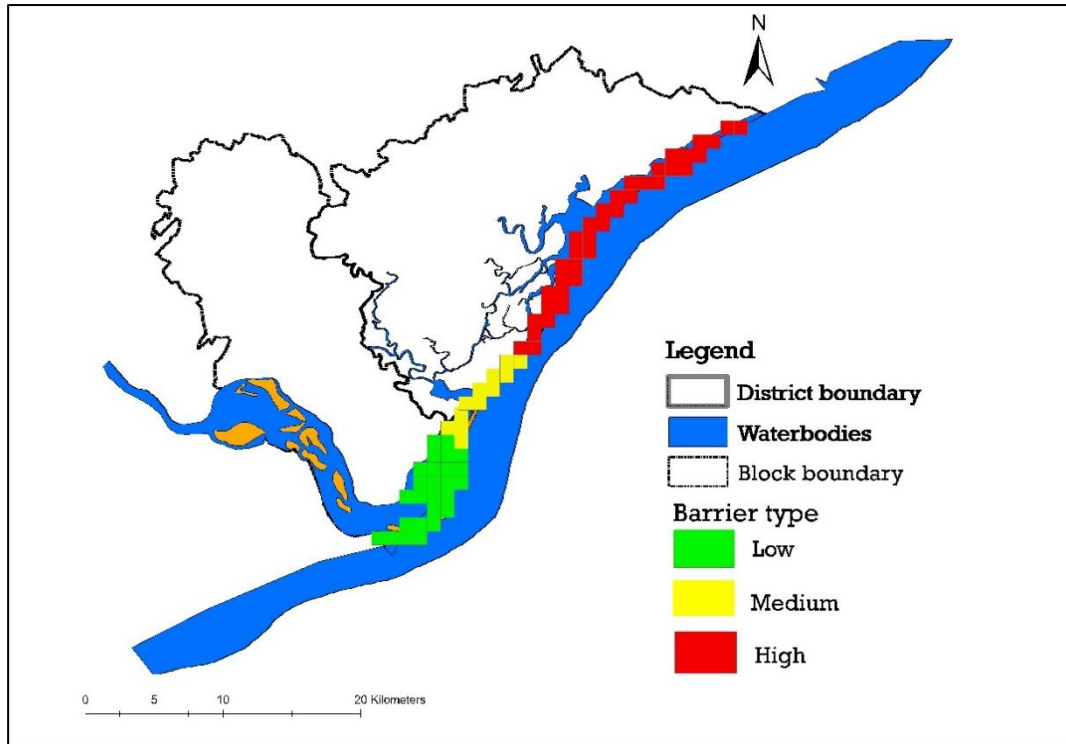
might vary even at rural level and the pre-existing conditions define the level of intervention that can be provided for lowering the overall vulnerability of the area. After evaluating, the concentration of number of grids of each colour is calculated to know the overall vulnerability of the entire coastline. It can be such that the entire stretch varies in rates of being vulnerable and each stretch needs to be managed separately as per their qualities.

5.4.4.1 Shore-line change rate (m/year)

The rate of change of shoreline is more towards the northern stretch of the coast that is, near the Hukitola bay and also in the exposed stretch of Erasama coastline near Sahadabedi village. Accretion is noticed in the southern stretches of Devi river estuary and Mahanadi delta. The rate is higher than what it should be in a year which makes the northern stretch extremely vulnerable to coastal erosion.

5.4.4.2 Barrier type

The Erasama beach is empty and has no such land use features or natural features which can be able to stop the surge of strong winds during a cyclone. On the other hand, the Balikuda coast consists of natural barriers like sand dunes, sand bounds and thorny bushes as vegetation which can combat the winds to a large extent. The lower part of Erasama is comparatively less exposed as stretches of mangrove vegetation can be found there which act as the barriers.



Map 21 Types of barriers along the coastline

Source: Generated by author

5.4.4.3 Coastal slope (degrees)

The gentler the slope, the higher is the vulnerability against storm surges. Entire Erasama coastline has a slope less than 0.2 degree. In some parts, the level of the continental shelf almost matches with coastline, where it paves way for the sea water to inundate the adjoining areas. Comparatively, due to the presence of sand dunes and mounds, the relief is undulated in Balikuda which makes it much less vulnerable than Erasama.

5.4.4.4 Significant wave height (metres)

This data has been obtained from the INCOIS data, and the values are being constantly monitored at each second of the day. If one accessed their website, he or she easily jot down the wave height sat various times of the day. I had taken three readings, and almost throughout the day, the variation was between 1.25 – 1.40, which makes the entire medium vulnerable to cyclones.

5.4.4.5 Shoreline exposure

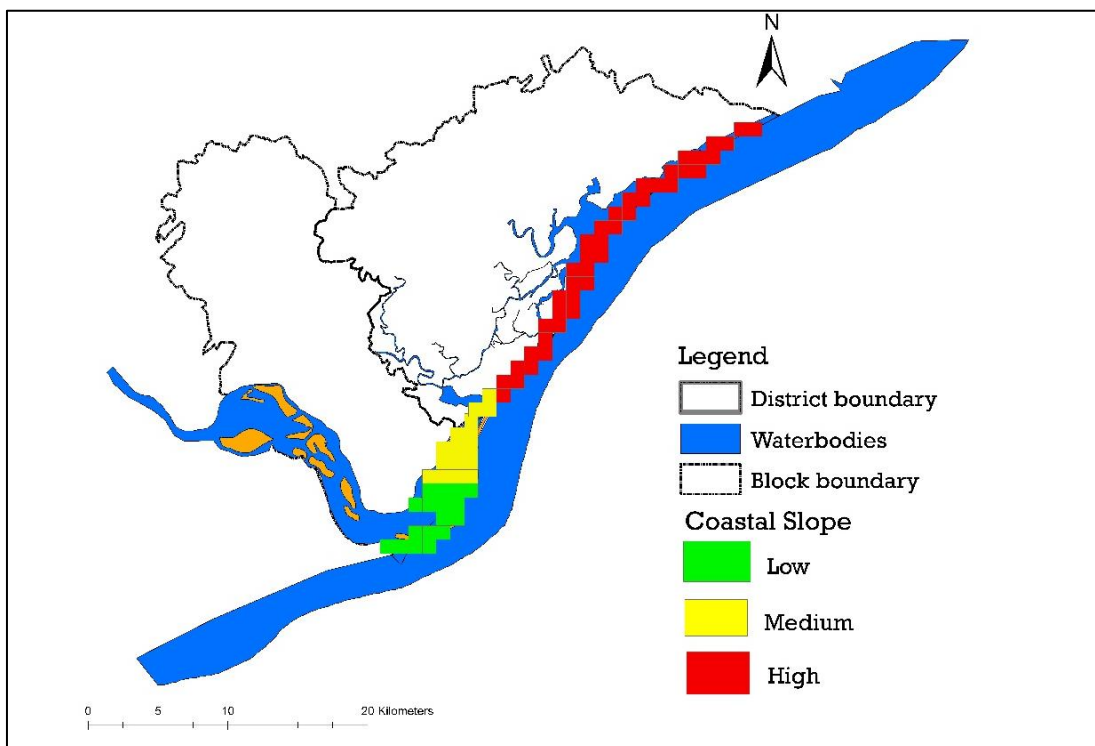
The shoreline along the Erasama beach is completely exposed having only casuarina vegetation and a single lighthouse as the only building footprint.

Exposed sea beach is equivalent no barrier which is required to stop the forcing winds. Exposed beaches are more vulnerable to both eater and wind erosion.

As the Balikuda coast comprises of dense thorny bushes, but without any building footprint, it can be termed as semi-exposed making it medium vulnerable.

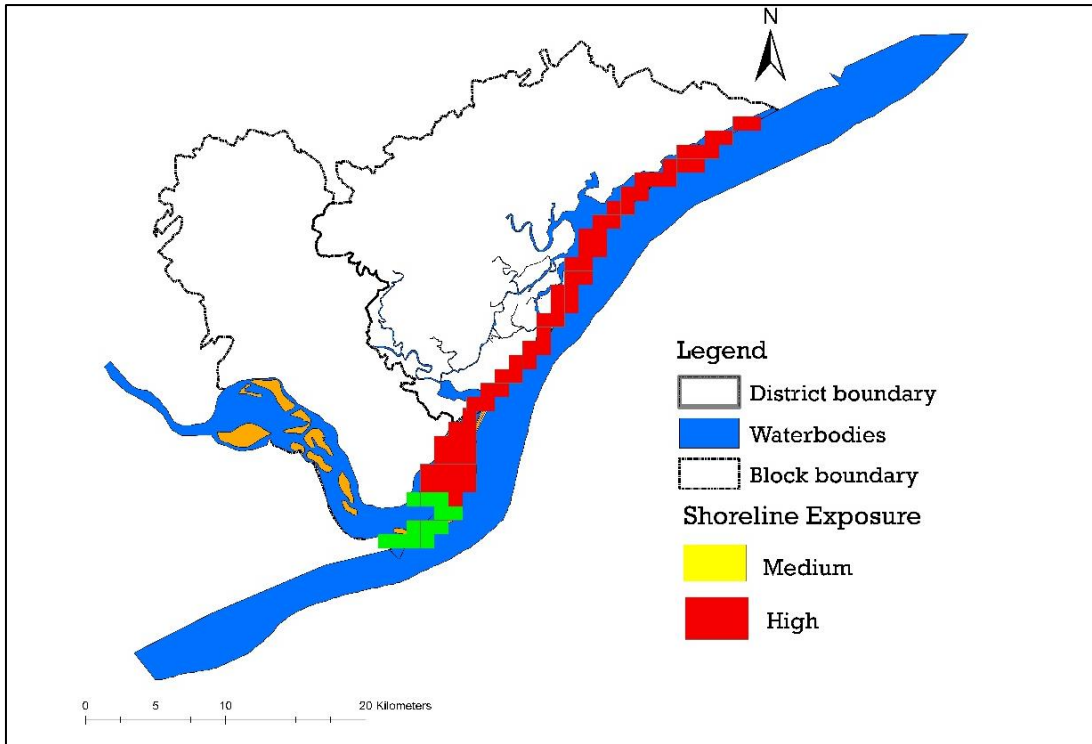
5.4.4.6 Regional elevation (metres)

The elevation profile is gentle throughout the district so the entire can be called highly vulnerable. There are some places near the coast, which are lower than mean sea level too. The gentler the elevation, the higher the risk factor in case of cyclone and floods. If the profile is higher, it could act a natural embankment to combat flood waters during high storm surges. Lower elevation means the area will be prone to salt water intrusion and water inundation.



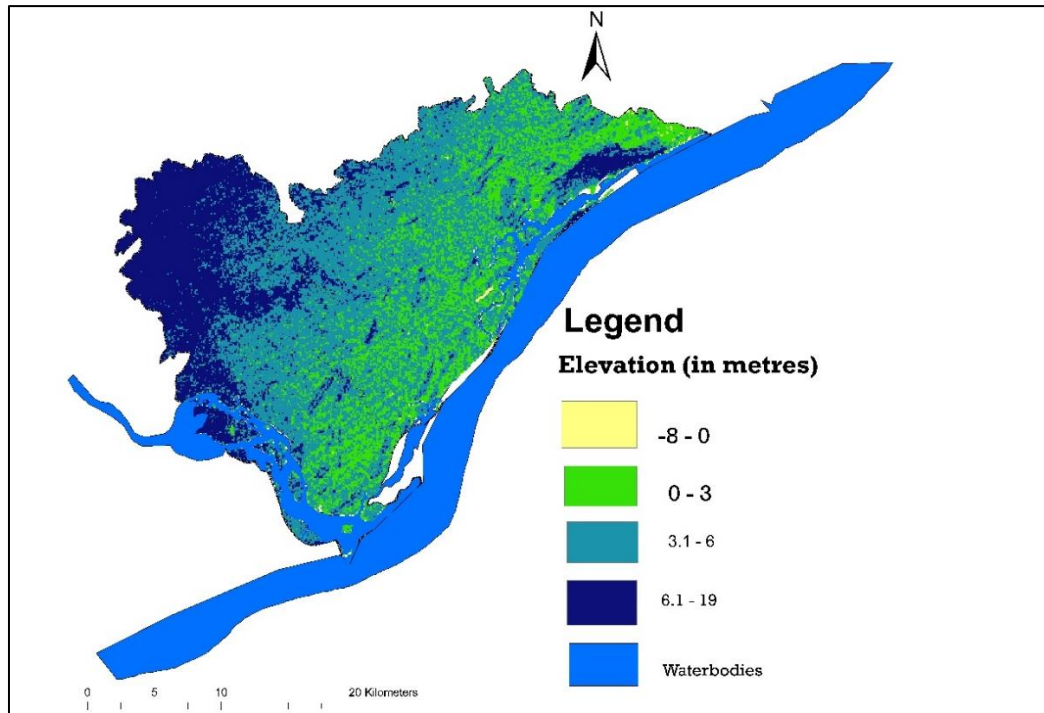
Map 22 Coastal slope variation in the coastal stretch

