Assessment of Climate Change Induced Disaster Vulnerability and Adaptation Strategy in Coastal Region of Bangladesh

Thesis has been submitted to the Department of Geography and Environment, University of Dhaka, in partial fulfillment of the requirement for the degree of DOCTOR OF PHILOSOPHY

Submitted by

Kazi Md. Barkat Ali
Registration No: 97
Session: 2015-2016
Department of Geography and Environment
University of Dhaka
Dhaka-1000

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CERTIFICATE OF APPROVAL

This is to certify that Kazi Md. Barkat Ali, Registration No: 97 and Session 2015-16, has prepared the thesis entitled **Assessment of Climate Change Induced Disaster Vulnerability and Adaptation Strategy in Coastal Region of Bangladesh** under our supervision. We do hereby approve the style and contain of the thesis. This is for the partial fulfillment of the requirement for the degree of DOCTOR OF PHILOSOPHY (Ph.D.) in the Department of Geography and Environment, University of Dhaka, Dhaka, Bangladesh.

Supervisor

(Rejuan Hossain Bhuiyan, Ph.D.)
Professor
Department of Geography and Environment
University of Dhaka
Dhaka-1000

Co-supervisor

(Kazi Md. Fazlul Haq, Ph.D.)
Professor
Department of Geography and Environment
University of Dhaka
Dhaka-1000

DECLARATION

I would like to declare that the dissertation entitled, **Assessment of Climate Change Induced Disaster Vulnerability and Adaptation Strategy in Coastal Region of Bangladesh** submitted to the Department of Geography and Environment, University of Dhaka for the Degree of Doctor of Philosophy (Ph.D.) is an original work and has not been submitted to anywhere for any degree or publication. The work reported within this manuscript has been executed by me, unless otherwise stated.

Kazi Md. Barkat Ali
Registration No: 97
Session : 2015-2016
Department of Geography and Environment
University of Dhaka
Dhaka-1000

Dedicated to my Parents

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ABSTRACT

Bangladesh is ranked among the countries that are most vulnerable to climate change. Its coastlines are vulnerable to disasters caused by climate change. The Intergovernmental Panel on Climate Change (IPCC) indicates that all SDGs will potentially be affected by the impacts of climate change, which is especially true in the Bangladesh context. Disaster impacts triggered by the aftermath of climate change induced disaster have spread through most social, economic and environmental areas, making it inherently related to the achievement of all other SDGs. The empirical study attempts to assess the climate change induced disaster vulnerability and adaptation strategy in coastal region of Bangladesh. The research primarily explores climate change induced disaster and its spatial variation, assesses social vulnerability and locational variations in comparison with current adaptation practices and regional variation in the study area, as well as formulates community based sustainable disaster management, acquiring scientific and indigenous knowledge together with adaptation strategy.

The study is based on primary and secondary sources of data. Participant's Observation, Key Informant Interview (KII), Focus Group Discussion (FGD) and In-depth Interview achieve qualitative data. The field study which consists of a questionnaire survey obtains quantitative data. A simple random sampling technique is adopted for successfully operating of 400 questionnaires from head of the household. The entire coastal area of Bangladesh is divided into three zones following the classification of Ali (1999), *viz.* western, central and eastern, to be convenient for study. Twenty community-level groups opinion through FGDs checklist, ten state actors thoughts through KII and 57 interviews have been conducted with non-state leaders, national climate experts, practitioners, policy makers, public representatives, journalists and public and private university academicians. The research strictly follows the duration of living and age structure of the respondents as well as ethical consideration of the study during surveyed of targeted participants. Data and maps are interpreted and presented by applying SPSS and GIS techniques applying IBM SPSS statistics V-2-64 and ArcGIS-9.1 respectively. Hypotheses have been tested by Chi-square (χ^2) test.

The research reveals that owing to using digital devices, people are aware about CCIDs and one quarter of coastal people do not have idea about the climate change

induced disasters yet. Total eleven types of CCIDs are identified, for instance, cyclone, flood, sea level rise and salinity intrusion, thunderstorm, rising of temperature (extreme heat), tornado, various diseases, river bank erosion, irregular rainfall and drought, storm surge and land slide. Cyclone, sea level rise and flood are found as main CCIDs in western, central and eastern zone respectively. CCIDs in the coastal area varies from zone to zone and directly responds to seasonal variation.

The study depicts that CCIDs are significantly correlated with livelihood patterns of the coastal people. The livelihood condition is found very worse in the eastern coastal zone than others two zones of the study area owing to high population density, locational variation, presence of canal, and uneven topography. Social safety net programs are the prime weapon to eradicate poverty and way forward to empower the marginalized coastal people in the study area though 55% coastal folks don't access these benefits yet. Nearly 150 types of social safety net programs are installed by state actors across the entire Bangladesh among them 10 types of programs can easily accessed of coastal people, such as health facilities, adult allowance, VGD and VGF card, awareness building and free medicine as well.

Almost 68% coastal people argued that local influential people interrupted the social safety net program. Social sectors infrastructure has been found as a high risk sectors in the study area. Social Vulnerability Index (SVI) mapping refers that general health considering on the health sector, school going students regarding on education, educational institute allowing for infrastructural sector, relocation and basic needs on the subject of government activities and occupation and fishing as regards on agricultural dependency are the subsectors those are highly vulnerable sectors (0-1 scale) in the study area. In these consequences, interruption of social network and disruption of communication and transportation are the main social implications of climate variability. Wage earners of the household became unemployed and damage of transport and communication are the main economic implications of climate variability in the study area. These processes rapidly accelerate the forced internal migration of coastal people from their origin. The mitigation strategies differ from zone to zone, community to community and disaster to disaster in the study area. Mitigation strategies that applicable to one zone may be or may not be applicable in another zone or community, but the learning from each strategy can introduce a new strategy that is adopted in the respective zone.

Proper and appropriate strategies at pre disaster period can be able to reduce the negative impact of disasters during disaster period. Insufficient shelter centers, lack of collaboration or coordination among the state and non-state officials and lack of institutionalization of Indigenous Knowledge (IK) are the prime barriers to adaptation of coastal people. Besides, buildup high, wide, strong and sustainable embankment; tree plantation/ afforestation through the coastal area; short duration rice and others crops; sufficient shelter center and proper medical/ health service are the prime choices for adaptation with CCIDs in the study area. The research has recommended nearly fourteen types of strategies and also given particular adoption approaches under each strategy. These strategies and approaches appear that if state actors or key official as well as non-state actors effectively follows or applied these strategies, including adaptation approaches then the level of vulnerability would be reduced. SDGs are the blue print to achieve a better and more sustainable future for all while CCIDs are the main drawbacks of overall economic growth and development of Bangladesh. Therefore it would be easy to achieve SDGs if state and non-state actors spontaneously perform their actual duties, particularly following the 'Delta Plan-2100'.

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LIST OF ABBREVIATIONS AND ACRONYMS

ADRC	Asian Disaster Reduction Centre
BARD	Bangladesh Rural Development Board
BBS	Bangladesh Bureau of Statistic
BCAS	Bangladesh Center for Advance Studies
BCCRF	Bangladesh Climate Change Resilience Fund
BCCSAP	Bangladesh Climate Change Strategy and Action Plan
BDP	Bangladesh Delta Plan
BELA	Bangladesh Environmental Lawyers' Association
BMD	Bangladesh Metrological Department
BRRI	Bangladesh Rice Research Institute
BUET	Bangladesh University of Engineering Technology
CBO	Community Based Organization
CCID	Climate Change Induced Disaster
CCC	Climate Change Cell
CZP	Coastal Zone Policy
C3ER	Centre for Climate Change and Environmental Research
CU	Chittagong University
DMO	Dhaka Meteorological Organization
DMB	Disaster Management Bureau
DoE	Department of Environment
DRRP	Disaster Relief and Rehabilitation Programme
DU	Dhaka University
EPA	Environmental Protection Agency
FAO	Food and Agricultural Organization
FGD	Focus Group Discussion
GCF	Green Climate Fund
GDP	Gross Domestic Production
GO	Government Organization
HHS	Household Survey
ICCCAD	International Center for Climate Change & Development
ICZM	Integrated Coastal Zone Management
ICZMP	Integrated Coastal Zone Management Plan
IOM	International Organization for Migration
IPCC	Intergovernmental Panel on Climate Change
ISDR	International Strategy for Disaster Reduction
IR	Irregular Rainfall
KII	Key Informant Interview
KUET	Khulna University of Engineering Technology
LGED	Local Governmental and Engineering Department
MDMR	Ministry of Disaster Management and Relief
MoEF	Ministry of Environment and Forest

MoEFC	Ministry of Environment, Forest and Climate Change
MoP	Ministry of Planning
MOF	Ministry of Finance
MSL	Mean Sea Level
NAMA	Nationally Appropriate Mitigation Action
NAPA	National Adaptation Programme Action
NEMAP	Nation Environmental Management Action Plan
NGO	Non-Government Organization
OECD	Organization for Economic C0-0peration and Development
RST	Random Sampling Techniques
SLR	Sea Level Rise
SMRC	SAARC Meteorological Research Center
SOD	Standard Order on Disaster
SPARRSO	Space Research and Remote Sensing Organization
SPSS	Statistical Package for Social Science
SRM, B	Save the River Movement, Bangladesh
SRS	Stratified Random Sampling
SSN	Social Safety Net
SVI	Social Vulnerability Index
TNA	Technical Needs Assessment
TR	Temperature Rise
TW	Tube Well
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environmental Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNISDER	United Nations International Strategy for Disaster Reduction
VGD	Vulnerable Group Development
VGF	Vulnerable Group Feeding
WB	World Bank
WEF	World Economic Forum
WHO	World Health Organization
YPSA	Young Power in Social Action

GLOSSARY

Adaptation: in response to real or anticipated climatic changes or their impacts, adaptation in natural or human systems to minimize harm or exploit beneficial opportunities.

Adaptation Strategy: means the degree practicable, and using effective strategies in their respective social, economic and environmental policies and activities, such as nationally formulated and defined impact assessments, with a view to mitigating adverse effects on the economy, public health and the quality of the atmosphere, programs or interventions undertaken by them to mitigate or adjust to climate change.

Adaptability: the capability, competency or capacity of a practice to adapt to (to alter to better suit) climatic stimuli.

Adaptive capacity: the potential or capability of a way to adapt to (to alter to better suit) climatic stimuli.

Assessment: is a method by which information is gathered relative to some known target or purpose. A general word that involves testing is assessment.

Climate: the usual weather pattern at fussy place for a long period of time.

Climate change: owing to natural variations or due to human activity, any change in weather averaged over time.

Climate Extreme (extreme weather or climate event): both extreme weather events and extreme climate events are mentioned to jointly as 'climate extremes.'

Climate variability: variations in the mean state and other statistics of the environment on all temporal and spatial scales beyond those of individual weather events (such as standard deviations, the frequency of extremes, etc.)

Climate adaptation: it refers to the capacity of a system to adapt (including climate fluctuations and extremes) to reduce potential damage, to take advantage of opportunities, or to deal with the consequences of climate change.

Climate mitigation: any action taken to permanently remove or reduce long-term threats and risks to human life, property, from climate change is taken.

Climate Change Mitigation: refers to attempt to reduce or stop release of greenhouse gases.

Coastal area: means a national or sub-national recognition that between the ocean and terrestrial realms there is a distinct transitional domains.

Coastal zone: the area most widely described is "land affected by its proximity to the sea and that part of the sea affected by its proximity to the land" or, in other words, the area where the processes that depend on the interaction between the sea and the land are most intensive. This interface exists along two axes: the maritime axis and the longitudinal axis to the coastline.

Disaster: means the abnormal situation of man's life, society and environment which dignifies the man. Disaster is primarily a social phenomenon and is thus identifiable in social terms

Exposure: the presence of people; livelihoods; services and resources for the environment; infrastructure; or economic, social or cultural assets in places that could be adversely affected.

Global warming: Gradual raise of the earth's average temperature.

Household: a household is made up of people, also related or unrelated, living together and taking food from the same kitchen. One-person household forms a single person living income and eating alone.

Katcha house structure: Katcha houses which is made of bamboo, mud, hays, plastic. Corrugated iron (CI) sheets etc.

Pucca house structure: Well-structured brick, cement and iron rod multi-storey buildings.

Planned Adaptation: it is the product of public agencies' deliberate policy choices vs. private actors' autonomous modifications caused by market or welfare changes.

Region: the vast or indefinite entirety of a space or area, or something compared to one or region is a continuous and localized area. **Regions** are broadly divided by physical and human characteristics and also the interaction of humanity and the environment

Resilience: the degree to which a system returns from a stimulus, recovers or recovers from it.

Semi-Pucca house: is a house which is made of brick, tin and corrugated iron (CI) sheet roof and also connected well.

Social vulnerability: means the social factors that affect or influence the vulnerability of different groups to harm and that also regulate their capacity to respond are partly the result of social inequalities.

Union: smallest governmental rural geographic and adminstrative unit comprising of mauzas and villages and having union parishad association.

Village: lowest rural geographic unit moreover equivalent to a mouza or part of a mouza.

Vulnerability assessment: means the analysis of vulnerability that include defines, identifies, and classifies the security of the community.

Vulnerability: the degree to which a human or natural system is vulnerable to adverse effects of climate change or is unable to cope with them. Vulnerability is a function of the nature, degree and rate of variation in the environment to which a system is exposed, its vulnerability and its capacity to adapt.

Waterborne diseases: The diseases caused by taking water polluted with germs.