Source: Generated by author



Map 23 Shoreline exposure in the coastal stretch

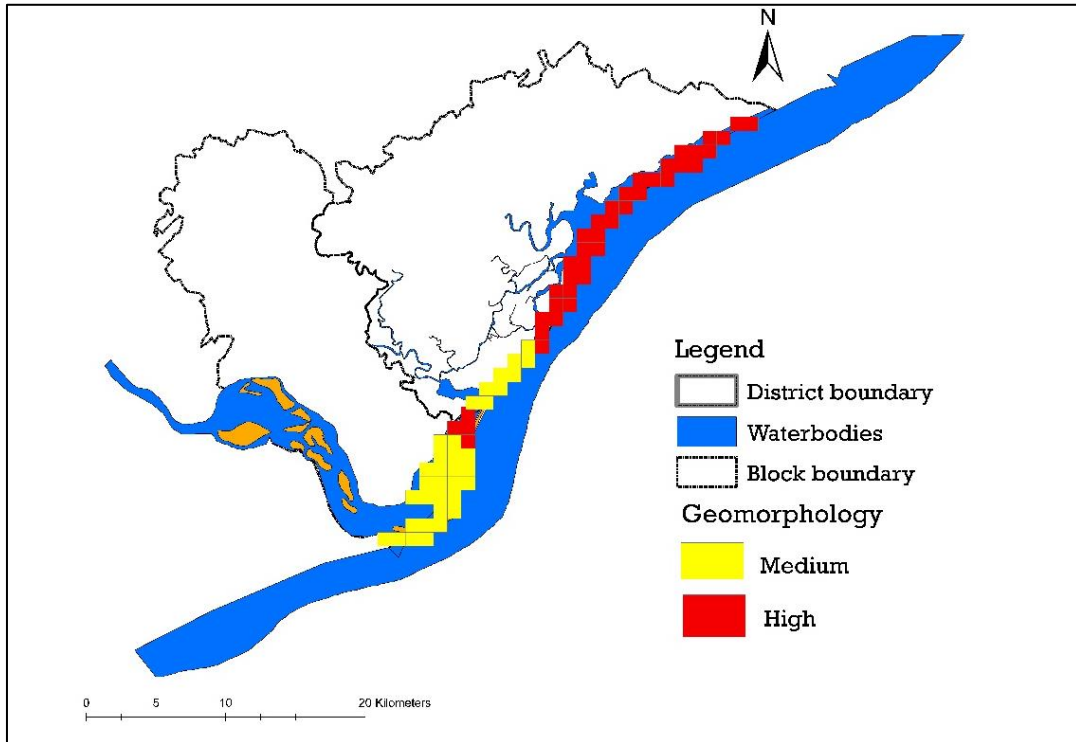
Source: Generated by author



Map 24 Elevation profile of the area

Source: Generated by author

5.4.4.7 Coastal geomorphology



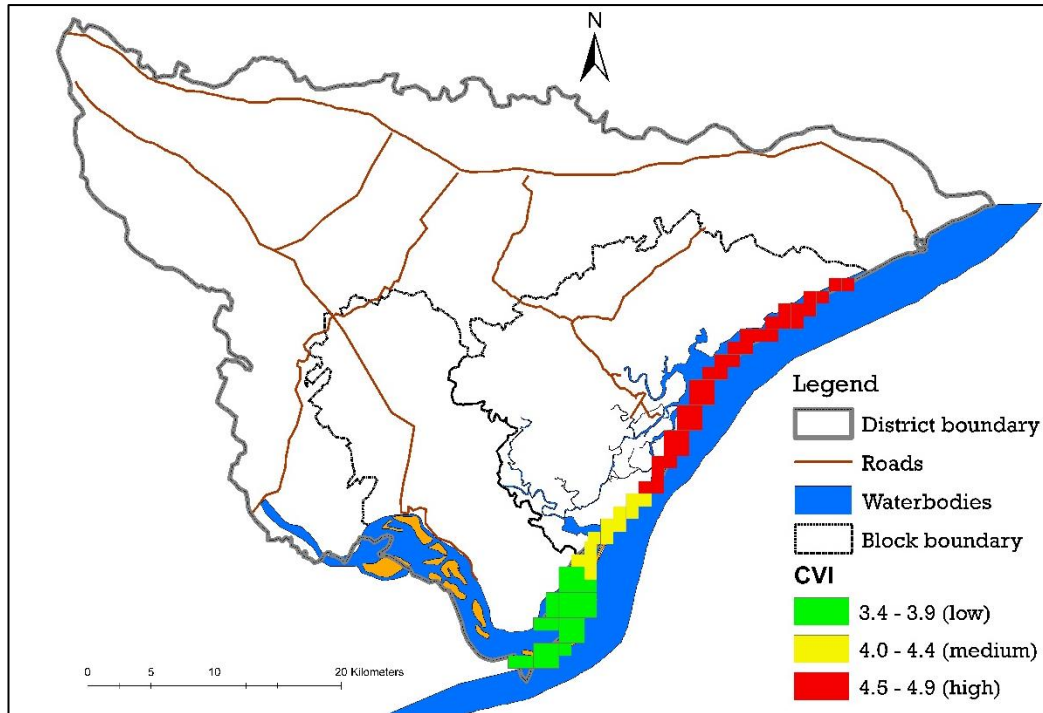
Map 25 Coastal geomorphology of the stretch

Source: Generated by author

The part of Erasama coast is medium vulnerable as it is the home to casuarina trees. The northern stretch however just contain virgin, sandy beaches which are way too exposed to face any kind of vulnerable situation. Balikuda is comparatively safe due to the presence of sand dunes.

5.4.4.8 Surge Height (metres)

According to various research papers, documents and BTPC Vulnerability Atlas, surge height along the entire stretch can go up till 7 mts. Any value more than 3 mts. is considered highly vulnerable as the height of a normal one storey building is taken to be 3 mts. So, anything above that has the potential to sweep away the buildings and entire settlements.



Map 26 The overall CVI of the stretch

Source: Generated by author

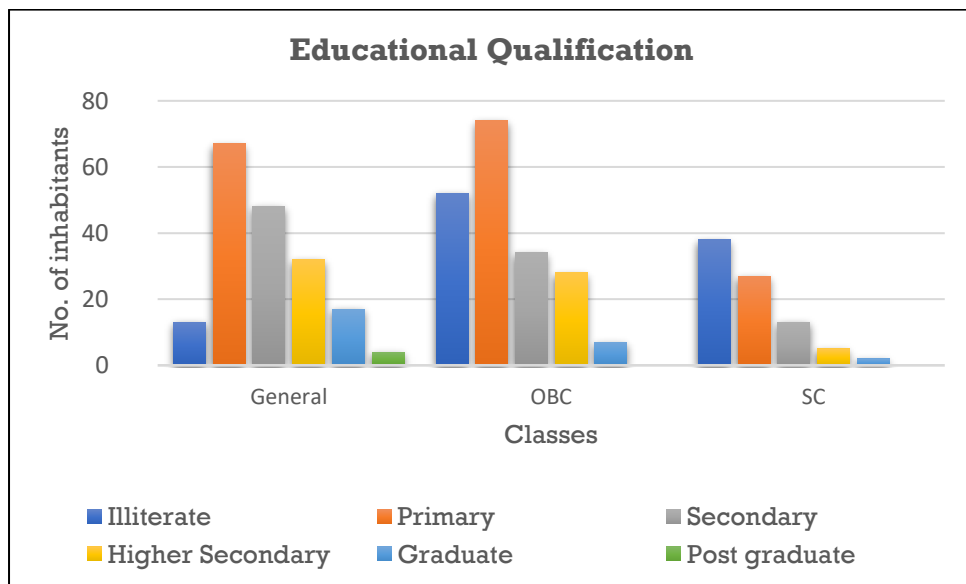
5.4.5 Socio-economic Vulnerability Index

SeVI is the method to analyse the vulnerability of socio-economic parameters of an area and is based on the definition of vulnerability given by IPCC, which covers three major aspects of sensitivity of the zones, risk factor analysis and adaptive capacity of the community. A list of 29 factors have been identified by the experts to judge the socio-economic vulnerability of an area. More research can be done and there is scope of adding as many factors which are eligible to check the risk factor of the area. It is a method where all the sustainable factors are combined together to give a single output. The indicator sources which determine the vulnerability of each parameters are given after much research and publications and at various times by different researchers. In the beginning, there were only 15 parameters, which goes on increasing as per the backdrop and settings of respective study areas. In Paris Agreement, IPCC made a special mention regarding vulnerability on the eastern coast of India and the versatility of SeVI method, which had been previously used to detect the vulnerability in three blocks of Odisha namely, Bhadrak, Balasore and Ganjam.

The data sources used are easily accessible. Secondary data about the parameters are readily available in Census of India website. The most recent data of 2011 has been used. Few parameters are obtained from primary survey. I had taken 100 household samples in each block to have an idea about the presence of socio-economic parameters in the villages. The weightage is given in two categories, either positive or negative. When all the values have been documented, a collective analysis is given on the basis of final score. The parameters are already discussed before when the questionnaire was being made.

5.4.5.1 Analysis of few socio-economic parameters

In case of educational awareness, the various categories in which the classes were divided were illiterate, primary, secondary, higher secondary, graduate and post graduate. The most number of illiterates were found in the lowest categories amongst the Bhois and Dhangars. Only few people from the upper caste are seen to have got education till post graduate level. The majority of the inhabitants are seen to have completed the primary education.



Graph 2 Variation of education awareness amongst the social classes

Source: Generated by author

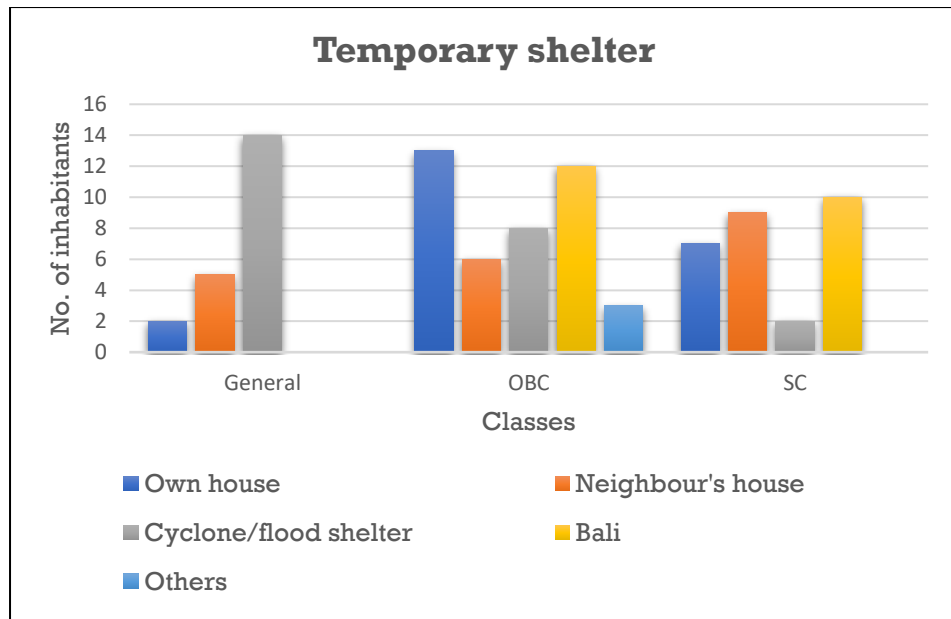
In housing typology, there are four categories as per the ownership i.e. kutcha, pucca (under PMAY schemes), semi-pucca and both typology i.e.

the old kutcha house and newly constructed pucca house. Many people in the upper caste are seen to possess either semi-pucca, pucca or both types of houses. In mediocre category most people have semi-pucca houses, and others have kutcha houses. The Bhoi and Dhangar community possess only kutcha houses made of mud and thatched roofs.

The location of the micro level neighbourhoods also varies according to the caste of the people. Each caste people live in separate neighbourhoods. The brahmins and khandayats live in the highland areas near the village temple strategically raised on high ground. Each neighbourhood is separated by some physical form of barrier or boundary like trees, road, nalahs, waterbodies etc. The Keote and the Bhoi communities live in very near proximity to the river mouth as for the Keotes it is easier to keep their boats anchored near the banks and Bhois are regarded as out caste.

Availability of temporary shelters also vary for various caste i.e. the upper class getting the priority and the lower caste people have given in to their fate and accepted the social evil that they should come in the last. Many people in lower caste have experienced harassment while receiving the provision of temporary shelters and saved their lives in the previous disasters by fleeing to the Bali or sand mound (naturally formed) and climbing a tree etc.

As per the primary survey data, the Bhoi and Dhangar communities are the most deprived ones in all respect, including availability of temporary shelter when a disaster strikes. Few people from the OBC community, especially the Keote community have access to higher education and better living conditions. Khandayats comprise the maximum number of general caste people and are mostly engaged with activities in the cities, business or other occupations.







Graph 3 Availability of temporary shelters for various social classes

Source: Generated by author

5.4.6 A tiff between the ideal and real time scenarios

Table 12 Contrasting ideal and real scenario

The ideal scenario	Contrasting real scenario
<p>Cyclone and flood shelters are mere regular structures with any separate facilities (rooms and washing/bating areas) for women.</p>	
<p>As per NDMA guidelines, shelters should be placed in the backdrop of any obstruction like big tree, hillock etc. to combat the raging winds.</p>	
<p>The new construction should at least follow any guidelines pertaining to cyclone resilience, for example, windows should be placed on both windward and leeward sides.</p>	
<p>In the coastal areas, thatched and mud houses are highly undesirable due to frequent occurrence of storms. But as per primary data, 80 percent of the households are in kuchcha condition. No intervention from PMAY scheme.</p>	
<p>Early warning facilities and awareness programmes should be conducted at every village prone to cyclones.</p>	<p>Early warning facilities was found only in Ambiki village. Rest of the villages have never witnessed any of such facilities from the authorities. Complete absence of awareness programmes.</p>

Seasonal migration should be the solution to live against a disaster situation.	People tend to look for safety by migrating frequently within a range of 1km. Giving rise to fragmentation of villages and loss of identity.
Economic insurance, livestock insurance and livelihood insurance who are totally dependent on indigenous activities like fishing should be provided.	No aid from authorities or insurance companies owing to loss because of floods and cyclones. The only aid received dates back to 1999 super cyclone – a sum of two thousand rupees was paid to the damaged households. 
	Issues prevail pertaining to losses in pisciculture during monsoon months or disasters due to heavy migration from neighbouring states. (as per Fisheries Department, Odisha.

Source: Generated by author, from observational survey

5.4.7 Documentation of stakeholder interviews

Table 13 Socio-economic profile of interviewees

Name	Age	Livelihood/ income source	Dependents	Education	Past encounters with disasters
Pratima Rani Mohanty	47	Rearing cattle, share cropping with brothers-in-law	3	Primary	Husband was killed during 1999 super cyclone when a tree fell on him.
Sashmita Biswal	28	Anganwadi worker	2	Graduate	Father was paralysed when he was trying to rescue the children
Hasibala Mohanty	36	Rearing cattle, turmeric farming	2	Secondary	Husband used to work as daily labour at Paradip. He went missing after Phailin in 2013.
Pragya Rekha Mishra	63	Widow pension	None	Illiterate	Husband died of cholera after super cyclone 1999
Hemlata Sahu	22	Daily labour	1	Primary	Husband was swept away during Phailin
Rashmi Rekha Senapati	34	Rearing goats, selling dry fish	4	Primary	Both husband and father-in-law went missing

					while they were out for fishing in 2014.
Subhasini Behera	48	Grocery shop	5	Primary	Husband paralysed when their semi-constructed concrete house fell on him in 2014.
Manorama Barik	46	Selling dry fish	3	Illiterate	Used to work as share labourers and cultivate paddy. Loss of livelihood due to saline water intrusion.
Jhulan Behera	29	House maid	3	Secondary	Husband was small scale fishermen whose fishing nets and boats were destroyed during Phailin.
Swosti Debaswini Senapati	27	House maid	2	Secondary	Husband used to work as labour in adjoining Puri district.
Sulata Barik	54	Widow pension	1	Illiterate	Husband was killed during a fight between communities for rights in catch.
Gunjamani Behera	31	Daily labour	2	Primary	No livelihood means due to loss of agricultural fields.
Saraswati Bhoi	42	Selling cow dung cakes, washing clothes	4	Illiterate	Social stigma. Cannot get employment in the village for being low caste woman.
Jhumpa Shetty	23	Daily labour	Childless	Primary	Stays at uncle's place after their house was devastated in 2013.
Nonibala Bhoi	37	House maid	4	Illiterate	Has to go to adjoining village as her husband is paralysed and the only milk-

					giving cow they had was perished in 2014.
--	--	--	--	--	---

Source: Generated by author, primary survey

5.5 Conclusion

It has been concluded from certain observations, studies, and collected data that the level of vulnerability and damage due to severe cyclonic storms and floods in coastal states of India particularly in Odisha and Andhra Pradesh is more due to socio-economic and anthropogenic factors rather than meteorological ones. The coastal areas are being engulfed due to rapid urbanization and industrialisation which accounts for the emission of a number of greenhouse gases and global warming of the area significantly which ultimately gives rise to temperature and formation of a micro-climatic zone.

It is important that the difference between the socio-economic and meteorological causes of the enhanced impacts of disasters be analysed, so that the tendency to blame natural causes for all the damages can be avoided from the team of administrative and political decision makers. All the ground realities and the response of primary respondents should be taken into account not only to frame a strong disaster management system, but also while planning for land use, development of ICZMPs, coastal districts, insurance measures and sustainable approaches to handle a disaster situation. One of the most critical shortfalls of the area is the lack of communication and almost the entire coastal areas of the particular district seem to suffer at the hands of frequent disasters.

CHAPTER 6: POSSIBLE INTERVENTIONS

6.1 Introduction

This is the final chapter of the study where I have come to the closure. The final step that is, to make possible future interventions for overcoming the issues identified is suggested in this chapter. These interventions are based on the analysis from various data collected from the sources. The ultimate goal of suggesting suitable measures is to upgrade the coastal ecosystem of Odisha, restore “fair conditions for living” and “means of livelihood” to the people who had been suffering at the hands of frequent cyclones and floods. Interventions in this case will be given for multi-directional benefits.

In my study area, two special categories of coastal regulatory zone were marked. CRZI are the zones which fall within 200mts. from the HTL line and also the eco-sensitive areas whereas CRZIII area the areas beyond 200mts. and within 500mts. of the HTL. Each have different types of interventions as per the permissible activities decided in the CRZ Act of 1991 and also according to the socio-economic and environmental conditions of the study area. The interventions will either go on in providing some sort of environmental benefit or enhancing the social and economic conditions of the people or both. Ideas have either been inspired from the measures taken in similar kinds of situation elsewhere or framed indigenously as per the analysis from the collected data.

6.2 Relating the possible interventions with the stakeholder interviews

This is an extremely important thing to do as the basis of a balanced and advocacy planning lies within the fact that the well-being of the affected people will be realised by those people only, means what can be the possible things to make their life better. The expertise of the distinguished authorities and feedback from the stakeholders can be the key to successful disaster managing strategy. For example, many of the people who were interviewed have talked about the lack of agriculture due to loss in agricultural fields, intrusion of saline water held responsible for the same. So, the possible solutions can be to provide kitchen garden facilities using scientific techniques, alternate crops which can grow in salt infused water

as well or other means of livelihood like opening of shops, employing them in Govt. funded institutions. These can be achieved by fulfilling the gap of social and physical infrastructure facilities. The main point is that each of the things are related and a symbiotic relationship should be maintained for overall progress of the situation.

Cases of submergence of entire settlements have also been reported in the coastal areas because of coastal erosion. Already the OSDMA is undergoing rehabilitation programme for entire village settlements where plots have been provided to the identified households in another settlement, which is located at a much safer place having high elevation profile.

Kitchen gardens have become a trend in Astarang block of Puri. This was done to enable the women folk to get engaged in work after the devastation during tsunami. Many people had complained about the poor road conditions which make it hard for them to commute to the places of work in the city on a regular basis. Moreover, bad road conditions have been recorded by DDMA of Jagatsinghpur itself which makes it impossible for the relief workers to reach the disaster-stricken site in time.

Afforestation along the coastal belt should be done for conserving the mangrove ecosystem as they help in maintaining the balance and also enhances the breeding of Olive Ridley turtles. The exposed sea beaches should have embankments using natural materials like perishable sand bags which can be changed from time to time if required. As we have already seen in Balikuda, due to presence of sand mounds and sand dunes, the vulnerability due to cyclones is much less than that of Erasama coastal areas, the idea can be derived from the nature's way of preventing cyclones. As I am focussing on the human-environment intervention and interaction, without paying attention towards bettering the socio-economic profile of the rural inhabitants along the coast, it is impossible to upgrade the conditions of the environment. Out of complications and compulsion, the people might be driven to exploit the components of environment as they lack awareness as well as education. Misuse of the natural resources might lead to an increase in vulnerability which is witnessed and recorded from the analysis in the preceding chapters.

6.4 Possible interventions in CRZ I areas

CRZI are the areas towards the landward side and is demarcated till 200 mts. from the like of High Tide Line. Certain activities which pose serious threat to the environment are not allowed in these areas. However, introducing new types of vegetation suiting the favourable conditions and promotion of eco-tourism in form of tree huts, mangrove walks, fish drying yards are permissible. With proper permission from the Coastal Zone Management Authorities, development of infrastructure facilities like roads and waste treatment plants also permitted which is of utmost importance for reducing the vulnerability of the study area.

6.4.1 Timber groynes

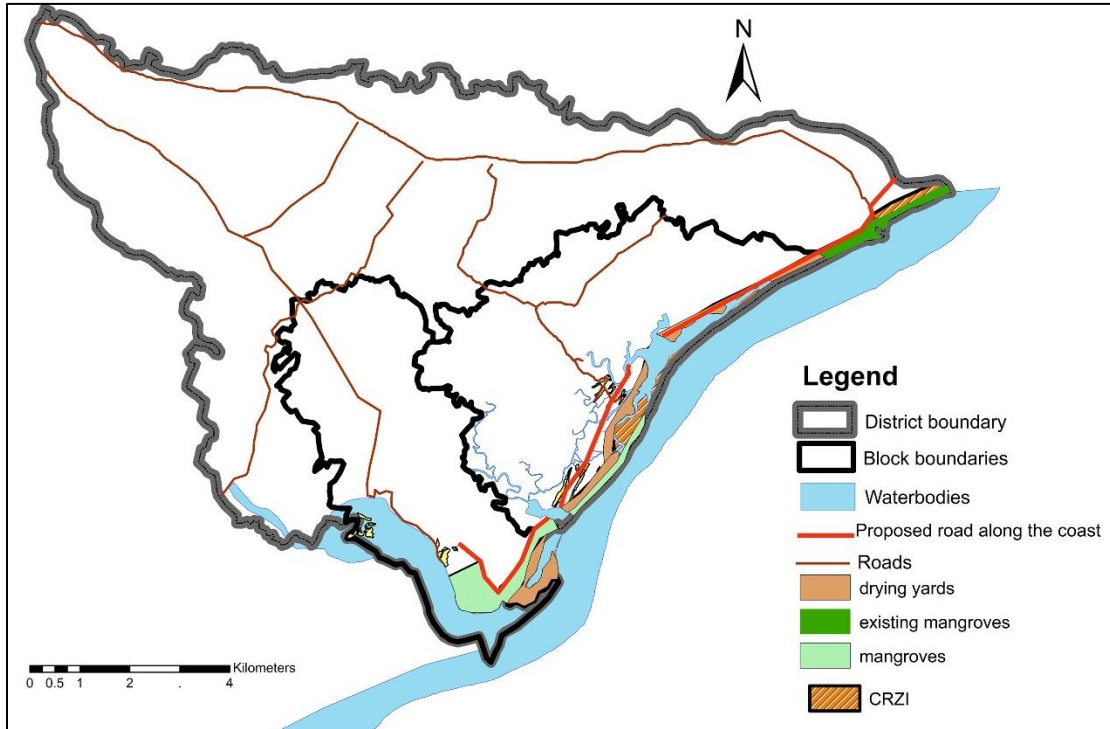
In these areas, timber groynes can be implemented to act as a barrier against the storm surges during the cyclone. Any measure which aid in reducing the erosion of the coastline are allowed. Timber will be used because they are easily mended even if the groynes get damaged by natural hazards. They will be projected towards the sea so that during the months when eco-tourism will be allowed, tourists can access the areas as promenades. Also, at the same time, these can act as the view-points for the tourists during the tourism season.

6.4.2 Mangrove culture

Mangrove culture can be practiced in the shallow areas near Devi river estuary and the saplings can be obtained from the species found in Bhitarkanika mangrove belt. Mangrove culture and the rehabilitation can both enhance socio-economic and environmental growth by offering employment in the maintenance of mangroves. At the same, upgrading the mangrove ecosystem will enhance the chances of the breeding of Olive Ridley turtles. Also. Mangrove trails and walks will be supported by promoting eco-tourism. The Devi river estuarine area can come up as a potential site for tourism to view the mass nesting of Olive Ridley turtles following the trails of Rushikulya river mouth in Gopal sea beach.

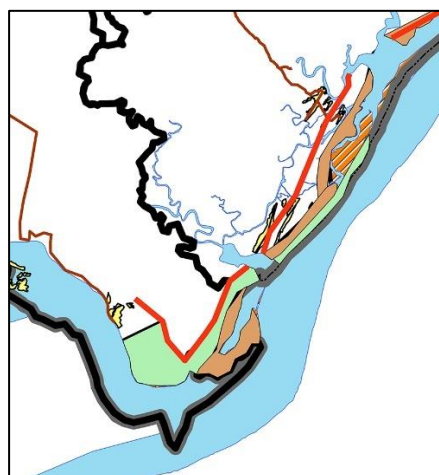
6.4.3 Natural fish drying yards and hatcheries

The areas can also be use as fish drying yards for the yield from estuarine and river fishing. Estuarine fishing to be supported and encouraged from the concerned authorities and equity to be maintained amongst the various communities due to the fact that various conflicts continue to prevail in the study area because of immigrants who came and settled in the place during partition.



Map 27 Possible interventions in CRZI areas

Source: generated by author



Map 28 Location of proposed mangroves near Devi river mouth

Source: Generated by author

6.5 Possible interventions in CRZ III areas

CRZIII areas can be divided into two parts. They consist of mainly scattered settlements comprising of fishermen villages, noliya basti, and boatmen communities. The first part comprises of the NDZ areas or the No Development Zones which lie within 500 mts of the HTL. No new construction is allowed here. Beyond NDZ areas, scope for eco-tourism still remains open as the communities living along the coast can provide for home-stays for the tourists with proper permission of improving their home as per permissible FSI. Fish drying units, kitchen gardens, infrastructural services can come up with prior review by State Coastal Zone Management Authorities.

6.5.1 Infrastructure services

Although there is provision for temporary shelters, PDS, health care facilities, they are not adequate in number for the current population of the village in the study area. The current scenario and the standard requirements for each kind of services are given below:

Standards for emergency services:

- Occupancy of CS – 200 people at a time.
- No. of PDS – 1 no. for every 500 people
- No. of schools – 1 for every 1000 people (for temporary shelter purposes)
- No. of HCs – 1 for every 200 people

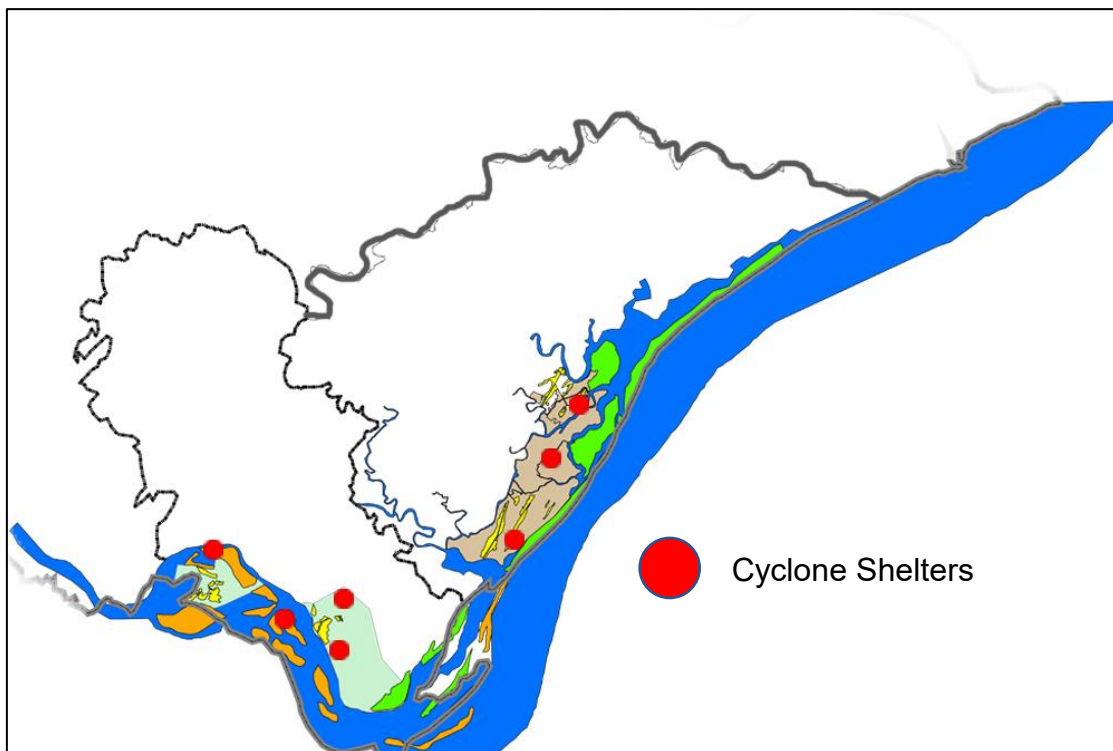
Table 14 Current and required number of infrastructural services