Chapter 1

INTRODUCTION

1.1 Introduction

Climate change following from human actions has appeared as a worldwide alarm in the last 30 years. Now climate change is the burning question to the whole world. Bangladesh is among the countries that are likely to be most awful affected by climate change. “Rapid global warming caused elemental changes to our climate. Climate change has become a global concern, especially since the international forums” (UNFCC, COP 13, and IPCC). FAO encourages urgent collective action to resolve the threats raised by climate change. Climate change pays to increase occurrence and severity of disasters with adverse impacts on humans, natural ecosystem and quality of human continued existence. In the coming years, floods, tropical cyclones, storm surges and droughts are likely to become more frequent and severe. The big accomplishments would be intimidated by these developments. Over the last 30 years, Bangladesh has been rising wages and reducing poverty, making it more difficult to achieve the MDGs. In the coastal area of Bangladesh, climate-induced changes such as extreme cyclones, catastrophic tidal waves, heavy flooding, treacherous river erosion, intense rainfall, thunderstorms and overwhelming salinity intrusions are more frequent and unpredictable (Salequzzaman, *et al.,* 2009; Ahmed, *et al.,* 2007 and IOM, 2009). In addition, climate change has long-term as well as short-term implications. The long-term and short-term effects of climate change have an impact on livelihoods in agriculture, fisheries, forestry, aquatic life, and will ultimately generate risks of poverty and food security (Birkmannm, 2010). As a result, vulnerabilities will increase both at local and community level. Climate change affects the national development and also affects people differently in a society, and it also has the likelihood to slow down nations’ abilities to attain sustainable development, harming the rushing process of these efforts. The world’s climate is changing, and the social vulnerabilities linked with these changes are rising. Due to its geographical location in a delta region, Bangladesh is vulnerable to several negative effects. Coastal regions have been already affected by recurrent natural hazards. Social vulnerability to climate change can be expressed as a function of exposure, sensitivity, and adaptive capacity. “The assessment will help the communities to identify their vulnerability locally, intending to give new thought about policy approaches in the region. Statistical data shows that in the last two decades, worldwide natural calamities related disasters have increased and most of them are caused by

meteorological and hydrological events" (Birkmann and Von Teichman, 2010). These events showing the countries that have densely populated coastal areas, often comprising deltas and jumbo deltas; geographical positioned in Ganges-Brahmaputra and delta Bangladesh is one of them (IPCC, 2007). Socio-economic development is influenced by the scale and occurrence of extreme events, mostly in densely populated areas, such as the east, south and south -East Asia regions. Bangladesh now tries to create a appropriate environment for the economic and social development of the country and to save the well-being of our people, particularly the poorest and most vulnerable groups, as well as women and children. Agriculture, water management, human health, forestry, fisheries and livestock, infrastructure and settlements are main vulnerable sectors of Bangladesh, like other developing countries (Hossain, *et al*., 2010).

In the Global Climate Risk Index (GCRI) established by German Watch, which informs countries' exposure and vulnerability to climate related threats, Bangladesh is regarded as one of the most vulnerable countries. In this sense, Bangladesh has been listed as one of the most affected countries in the period of 1992-2011" (German watch, 2011). "The geographical location of the coastal areas in Bangladesh is dynamic, with their long and densely populated coastlines and many low-lying remote islands have an unsteady and changing patterns' due to erosion and accretion" (Shamsuddoha *et al*, 2009). Finally, Vulnerability, the extent at which a system is prone to, or is unable to cope with, the adverse effects of climate change, as well as the instability and extremes of climate change. It is a function of the nature, extent and rate of climate change to which a system is exposed, its vulnerability, and its capacity to adapt.

1.2 Background of the Study

Global climate is already getting warmer at an unprecedented rate and is inevitably altering the character of local and regional weather around the world, (Adger, *et al.*, 2003). Climate change, with its potential negative aspects to human health, food security, agriculture, fisheries, biodiversity, water, economic activity and other natural resources, is considered to be one of the greatest serious threats to the global environment. (MoEF, 2007). Besides, Bangladesh has been repeatedly listed as the

most vulnerable country to climate change (Maplecroft, 2015). Bangladesh is at special risk from climate change due to its exposure to sea-level rise and extreme events and the concentrated multidimensional poverty in the country (Fifth Assessment Report - AR5- IPCC, 2013). It is well known that Bangladesh is one of the countries most adversely affected by climate change, both in the science and negotiating community. "Low economic strength, inadequate infrastructure, low social development levels, lack of institutional capacity and greater dependency on the natural resource base make the country more vulnerable to climate stimulus, including both variability and extreme events." (NAPA, 2005). Moreover, "The combination of high population density, low income, weak infrastructure and a low-lying delta makes Bangladesh particularly vulnerable to frequent natural disasters and particularly vulnerable to climate change impacts." (AF, 2012). “Climate induced changes such as extreme cyclone, devastating tidal surges, severe floods, treacherous river erosion, excessive rainfall and overwhelming salinity intrusion occur more frequently and in an unpredictable manner in the coastal regions of Bangladesh” (Salequzzaman *et al,* 2009). On the other hand, The climate change-induced catastrophe is a cyclone, tidal surge, flash flood, coastal erosion and trans-regression, heavy rainfall, salinity, thunderstorms and disaster borne disease (fever), mostly occurring in the southeast coastal belt of Bangladesh (Ali *et al*. 2015). Thousands of people of the coastal areas of Bangladesh are under threat of climate change and climate variability issues. Over 35 millions of people will be displaced from 19 coastal districts of Bangladesh in case of 1 meter sea level rise in this century, (Rabbani, 2009). "Many individuals have already migrated from the coastal areas of Bangladesh to urban slums due to frequent cyclones, storm surges and river erosion, etc." (IOM, 2009).

Vulnerability is therefore a socially constructed phenomenon influenced by institutional and economic dynamics. The vulnerability of a system to climate change is determined by its exposure, physical setting, ability and opportunity to adapt to change. “Social vulnerability is partially the product of social inequalities” - those social factors that influence or shape the susceptibility of various groups to mischief and that also govern their ability to respond. However, vulnerability includes place inequalities—those characteristics of communities and the built environment, such as the level of urbanization, growth rates, and economic vitality, that contribute to the

social vulnerability of places" (Cutter *et al.*, 2003). Vulnerability is the susceptibility to exposure to adverse stresses and the capacity to respond to these stresses in relation to climate change. It is contextual and must always be correlated with unique risks and sensitivity to the consequences of these risks, (Mertz *et al.* 2009).

Bangladesh's coastal area is heavily populated and about 28 percent of the population lives in the coastal region (GoB, 2005). It is projected that, the population will rise from 36.8 million in 2001 to 43.9 million in 2015 and 60.8 million by 2050, respectively. (ICZM, 2005). The Bangladesh's coast is recognized as a region of numerous vulnerabilities as well as opportunities. It is vulnerable to extreme natural catastrophes, such as cyclones, storm surges, floods, etc. These disasters have left coastal dwellers very vulnerable and threatened the entire coastal and marine ecosystem, in combination with other natural and man-made hazards such as flooding, high arsenic content of groundwater, water logging, water and soil salinity and various types of pollution (Islam, 2004).

The global climate is changing, and the social vulnerabilities are increasing with these changes. Bangladesh is vulnerable to numerous negative effects of climate change. Coastal areas have been by now affected by frequent natural hazards. Social vulnerability to climate change can be articulated as a function of exposure, sensitivity, and adaptive capacity. "The assessment will help the coastal communities to distinguish their vulnerability locally, intending to give new thought about policy approaches and adaptation in the region. Adaptation requires improvements to increase the sustainability of social and economic activities and to decrease their climate vulnerability, including current fluctuations and extreme events, as well as longer-term climate change (Smith 1993, quoted in Smith *et al*, 2000). Adaptive capacity is the ability of a community to adjust with adverse effects of changing climate. The active adaptation or defense mechanism could only reflect the reality and can meet the goal with active public or community contribution. An approach to better adaptation and defense process, need to highlight the coastal belt, community and their livelihoods, vulnerabilities and hazards, people's contribution and disaster attentiveness. Climate change and Climate Change Induced Disaster (CCID) means an ideal rebuilding and recovery procedure that delivers resilient, sustainable and efficient recovery solutions to disaster-affected communities. The motivation behind the CCIDs concept is to make communities stronger and more adaptation following

the disaster event. This thesis is focused on understanding the theory that lies behind CCIDs and delivering practical solutions to enable successful adaptation with CCIDs practices in future reconstruction and recovery efforts. The nature of climate change induced disasters, trailed by demonstrating the standing of the disaster reconstruction and recovery phase as an opportunity to induce resilience into disaster-affected communities, which has led to the emergence of the CCIDs expression and perception.

1.3 Significance of the Study

Coastal disasters (such as tropical cyclones, storm surges, coastal flooding and flood) have had a huge effect on rural coastal communities. These extreme events make it more difficult for the coastal population to survive, remain at risk, damage property and restrict the choices for livelihoods. However, regardless of area, the threat or effect of a disaster often results in some sort of displacement of individuals and communities. In very graphic ways, disasters act as measures of a society's progress or inability to adapt to certain features of its rural and socially built climate in a sustained manner, for whatever cause (Oliver, 2002).In Bangladesh, the gross domestic product (GDP) per capita is around $ 1220. Over the past 40 0years, economic losses in Bangladesh have already been estimated at $ 12 billion, decreasing GDP annually by 0.5 to 1 percent (World Bank, 2016). The IPCC finds that Bangladesh will experience a net increase in poverty of 15% by 2030 in a low productivity scenario (IPCC, 2013). Besides, the susceptibility to cyclones is also expected to increase (IPCC, 2013). Also, floods have led to multifaceted humanitarian disasters (Nizamuddin, 2001). However, the impacts of climate change on water, agriculture and infrastructure have led to increased migration to the cities where their infrastructural and social capacities are already at their limits. In response to the water-related challenges, as people look for new economic opportunities, migration to urban areas is growing. They mostly end up in urban slums, on the other hand, and would be among those mainly impacted by climate change. Bangladesh's urban slums are still overcrowded, poorly controlled by local governments, and face significant constraints in the provision of water and sanitation services (AF, 2012: 19). BCCSAP (GoB, 2009) reports that more than 20 million people are at risk of being displaced by the combination of sea level rise, an increase in saline intrusion from freshwater

sources, and an increase in cyclone and storm surges in the near future. In addition, coastal land is used extensively for agriculture, settlements, forestry; shrimp farming, fishing and water bodies, salt production, industrial and infrastructural developments and tourism. It is significantly that the coastal areas are ecologically important, as they provide a number of environmental goods and services for local settlers. They contain critical terrestrial and aquatic habitats, such as the mangrove forests, wetlands and tidal flats. These trends are expected to continue some of the statistics provide an alarming picture is 220 hectares arable land is being reduced daily due to uses like road construction, industry, houses etc., (Islam, 2004). Indigenous knowledge of populations in most countries and habitats have contributed to solutions to numerous climate-related problems that can theoretically be repeated and implemented in areas likely to be impacted by climate change (Huq & Wright, 2013). UNFCCC (2013) found that in their Technical Needs Assessments (TNA's), several Parties prioritized local technologies and knowledge that could be applied for adaptation, such as habitual designs for housing, bunds, levees, dikes and mangrove plantations. However, Wilk and Wittgren (2009) find that there continues to be a great need to be well-known with the knowledge held by local community.

1.4 Research Gap

Owing to climate change, Bangladesh has already faced different type of environmental problems. However, Bangladesh is a capital of adaptation in the entire world. The coastal region has been selected for a number of reason: Firstly, The coastal region of Bangladesh is densely populated (Twenty eight percent of total population of Bangladesh) and mostly vulnerable area in world due to climate change induced disaster. It declines the poverty line and interrupted the achievement of the Millennium Development Goals (MDGs) of the least developed countries, who are highly vulnerable to the climate-induced disasters (IPCC, 2014). Bangladesh has consistently been described as the country most vulnerable to climate change. (Maplecroft, 2015). Secondly, it is prone to severe natural disasters such as cyclone, storm surge, salinity intrusion, floods etc. as a result this area is more vulnerable. Due to its vulnerability to sea level rise and extreme events and the concentrated multidimensional poverty in the region, Bangladesh is at special risk from climate change. (IPCC`s Fifth Assessment Report (AR5) ,IPCC, 2013), Thirdly, The coastal

are of Bangladesh is not only the facing the problem to adopt with the changing climate but also facing with social vulnerability especially on health, education, infrastructure, government activities, demographic and geographic and also agricultural dependency. Fourthly, the coastal area of Bangladesh play a vital role in the national economy but due to bad effect of climatic disaster agricultural activities and port activities are badly hampered. “Bangladesh aims to be classified as a developed country in the next 20 years. Despite Bangladesh’s huge economic potential. It still has many challenges to overcome and climate change is top of the list with one-third of the population at risk of displacement because of rising sea levels” (World Economic Forum, 2019). “The remarkable development gained over the last few decades are being gradually outweighed due to negative impacts of climate change” (Delta Plan, 2017). Fifthly, Due to poor economic capacity the coastal dwellers are not properly able to adopt/cope with CCID. About 33% of coastal dwellers under the poverty level (BBS, 2013). “Adaptive capacity is closely linked to social and economic development” (Alauddin, et al 2013). Coastal environment as a research field not only for geographer, but also for planner, environmentalist, sociologist, anthropologist, policy makers, economist, engineers and so on, all are trying to make a better and sustainable coastal environment. A number of researchers have already experimented about coastal environment related and also related issues at the different areas of Bangladesh.

Reviews of literature helps to identify some research works done in the coastal area of Bangladesh. Abedin *et al, (*2019) conducted “In Southwest Coastal Bangladesh,“ Climate Change, Water Shortage and Health Adaptation”. Focus has been focused on climate change, water shortage and South-eastern coastal belt health adaptation. Barua *et al, (*2017) research entitled “Sustainable adaptation to resolve climate displacement issues in Bangladesh’s South Eastern Islands”. The findings of the research were nature of climate displacement and existing adaption process in South Eastern Islands in Bangladesh. Rahman, et al, (2017), “Coastal Livelihood Vulnerability to Climate Change: A Case Study of Char Montaz in Patuakhali District of Bangladesh”. Ali *et al, (*2015), research was “Climate Change Induced Disasters in the Southeastern Coastal Belt of Bangladesh”. They highlight overall CCIDs and impact on coastal dwellers. Rashid, (2015), conducted “Climate Induced Disaster Management: A case Study on Patharghata Upazila, Barguna District”. Rahman and Rahman, (2015),

"Natural and traditional defense mechanisms to reduce climate risks in coastal zones of Bangladesh." Brammer, (2014), "Bangladesh's dynamic coastal regions and sea-level rise". Laila, (2013), "Assessment on Social Vulnerabilities to Climate Change – a Study on South-Western Coastal Region of Bangladesh". Minar *et al, (*2013), "Climate Change and Coastal Zone of Bangladesh: Vulnerability, Resilience and Adaptability". Mahmood and Mahbub, (2018), "Building Vulnerable Islander Resilience to Natural Hazards: A participatory Approach". Sarker and Hossain, (2012), "Climate Change Disaster and Community Based Mitigation Options at Ramgati Coast, Bangladesh". This work emphasizes the community based mitigation options on particular area. However, to find out the statement of the research gap, researcher effectively conducted the literature review survey on relevant government and non-government organizations, educational institutions, research cells, newspapers as well as online media, especially Google scholar, academia edu, research gate and national and international publishing journal articles and so on. After literature review the present study has under taken to explore the real condition of social vulnerability index according to CCIDs in the coastal region of Bangladesh. However, the research has some uniqueness these are making little bit difference with others, like it has been done on whole coastal area of Bangladesh with geographic differences.

1.5 Research Questions

Empirical research is driven by research question (Punch, 1998 cited in poul, 2009). In this context, present research has been searching the following questions and it has provided possible solution carefully such as:-

- What types of CCIDs occurred in the coastal region of Bangladesh?
  This question tries to find out the nature of climate change induced disaster in the coastal area of Bangladesh.
- What are the spatial variations of CCIDs in the study area?
  This question mentions the spatial variation of climate change induced disaster in the coastal region of Bangladesh.

- What are the present scenarios of social vulnerability and their locational differences in the study area?

  This question discloses the social vulnerability position due to climate change induced disaster in the study area and their locational differences.
- What is the existing scenario of adaptation practices in the study area?

  This question tries to find out the present adaptation process of coastal dwellers with climate change induced disaster.
- What is considered successful adaptation in line with CCIDs?

  This question mentions the main barriers and principal choice/advice for adaptation with CCIDs of coastal dwellers.
- How do the proposed strategies fit with the existing one for comprehensive climate change induced disasters management plan?

  This question shows the comprehensive climate change induced disaster management process on the basis of quantitative and qualitative data and information from expert, professional, administrator and the coastal dwellers of the coastal region of Bangladesh.

1.6 Aim and Objectives of the Study

The aim of the study is the assessment of CCIDs vulnerability and adaptation strategy in coastal region of Bangladesh.

The basic study goals are as follows:

- To investigate the climate change induced disaster and their spatial variation in the study area;
- To assess the social vulnerability and their locational differences in the study area;
- To find out the existing adaptation practices and their regional variation in the study area; and
- Finally, to formulate community based sustainable disaster management obtaining scientific and indigenous knowledge along with adaption strategy.

1.7 Research Hypothesis

Following hypothesis has been adjusted for justifying the significance level at different points of this research. An effort has been made to statistically classify the data in order to evaluate it more strictly-

i) Association between the idea about climate change of coastal dwellers and climate change induced disasters in the study areas.

Null Hypothesis (***H_o***): ***there is no relationship between the idea about climate change of coastal dwellers and climate change induced disasters in the study areas.***

ii) Significant relation between the idea about climate change and climate change induced disasters of coastal people regarding on regional differentiation.

Null Hypothesis (***H_o***): ***there is no significant relation between the idea about climate change and climate change induced disasters of coastal people regarding on regional differentiation.***

iii) Significant relation between climate change induced disasters and livelihood.

Null Hypothesis (***H_o*****): there is no significant relation between CCIDs and livelihood.**

iv) Significant relation between climate changes induced disasters and livelihood of coastal people regarding on regional differentiation.

Null Hypothesis (***H_o*****): there is no significant relation between climate changes induced disasters and livelihood of coastal people regarding on regional differentiation.**

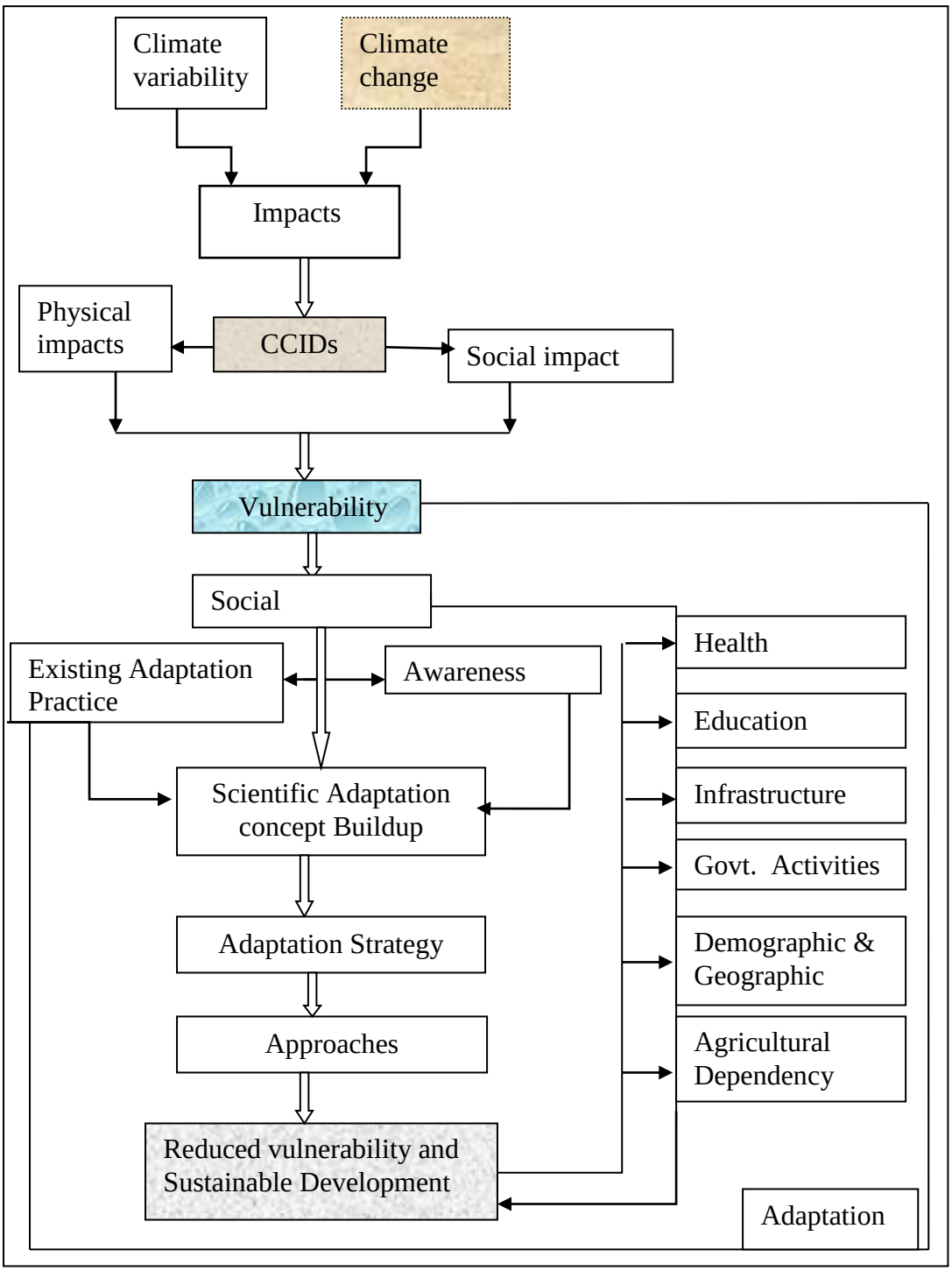
v) Association among CCIDs and livelihood of coastal people in the study area.

Null Hypothesis (***H_o*****): there is no relationship among CCIDs and livelihood of coastal people in the study area.**

1.8 CCIDs Vulnerability and Human Adaptation: a Conceptual Framework

Climate change contributes to higher temperatures, shifting trends and quantities of rainfall, and greater frequency and severity of extreme climate events such as flooding, cyclones, droughts, and heat waves (IPCC, 2007). The IPCC Third Assessment Report (TAR) describes vulnerability as “The degree to which a system, including climate instability and extremes, is vulnerable or unable to cope with the adverse effects of climate change. Vulnerability is a function of the nature, degree and rate of variation in the environment to which a system is exposed, its vulnerability and its capacity to adapt. (IPCC, 2001). Bangladesh is known as a climate vulnerable country of the world. The coastal areas people are most vulnerable in the event of frequent cyclonic disaster. Almost every segment of socio-economic life in Bangladesh particularly the coastal areas are likely to be affected by cyclone and its associated hazard. 'Adaptation requires adaptation to increase the sustainability of social and economic activities and to reduce their environment vulnerability, including current variability, extreme events and longer-term climate change.' (Smit 1993, quoted in Smit *et al.* 2000); “Social vulnerability refers to the characteristics of a person or group in terms of their capacity to anticipate, cope with, resist and recovery from the impact of a natural hazard” (Wisner et al., 2004). IPCC (Intergovernmental Panel on Climate Change) defines adaptation as 'adjustment in natural or human systems to a new or changing environment. Adaptation to climate change refers to adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities'.(IPCC 2007). At the regional level, however, adaptation methods vary from area to area or region to region. The socio-demographic characteristics, economic characteristics and accessibility to institutional factors test people’s adaptive potential. On the basis of the following conceptual framework (Figure 1.1), this analysis was intended to achieve the aforementioned objectives.

Figure 1.1: Conceptual Framework of CCIDs and Vulnerability Adaptation



Source: Prepared by the Author

1.9 Chapter Overview of the Thesis

The thesis has been framed into eight chapters. Each chapter has been arranged in a unique way because it differs from characteristics of reasoning of research as well as the objectives and questions of this thesis.

Chapter 1 discusses the background statement of the research problem, significance and rationality, research gap, research questions, statistical hypothesis, research aim and objectives, CCIDs Vulnerability and Human Adaptation: a conceptual framework, chapter overview of the thesis and constraints of the research.

Chapter 2 explores the theoretical perspectives and reviews of literature of the thesis. As well as it introduces and explains the concept of climate change, climate change induced disaster vulnerability and earlier adaptation strategies. Along with conception of the core categories and principles representing Climate Change Induced Disasters (CCIDs) and adaptation strategy and the CCIDs and adaptation framework which form the basis of this thesis are introduced in this chapter. Also, this chapter draws from previously published climate change induced disaster vulnerability and adaptation strategy guidelines and existing literature on the subject as annotation bibliography of relevant documents, books, reports, articles, thoughts and so on.

Chapter 3 illustrates the research methodology in term of used methods and techniques. Largely, this chapter explored the selection of the study area, sources of data in term of primary and secondary, primary data or qualitative data collecting methods, like Participant Observation, In-depth Interview, and Scheduling of in-depth Interview, Key Informant Interviews (KII), Focus Group Discussion (FGD) and Photograph Methods. It also shows Quantitative data collection method, like questionnaire survey. Determination of representative sample size and sampling techniques, considering types of universe, sample size determination, questionnaire design, and questionnaire survey in household's level and rearranging of conducting questionnaire. Besides, this chapter focuses on secondary data from primary sources (first hand source), secondary data from secondary and tertiary sources (second and third hand source), as well as data analysis and interpretation, qualitative data analysis and interpretation, Chi Square (χ^2) Test, Weightage Scale Analysis for Satisfaction level of Coastal people, Social Vulnerability Index (SVI), general characteristics of the respondents, reliability and validity of the research and ethical considerations.

Chapter 4 *illustrates the demographic and socio-economic characteristic of the respondents.*

Chapter 5 depicts the climate change induced vulnerability and their spatial variation in the coastal region of Bangladesh. Especially, this chapter focuses on ideas about climate change, symptoms of climate change in the coastal areas of Bangladesh, ideas about climate change induced disaster, types of climate change induced disaster in Bangladesh, types of climate change induced disaster in your area, spatial variation of the climate induced disasters in the coastal regions of Bangladesh, nature of disasters in coastal area of Bangladesh, times of disaster in the coastal areas of Bangladesh throughout the whole year, relationship between climate changes induced disasters and livelihood in the coastal people of Bangladesh, and relationship between climate induced disasters and livelihood of the coastal people regarding on regional differentiation.

Chapter 6 deals with the Social Vulnerability Index (SVI) applying on particular social issues and their locational differences with comparison among coastal areas of Bangladesh. Mainly this chapter has come together on idea about social safety net program, operation of social safety net program, getting benefit from social safety net program, reasons for not getting the benefit of coastal people from this program and organizational services. As well as sectors are highly risky for climate change (western, central and eastern zones), social vulnerability index applying on social issues among coastal zones, spatial variation of the social vulnerability index and spatial variation of the social vulnerability index on health, education, infrastructure, government activities, demographics and geographic and agricultural dependency.

Chapter 7 determines the existing adaptation practices and their regional variation in the coastal area of Bangladesh. Generally this chapter has meet different issues of adaptation like attempts for protection of people from disasters, perception about the initiatives of disasters, for instance flood, cyclone, tornado, river bank erosion, salinity or salinization, temperature increase, tidal water entrance, sea level rise, thunderstorm and water borne diseases in the Pre, During and Post disasters periods. It has also explored the perception about the strategies to protect the different social sectors, especially health sectors, education, physical infrastructure, government activities, demographics and geographic causes and agricultural dependency respectively.

Chapter 8 explores the formulate community based sustainable disaster management in terms of climate induced disasters, social safety net programme, Social Vulnerability Index (SVI) and different social sectors, health sectors, education, physical infrastructure, government activities, demographics and geographic causes and agricultural dependency in the coastal reigns of Bangladesh. Basically, this chapter has mentioned common adaptation strategies and approaches in the whole coastal areas of Bangladesh, especially fourteen strategies and thirty five individuals' approaches to ensure sustainable disaster management in the coastal regions of Bangladesh. This chapter has explored the 'theory of change' or 'research for changes' meaning what change would be found after completion of this thesis.