Name of the village cluster	No. of cyclone shelters	No. of PDS	No. of schools	No. health care centres	Population	Required no. of CS	Required no. of PDS	Required no. of HCs	Required no. of schools
Ambiki	2	2	1	1	1850	8	2	9	1
Saharabedi	1	2	1	1	1400	6	1	6	1

Tarasahi	2	2	1	1	1250	5	1	6	1
Balipatna/ Marichpur	2	1	0	1	750	2	1	3	1

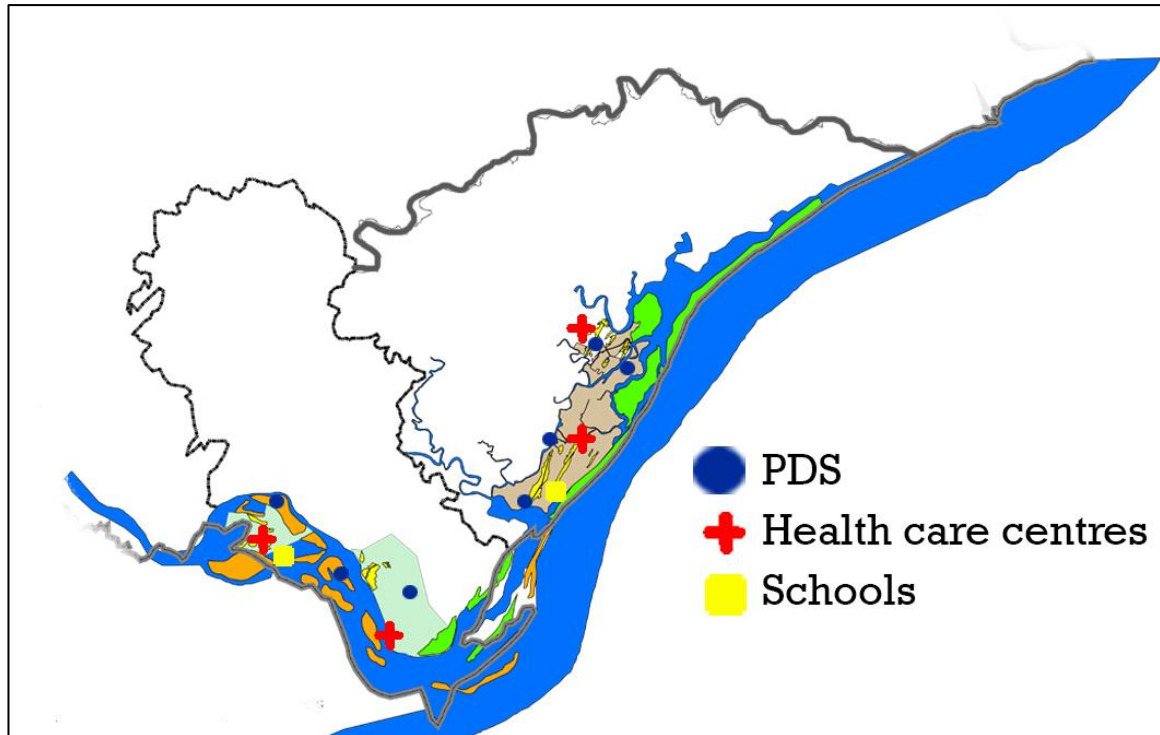
Source: Author, primary survey

The roads along the coastline can be developed under the Border Road Organisation, which is much more effective in relief and removing debris after the disaster.



Map 29 Location of cyclone shelters

Source: Author



Map 30 Location of other infrastructural services

Source: Author

6.5.2 Alternative scope for livelihood

Encouraging development of eco-tourism can be done areas 500 mts. beyond the HTL. Eco-tourism are sustainable means of tourism which aims towards the use of local materials, promotion of local culture and betterment of the local inhabitants. Tourism can be developed as a sector on a seasonal basis as in, from mid-November till June. From July till September, during the monsoons, estuarine fishing can be a livelihood for the local people.

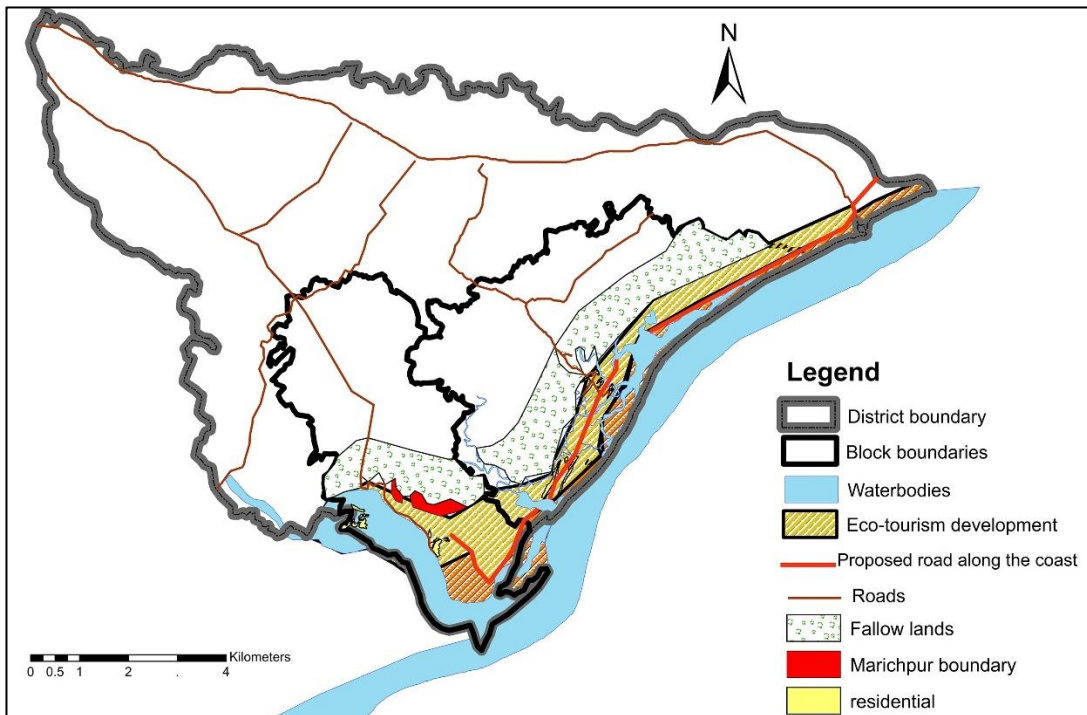
As the agricultural lands have turned into fallow lands because of saline water intrusion, alternative farming practices like oyster farming can find their way in enhancing the economic profile of the local inhabitants. Even the women folk can take active participation in the processes to improve the gender roles and have even stronger say in the decision-making situations.

Kitchen gardens can be introduced to give a start to the women of the affected villages. They can practice farming on smaller scale in their courtyards and enhance their livelihood taking proper aid from the Skill Development Centres and Agriculture Department of the State Ministry.

6.5.3 Rehabilitation of inhabitants of Tarasahi under Marichpur Gram Panchayat

Due to its location, Tarasahi is highly vulnerable to seasonal floods by river Devi along with storm surges during cyclones. The condition becomes even more grave because of the lack of road. It can be reached only by means of country as the road connectivity is there till Machhgaon-Marichpur. Ghats are located on each side of Devi river for accessing the country boats. An under-construction bridge will supposedly bridge this gap in some indefinite period of time.

People find it difficult to go to the neighbouring villages or city for regular livelihood sources, higher education and temporary shelters during crisis situations. Rehabilitation programme via proper channelization can be a means to provide the inhabitants with “fair means of living”. Marichpur village panchayat can be suggested for the same because of the fact that people will like to stay and protect their integrity and the suggested place is extremely near to the previous location but have better road connectivity and higher chances of better livelihood.



Map 31 Possible interventions in CRZIII areas

Source: Generated by author

6.6 Other interventions

Enhancing educational facilities and spreading awareness are extremely important in making the people at par with the disaster scenarios which are inevitable. There should be training programmes held by trained personnel for the rural folk to have an idea about how to react, face and manage a disaster. OSDMA should be responsible for holding these programmes in all the stages of the disaster. Awareness is required even after the disaster is over as it brings along with variety of communicable diseases like malaria, typhoid, jaundice, dysentery etc. Also, moral boost up is highly acclaimed in such scenarios and that can be provided only by the expert group who already are well-versed with the pros and cons of the disasters.

Economic security can be provided by means of provision of group insurance and can be made available by the bank services available there. Preferably, the nationalised banks should come forward with various schemes of enhancing the economic security in the affected areas.

6.7 Future research areas

These can be drawn from the results obtained from the analysis and the possible interventions. Because of time constraint, every area cannot be touched even though there are scope of improvement. As an environmental planner also, I have certain limitations while suggesting the possible interventions. There are always scope for modification with time which can be taken by as researches in the years to come. Also, each intervention has the potential of turning into a research topic.

As talked about the mangrove culture, a research can be done on the ecological conditions required for mangrove culture in the study area. The governing factors for rehabilitation and giving the responsibility of maintenance of roads and the policy formulation can be another way to put some light on the issue. Looking into the fact how eco-tourism can be developed in the study area, the types of materials used, the jobs associated with the tourism industry and upgradation of the same is one important aspect of study which will help the inhabitants and upgrade the environmental conditions in the long run.

Table 15 Inferences from the analysis and their causes

Objectives	Analysis	Causes
To analyse the vulnerability of CRZ areas within the study area and various influencing factors through literature studies and spatial analysis tools.	<ul style="list-style-type: none"> Based on the CVI, the northern stretch of Erasama (almost 25kms out of 32 kms) is highly vulnerable. Balikuda coast evaluated as medium-less vulnerable. Tarasahi village exposed to regular flooding. 	<ul style="list-style-type: none"> Exposed sea beaches, clearing of mangrove/casuarina vegetation for prawn farming, no natural barriers. Presence of sand dunes/ mounds, vegetation and undulating terrain. Due to location in eco-sensitive zone. Bounded by Devi river on all sides, it exists like an island.
To understand the effects of frequent disasters on socio-economic infrastructure and environmental status of the study area.	<ul style="list-style-type: none"> Based on SeVI, loss of livelihoods for agrarian households. Excessive brackish water prawn culture by illegal means. Poor modes of communication. Inadequacy in CS, PDS and health facilities. Scope for eco-tourism but no developments yet. 	<ul style="list-style-type: none"> Salt water inundation into the agricultural fields. Absence of All Weather Roads. Lack of awareness and education amongst people. Lack of economic security like group insurance facilities.

Source: Generated by author

Table 16 Possible interventions for reducing socio-economic and environmental vulnerability

Interventions to reduce the socio-economic vulnerability	Interventions to reduce the environmental vulnerability
<ul style="list-style-type: none"> • Encouraging estuarine fishing near Devi river mouth and Jatadharmohan river mouth. • Provision of fish drying yards within NDZ areas of CRZI. • Alternative livelihood measures by promoting eco-tourism in CRZIII areas. i.e. beyond 500mts. From the HTL. • Generating employment: <ol style="list-style-type: none"> 1) Maintenance of mangroves. 2) Maintenance of temporary shelters. • Designing the temporary shelters according to the guidelines in NDMA. • Developing the roads under Border Security Organisation along the coastal stretch. • Implementing the required number of AWCs in the affected areas to enhance communication facilities. • Provision of “Dignified Living Conditions” to the inhabitants of Tarasahi. 	<ul style="list-style-type: none"> • Prevention of coastal erosion by implementation of groynes along the coast of Erasama within 200mts of the HTL. • Upgrading the habitat condition for Olive Ridley turtles and other species. • Provision of artificial sand features in between the groynes to act as natural barriers against coastal erosion.

Source: Generated by author

6.8 Conclusion

While manifesting a disaster situation, a theory simple enough can be established which shows the presence of two types of entities. One is the disaster itself, which is considered to be the external threat having the potential to cause harm to a certain set of people or settlements or to be more specific,

people inhabiting the disaster-stricken areas, and the vulnerabilities of the people, be it social, economic or culture, which is taken to be the internal characteristics. These very characteristics when become the reason of them getting affected in a worse manner, it takes the form of a disaster. There are different line of opinions prevailing regarding this controversial issue. Since a long time, geographers and other social scientist groups have put their emphasis on the causes and impacts of disasters rather than giving much importance to the needs and outlook of people. Whenever few people with genuine concern had tried to consider people, the idea had been referred to as the “war-approach” in which the intriguing main event again is the disaster after which the rest of the events follow. So, a need to recognize the importance of people and their internal characteristics that is, their vulnerabilities which make them more exposed or the impacts of disasters is expected. While few groups lay their focus on the hazard other groups tend to give significance to the characteristics of the affected population. Disaster is such a thing which neither can be overlooked or overcome completely so it's better to find the negativities lying buried deep within ourselves and pave way for a better tomorrow.

However, we fail to notice one very important aspect that is, disasters tend to become what they are once the human component comes into play. Any disaster be it cyclone, flood or earthquake is merely an event and not any major problem all by themselves.

They are counted as hazards only when they pose serious threat to human populations and settlements located in and near the areas where they have occurred. Once these events start interacting with the exposed vulnerabilities of the people living in the affected areas, disasters occur. The designation of hazards not only as events but as a serious threat to socially created structures is necessary, without which the scope of definition of hazards will cease to create an impact on the concerned authorities.

For example, if a cyclone would have occurred in an uninhabited area, it would be just any other natural event, but when it occurs in a densely populated coastal village having enormous population associated with agriculture or fishing, it is sure to cause a setback in the social, economic and cultural settings of the settlements and the inhabitants and when a considerable loss has

occurred in all aspects, it is a disaster. Any natural event, like cyclone or flood is not enough to cause a disaster, time and space are two integral factors which defines correctly when it occurs, where it occurs, and who gets affected. In this context, it is required to have a knowledge about the people and their vulnerabilities who get regularly affected by disasters. This is done with the help of detailed documentation during field visit, and also by various factors of vulnerability like their living conditions, livelihood, exposure to education, ability to reach out to safe places during disasters and the time they take to recover from the situation. Their ability to cope with the disasters and the resilience factor will also be taken into consideration.

References

- Aggarwal, D. and Lal, M., 2001. Vulnerability of Indian coastline to sea level rise. *Centre for Atmospheric Sciences, Indian Institute of Technology, New Delhi*.
- Ali, A., 1996. Vulnerability of Bangladesh to climate change and sea level rise through tropical cyclones and storm surges. In *Climate Change Vulnerability and Adaptation in Asia and the Pacific* (pp. 171-179). Springer Netherlands.
- Barik, S.K., Mohanty, P.K., Kar, P.K., Behera, B. and Patra, S.K., 2014. Environmental cues for mass nesting of sea turtles. *Ocean & coastal management*, 95, pp.233-240. Available at: https://s3.amazonaws.com/academia.edu.documents/44981820/Environmental_cues_for_mass_nesting_of_s20160422-9062-wlnqma.pdf?AWSAccessKeyId=AKIAIWOWYYGZ2Y53UL3A&Expires=1526518715&Signature=Bh1S%2Bo3Q4URAcLGosPwH32%2FyjgA%3D&response-content-disposition=inline%3B%20filename%3DEnvironmental_cues_for_mass_nesting_of_s.pdf. [Accessed: May, 2018]
- Barman, N.K., Chatterjee, S. and Paul, A.K., 2016. Spatial Characteristics Analysis of Coastal Vulnerability in the Balasore Coastal District, Odisha, India. *J. Ind. Geophys. Union (April 2016)*, 20(2), pp.216-230. Available at: [http://j-igu.in/igu%2020-2%20\(web\)/Paper-7.pdf](http://j-igu.in/igu%2020-2%20(web)/Paper-7.pdf) [Accessed: May, 2018]
- Chhotray, V., 2016. Justice at Sea: Fishers' politics and marine conservation in coastal Odisha, India. *Maritime Studies*, 15(1), p.4. Available at: <https://maritimestudiesjournal.springeropen.com/articles/10.1186/s40152-016-0043-3> [Accessed: May, 2018]
- Chhotray, V., Hill, J., Biswal, R. and Behera, S., 2013. Socio-political and environmental dimensions of vulnerability and recovery in coastal Odisha: Critical lessons since the 1999 super-cyclone. Norwich, England. University of East Anglia. Available at: http://www.in.undp.org/content/india/en/home/library/environment_energy/socio-political-and-environmental-dimensions-of-vulnerability-an.html [Accessed: May, 2018]
- Chittibabu, P., Dube, S.K., Macnabb, J.B., Murty, T.S., Rao, A.D., Mohanty, U.C. and Sinha, P.C., 2004. Mitigation of flooding and cyclone hazard in Orissa, India. *Natural Hazards*, 31(2), pp.455-485. Available at: <http://repository.ias.ac.in/26593/1/313.pdf>. [Accessed: May, 2018]
- Das, S., 2009. Addressing Coastal Vulnerability at the Village Level: The Role of Socio-economic and Physical Factors. Canberra, Australia. East Asian Bureau of Economic Research, Australian National University. Available at: <https://ideas.repec.org/p/eab/develo/22920.html> [Accessed: May, 2018]

- Das, S., 2011. Examining the storm protection services of mangroves of Orissa during the 1999 cyclone. *Economic and Political Weekly*, 46(24), pp.60-68. Available at: https://www.researchgate.net/profile/Das_Saudamini/publication/265624272_Examining_the_Storm_Protection_Services_of_Mangroves_of_Orissa_during_the_1999_Cyclone/links/550a71a00cf26198a63acc87/Examining-the-Storm-Protection-Services-of-Mangroves-of-Orissa-during-the-1999-Cyclone.pdf [Accessed: May, 2018]
- Das, S. and Vincent, J.R., 2009. Mangroves protected villages and reduced death toll during Indian super cyclone. *Proceedings of the National Academy of Sciences*, 106(18), pp.7357-7360. Available at: <http://www.pnas.org/content/106/18/7357.full> [Accessed: May, 2018]
- Dahdouh-Guebas, F., Jayatissa, L.P., Di Nitto, D., Bosire, J.O., Seen, D.L. and Koedam, N., 2005. How effective were mangroves as a defence against the recent tsunami? *Current biology*, 15(12), pp. R443-R447. Available at: <https://www.sciencedirect.com/science/article/pii/S0960982205006032>. [Accessed: May, 2018]
- Drake, C.W., 2014. Assessment of flood mitigation strategies for reducing peak discharges in the Upper Cedar River watershed. Iowa, USA. The University of Iowa. Available at: <https://search.proquest.com/docview/1559962418?pq-origsite=gscholar> [Accessed: May, 2018]
- Füssel, H.M., 2007. Adaptation planning for climate change: concepts, assessment approaches, and key lessons. *Sustainability science*, September, 2(2), pp. 265-275. Available at: https://www.researchgate.net/profile/HansMartin_Fuessel/publication/215677053_Adaptation_Planning_for_Climate_Change_Concepts_Assessment_Approaches_and_Key_Lessons/links/09e415099025ac7a1a000000/Adaptation-Planning-for-Climate-Change-Concepts-Assessment-Approaches-and-Key-Lessons.pdf [Accessed: May, 2018].
- Gandhi, K., 2010. Identity politics, power and resistance in disaster response: A case study of the 2004 tsunami relief, rehabilitation and recovery in Tamil Nadu. Singapore. National University of Singapore. Available at: <http://scholarbank.nus.sg/bitstream/10635/22061/1/Gandhi%20K3.pdf> [Accessed: May, 2018]
- Gupta, P., 2009. Ethnicity, caste and community in a disaster prone area of Orissa. Institute for Social and Economic Change. Bengaluru, Institute for Social and Economic Change. Available at: <http://www.isec.ac.in/WP%20231%20-%20Priya%20Gupta.pdf>. [Accessed: May, 2018]
- Gupta, P., 2010. Survival and Resilience of Two Village Communities in Coastal Orissa: A Comparison of Coping with Disasters. Bengaluru, Institute for Social and Economic Change. Available at: http://www.isec.ac.in/WP%20255%20-%20Priya%20Gupta_2.pdf. [Accessed: May, 2018]

- Karim, M.F. and Mimura, N., 2008. Impacts of climate change and sea-level rise on cyclonic storm surge floods in Bangladesh. *Global Environmental Change*, 18(3), pp.490-500. Available at: <http://files.lfigueroaclases.webnode.cl/200000122-9ae669cd84/Karim%20-%20Mimura%202008%20impactos%20del%20cambio%20climatico%20y%20el%20nivel%20del%20mar%20en%20tormentas%20ciclonicas%20en%20bangladesh.pdf> [Accessed: May, 2018].
- King, D., Gurtner, Y., Firdaus, A., Harwood, S. and Cottrell, A., 2016. Land use planning for disaster risk reduction and climate change adaptation: Operationalizing policy and legislation at local levels. *International Journal of Disaster Resilience in the Built Environment*, 7(2), pp.158-172. Available at: <https://www.emeraldinsight.com/doi/abs/10.1108/IJDRBE-03-2015-0009>. [Accessed: May, 2018]
- Kumar, A.A. and Kunte, P.D., 2012. Coastal vulnerability assessment for Chennai, east coast of India using geospatial techniques. *Natural Hazards*, 64(1), pp.853-872. Available at: http://drs.nio.org:8080/drs/bitstream/handle/2264/4167/Nat_Hazards_64_853a.pdf?sequence=1&isAllowed=y. [Accessed: May, 2018]
- Kumar, M., 2015. Remote sensing and GIS based sea level rise inundation assessment of Bhitarkanika forest and adjacent eco-fragile area, Odisha. *International Journal of Geomatics and Geosciences*, 5(4), p.674. Available at: https://www.researchgate.net/profile/Manish_Kumar158/publication/275957041_Remote_sensing_and_GIS_based_sea_level_rise_inundation_assessment_of_Bhitarkanika_forest_and_adjacent_eco-fragile_area_Odisha/links/554b4d3c0cf21ed213591fe4/Remote-sensing-and-GIS-based-sea-level-rise-inundation-assessment-of-Bhitarkanika-forest-and-adjacent-eco-fragile-area-Odisha.pdf. [Accessed: May, 2018]
- Kumar, T.S., Mahendra, R.S., Nayak, S., Radhakrishnan, K. and Sahu, K.C., 2010. Coastal vulnerability assessment for Orissa State, east coast of India. *Journal of Coastal Research*, pp.523-534. Available at: <http://www.jstor.org/stable/pdf/40605480.pdf>. [Accessed: May, 2018]
- Mishra, A., 2014. Temperature Rise and Trend of Cyclones over the Eastern Coastal Region of India. *Journal of Earth Science & Climatic Change*, 5(9), p.1. Available at: <https://www.omicsonline.org/open-access/temperature-rise-and-trend-of-cyclones-over-the-eastern-coastal-region-of-india-2157-7617.1000227.php?aid=32625>. [Accessed: May, 2018]
- Mishra, D. and Sahu, N.C., 2014. Response of farmers to climate change in Odisha: An empirical investigation. *International Journal of Environmental Sciences*, 4(5), p.786. Available at: <http://www.ipublishing.co.in/ijesarticles/fourteen/articles/volfour/EIJES41074.pdf>. [Accessed: May, 2018]

Mohanty, P.K., Panda, U.S., Pal, S.R. and Mishra, P., 2008. Monitoring and management of environmental changes along the Orissa coast. *Journal of Coastal Research*, 24(sp2), pp.13-27. Available at: https://s3.amazonaws.com/academia.edu.documents/41165242/Monitoring_and_Management_of_Environment20160114-28238-1dn9a96.pdf20160114-19908-s797x4.pdf?AWSAccessKeyId=AKIAIWOWYYGZ2Y53UL3A&Expires=1526518302&Signature=%2BVJn1nUGc8aj7UtA1p01w9OnAa0%3D&response-content-disposition=inline%3B%20filename%3DMonitoring_and_Management_of_Environment.pdf. [Accessed: May, 2018]

Mojtahedi, M. and Oo, B.L., 2017. Critical attributes for proactive engagement of stakeholders in disaster risk management. *International Journal of Disaster Risk Reduction*, 21, pp.35-43. Available at: <https://www.sciencedirect.com/science/article/pii/S2212420916303284>. [Accessed: May, 2018]

Nandakumar, D. and Muralikrishna, M., 1998. Mapping the extent of coastal regulation zone violations of the Indian coast. *Valiathura, Thiruvananthapuram. National Fish workers Forum*. Available at: http://ceeindia.org/cee/pdf_files/cmz_violation_studyby_thomas_kocherry.pdf. [Accessed: May, 2018]

Nath, S., 2015. Socio-Economic and Environmental Implications of Prawn Cultivation in Chilika Lake, Odisha. Rourkela, Odisha. National Institute of Technology. Available at: http://ethesis.nitrkl.ac.in/6740/1/Socio-Economic_Nath_2015.pdf. [Accessed: May, 2018]

Panigrahi, J.K. and Mohanty, P.K., 2012. Effectiveness of the Indian coastal regulation zones provisions for coastal zone management and its evaluation using SWOT analysis. *Ocean & coastal management*, 65, pp.34-50. Available at: https://www.researchgate.net/publication/257423729_Effectiveness_of_the_Indian_coastal_regulation_zones_provisions_for_coastal_zone_management_and_its_evaluation_using_SWOT_analysis. [Accessed: May, 2018]

Pati, B., 2001. Identity, hegemony, resistance: conversions in Orissa, 1800-2000. *Economic and Political weekly*, pp.4204-4212. Available at: <http://www.jstor.org/stable/4411327?refreqid=excelsior%3Ab7f71e4605352868d717f4d811a5234e>. [Accessed: May, 2018]

Pattanaik, S., 2007. Conservation of environment and protection of marginalized fishing communities of lake Chilika in Orissa, India. *Journal of Human Ecology*, 22(4), pp.291-302. Available at: <http://www.krepublishers.com/02-Journals/JHE/JHE-22-0-000-000-2007-Web/JHE-22-4-000-000-2007-Abstract-PDF/JHE-22-4-291-07-1507-Pattanaik-S/JHE-22-4-291-07-1507-Pattanaik-S-Tt.pdf>. [Accessed: May, 2018]

Piman, T. and Shrestha, M., 2017. Case study on sediment in the Mekong River Basin: Current state and future trends. Stockholm, Stockholm Environmental Institute. Available at:

https://www.researchgate.net/profile/Thanapon_Piman/publication/322948784_Case_study_on_sediment_in_the_Mekong_River_Basin_Current_state_and_future_trends_Case_study_on_sediment_in_the_Mekong_River_Basin_Current_state_and_future_trends/links/5a78fa9a0f7e9b41dbd443d5/Case-study-on-sediment-in-the-Mekong-River-Basin-Current-state-and-future-trends-Case-study-on-sediment-in-the-Mekong-River-Basin-Current-state-and-future-trends.pdf. [Accessed: may, 2018]

Quarantelli, E.L., Lagadec, P. and Boin, A., 2007. A heuristic approach to future disasters and crises: new, old, and in-between types. In *Handbook of disaster research* (pp. 16-41). Springer, New York, NY. Available at:

https://www.researchgate.net/profile/Arjen_Boin/publication/227097947_A_Heuristic_Approach_to_Future_Disasters_and_Crises_New_Old_and_In-Between_Types/links/55a383e708ae7ed8b92e8cda.pdf. [Accessed: May, 2018]

Ramesh, R., Purvaja, R. and Senthil, V.A., 2011. National assessment of shoreline change: Odisha coast. New Delhi. Ministry of Environment and Forests, Government of India. Available at: http://ncscm.res.in/cms/more/pdf/ncscm-publications/pondy_report_web.pdf. [Accessed: May, 2018]

Rani, N.S., Satyanarayana, A.N.V. and Bhaskaran, P.K., 2015. Coastal vulnerability assessment studies over India: a review. *Natural Hazards*, 77(1), pp.405-428. Available at: <https://link.springer.com/article/10.1007/s11069-015-1597-x>. [Accessed: May, 2018]

Ray-Bennett, N.S., 2009. The influence of caste, class and gender in surviving multiple disasters: A case study from Orissa, India. *Environmental Hazards*, 8(1), pp.5-22. Available at:

http://gdnonline.org/resources/RayBennett_Influence_of_Caste_Orissa.pdf. [Accessed: May, 2018]

Ray-Bennett, N.S., 2018. Disasters, Deaths, and the Sendai Goal One: Lessons from Odisha, India. *World Development*, 103, pp.27-39. Available at:

https://www.researchgate.net/profile/Nibedita_Ray-Bennett/publication/320957071_Disasters_Deaths_and_the_Sendai_Goal_One_Lessons_from_Odisha_India/links/5a0453efaca272b06ca9e31a/Disasters-Deaths-and-the-Sendai-Goal-One-Lessons-from-Odisha-India.pdf. [Accessed: May, 2018]

Suganya, R., Sarathy, R.V., Raj, B., Rajamanickam, M. and Anandaraju, K., 2015. Assessing Coastal Vulnerability to Sea-Level Rise between Gopalpur and Puri, Odisha Coast of India, using Remote Sensing and GIS. *International Journal of Engineering and Management Research (IJEMR)*, 5(2), pp.844-851. Available at:

<http://www.indianjournals.com/ijor.aspx?target=ijor:ijemr&volume=5&issue=2&article=148>. [Accessed: May, 2018]

Sahoo, B. and Bhaskaran, P.K., 2017. Coastal Vulnerability Index and Its Projection for Odisha Coast, East Coast of India. *World Academy of Science, Engineering and Technology, International Journal of Environmental, Chemical, Ecological, Geological and Geophysical Engineering*, 11(6), pp.519-523. Available at: <http://waset.org/publications/10007351/coastal-vulnerability-index-and-its-projection-for-odisha-coast-east-coast-of-india>. [Accessed: May, 2018]

Saravanan, D., 2016. Structural and nonstructural mitigation measures in coastal area threats. *International Journal of Oceans and Oceanography*, 10(2), pp.141-148. Available at: http://www.ripublication.com/ijoo16/ijoo16/ijoo16n2_06.pdf. [Accessed: May, 2018]

Schipper, L. and Pelling, M., 2006. Disaster risk, climate change and international development: scope for, and challenges to, integration. *Disasters*, 30(1), pp.19-38. Available at: Wiley Online Library [Accessed: May, 2018].