Chapter 9 *provides the overview of the* findings of the study and suggests some recommendations and directions for Further Study and also conclusion.

1.10 Research Limitations

The research provides, particular helpful information for coastal dwellers as well as relevant researchers, planners and policy makers concerning the taking future initiatives about sustainable disaster management. As well as obtaining scientific and indigenous knowledge along with adaption strategies as CCIDs vulnerability in the coastal region of Bangladesh. During conducting this study researchers faced some difficulties or complexities. Firstly and foremost, the study did not attempt to collect information on components of weather, like temperature, rainfall, pressure, humidity and direct wind or anything in relation to carbon emission, greenhouse gas etc. Therefore, it is difficult to gain a perfect understanding of the climate change and climate change induced disaster vulnerability and adaptation atmosphere, and the implications of decisions made and initiatives implemented during this period. The complexity of reconstruction and recovery makes it difficult for stakeholders to obtain a full understanding of the issues and implications related to the recovery and adaptation efforts. Through the use of multiple stakeholders within the case study and a multiple case study approach, the reliability and validity of the data was improved. Cross-verification of evidence has allowed accurate outcomes to be obtained.

Structured in-depth interview checklists were chosen as the most suitable qualitative data collection method from the three recognized coastal regions of Bangladesh

(i.e. western, central and eastern coastal region). Limited qualitative survey being located in different coastal regions of Bangladesh and conforming time, distance and budget constraints only permitted data collection at specific times during the limited time periods, the researcher was able to visit the whole study area. The data collection was limited to interviewees who were willing to participate in this research study and those were available during those periods. However, the sample size is statistically presented and well distributed on the basis of coastal zones, but the disaggregated data of urban and rural areas are not separated.

The study of recovery efforts in different coastal region of Bangladesh was not easy due to time and budget constraints. Besides, for key Information Interviews (In-depth Interviews), researcher tried to interview the highest ranked officials, professionals and public representatives, but in some cases author experienced that they were unwilling to keep the Sand referred to other officials or persons.

While expert justification was assimilated during the quantitative phase of this study, it is essential to test this strategy and the plans in a range of different climate change induced disaster recovery programmes. A larger data set might perhaps re-shape the climate change induced disaster and vulnerable propositions suggested in this thesis. It is also significant to admit that although the strategy suggested in this thesis attempts to address overarching issues commonly dealt with in climate change induced disaster and vulnerability reconstruction and recovery efforts in order to better adaptation with changing situation due to climate change in the coastal region of Bangladesh, it should not be taken in a prescriptive format, but rather as a direction that can be used as an orientation and fine-tuned at the local level during application to uniform local settings.

Chapter 2

THEORETICAL RSPECTIVES & LITERATURE REVIEW

2.1 Introduction

"Literature review educates a researcher, enhances his/her knowledge and increases confidence which ultimately contributes towards preparing an appealing proposal" (Islam, 2014). Such a review not only provides an exposure to a larger body of knowledge, but also equips with efficiently setting research objectives, formulating testable hypothesis, identifying the variables to be included and conceptualizing the theoretical framework for analyzing data. It helps to avoid duplication of works, explore the previously done related works, appraises the shortcomings of other researchers and help to examine the weakness of previous research easy to find out the research gap of the present work. Its functions are: a. bring clarity and focus research problem and idea; b. improves methodology; c. broadens knowledge; and d. contextualized findings (Islam, 2014; Healey and Healey, 2010).

2.2 Theoretical Perspectives

2.2.1 Climate Change

Climate change is recognized as one of the most important challenges o sustainable growth and is projected to have detrimental effects on the atmosphere, human health, food security, natural resources, economic activity and physical infrastructure. Naturally, he global environmental differs, but scientists accept that rising concentrations of anthropogenically induced greenhouse gases in the earth's atmosphere are growing. During the earth's geological past, scientists have documented several episodes of climate changes; more recently, human activities causing global warming have gradually influenced the climate since the industrial revolution, and the terms are widely used interchangeably in that sense (IPCC (2007).

2.2.2 Climate Change: Global Sign

Worldwide, Climate change results in change in long-term weather patterns. More specifically, climate change signifies a major statistical variation, either in the average climate state or in its long-term fluctuations, usually decades or longer (Vijaya Venkata Raman et al. 2011). The consequences of climate change have already been observed due to human actions (such as fossil fuel burning), from rising sea levels to

melting snow and ice to shifting weather patterns (IPCC, 2007). Sign of global climate changes are as follows-

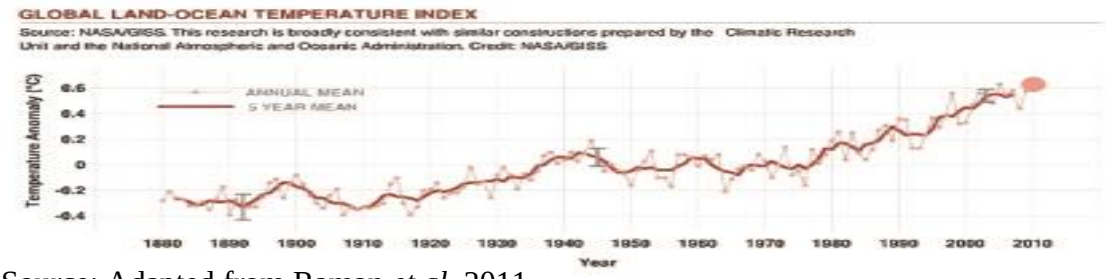
i. Global Temperature Increase: Since the 1970s, global temperature warming has occurred, with the 20 warmest years taking place since 1981, including 10 of the warmest years in the past 12 years (Vijaya Venkata Raman et al. 2011).

ii. Decreasing Arctic Sea Ice: Over recent decades, both the extent and intensity of the Arctic ice has decreased rapidly.

iii. Sea Level Rise: In the last 100 years, global sea levels have increased by around 17cm. In the last decade, the average was almost double that of the previous century.

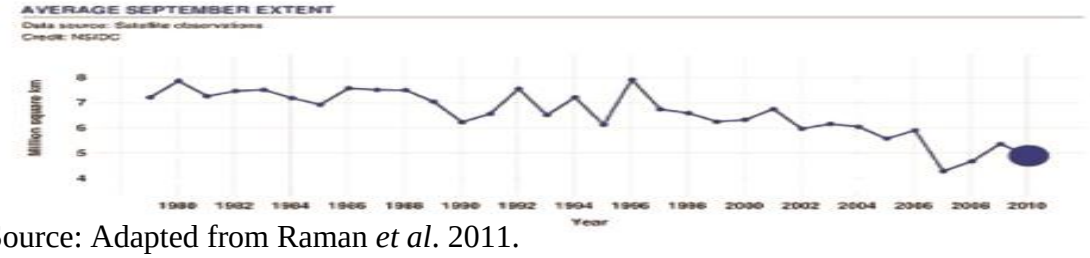
Figure 2.1-2.3 "shows the global surface temperature increase, Arctic sea ice level, and sea level rise (Raman et al. 2011).

Figure 2.1: Variation Trends of Global Temperature, 1880–2010



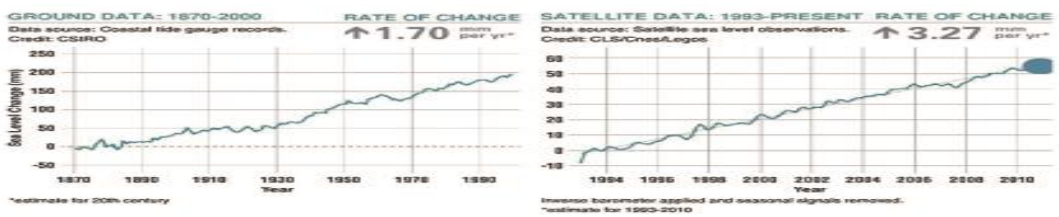
Source: Adapted from Raman *et al.* 2011.

Figure 2.2: Changing trends of Arctic Sea Ice Level, 1980–2010



Source: Adapted from Raman *et al*. 2011.

Figure 2.3: Rising Nature of Sea level, 1870–2010



Source: Adapted from Raman *et al.* 2011.

2.2.3 Climate Change: Global Context

Global warming is changing rapidly. Many nations, habitats and people are already distressed by its consequences. Our weather patterns have been influenced by global warming and our climate fluctuations and trend have been disturbed. “Global warming results in an increase in extreme climate related events such as heavy rainfall, floods, cyclones, storm surges, etc. that claim thousands of lives, destroy assets worth billions of dollars, and disrupt hundreds of people’s livelihoods.” (CCC, 2007). The First Assessment report of the IPCC (IPCC, 1988) (IPCC AR1) (IPCC, 1992) in 1990 noted that the utmost single impact of climate change might be on human livelihood as they will have to migrate from the place to reduce of coastal area for the raise of sea level. The report predicted that by 2050, 150 million people could be displaced by climate change related phenomenon like increasing water scarcity, desertification, floods and storm etc.[1] Many people of the largest deltas of the world are already subject to flooding from both storm surges and seasonal river floods, and therefore it is essential to develop further methods to review individual delta vulnerability. The Stern Analysis and the IPCC 4th Assessment Report also note that climate change would have a negative effect on the health, protection and livelihoods of people, with “both poorest people expected to suffer first and foremost in the poorest countries”. Climate change is expected to build obstacles to potential poverty reduction and to reveres many of the major socio-economic gains achieved by developing countries. The United Nations climate conversation in 1992 led to the creation of an intergovernmental process to recognize and implement the necessary response measures to curb global warming and to address its negative impacts. In 1997, the Convention led to the development of the Kyoto Protocol which sets out the mechanisms, targets and timetable for reducing greenhouse gas emissions. To help susceptible countries and people adapt to climate change and raise resilience, additional support was also agreed. The report card, however, is unsatisfactory in terms of progress made in reducing greenhouse gas emissions. The commitments of the Convention to tackle current global warming impacts and future risks through support for vulnerability reduction and adaptation measures have yet to materialize in a way that is consistent with current and future properties. Over the last century, the oxide level of carbon dioxide has increased by 25 %, nitrous oxide by 19 %, and the

[1] (www.ipcc.ch/ipcc reports/ assessment-reports.htm. Accessed: 12/4/12).

methane level by 100 percent. These are the three major gases of global warming. The average surface temperature of the earth has risen by around 0.74^0C Over the past 100 years (1906-2005), with warming higher over the last 50 years at almost twice the rate over the last 100 years. The last 1990s and the early 21st century have featured the warmest years since modern records began. A further warming of about 0.2^0 C is projected for each of the next two decades. (WB, 2006). Scientists say the world needs to cut release of global warming gasses by 50 to 70 percent just to stabilize the level of gases already in the atmosphere. However, emission of these gases are projected to continue rising in the coming decades. Scientists (IPCC, 2007) have expected that stabilizing atmospheric attention of gases responsible for accelerated global warming must happed as possible to prevent the temperature to rise at a level that activates dangerous climate. Very minor changes in temperature, rainfall or SLR, however can have significant implications for a nation that is already environmental, social and economically stressed.

2.2.4 Climate Change: Regional Context

According to IPCC Fourth Assessment Report (AR4) and scientists of the world, different country/sub regions of Asia will shows changes in climate parameters including variation in temperature and precipitation. The water keeping power of the atmosphere to evaporate into the atmosphere increase with higher temperatures, and this favors increased climate instability with more extreme precipitation and drought (Trenberth *et al.,* 2003).In the past few decades inter seasonal, inter annual and spatial variability in the pattern of rainfall has been observed across Asia. In many parts of Asia, including coastal belts and arid plains of Pakistan, areas of North-East India, decreasing trends in annual mean rainfall are observed. But in Bangladesh annual mean rainfall exhibits rising trends. The following table shows the recent trends, mainly on the rising tendency in the intensity and frequency of severe weather events in some South Asian nations. A number of ill effects-change in severe events and severe climate anomalies have also been observed in both south and south-east Asia countries. The following table 2.1 shows some of the past and present climate trends of East and South Asia:

Table 2.1: Summary of Key Observed Past and Present Climate Trends and Variability

Region	Country	Change in temperature
East Asia	China	Warming during last 50 years.
	Japan	In the 20th century, an increase of around 1 ° C and in major cities of 2 ° to 3 ° C.
	Korea	Increase of 0.23° C per decade in annual mean temperature
South Asia	India	0.68° C rise per century, rising annual mean temperature patterns.
	Nepal	In the Himalaya, an increase of 0.09°C per year and 0.04°C in the Teraj region, more in water.
	Pakistan	Since the early 19900s, the mean temperature in coastal areas has risen from 0.6° C to 1°C.
	Bangladesh	Growing patterns of around 1°C over the 14 year period from 1985 to 1998 in May and 0.5 in November.
	Sri Lanka	Between 1961 and 1990, an increase of 06° C I per year over the whole country, a 2° C increase per year in the central highlands.

Source: IPCC, 2007

2.2.5 Climate Change: National Context

Today, climate models have generally been reliable for Bangladesh in simulating country wide warming in all seasons, modest increases in monsoon rainfall and moderate decreases in dry season rainfall. Bangladesh will be especially affected by climate change through (IPCC, 2007) according to IPCC AR4; extreme and frequent floods due to glacier melting and increased rainfall rate. It is interesting that the predicted rise in summer rainfall seems to be noteworthy. MAGICC is a Basic Climate Model that computes the mean global surface air temperature and sea-level rise for exacting emissions scenarios for greenhouse gases and sulphur dioxide (Raoer et al., 1996). MAGICC (Model for the Assessment of Greenhouse Gas Induced Climate Change) has been the primary model used by IPCC to generate predications of projected global-mean temperature and SLR (Houghton et al., 2001). SCENGEN (SCENario GENerator) is a database that contains the results of a large number of GCM (Global Climate Model) experiments. By exploiting the effects of MAGICC and a series of GCM experiments, and integrating these with observed global and

regional climate data sets. SCENGEN creates a number of geographically-explicit climate change scenarios for the planet. Special trends are by exploiting the results from spatial trends are "regularized" and reflected in global-mean temperature variations per 1°C transition. The greenhouse-gas and aerosol components are properly weighted, added, and scaled up to the actual global- mean temperature. The rise in temperature and precipitation forecasts of these 11 CMs over different years in the future provides an estimate of the degree of agreement exacting projections across different models. Table 2.2.displays the results of the MAGICC/SCENGEN study for Bangladesh.

Table 2.2: GCM Projection for Changes in Temperature and Precipitation

Year	Temperature change (°C) mean (standard deviation)			Precipitation change (%) mean (standard deviation)		
	Annual	DJF	JJA	Annual	DJF	JJA
Baseline Average 2030	1.0 (0.11)	1.1 (0.18)	0.8 (0.16)	+3.8 (2.30)	-1.2 (12.56)	+4.7 (3.17)
2050	1.4 (0.16)	1.6 (0.26)	1.1 (0.23)	+5.6 (3.33)	-1.7 (18.15)	+6.8 (7.58)
2100	2.4 (0.28)	2.7 (0.46)	1.9 (0.40)	+9.7 (5.80)	-3.0 (31.60)	+11.8 (7.97)

Source: Agrawala *et.al*. 2003

Note: The months of December, January and February are represented by DJF, normally the winter month JJA, the months of June, July and August, the monsoon months.

Heating is 0.9 and 1.0° C (A2 and B1) by 2050 and 2.0° C (A2) by 2050 and 1.6°C(A2) (B1). The averages of climate change model indicate much smaller increase in annual precipitation by the 2020s (0% and -1% with A2 and B1, respectively). Also modest are the seasonal changes: marginally wetter winters (+3% A2, 0% B1) and monsoon summers (+1 A2, +4% B1). The average shifts in the 2050s are slightly larger, with winter drying (-3% A2, -4% B1) and summer wetting (+2% A2, +7% B1). The table 2.3 shows the scenario of temperature change in 2020s and 2050s.

Table 2.3: Changes in Temperature for Bangladesh, in 2020s and 2050s

Absolute Temperature Change (°C)		2020s			2050s		
		Annual	DJF	JJF	Annual	DJF	JJF
A1	Cool	0.6	0	0.2	1.3	1.5	1
	Average	0.9.	1	0.9	2	2.4	1.8
	Warm	1.4	1.8	1.3	2.6	3.7	2.3
B1	Cool	0.5	1.7	0.1	1	1.1	0.9
	Average	1	1.2	0.9	1.6	1.9	1.4
	Warm	1.3	2.2	1.6	2.1	2.9	1.9

Source: NAPA, 2005

Climate related factors such as extreme flooding can affect diarrheal diseases and outbreaks of other infectious diseases (e.g., cholera, hepatitis, malaria, dengue fever). An rise in tropical intensity of 10 to 20 percent with increase in sea surface temperature of 2 to 4°C. As stated earlier, Bangladesh is highly vulnerable to climate change impacts due to its low- lying, deltaic characteristics and dense population. The national economy heavily depends on climate change responsive agriculture and natural resources and rising sea levels. By now, Bangladesh is under considerable onslaught of climate change and its connected impacts. These are manifested in frequent rises of changing weather patterns, drought, floods, sea level rise (SLR) that increases salinity intrusion, natural disaster and various other impacts to health, economy and society. These climate change evils have direct impacts in areas of fresh water availability, surface drainage congestion, food security, energy security, poverty reduction, economic growth, and in general development. It is important to remember that climate change threat for Bangladesh is closely interlinked to development issues. The IPCC AR4 has already recognized that development could facilitate adaptation to climate change through increase in adaptive ability.. In order to address climate change and its impacts, the government of Bangladesh has formulated the National Adaptation Programme of Action (NAPA) under the direction of the UNFCCC. The NAPA identifies the instant and urgent needs of the country in look upon to adaptation activities and has scheduled priority activities. So far the NAPA has also designed future adaptation strategies for the country. The NAPA (National Adaptation Programme of Action) was prepared by the MOEF (Ministry of Environment and Forest), Government of the People's Republic of Bangladesh as a reply of the choice of seventh Session of the Conference of the Parties (COP7) of the UNFCCC. The preparation procedure following the generic guiding ethics outlined in annotates guideline prepared by LDC Expert Group (LEG). The NAPA has recommended the

following adaptation measures for Bangladesh to address adverse effects of climate change including variability and severe events based on accessible coping mechanisms and practices. The future adaptation techniques are, Decrease of climate change hazards through costal afforestation with society's contribution. Providing drinking water to costal struggle raised salinity owing to SLR. Ability building of climate change integration for water management institutions in planning, project design dispute management and land water zoning. Allocation of climate change and adaptation information to vulnerable communities for emergency preparedness measures and awareness - building on climatic risk enhancement, building of flood shelter development, and information and assistance centers to deal with increased frequent flooding in major floodplains (MOEF, 2005).

Climate change will impact both sectoral and regional trends and existing strategies for disaster preparedness. It also likely that climate change will stand in the way of achieving the Sustainable Development Goals (SDGs), especially the goal of eradicating hunger and poverty.

2.2.6 Climate Change: Sub-national and Local Context

The key problem due to climate change in Bangladesh are location specific. Climate change has different area of the country. A number of parts of Bangladesh are affected by floods whereas others are drought prone and are affected by sea level rise. For example in the case of floods, the most vulnerable areas are central Bangladesh and flashfloods in the hilly areas namely in the northeast part of Bangladesh. Some of the climate change issues at the sub national level and local context are:

Increasing Floods in Flood Prone Area

The enhanced snow melt from the Himalayan permafrost, owing to raise in temperature will force more water to flow through the Ganges, Brmaputrutra, Meghna, river systems and their river system. This will generate additional flooding covering over the central flood plain of Bangladesh.

Increase in Drought

The north-western drought oriented areas of Bangladesh are estimated to be greatly affected by decreasing rainfall. These has been key investment in excess of the last

two decades in the Braind area and succeeded in rising agricultural productivity. But most of these effects will be challenged by predicted increasing drought in the north-west area of Bangladesh.

Sea Level Rise and Salinity Intrusion

Sea level rise is a crisis faced by the entire costal region in southern Bangladesh. Salinity has already increased in the Coastal areas. Intrusion of salinity is contributed by fewer flow of fresh water from the Ganges and doorway of salt water from Bay of Bengal. It is predicted that for 45cm of sea level increase about 10 %t of the country will be increased. Further for a 1m SLR 21 percent of the country will go under salt water (IPCC, 2007).

Increase in Cyclones and Storm Surges

The intensification is of the severe weather events such as cyclones and associated storm surges are one of the predictions of the IPCC AR4. Bangladesh coast is susceptible to frequent cyclones. As a result the effect of storm surge will go through deeper into the landmass. As population raise both numbers of affected people and investment in infrastructure will acquire larger losses.

Impact on Mangrove Ecosystem of the Sunderbans

Sunderbans in the costal Southern Bangladesh will be exposed to some of the adobe linked risks of climate change, mainly sea level rise, saline intrusion and intensive severe weather events. The rate at which sea level rise and saline intrusion to climate change is expected to occur is going to be much higher than the rate at which the mangrove ecosystem can be readjusted. This would lead to a decline in species and biodiversity as well as decrease in the areas of area of the mangrove forest with all its related effects. All these above factors results in loss of agricultural production, health, loss of livelihoods and increase in poverty. Climate change is also responsible for the increase in rural- urban migration.

2.3 Coastal Area

“The coastal area is a zone of varying width and includes the shore and the landward limit of penetration of marine influence whether that is the foot of a cliff, the head of tidal estuary or the solid ground that lies beyond coastal duns, lagoon and swamp”

(Bird,1969). “Coastal areas are generally described as land-to-sea interfaces or transition areas, including large island lakes. In function and shape, coastal areas are complex, dynamic and do not lend themselves well to the concept of strict spatial boarders. There are no precise natural boundaries that unambiguously delineate coastal zones, unlike watersheds’’ (FAO, 1997).

2.4 Vulnerability

The IPCC Third Assessment Report (TAR) describes vulnerability as “The degree to which a system, including climate fluctuations and extremes, is vulnerable to or unable to cope with the adverse effects of climate change. Vulnerability is a function of the existence, extent, and rate of climate variation to which a system, its capacity for adaptation, is exposed” (IPCC, 2001, p. 995, Def. 1). In the literature of climate change, vulnerability is defined as the group measure of threats to a exact system. Vulnerability is the degree to which a system, including climate fluctuations and extremes, is vulnerable to or unable to cope with the adverse effects of climate change, (Pearson, L. & Langridge, and J. 2008). Characteristics that decide human, social, economic and environmental factors or processes that increase the vulnerability of a person, society, properties or systems to the effects of hazards (UNISDR Terminology, 2017). The literature makes a distinction between human vulnerability, social vulnerability and physical vulnerability: in conditions of ecological and environmental fragility, non-human elements are identified.

Table 2.4: Definitions of Vulnerability More Related to Disaster Adaptation

Author	Definition
(Timmerman, 1981)	Vulnerability is the extent to which device behaves adversely against the system occurrence of a risky event. The degree and quality of the adverse reaction is determined by the durability of the system (a measure of the ability of the system to withstand and recover from the event).
(Pijawka and Radwan, 1985)	The relationship between risk and preparedness is vulnerability.
(Dow, 1992)	Vulnerability is the distinct capacity of groups and individuals, based on their physical and social roles, to cope with hazards. Vulnerability is characterized in terms of exposure, capacity and potential.

Table 2.4: Definitions of Vulnerability More Related to Disaster Adaptation (Cont.)

(Watts and Bohle, 1993)	The prescriptive and normative approach to vulnerability is therefore to minimize exposure, increase coping capacity, strengthen the potential for recovery and strengthen the control of harm (i.e. reducing disruptive consequences) by private and public means.
(Blaikie *et al*., 1994)	By vulnerability, we mean the characteristics of their ability to predict, cope with, resist and recover from the impact of a natural hazard by an individual or a community.
(Green *et al*., 1994)	Vulnerability is better described as an aggregate human welfare evaluation. It incorporates natural, social, economic and political exposure to a number of possible harmful disturbances.
(Weichselgartner and Bertens, 2000)	By vulnerability, we mean the situation of a given area with respect to Hazard, exposure, preparedness, prevention, and reply characteristics to survive with definite natural hazards.
(ISDR, 2005).	Vulnerability is characterized by human, social, economic and environmental factors or processes that increased a community's vulnerability of to the effects of hazards.

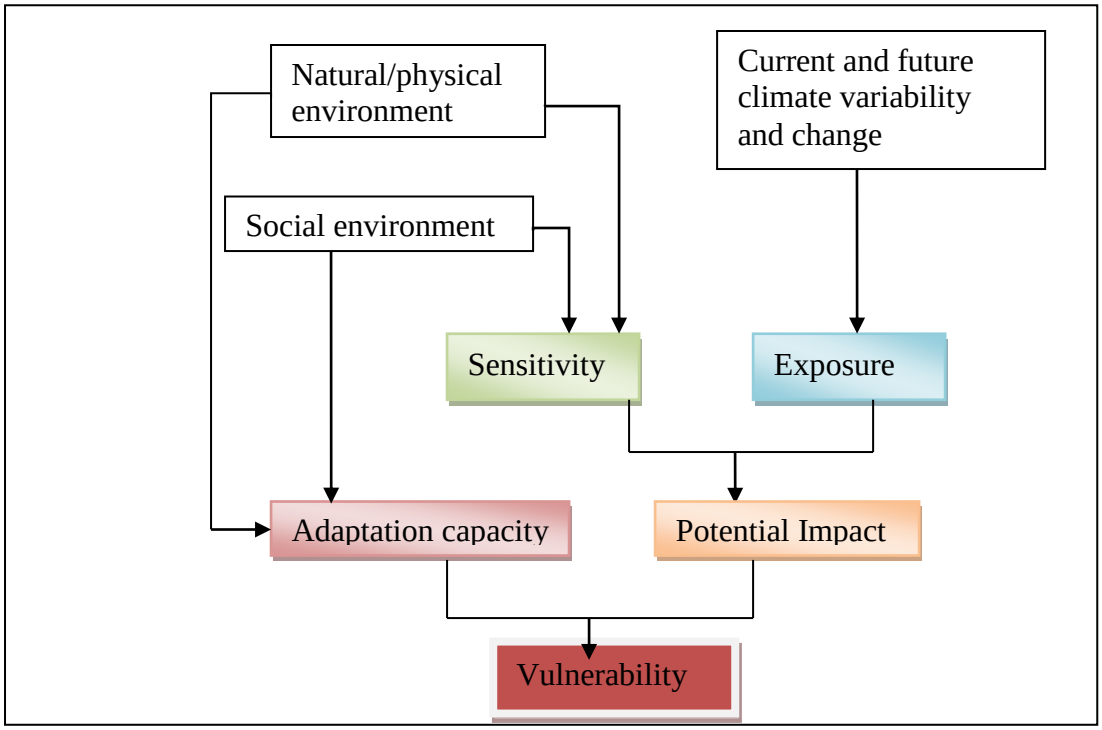
Source: Prepared by the Author, Adapted from Weichselgartner ,2001

2.4.1 Concept of Vulnerability & Vulnerability Assessments

Vulnerability is a concept used to state the complex interface of climate change effects and the vulnerability of a system to its effects. There exist manifold definitions and methods of operationalizing this idea. The IPCC (Intergovernmental Panel on Climate Change) required to intricate and advance an approach for understanding vulnerability in its Fourth evaluation Report (AR4) as:—the degree to which a system, including climate instability and extremes vulnerable to and unable to cope with, adverse effects of climate change. Vulnerability is a function of a system's existence, extent, and rate of climate change and variability, its sensitivity, and its adaptive capability (IPCC, 2007).

Within the above viewpoint (Figure 2.4), vulnerability is understood to be the role of exposure to climate change, resilience and adaptive capacity of a system to cope with the effects climate change, as shown below:

Figure 2.4: Vulnerability Concept According to the IPCC AR4



Source: Vulnerability Sourcebook, 2014

Exposure: means the socio-ecological processes are influenced by changes in climate parameters that coagulate. These parameters include, for example, temperature or precipitation that, by examining its quantity and consistency as well as its spatial and earthly distribution, is altered by climate change.