Sethi, R.R., SagarSahu, A., Srivastava, R.C., Das, M., Kumar, A. and Tripathy, J.K., 2014. Monitoring Land Cover Changes in coastal tract of Odisha using Landsat ETM+ Imagery. *Current World Environment*, 9(2), p.430. Available at: <http://www.cwejournal.org/vol9no2/monitoring-land-cover-changes-in-coastal-tract-of-odisha-using-landsat-etm-imagery/>. [Accessed: May, 2018]

Tamima, U., 2009. Population Evacuation Need Assessment in Cyclone Affected Barguna District. *Journal of Bangladesh Institute of Planners*, 2, pp.145-157. Available at: <https://www.banglajol.info/index.php/JBIP/article/download/9575/7098>. [Accessed: May, 2018]

Yadav, D.K. and Barve, A., 2017. Analysis of socioeconomic vulnerability for cyclone-affected communities in coastal Odisha, India. *International Journal of Disaster Risk Reduction*, 22, pp.387-396. Available at: <https://www.sciencedirect.com/science/article/pii/S2212420916306653>. [Accessed: May, 2018]

ANNEXURES

SURVEY QUESTIONNAIRRE

General Questions:

- 1) Name of the person: _____
- 2) Village/ Block Name: _____
- 3) Household size:
 - i) Males:
 - ii) Females:
 - iii) Children:
- 4) Type of house (Kutcha/ Semi-Pucca/ Pucca)
- 5) Condition of house (Dilapidated/ Livable/ Good)
- 6) Current livelihood:
 - i) Member 1
 - ii) Member 2
 - iii) Member 3
 - iv) Others
- 7) Have you migrated from some other village? (Yes/ No)
- 8) What is the reason for migration?

Cropping pattern:

- 1) What kind of crops do you grow?
 - i) Kharif:
 - ii) Rabi:
- 2) What is the source of water for agriculture? (canals/ river water/ bore well/ others)
- 3) What kind of fertilizer do you use?
- 4) How much land do you own? (less than 1 acre/ 1-3 acres/ 3-5 acres/ more than 5 acres)
- 5) Is there any change in cropping pattern (season wise)? (Yes/ No)
- 6) Is there any change in variety of crops grown? (Yes/ No)
- 7) Details:

Impacts of disasters

- 1) Is there any deaths pertaining to disasters?
- 2) Is there any loss of property due to disasters?
 - i) Livestock
 - ii) House
 - iii) Agricultural lands
 - iv) Others
- 3) Is there any change in livelihood pattern due to disaster?
- 4) Do you have any disaster insurance certificate?
 - i) Govt.
 - ii) Private companies
- 5) Have you ever received any benefit from the insurance companies?

Preparedness and awareness

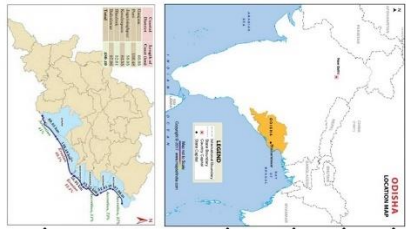
- 1) Do you receive warnings beforehand if any cyclone is approaching?
- 2) What is the minimum time before the warning is received?
- 3) Is there any provision of moving to high lands/ safe areas before disaster strikes?
- 4) Are awareness programmes held in your area?
- 5) Have you ever attended any pre-cyclone session/ public meetings?
- 6) What do these programmes conduct?
 - i) Causes of disasters?
 - ii) Preparedness of disasters?
 - iii) How to act immediately in times of disasters?
 - iv) Utility of cyclone shelters?
 - v) Coping with the disasters?
- 7) Is there equal participation in the awareness and preparedness programmes from both genders?

Cyclone/ flood shelters

- 1) What is the probable distance of cyclone/ flood shelters from your residence?
(less than 1km/ 1-3kms/ 3-5kms/ more than 5kms)
- 2) What is the actual building use of the cyclone shelter?
- 3) Are there separate chambers for men and women?
- 4) Are there separate toilet/ bathing area facilities?
- 5) How far is the supply areas (water, firewood and relief materials) from the shelter?
(adjoining/ less than 500 mts/ 500mts-1km/ 1-3kms/ more than 3 kms)
- 6) Is there separate areas for the livestock?

- 7) Is the design of the shelters meant for universal usage?
- 8) What is the plinth height used?
- 9) What is the number of floors normally given in a cyclone shelter?

INTRODUCTION - Background | Need | Definitions | Justification

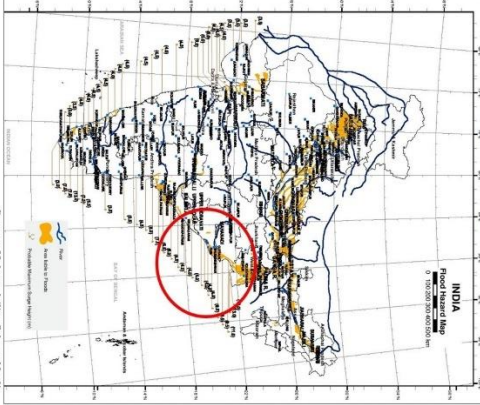
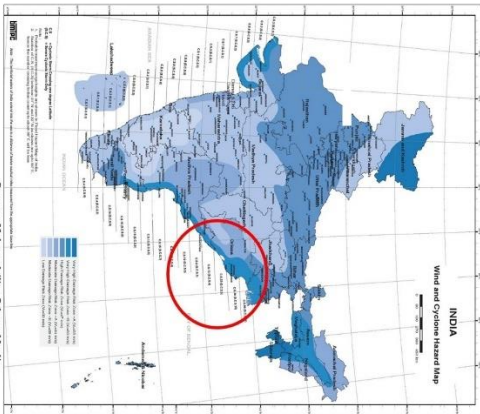


Odisha is located on the eastern coast of India with an area of 1,35,707 sq.km. Has a coastline of 485 kilometres, stretching from Balasore to Ganjam. The coastline includes various establishments such as fishing villages, large and small towns, hotels and tourism centers. Asia's largest brackish water lagoon, called Chilika, the sandy beaches in Rushikulya and Gahinmatha, which comprise the largest rookeries in the world for the Olive Ridley sea turtles, and the wildlife sanctuary of Bhitarkanika, which is an extensive mangrove cover hosting a variety of flora and fauna are located in Odisha. The Mahanadi delta and two very important estuarine river mouths are present here.

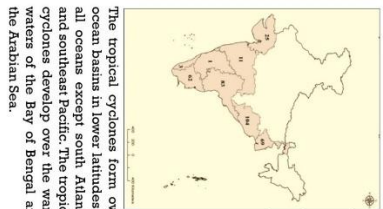
1971 Super Cyclone
The village of Sanahelya (the seven-village cluster) in Kendrapara district suffered the maximum loss as submerged due to high storm surge and heavy coastal erosion.

1989 Super Cyclone
The noble development which took place at the immediate result of the super cyclone was the formation of Odisha State Disaster Management Authority in December the same year.

2013 Phalan
The important thing which took place was the biggest evacuation in the twenty-five years history of India, as people were evacuated from the coastline to high ground in cyclone shelters.



DISASTER RISK REDUCTION FOR FREQUENT OCCURRENCE OF CYCLONES AND FLOODS - A CASE OF JAGATSINGHPUR, ODISHA

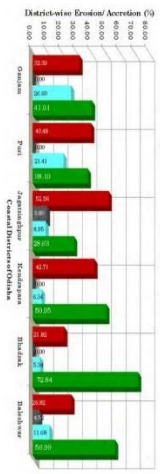
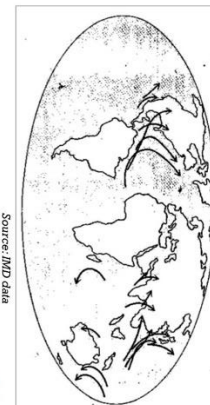


Why eastern coast of India is more prone to cyclones?

- Temperature- BOB is hotter than Arabian sea. Hot water temperature is the basic criteria for the development & intensification of cyclones.
- Salinity- Arabian sea has higher salinity than BOB. Its easier to heat & simultaneously evaporate water having lower salinity.
- Movement- According to IMD cyclones originating in Arabian sea are belted to move northwest. So they actually move away from Indian mainland.

14 Cyclones that form over the Bay of Bengal are either those develop in situ over southeast Bay of Bengal and adjoining Andaman Sea or remnants of typhoons over northwest Pacific and move across south China sea to Indian Seas. As the frequency of typhoons over northwest Pacific is quite high (about 35% of the global annual average), the Bay of Bengal also gets its increased quota. ¹¹

The tropical cyclones form over ocean basins in lower latitudes of all oceans except south Atlantic and southeast Pacific. The tropical cyclones develop over the warm waters of the Bay of Bengal and the Arabian Sea.



A comparison amongst all the coastal states of eastern India shows that the six coastal districts of Odisha are highly prone to cyclones. Jagatsinghpur district has a highly unstable coast and frequently affected by cyclone and floods.

Disaster is a situation where life, livelihood, livestock and properties are in stake in large scale. According to UNISDR, there is nothing called "disaster". There are natural or man-made hazards which when come in contact with the human beings and settlements turn into "disaster". The impacts can be perceived only when it affects people and their assets.

Cyclone can be defined as a large mass of air moving in spirals with an extremely low-pressure zone as the centre. Cyclogenesis is the procedure of formation and strengthening of cyclone in favourable conditions like warmer surface temperature, location of handrassas etc.

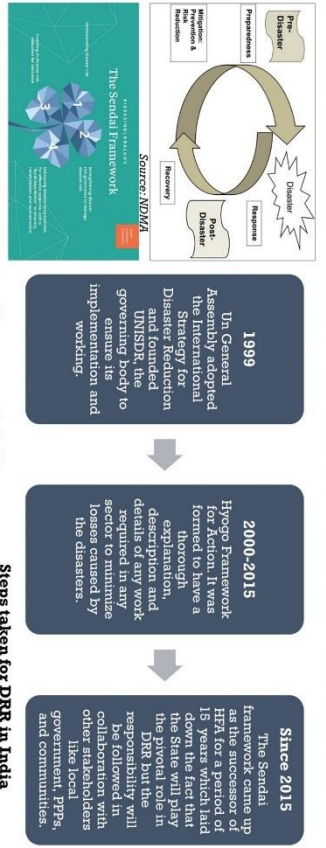
Flood is usually defined as submergence of lands which normally remain dry. It normally happens in waterbodies due to heavy precipitation, usually which is a seasonal phenomenon but can be triggered by other hazards like tsunamis and cyclones as well.

Flood plains are the areas lying between and surrounding the main rivers and their distributaries. These are the areas which get flooded and affected the most.

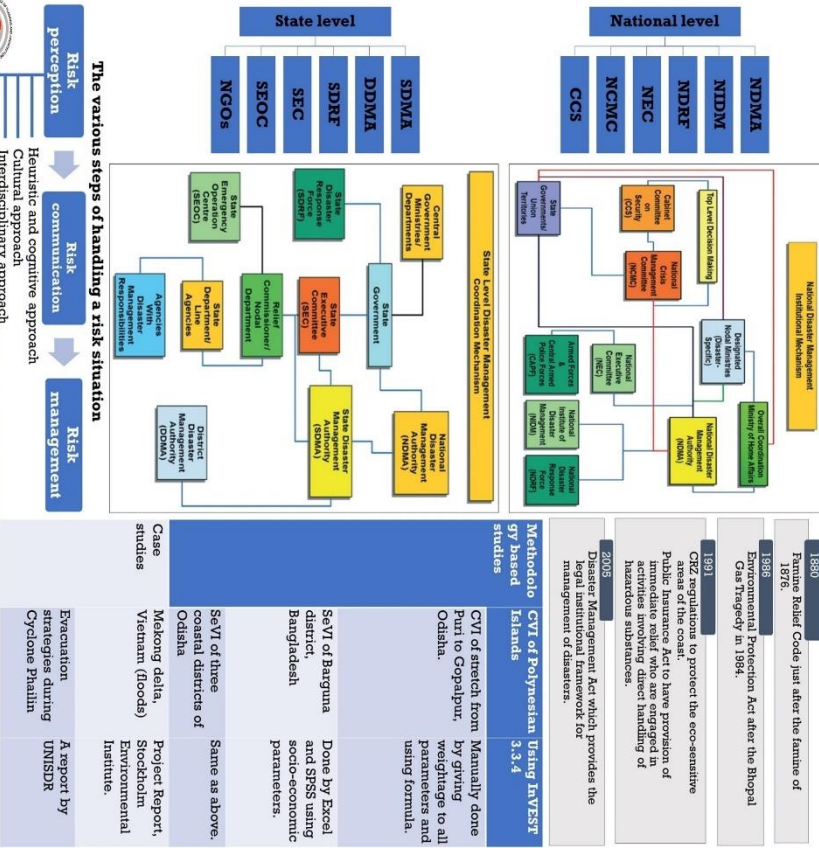
Vulnerability is the extent of helplessness of individual, individuals or communities in case of natural hazard and it depends on the physical settings of the place, socio-economic and cultural constraints of the affected people and the condition of the environmental factors in that area.