Sensitivity: refers to the site of the physical and natural environment of the affected systems that makes them largely susceptible to climate change. For instance, a sensitivity factor could be topography, land use, portion, density of inhabitants, etc.

Potential Impact: is strong-minded by combining exposure and sensitivity to climate change, on a system.

Adaptive Capacity: refer to, according to the IPCC's Fourth Assessment Report (AR4), the system's ability to adapt (including climate fluctuations and extremes) to climate change, to moderate possible harms, to take advantage of opportunities, or to cope with the consequences.

Vulnerability Assessment: is a process to identify what elements are at risk for every hazard types and analyze the root reason why these elements are at risk.

Vulnerability = Impact of hazards – Adaptation capacity with the hazards

The Vulnerability Assessment is systematic way. In this way Vulnerability is assess through some indicator. In this study vulnerability have been assessed though the following indicator, such as:

- Physical or locational indicator
- Socio-economic indicator
- Attitudinal indicator.

Figure 2.5: Concept of Adaptive Capacity Linked through Vulnerability and resilience frameworks

Source: Adjusted from Engle , 2011

2.4.2 Types of Vulnerability

Mostly 4 types of vulnerabilities are used to explain how communities are at-risk for disaster. They are-

Physical Vulnerability: physical vulnerability involves the difficulty of access to water resources, communications services, hospitals, police stations, fire brigades, highways, bridges and, in the event of a disaster, the exits of a building or environment.

Economic Vulnerability: economic vulnerability of a society can be measured by determining how varied its sources of income.

Social Vulnerability: a socially vulnerable community has weak family structures one in which peoples are discriminated on racial, ethnic, linguistic or religious basis.

Attitudinal Vulnerability: a community which has negative attitude towards change…Their sources of livelihood does not have diversity, lacks entrepreneurship.

Emotional Vulnerability: although emotional weakness is not used as a tst to assess if a society is at risk of catastrophe, in its own skin and emotion, a real man is comfortable *(*Fussel, 2007).

2.4.3 Factors that Affect Vulnerability

There are numerous general factors that control vulnerability of a system to climate change. Such characterizations can be used in two ways to examine the need for bearing in mind climate change in a sustainable development program. The first is: to help recognize vulnerabilities to climate change and where positive adaptation needs to be considered. The second is: those identifying characteristics that contribute to vulnerability can be used to identify proactive adaptations that would change these characteristics. The factors that affect vulnerability to climate change can be divided into three groups: climate, biophysical, and socioeconomic.

Climate Factors

The type of current climate in an area can help determine vulnerability to climate change. Arid or semi arid areas tend to experience more inconsistency and drought and floods. These areas could experience greater changes in such events. For example, arid and semi-arid areas tend to have greater changes in runoff for a given change in climate (e.g., +2°C) than humid areas.. Frequency or intensity of floods, droughts, cyclones, or other extreme events could change and possibly ease because of climate change. The nature of the change in climate also affects the sensitivity and ultimately the vulnerability of systems.

Biophysical Factors

There are numerous biophysical factors that affect the sensitivity of systems to climate change, including the following:

- ***Low-lying Coasts:*** Deltas and low-lying coastal areas are more vulnerable to SLR and increased intensity or frequency of coastal storms than coasts dominated by cliffs.

- ***Mountainous Areas:*** Mountainous areas tend to be more vulnerable to flooding from severe rainfall events than flat areas.
- ***Vegetation close to heat or drought tolerance:*** The existence of natural vegetation or crops that are securing to heat or drought tolerances (or have a narrow range of temperature or soil moisture they can tolerate) raises risk to climate change.

Socioeconomic Factors

Socio-economic factors tend to influence the ability of a system to absorb (robustness) or respond to climate change (resiliency). These factors include the following:

- ***Per Capita Income.*** Wealthier societies have more financial resources with which to reply to climate change. Adaptations such as building infrastructure are more affordable in wealthy countries. Income is also connected to several of the variables mentioned below.
- ***Health of the Population:*** Healthier populations, such as increases in extreme heat events, illnesses, food production, or life threatening extreme events, will appear to be less vulnerable to climate change impacts. Factors such as nutrition and access to health care are significant, and per capita income is strongly connected with these. For instance, access to health care affects the kindliness of a population to outbreaks of disease.
- ***Education:*** In order to cope with climate change, a well-educated/ informed population will better understand improvements in behavior or technology that might be required. Higher stage of education increases people's technical and scientific awareness, which can be useful in coping with climate change.
- ***Information Networks:*** Having networks to broadcast information to people about climate change can decrease vulnerability and help in adjustment. Flood or cyclone warning systems facilitate people to take defensive measures should such severe events be forecast. Information dissemination networks or systems such as agriculture extension services can

be used to provide information on climate change disasters and adaptation or disseminate adaptation technologies to particularly affected groups.

- ***Research Capacity:*** Climate change may require the development of new varieties of crops and better systems for managing natural resources. A country's research capability or access to research networks can decrease its vulnerability to climate change.

- ***Population Density:*** Population density will tend to raise danger to climate change because the potential for migration is reduced. People living in low-lying coastal regions have fewer places to go in densely populated nations than in more sparsely populated countries. High population growth rates tend to decrease per capita income and health- factors that contribute to vulnerability.

- ***Country Size:*** If everything else is equal, a country with larger area will be less vulnerable to climate change than a smaller country. A larger country with a greater variety of climates. Unfavorable weather in one part of the country will be compensated for in another part by good weather. A larger country will tend to have more area for people to migrate to if essential. With the exception of country size, the factors scheduled above tend to be connected with development, i.e. the level of development increases these factors, dropping vulnerability to climate change. This is the case particularly if development consequences in the following:

  Institutions that Discourage Adaptation: Land occupancy, subsidies, and command & control economies may be tied to particular uses of climate responsive systems. For instance, subsidies given to farmers to grow particular crops in definite locations discourage farmers from switching crops as needed to adapt to climate change.

  Infrastructure with Limited Robustness to Climate Extremes or Change: Infrastructure for managing climate responsive resources (e.g., flood protection) with narrow tolerances for increased extreme events will result in higher vulnerability to climate change compared to infrastructure with wider tolerances.

Use of Resources that Increase Sensitivity to Extreme Events: Resources can be developed in a manner that increases sensitivity to severe events. Areas vulnerable to coastal or riverine flooding may be developed rising possible losses from increased SLR, or amplified coastal storms or floods. High ratios of demand to supply of water resources increases vulnerability to drought.

2.4.4 Vulnerability Due to Climate Change

There are four types of coastal vulnerability are expected in Bangladesh's coastal areas; these are drainage congestion, saline water intrusion, extreme weather events, and changes in coastal morphology. The combined effects of higher sea level rise, subsidence, estuary branches silting and higher river bed levels would hinder drainage and eventually increase problems with water logging. Increased periods of inundation may hamper agriculture productivity, and will also pressure human health by raising the potential for water borne disease (NAPA, 2005). However, Bangladesh is likely to be able to brace of a sea level increase of 30-100 cm by 2100 in the absence of any particular. The following table (Table 2.5) shows the key vulnerabilities from climate change and impacts. This is far higher than that predicted worldwide by the AR4 as discussed earlier.

Table 2.5: Key Vulnerabilities from Climate Change and Impacts

C.C Impact	Current State	Expected change	Consequences Under a BAU Scenario
1. Accelerated SLR (ASLR)	2.0 mm / year SLR	1 m or mane by 2100; increase m tidal flooding; with monsoonal rainfall and river discharge increase in hooded area.	Inundation of between 17-21% (Up to 30,000 km^2) of total area; increased feline land area; loss of farmland; loss of livelihood out-migration; destruction of infrastructure; destruction of mangroves.

Table 2.5: Key Vulnerabilities from Climate Change and Impacts (Continued)

C.C Impact	Current State	Expected change	Consequences Under a BAU Scenario
2. Temperature	Increase in minimum temperatures by 0.85^0c between 1948 to 2011, maximum temp's increased by 0.5^0c.	Increases in temp's of up to 2^0c or more.	Reduced rice yields; increases in pests and insects; extinction of some Species.
3. Dry periods/drought	Long period of Corse cutline dry days	Increase in number of dry days and drought	Further reduction in ground water scarify to irrigation and house hold Consumption. Land degradation and impeded ecosystem functioning.
4. Precipitation	Increase in total annual rainfall by 10% between 1948-2011.	Increase between 300 mm in southeast to 800 mm in northwest with increase in intensity.	Increases in mean annual discharge in the Ganges the Brahmaputra the Meghan ricers; may cause flash floods extensive area under flooding, damage to infrastructure, destruction of crops.
5. Cyclones	Number of cyclones decreasing lout intensify increasing.	Increased intensify of cyclones with high wind speeds up to and over 250 km/p/H.	Devastating effects on homesteads. Crops, line stock; salt water inters ion; water wagging.
6. Storm surge	Current storm surge heights over topping polder embankment (Sidr and Aila cyclones).	Future storm surge heights will increase due to higher wind speeds.	All current polders will be flooded with prolonged water legging.

Source: BDP 2100, (Strategy), Technical Team Analysis. GED, 2015, P-28

2.4.5 Country Ranking According to Climate Change Vulnerability Index (CCVI), 2013

Bangladesh, the most vulnerable country in the world due to climate change. According to the Climate Change Vulnerability Index (CCVI), Bangladesh is set to suffer more from Climate Change by 2025 than any other country in the world owing to increasing sea levels, severe storms and other climate related events (IPCC, 2014a). Vulnerability ratings are based on three indicators; i) exposure to severe climate linked events, including SLR and future changes in temperature, precipitation and definite humidity; ii) Population sensitivity in terms of health, education, agricultural dependence and the infrastructure available, iii) and the adaptive ability of countries to contest the impacts of climate change, which encompasses, explore and development, economic factors, resource security and he effectiveness of government. This kind of valuation exposes Bangladesh the first (Table 2.6) and most at risk out of 196 countries in the world and table 2.7 shows the key vulnerable sectors due to impact of climate change in Bangladesh.

Table 2.6: Country Ranking According to Climate Change Vulnerability Index (CCVI), 2013

Rank	Country	Continent	Category
1.	Bangladesh	Asia	Extreme
2.	Guinea-Bissau	Africa	Extreme
3.	Sierra Leone	Africa	Extreme
4.	Haiti	North America	Extreme
5.	South Sudan	Africa	Extreme
6.	Nigeria	Africa	Extreme
7.	DR Congo	Africa	Extreme
8.	Cambodia	Asia	Extreme
9.	Philippines	Asia	Extreme
10.	Ethiopia	Africa	Extreme

Source: IPCC, 2014a. Assessment Report of the Intergovernmental Panel on Climate change.

Table 2.7: Key Vulnerable Sectors Due to Impacts of Climate Change in Bangladesh

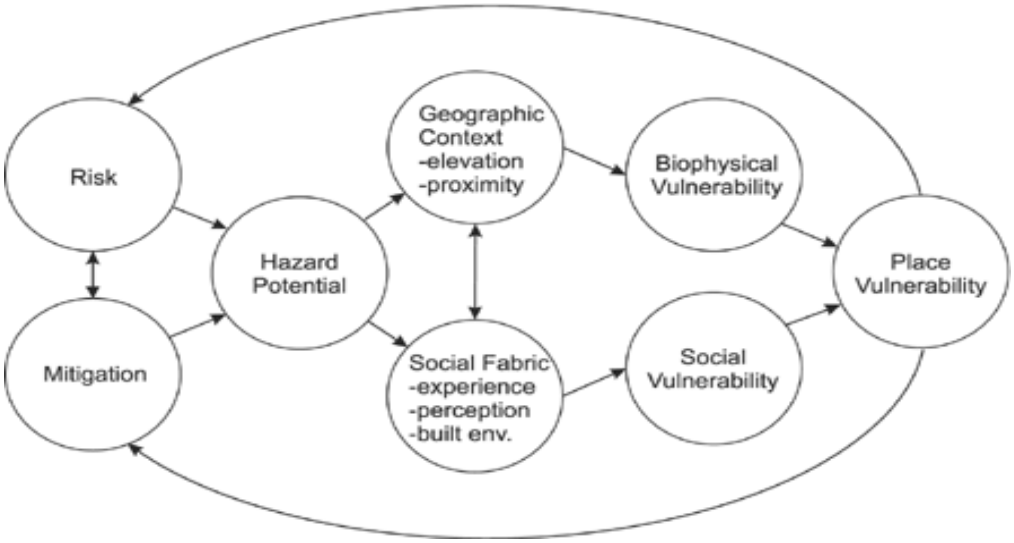
Sector	Likely impacts of climate change
Water	– Rise of sea level – Increased flooded areas owing to flooding of both the sea and river – Reduced supply of water for uses such as drinking water due to intrusion into saline water – Increased water shortages in the northwest and southwest areas, in particular – Increased drought numbers, mainly in the western parts of the country - Coastline population's Displacement
Agriculture	- Reduced main crop production by 13.9% in 2050, with the exception of the production of Boro rice - Loss of productive agricultural land as a result of saline intrusion, coastal erosion and flooding
Fisheries	– Reduced output of aquaculture because of floods – Reduced habitat for freshwater fish due to the intrusion of salt water
Livestock	– Reduced of milk production – Decrease of suitable land for livestock – Increased mortality of livestock due to severe climate events
Human health	– Increased water- and air-borne diseases such as malaria, diarrhea and cholera – Changes in diseases spatial distribution and higher incidence areas for diseases such as malaria - Increased risks due to saline water for vulnerable groups, such as women and children.
Ecosystems and forests	– Endangerment biodiversity in the Sundarbans mangrove forest and wetlands to the Sundarbans due to environmental threat caused by climate change. - Loss of coastal forest species and habitats due to increasing sea level and inland levels due to higher moisture stress during dry periods
Infrastructure	– Damage to roads and highways and railways due to flooding
Urban centers	– Increased flooding and drainage congestion in cities – Increased flash floods and landslides due to urban and population growth (e.g., on hills) - Reduced water quality due to cyclones, floods causing saline intrusion and storm surges

Source: MoEF, 2009; MOEF, 2012

2.4.6 Social Vulnerability

"Social vulnerability is partly the result of social differences, which affect or form the susceptibility of different groups to harm and that also regulate their capacity to react. In terms of their ability to predict, deal with, resist and recover from the impact of a natural disaster, social vulnerability refers to the characteristics of an individual or community. (Wisner et al., 2004). “Social vulnerability extends to perceive damage to individuals. It involves a variety of factors that decide the degree to which a distinct and recognizable occurrence in nature or in society puts someone’s life and wellbeing a risk. (UNDP, 2007). However, it also involves location disparities, the features of populations and built environment that contribute to the social insecurity of places, such as the degree of urbanization, growth rates, and economic vitality. To date, no research effort has been made to compare the social vulnerability of one location to another. Following figure 2.6 shows the components of social vulnerability.

Figure 2.6: The Components of Social Vulnerability



Source: Cutter, 1996

2.4.7 Factors Influencing Social Vulnerability

There is a universal agreement within the social science group of people about some of the key factors that control social vulnerability. These contain: lack of access to resources (including information, knowledge, and technology); limited interaction to political power and representation; social capital, including social networks and

connections; beliefs and customs; building stock and age; frail and physically limited individuals; and type and density of infrastructure and lifelines (Cutter, 2001a; Tierney, Lindell, and Perry, 2001; Putnam, 2000; Blaikie et al., 1994).

That uniqueness that control social vulnerability most often found in the literature is listed in table 2.8, along with the related research that accepted them. Between the generally recognized are age, gender, race, and socio-economic status. In the understanding of social vulnerability, the dominance of human settlements (type and construction of housing, infrastructure, and lifelines) and the built environment are also significant, particularly as these characteristics influence likely economic losses, injuries, and fatalities from natural hazards. The social material includes community knowledge with hazards, and community ability to respond to, cope with, recover from, and adapt to hazards, which in chance are influenced by economic, culture, demographic, transport and communication and housing characteristics. The socio-economic and biophysical vulnerabilities intersect to produce the inclusive place vulnerability.

Table 2.8: Concepts and Metrics of Social Vulnerability

Concept	**Description**	**Increases (+) or Decreases (-) Social Vulnerability**
Socio-economic status (income, political power, prestige)	The ability to absorb losses and increase resistance to the effects of hazards. Income helps societies, because of insurance, social security networks, and entitlement services, to withstand and recover from losses more quickly.	High status (+/ -) Low income or status (+)
Gender	During recovery, women will have a more challenging time than men, mostly because of sector-specific employment, lower incomes, and responsibility for family care.	Gender (+)
Race and ethnicity	It introduces language and cultural barriers that affect access in high- risk areas to post-disaster funding and residential locations	Nonwhite (+) Non-Anglo (+)

Table 2.8: Concepts and Metrics of Social Vulnerability (Continued)

Concept	Description	Increases (+) or Decreases (-) Social Vulnerability
Age	Extremes of the age range affect the movement out of harm's way. Parents lose time and money loving for children when daycare facilities are affected; elderly may have mobility constraints or mobility concerns rising the problem of care and lack of resilience.	Elderly (+) Children (+)
Commercial and industrial development	The importance, efficiency and density of commercial and industrial buildings provide a measure of a community's economic health status, future losses in the business community, and long-term recovery problems after a case.	High density (+) High value (+/-)
Employment loss	The possible employment loss after a disaster exacerbates the number of unemployed workers in a community, leading to a slower disaster recovery.	Employment loss (+)
Rural/urban	Residents of rural may be more vulnerable owing to lower incomes and more dependent on locally based resource extraction economies (e.g., farming, fishing). High-density areas (urban) complicate migration out of harm's way.	Rural (+) Urban (+)
Residential Property	The value, quality, and density of residential structure affect potential losses and recovery. Exclusive homes on the coast are costly to replace; mobile homes are easily damaged and less resilient to hazards.	Mobile homes (+)

Table 2.8: Concepts and Metrics of Social Vulnerability (Continued)

Concept	Description	Increases (+) or Decreases (-) Social Vulnerability
Infrastructure and lifelines	Loss of sewers, bridges, waterways, and transportation infrastructure compounds potential disaster losses. The loss of infrastructure may place an insurmountable financial burden on smaller communities that lack the financial resources to restructure.	Extensive infrastructure (+)
Renters	People who rent do so because they are either transient or do not have the home ownership financial capital. Often, during rehabilitation, they lack access financial aid information. In the most extreme situations, when housing becomes uninhabitable or too expensive to afford, tenants lack adequate shelter options.	Renters (+)
Occupation	Some occupations can be significantly affected by a hazard occurrence, especially those involving resource extraction. Self-employment fishermen suffer from the loss of their means of production and do not have the resources needed to resume work in a timely manner and therefore pursue alternative employment. Those migrant workers occupied in agriculture and low- skilled service jobs (housekeeping, childcare, and gardening) may similarly suffer, as throwaway income fades and the need for services declines. Immigration status also affects work-related recovery.	Professional or managerial (-) Clerical or laborer (+) Service sector (+)

Table 2.8: Concepts and Metrics of Social Vulnerability (Continued)

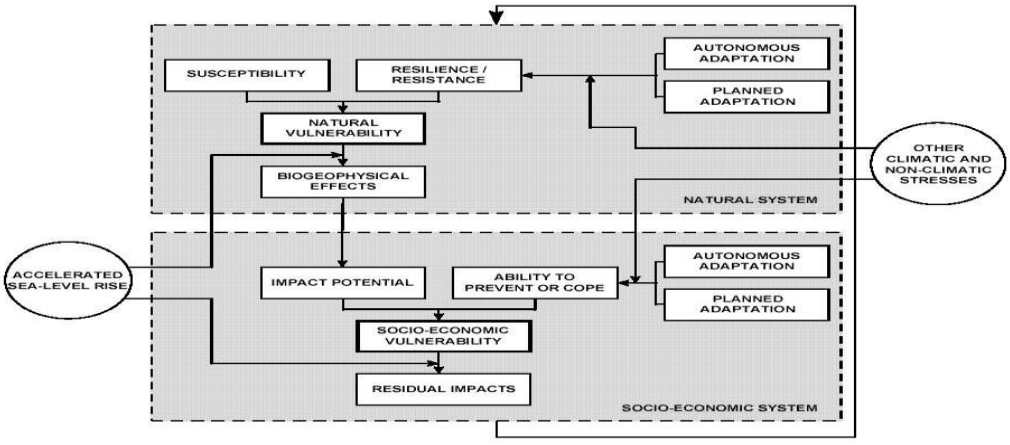
Concept	Description	Increases (+) or Decreases (-) Social Vulnerability
Education	Education is linked to socio-economic status, with higher educational connection resulting in greater lifetime earnings. Lower education constrains the ability to understand notice information and ingoing to rescue information.	Little education (+) Highly educated (-)
Population growth	Nations experiencing quick increase lack available quality housing, and the social services network may not have had time to adjust to increased populations. New migrants may not speak the language and not be well-known with bureaucracies for obtaining relief or recovery information, all of which raise vulnerability.	Rapid growth (+)
Medical services	Health care providers, including physicians, nursing homes, and hospitals, are significant post-event sources of relief. The lack of proximate medical services will lengthen immediate relief and longer-term recovery from disasters.	Higher density of medical (-)
Social dependence	Those people who are completely dependent on social services for survival are already economically and socially marginalized and require additional support in the post-disaster period.	High dependence (+) Low dependence (-)
Special needs populations	Particular needs of populations (infirm, institutionalized, transient, homeless), as difficult to identify and determine, are unreasonably affected during disasters and, because of their invisibility in communities, mostly unnoticed during recovery.	Large special needs population (+)

Source: Modified form Cutter, Boruff, and Shirley,2003

2.4.8 Vulnerability Assessment

Generally assessment means a method by which information is obtained relative to some known objective or goal. Assessment is a broad term that includes testing. On the other hands vulnerability assessment means the analysis of vulnerability that include defines, identifies, and classifies the security of the community. . It is a process by which we can identify the physical, material, socio-economic conditions and political situation of the community. ‘’Vulnerability assessments are increasingly being used to classify vulnerability-producing processes and related variables that can be used to test to test the susceptibility of differential hazards. Qualitative approaches have been instrumental in identifying particularly the main drivers of vulnerability, recognizing coping and adaptation strategies, and deconstructing aspects of vulnerability as social networks and organizations particularly at the local level (Birkmann 2006b). Following figure 2.7 shows the coastal zone vulnerability assessment concept.

Figure 2.7: Conceptual framework for coastal zone vulnerability assessment.



Source: Klein and Nicholls ,1999

2.5 Hazard and Coastal Bangladesh

Generally hazards refer to the phenomenon that poses a danger to persons, structure, or economic properties and that can cause a catastrophe. In our environment, hazards could be either manmade or naturally occurring.

Natural hazards such as flooding and drought (Map 2.2) can also be triggered by human. Floods can be caused by bad drainage facilities and over-irrigation or groundwater contamination can cause droughts. Environmental hazards include long term degradation of the environment such as soil acidification and ambient carbon dioxide build-up to communal and unintentional social hazards such as

crime and terrorism to voluntary and personal hazards such as substance abuse and mountain climbing (Smith, 1992).

The threats posed by a hazard are:

1. Hazards to people – death, injury, disease and stress
2. Hazards to goods – property damage and economic loss
3. Hazards to environment –loss of flora and fauna, pollution and loss of amenity.

The following table 2.9 shows the vulnerable areas and remarkable events due to hazards in Bangladesh.

Table 2.9: Hazards in Coastal Bangladesh

Types of Hazards	**Vulnerable Areas**	**Remarkable events**
Cyclone and Storm Surges	Islands and exposed upazilas, central coast is relatively more vulnerable	At least 70 major cyclones have struck the coatal regions over the past 200 years and killed about 900,000 people. There are reports of six Bay of Bengal tsunamis in the last 250 years.
Land erosion	Meghna and other estuaries, islands and coastal rivers	In Meghna estuary total 86, 366 ha of land eroded within 1973-2000
Flood (tidal floods mainly)	Exposed islands	Total of 123 polders with 5017 km embankment have been constructed to protect coastal areas
Water logging	Khulna, Jessore (western coastal zone) Noakhali and also Bhola, Patuakhali, Pirojpur and Barguna districts	The Khulna-Jessore Drainage Rehabilitation Project was funded by the ADB in 1993. But the assessment report prepared by the ADB in 2007 considered the project in many respects to be an ineffective one.
Salinity intrusion	Western exposed upazilas	70 % of 2.35 million hectors of agricultural land of south-western division are affected by soil salinity

Table 2.9: Hazards in Coastal Bangladesh (Continued)

Types of Hazards	Vulnerable Areas	Remarkable events
Drought	Satkhira district(western coastal zone) and also Bagerhat, Khulna, Pirojpur districts	In Kharif season (June/July to October) few of south-eastern coastal districts face severe drought
Earthquake	Chittagong	Though coastal zones are less vulnerable to earthquake recently incidences felt. 40 registered during 2002
Shortage of drinking water and arsenic contamination	All over	In coastal areas, about 53 percent of tube-wells are polluted with arsenic above the allowable level. This figure is 29 per cent nationally.
Ecological unit degradation	Marine, Sundarban	Sundarban is World Heritage site. However, some species are affected by various diseases such as top-dying, root rot, dying back
Contamination	Chittagong, Khulna(sea port areas)	Oil spills, domestic effluents and the demolition old ships (90 vessels a year on average) have detrimental effects on flora and fauna, thus degrading important habitats.
Climate change	All over	Coastal area of Bangladesh is at countless risk from climate change. By 2030 estimated Sea Level Rise is 30cm and temperature rise is 0.7 ^{0}C in monsoon and 1.3 ^{0}C in winter

Source: Islam and Ahmad, 2004 (cited in Islam, 2008), column title 'remarkable events' is added by author taking information from Islam 2004 and 2008

Coastal areas of Bangladesh are divided into three geo-morphological regions (eastern, western and central), with 19 districts which also face different hydro-morphological process (Islam, 2004). These geological and hydrological variations have made variation both in prospects and threats in different parts of coast. Table 2.10 indicates a brief but clear view of different hazards and rank in different districts of coastal regions of Bangladesh.

Table 2.10: District wise Natural Hazard Ranking of Coastal Bangladesh.

S.L	District	Hazard Ranking	SLR	Flood	Cyclone	Salinity	Drought	River Erosion	Water Logging
1.	Bagerhat	1	x	x	x	x			x
2.	Barishal	2	x	x	x			x	
3.	Barguna	1	x	x	x	x		x	
4.	Bhola	1	x	x	x	x		x	
5.	Chandpur	1		x				x	
6.	Cox's Bazar	1	x	x	x	x			
7.	Feni	1	x		x	x		x	
8.	Jashore	2				x	x		x
9.	Jhalokati	2		x		x			
10.	Khulna	1		x	x	x			x
11.	Lakshmipur	1	x	x	x	x		x	x
12	Chattogram	1	x	x	x	x	x	x	x
13.	Gopalgong	2		x	x			x	x
14.	Noakhali	1	x	x	x	x		x	x
15.	Narial	2		x	x			x	x
16.	Patuakhali	1	x	x	x	x		x	
17.	Pirojpur	1		x	x	x		x	
18.	Satkhira	1	x	x	x	x	x	x	x
19.	Shariatpur	2		x	x				

Source: Modified from BDP 2100 Technical Team Analysis, GED, 2015, P-110

2.6 Disaster and Bangladesh

Generally disaster means the abnormal situation of man's life, society and environment which dignifies the man. Disaster is primarily a social phenomenon and is thus identifiable in social terms.

A disaster is a significant disturbance that causes widespread human, material, economic or environmental loss over a short or long period of time that exceeds the capacity of the affected community or society to cope with using its own resources (IFRC& RCS, 2017, WHO, 2002). When a disaster occurs, developing countries bear the greatest costs-more than 95 percent of all deaths caused by hazards occur in developing countries, and losses due to natural hazards are 20 times greater (as a % of GDP) than in developed countries (WB).