Mitigation is the way to reduce the impact of natural hazards on the communities and is done by embracing both proactive and reactive measures. It will involve preparedness, response and recovery. Proactive measures are required as if we are not prepared for it, the penalties can be fatal.





Institutional framework for Disaster Management in India



The various steps of handling a risk situation



DISASTER RISK REDUCTION FOR FREQUENT OCCURRENCE OF CYCLONES AND FLOODS – A CASE OF JAGATSINGHPUR, ODISHA



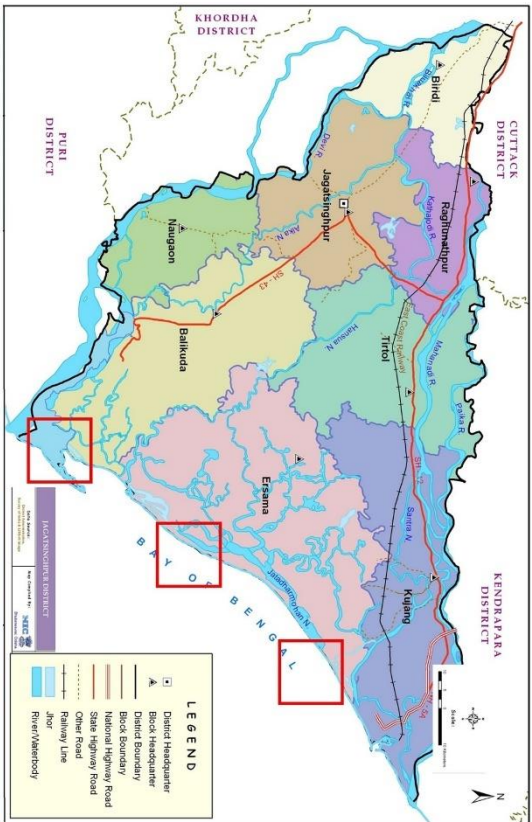
Kaustubh Mandal
2025BPH001

To reduce the vulnerability due to frequent occurrence of floods and cyclones by means of an integrated approach of Disaster Risk Reduction and Management in Jagatsinghpur district of Odisha.

- 1) To analyse the vulnerability of CRZ areas within the study area and various influencing factors through literature studies and spatial analysis tools.
- 2) To understand the effects of frequent disasters on socio-economic infrastructure and environmental status of the study area.
- 3) To improve risk reduction and mitigation approaches so as to make the study area and the inhabitants resilient to disasters.

1) The surveys conducted cannot be performed at various seasons or at the time when the disaster has struck.
2) Due to limited period of time, surveys cannot be conducted at every village of the affected blocks.

Study Area



DISASTER RISK REDUCTION FOR FREQUENT OCCURRENCE OF CYCLONES AND FLOODS – A CASE OF JAGATSINGHPUR, ODISHA

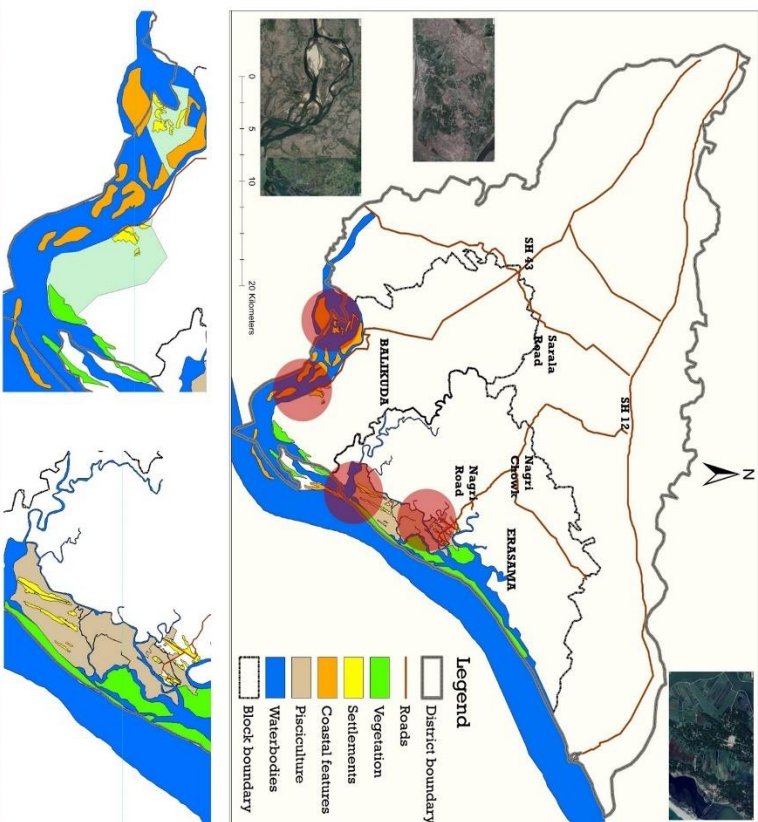
Kaustubh Mandal
2025BPH001

Methodology

1. **Issue Identification.**
 2. **Area Identification.** (On basis of various records, literature and history of disasters)
 - Data used: Indian Meteorological Department, Vulnerability Atlas of India, Odisha State Disaster Management Authority
 3. **Framing aim, objectives, scope and limitations.**
 4. **Need of the Study**
 - (Supported by literature studies)
 - Vulnerability analysis of the coastal areas of Jagatsinghpur, using CVI index method and eight parameters used for the Integrated Coastal Zone Management Plan.
 - Data sources required for the various parameters are obtained from Landatst Imagery, GEBCO data, GLOSS data and INCOIS data.
 5. **Literature Review** (in two phases)
 - 1) **Before the site visit**
 - Conceptual – To have an idea about the background, terms, definitions and theories in practice.
 - Case Studies – To have an idea of strategies and development measures in similar scenarios.
 - Approach based studies – To have a know-how regarding current approaches and strategies.
 - 2) **After the site visit**
 - Perception based studies – To acquire detailed ideas about various social stigmas after primary surveys.
 - Materials available from various concerned secondary sources.
 - a. OSDMA
 - b. Ministry of Forestry, Odisha.
 - c. Department of Fisheries Handbook, Odisha.
 - d. District Collec orate, Jagatsinghpur, Odisha
 - e. Census data of India.
 6. **Selection of Site**
 - District highly affected by cyclones and floods
 - a) Presence of numerous rivers and formation of flood-plains.
 - b) Holding high records of getting devastated by frequent cyclones.
 - c) High migration profile.
 - d) Decrease in crop production (rice, moony)
 - Macro level selection
 - a) Three coastal blocks in the district, out of which two completely portray rural characteristics.
 - b) Presence of flood plain and ecologically sensitive areas.
 - c) Erasama and Balikuda selected on basis of vulnerability analysis.
 - Micro level selection.
 - a) 3 villages selected from each block.
 - b) Distance from the shoreline.
 - c) Proximity to the estuary.
 - d) Proximity to river.
 - e) Condition of road connecting the village to the block headquarters.
 - Names of the villages
 - a) Erasama
 - Armbikl (located by the side of Hanshna river)
 - Padmapur (located near the estuary of Jajadharman river)
 - Sahadabedi (located at a distance of 450 mts from the sea)
 - b) Balikuda
 - Tharaskil (located by the Devi river)
 - Marichippur/ Balipatana (located near the estuary of Devi river)
 - Bandara (located at a distance of 300 mts. From the sea)
- All the settlements come under the CRZ- II category as per the Coastal Zone Notification.

7. **Data Collection**
 - Primary Survey based on questionnaire on the following topics:
 - General topics such as household size, housing typology and conditions, livelihood pattern, change in livelihood pattern and migration status.
 - Cropping pattern and usage of fertilizers.
 - Infrastructural facilities.
 - Impact of previous disasters and aids from the concerned authorities.
 - Preparedness and awareness.
 - Availability and condition of cyclone/ flood shelters.
8. **Data Analysis**
 - Quantitative
 - Stakeholder interviews (to get a picture of the previous disasters)
 - Graphical analysis from the data obtained from primary sources.
 - Analyst tools and softwares for finding the critical areas and finding out the suitable areas for development. (Suitability analysis of areas for development as per CRZ notifications)
9. **Gap Identification**
10. **Development Concept and implementation strategies**

An overview of the alarming situation of the coastal blocks of Jagatsinghpur



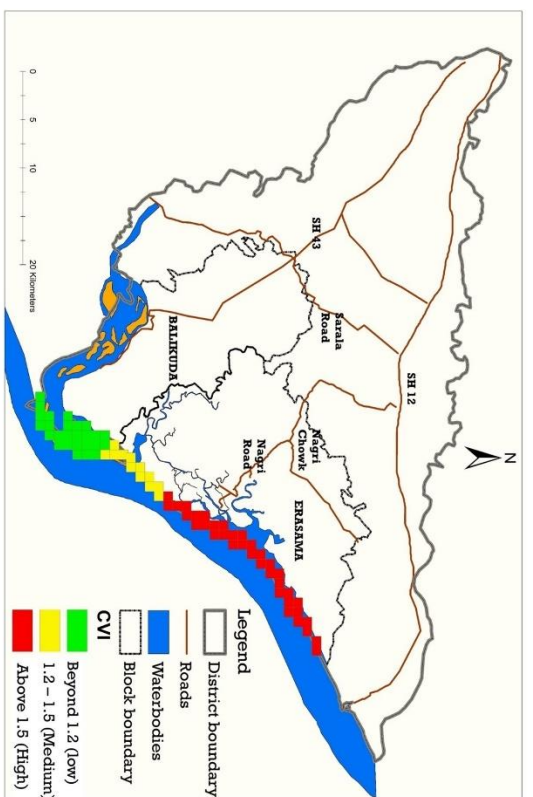
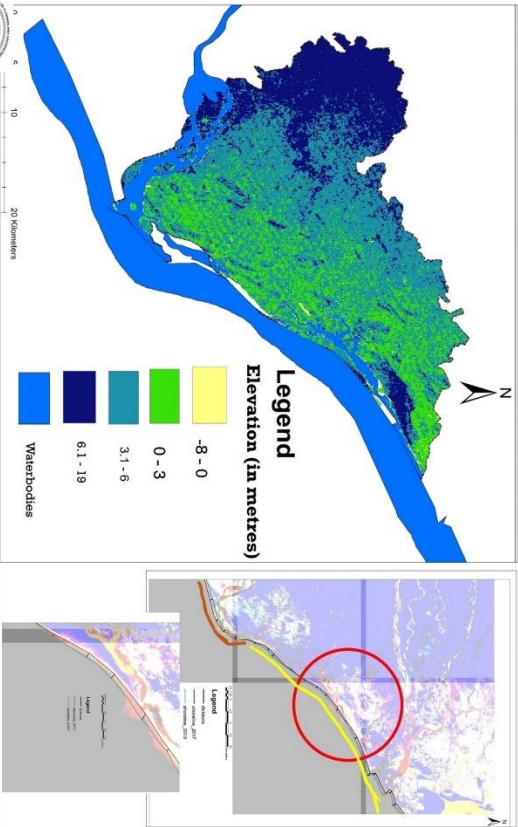
Vulnerability Analysis of the Coast

Vulnerability may be defined as an internal risk factor of the subject or system that is exposed to a hazard and corresponds to its intrinsic predisposition to be affected, or to be susceptible to damage. In general, the concept of "hazard" is now used to refer to a latent danger or an external risk factor of a system or exposed subject. **This can be in mathematical form as the probability of occurrence of an event of certain intensity in a specific site and during a determined period of exposure.**

On the other hand, vulnerability may be understood, in general terms, as an internal risk factor that is mathematically expressed as the feasibility that the exposed subject or system may be affected by the phenomenon that characterizes the hazard. Thus, risk is the potential loss to the exposed subject or system resulting from the convolution of hazard and vulnerability. **In this sense, risk may be expressed in a mathematical form as the probability of surpassing a determined level of economic, social, or environmental consequence at a certain site and during a certain period.**

Parameters	Data used (sources)	Procedure
Shore-line change rate	Landast data	GIS algebraic procedure and mapping
Barrier type	Google earth imagery/ visual survey	Mapping/ Visual survey
Coastal slope	SRTM dem file	Spatial analysis tool
Significant wave height	INCOIS data	Image taken at an interval of 6hrs in a day
Shoreline exposure	Google earth imagery/ visual survey	Mapping/ Visual survey
Regional elevation	SRTM dem file	GIS tools
Coastal geomorphology	Google earth imagery/ visual survey	Mapping/ Visual survey
Surge Height	OSDMA data/ vulnerability atlas	documented

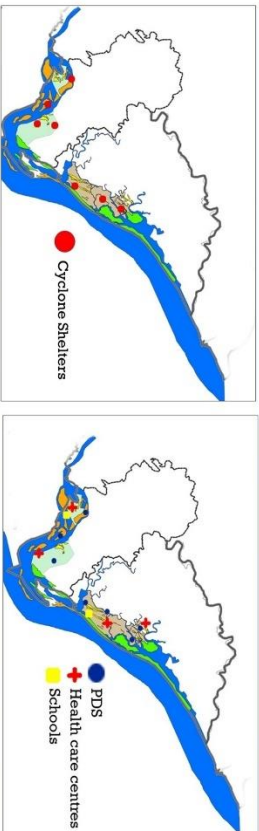
Parameters	Low Risk	Medium Risk	High Risk
Shore-line change rate (m/year)	>0 (accretion)	>= -10 and <= 0 (erosion)	<-10 (severe erosion)
Barrier type	Sand dunes, sand mounds	Mainland beach barriers	No land use features
Coastal slope (degrees)	>1.0	>0.2 and <= 1.0	>= 0 and <= 0.2
Significant wave height (metres)	Below 1.25	1.25 - 1.40	Above 1.40
Shoreline exposure	Sheltered	Semi-exposed	Exposed
Regional elevation (metres)	> 6.0	> 3.0 and <= 6.0	>= 0 and <= 3.0
Coastal geomorphology	Inundated coasts, cliffs	Estuaries, vegetated coasts (other than mangroves)	Sandy beaches, deltas, sand-bars, mud flat
Surge Height (metres)	< 3.0	>=3.0 and <= 5.0	>5.0



The CVI is determined by combining the relative risk variables to create a single indicator. For the purpose of the current study, the entire coastline is divided into grids of 1 km X 1 km. Each of the eight input relative risk variables are then assigned appropriate risk classes 1, 2, and 3 based on its ability to cause low, medium and high damage, respectively, for a particular area of the coastline. After this process, each coastal grid will have risk ratings for all eight variables under consideration. Once each section of coastline is assigned a risk value for each variable, the CVI is calculated as the square root of the product of the ranked variables divided by the total number of variables

$$CVI = \sqrt{a * b * c * d * e * f * g * h} / 8,$$

Analysis of the Infrastructural parameters



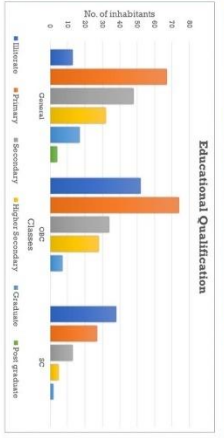
Name of the village cluster	No. of cyclone shelters	No. of PDS	No. of schools	No. health care centres	Require PDS	Required no. of PDS	Required no. of HCs	Required no. of schools
Ambiki	2	2	1	1	1	1850	8	2
Saharabedi	1	1	1	1	1	1400	6	1
Tarasahi	2	2	1	1	1	1250	5	1
Balipama/ Marichpur	2	1	0	1	1	750	2	1

Standards for emergency services:
 Occupancy of CS - 200 people at a time
 No. of PDS - 1 no. for every 500 people
 No. of schools - 1 for every 1000 people (for temporary shelter purposes)
 No. of HCs - 1 for every 200 people

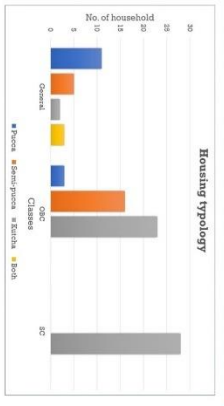
DISASTER RISK REDUCTION FOR FREQUENT OCCURRENCE OF CYCLONES AND FLOODS - A CASE OF JAGATSINGHPUR, ODISHA

Kamini Mandali
2018MPP01

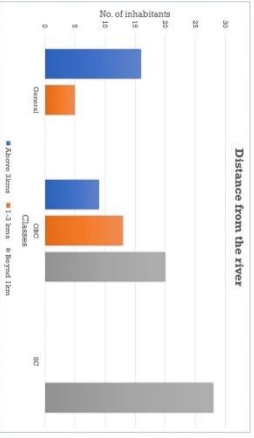
Influence of caste on socio-economic parameters



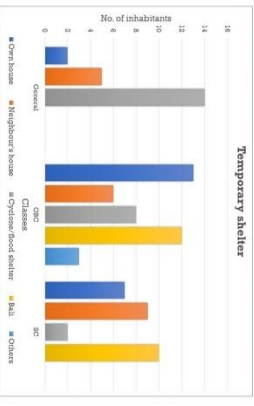
In case of educational awareness, the various categories in which the classes were divided were illiterate, primary, secondary, higher secondary, graduate and post graduate. The most number of illiterates were found in the lowest categories amongst the Bhois and Dhangars. Only few people from the upper caste are seen to have got education till post graduate level. The majority of the inhabitants are seen to have completed the primary education.



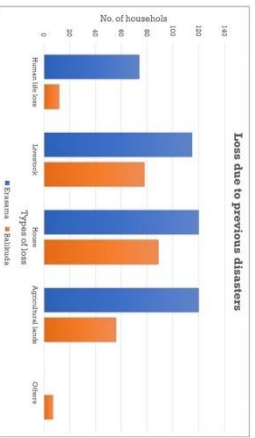
In housing typology, there are four categories as per the ownership i.e. kutchha, pucca (under PMAY scheme), semi-pucca and both typology i.e. the old kutchha house and newly constructed pucca house. Many people in the upper caste are seen to possess either semi-pucca, pucca or both types of houses. In middle class category most people have semi-pucca houses, and others have kutchha houses. The Bhoi and Dhangar community possess only kutchha houses made of mud and thatched roofs.



The location of the micro level neighbourhoods also vary according to the caste of the people. Each caste people live in separate neighbourhoods. The Brahmins and Khandayats live in the highland areas near the village temple strategically raised on high ground. Each neighbourhood is separated by some physical form of barrier or boundary like trees, road, nahals, waterbodies etc. The Keote and the Bhoi communities live in very near proximity to the river mouth as for the Keotes it is easier to keep their boats anchored near the banks and Bhois are regarded as out-caste.



Availability of temporary shelters also vary for various caste i.e. the upper class getting the priority and the lower caste people have given in to their fate and accepted the social evil that they should come in the last. Many people in lower caste have experienced harassment while receiving the provision of temporary shelters and saved their lives in the previous disasters by fleeing to the Ball or sand mound (naturally formed) and climbing a tree etc.



Primary records regarding loss of assets during occurrence of previous disasters show that Erasama had witnessed more damages in respect to human life, livestock, and houses. The natural barriers present in Balabala form a shield for the cyclones making it vulnerable mostly to the floods caused by Devi river. Salinity of the soil though has affected the livelihood of people of both the blocks as there was loss of agricultural fields during previous cyclones and floods.

Inferences from the site visit/ visual survey

The ideal scenario
Cyclone and flood shelters are more regular structures with any separate facilities (rooms and washing/ bathing areas) for women. As per NIDMA guidelines, shelters should be placed in the backdrop of any obstruction like big tree, hilllock etc. to combat the raging winds.



The new construction should at least follow any guidelines pertaining to cyclone resilience, for example, windows should be placed on both windward and leeward sides.



In the coastal areas, thatched and mud houses are highly undesirable due to frequent occurrence of storms. But as per primary data, 80 percent of the households are in kutchha condition. No intervention from PMAY scheme.



Early warning facilities and awareness programmes should be conducted at every village prone to cyclones.



Seasonal migration should be the solution to live against a disaster situation. Economic insurance, livestock insurance and livelihood insurance who are totally dependent on indigenous activities like fishing should be provided.

People tend to look for safety by migrating frequently within a range of 1km. Giving rise to fragmentation of villages and loss of identity. No aid from authorities or insurance companies owing to less because of floods and cyclones. The only aid received dates back to 1989 super cyclone – a sum of two thousand rupees was paid to the damaged households.



Can't do even a bit of agriculture because of this migration issues. Many of them lack license and have their own associations
- Patnua Senapati
- Durgadas Sahu

Issues prevail pertaining to losses in pisciculture during monsoon months or disasters due to heavy migration from neighbouring states. (as per Fisheries Department, Odisha).
Have received a mere 3000 rupees during 1989 cyclone. After that no help in building in a pucca house
- Babuli Barik

My husband died in the 1989 cyclone. After that my son opened up the shop on the beach side – Rarabala Das



DISASTER RISK REDUCTION FOR FREQUENT OCCURRENCE OF CYCLONES AND FLOODS – A CASE OF JAGATSINGHPUR, ODISHA

Kauntal Mondal
2016M2P001

Socio-economic profile of the interviewees

Name	Age	Livelihood/ Income source	Dependents	Education	Past encounters with disasters
Pratima Rani Mohanty	47	Rearing cattle, share cropping with brothers-in-law	3	Primary	Husband was killed during 1989 super cyclone when a tree fell on him.
Sashanka Biswal	28	Anganwadi worker	2	Graduate	Father was paralysed when he was trying to rescue the children from the sea during super cyclone in 2013. Husband was killed in a house in Puri district. Husband meting after Puri in 2013.
Harshita Mohanty	36	Rearing cattle, turmeric farming	2	Secondary	Husband died of cholera after super cyclone 1989
Preyaga Rabha Mishra	63	Widow pension	None	Illiterate	Husband was swept away during Puri.
Hemanta Sahu	22	Daily labour	1	Primary	Both husband and father-in-law went missing while they were out for fishing in 2014.
Rashmi Kerkha Senapati	34	Rearing goats, selling dry fish	4	Primary	Husband paralysed when their semi-constructed concrete house fell on him in 2014.
Subhasini Behera	48	Grocery shop	5	Primary	Used to work as share labourers and cultivate paddy. Loss of husband due to same water intrusion.
Manorama Barik	46	Selling dry fish	3	Illiterate	Husband was small scale fishermen whose fishing nets and boats were destroyed during Puri.
Jhulan Behera	29	House maid	3	Secondary	Husband used to work as labour in adjoining Puri district. Husband was killed during a fight between communities for rights in catch.
Sweeti Debaswari Senapati	27	House maid	2	Secondary	No livelihood means due to loss of agricultural fields.
Sulata Barik	54	Widow pension	1	Illiterate	Social stigma. Cannot get employment in the village for being a widow.
Gurjunanti Behera	31	Daily labour	2	Primary	Stays at uncle's place after their house was devastated in 2013. Has to go to adjoining village as her husband is paralysed and the only milk-giving cow they had was perished in 2014.
Saraswati Bhoi	42	Selling cow dung cakes, washing clothes	4	Illiterate	
Jhumpa Shety	23	Daily labour	Childless	Primary	
Kaushala Bhoi	37	House maid	4	Illiterate	

Objectives

- To analyse the vulnerability of CRZ areas within the study area and various influencing factors
- To identify the socio-economic and environmental factors through literature studies and spatial analysis

Analysis

- Based on the CVI, the northern stretch of the study area (almost 28 kms out of 32 kms) is the most vulnerable.
- Barbuda coast evaluated as medium-low vulnerable.
- Tarasahi village exposed to regular flooding.

Causes

- Exposed sea beaches, clearing of mangroves, casuarina vegetation for prawn farming.
- Presence of sand dunes/ mounds, vegetation and undulating terrain.
- Due to location in eco-sensitive zone. Bounded by Devi river on all sides, it exists like an island.
- Salt water inundation into the agricultural fields.
- Absence of All Weather Roads.
- Lack of awareness and education amongst people.
- Lack of economic security like group insurance facilities.

To understand the effects of frequent disasters on socio-economic infrastructure and environmental status of the study area.

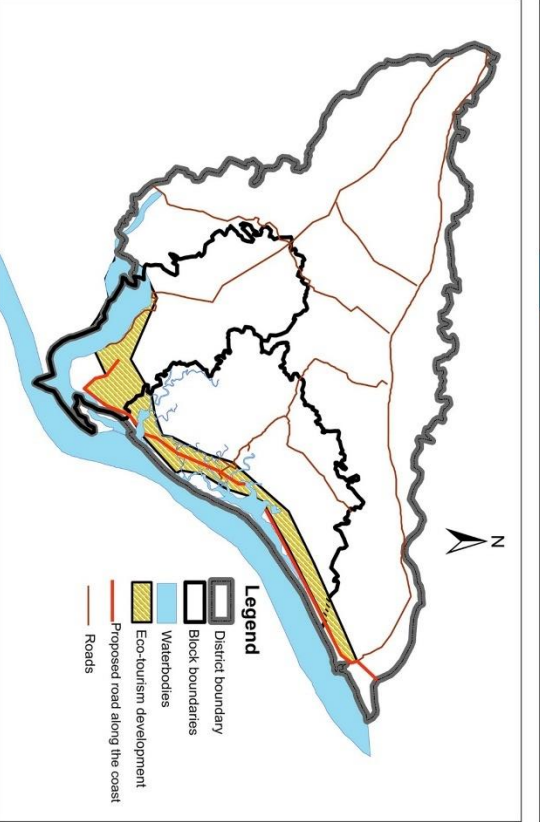
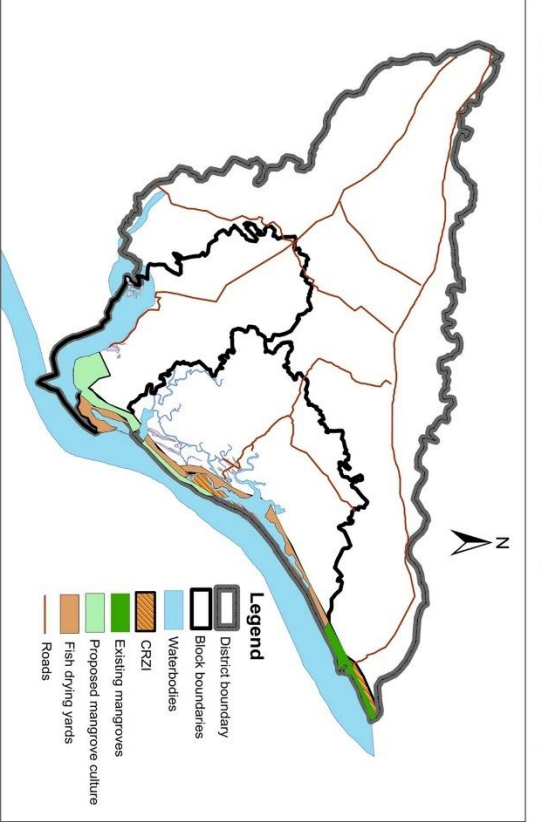
Interventions to reduce the socio-economic vulnerability

- Encouraging estuarine fishing near Devi river mouth and Jardahmohan river mouth.
- Provision of fish drying yards within NDZ areas of CRZII.
- Alternative livelihood measures by promoting eco-tourism in CRZIII areas, i.e. beyond 500ms from the HTL.
- Maintenance of mangroves.
- Designing of temporary shelters.
- Developing the roads under Border Security Organisation along the coastal stretch.
- Implementing the required number of AWOCs in the affected areas to enhance communication facilities.
- Provision of "Upgraded Living Conditions" to the inhabitants of Tarasahi.

Interventions to reduce the environmental vulnerability

- Prevention of coastal erosion by implementation of groynes along the coast of Barasani within 200ms of the HTL.
- Upgrading the habitat condition for Olive Ridley turtles and other species.
- Provision of artificial mangrove features in between the groynes to act as natural barriers against coastal erosion.

Possible means of intervention



- Mangrove species can be obtained from the existing mangrove eco-system in Bhitarakanika wildlife sanctuary.
- Alternative means of livelihood in form of eco-tourism (in place of brackish water prawn farming).
- Major road along the coastal stretch joining the villages which lack communication due to unavailability of All Weather Roads.
- Upgrading the Coastal Zone Management Plan of the state.

DISASTER RISK REDUCTION FOR FREQUENT OCCURRENCE OF CYCLONES AND FLOODS – A CASE OF JACATSINGHPUR, ODISHA