Every year Bangladesh faced various types of disaster which is caused by human activities or natural like flood, cyclones, drought, Salinity intrusion, thunderstorm, landslide, various types diseases and so on. In addition, per year Bangladesh has been lost huge human and natural resources.

(VULNERABILITY+ HAZARD) / CAPACITY = DISASTER

2.6.1 Natural Disasters

A natural disaster is a natural process or occurrence that can result in loss of life, injury or other impacts on health, damage to property, loss of livelihoods and services, social and economic disturbance, or damage to the environment. Moreover, Earthquakes, landslides, volcanic eruptions, flooding, hurricanes, tornadoes, blizzards, tsunamis, and cyclones are all natural disasters that kill thousands of people and annually damage billions of dollars of ecosystem and property each year (Ali,1999).

2.6.2 Human-made Disasters

The effect of technical or human hazards is human-instigated disasters. Stampedes, fires, railways incidents, transport accidents, industrial accidents, oil spills, terrorist attacks, nuclear explosions and nuclear radiation are examples. In this group, war and deliberate attacks can also be placed in. Other types of induced

disasters include the more cosmic scenarios of catastrophic global warming, nuclear war, and bioterrorism. One opinion suggests that, due to human inability to implement effective (Blaikie, 2003).

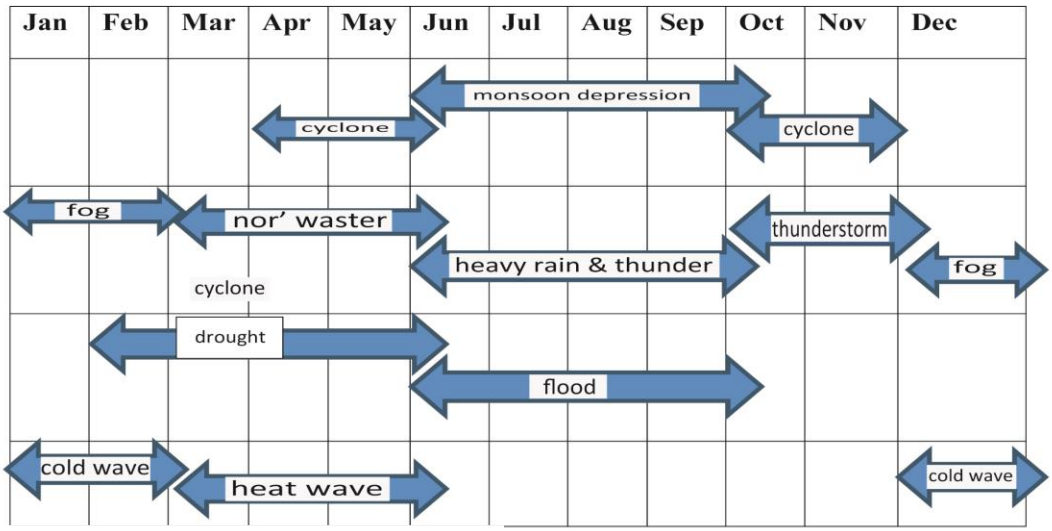
2.6.3 Recipe for a Disaster:

Hazard x Vulnerability = A potential for Disaster (risk) or Hazard + Vulnerability = Disaster

2.6.4 Disaster Calendar of Bangladesh

Climate change leads to increase different natural disaster. Bangladesh is one of the most disaster prone countries of the world. We exposed to a variety of natural disasters including tropical cyclone, floods, droughts, tornadoes, river erosions, heat wave, fog, and landslide and so on. We should know the seasonal calendar of disasters. The figure 2.8 shows the disaster calendar of Bangladesh.

Figure 2.8: Disaster Calendar of Bangladesh



Source: Prepared by the Author

2.6.5 Natural Disaster and Vulnerability Profile of Coastal Bangladesh

The geographical setting and poor management capacity of Bangladesh makes the country vulnerable to natural disasters. As more than half of the population is poor and landless, a significant number of people are comparatively more vulnerable than

other region of the country. Fourth Assessment Report of IPCC (2007),The National Adaptation Program of Action (NAPA, 2005) and other scholars have recognized Bangladesh's the coastal areas as one of the country's and the world's most vulnerable areas because of the recurring coastal hazards and the impacts caused by climate change. The household vulnerability in the coastal region differs with the seasons and now the climate changes take the prime to change the livelihood and increase the vulnerability. Other core causes of vulnerability in coastal communities are social and economic power imbalances, lack of involvement in decision-making, limited asset ownership, resource dependence, and laws and conventions that stimulus people's capacity to use resources. The root causes of vulnerability are known, steps can be placed in place to tackle them and improve the community's resilience to shakes, seasonal variables and human and natural changes (Pomeroy, *et al.* 2006).

In the coastal region of Bangladesh, there are four primary vulnerabilities that have been identified: salt water intrusion, drainage congestion, severe events and changes in coastal morphology. The combined effects of climate changes, sea level rise , subsidence and change of upstream river drainage, cyclone and coastal embankments will render these vulnerabilities acute (NAPA, 2005).

Coastal vulnerability generally differs for different communities living in different parts of the coastal region, because of location, the livelihood pattern and resources dependency. The major affair that guidance the livelihood of the coastal societies are:

- Natural disaster (flood, cyclone, land erosion, salinity, etc.)
- Natural resource base (land, wetland and water bodies)
- Death/accident/illness
- Governance (local government support and linkage with the central) (Ahmed 2003).

However among all the vulnerability investigations, natural disaster, particularly the cyclone and flood have direct effect on coastal livelihood pattern. Bangladesh as a delta region is relatively vulnerable to cyclones related with tidal surge mainly in pre-monsoon months (April-May) and post-monsoon months (October-November). For last 300 years Bangladesh has faced some of the major devastating cyclones that caused massive damage and deaths of vast number of people and livestock in the coastal regions.

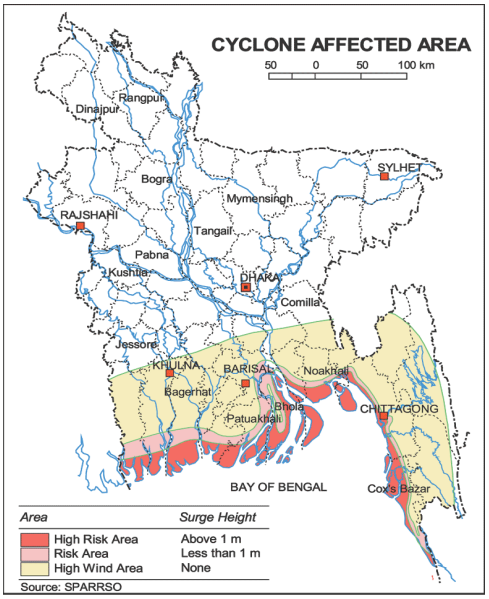
From 1699 to 2019, various main cyclone storms have been reported. These point out that Bangladesh is level to frequent destructive tropical cyclones associated with tidal surge. The low-lying coastal areas are mainly vulnerable, thus placing these populations, health, education, government activities, infrastructure, agriculture, livestock, economic development and also the livelihoods of coastal dwellers in a high-risk position. It has been observed that the returning period of a devastating coastal cyclone is reducing over the eras. Such time frame indicates the changes in the natural system that brings cyclones as a very frequent disaster with huge losses in Bangladesh typically in coastal region (table 2.11). According to ADRC, the disaster pattern and death in Bangladesh was as follows:

Table 2.11: Devastating Cyclones in Bangladesh

Date and Year	Disaster	Death	Date and Year	Disaster	Death
1699	Cyclone	50000	24-30 Nov,1988	Cyclone	5704
1767	Cyclone	30000	29-30 Apr, 1991	Cyclone	138,868
June, 1822	Cyclone	50000	21–25 Nov,1995	Cyclone	650
31 Oct, 1831	Cyclone	22000	16-19 May, 1997	Cyclone	550
1847	Cyclone	75000	15 Nov,2007	Cyclone	3500
29 Oct-1 Nov,1876	Cyclone	200000	26–27 Oct, 2008	Cyclone	15
24 Oct, 1897	Cyclone	14000	27–29 May 2009	Cyclone	150
17-19 May, 1948	Cyclone	1200	16–17 May 2013	Cyclone	17
30-31 Oct,1960	Cyclone	10000	29 July 2015	Cyclone	132
9 May, 1961	Cyclone	11468	21 May 2016	Cyclone	26
11-12 May,1965	Cyclone	19279	29–31 May 2017	Cyclone	17
May 25, 1985	Cyclone	11,069	29–31 May 2017	Cyclone	18
7-3 Nov,1970	Cyclone	500,000	4 May 2019	Cyclone	12

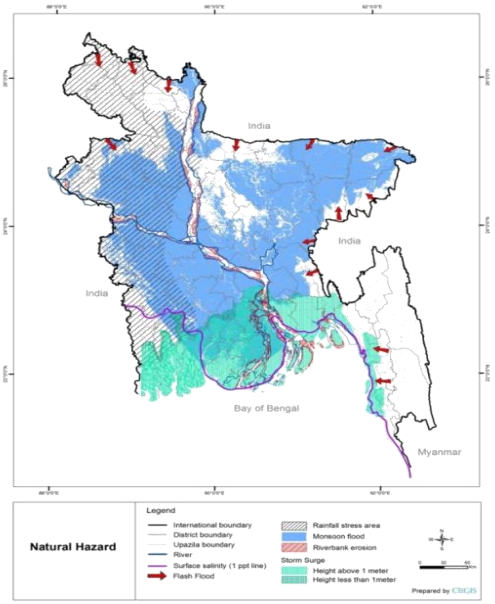
Source: ADRC, 2014. Asian Disaster Reduction Centre, Country report Bangladesh 2014, ADRC, Japan.

Map 2.1: Cyclone affected area of Bangladesh



Source: SPARRSO

Map 2.2: Natural hazards of Bangladesh



Source: CEGIS, Bangladesh, 2013

Not only the cyclone, coastal flash flood, draught, tornado and river overflow flood are other natural disasters that become a regular curse for the people of Bangladesh and the coastal communities (Map-2.1) are the mostly affected community. According to ADRC 2014, the disaster pattern and death in Bangladesh was as follows (Table 2.12).

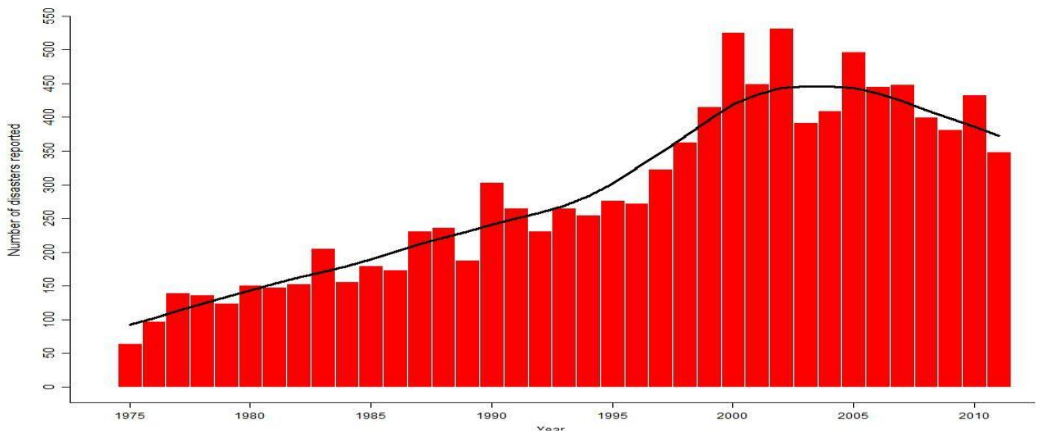
Table 2.12: Disasters in Bangladesh

Year	Disaster	Death
1970	Cyclone	500,000
1974	Flood	2373
1987	Flood	1657
1988	Flood	2373
1989	Drought	800
1991	Cyclone	138,868
1996	Tornado	545
1997	Cyclone	550
1998	Flood	1050
2004	Flood	747
2007	Flood	800
2007	Landslide	127
2007	Cyclone	3500
2010	Landslide	96

Source: ADRC, 2014. Asian Disaster Reduction Centre, Country report Bangladesh 2014, ADRC, Japan.

In South Asia, Bangladesh is a low-lying delta country or by the rivers Ganges (Padma), the Brahmaputra (Jamuna) and the Meghna rivers and their respective tributaries. Due to its geographical location Bangladesh already is vulnerable and frequently affected by many natural disasters. Frequencies of natural disasters in the last three decades have increased in the country as it is shown in figure 2.9. The impacts of these natural phenomena are enormous hindering human development (EMDAT, 2013).

Figure 2.9 Natural Disasters Reported 1975-2011 in Bangladesh



Source: EMDAT, 2013

"The natural disasters not only cause death but the overall damage that includes infrastructures, natural resources, and livestock is simply uncountable and inconsiderable for a developing country like Bangladesh. Property loss in 1991 was estimated at 1.8 billion US dollars. The damage in 1999 and 2007 is reported as 4.2 and 5.3 billion US dollar respectively" (Hossain, *et al*.2008).

2.7 Adaptation

Adaptation means to adapt with changing circumstance. In response to real or anticipated climatic changes or other effects, modifications in natural or human processes to minimize harm to exploit beneficial opportunities. The IPCC's Third Assessment Report, COP 9 requested the UNFCCC Subsidiary Body for Scientific and Technological Advice (SBSTA) to initiate work on scientific, technical and socioeconomic aspects of, and vulnerability and adaptation to, climate change

(decision 10/CP.9). Adaptation refers to the capacity of a system to adjust to climate change in order to decrease its vulnerability, and raise the resilience to experiential and anticipated effects of climate change.

Adaptation requires improvements to increase the sustainability of social and economic activates and to decrease their climate vulnerability, including current fluctuations and extreme events, as well as longer-term climate change (Smit 1993, quoted in Smit *et al.* 2000).

According to the IPCC Third Assessment Report, adaptation "has the potential to reduce adverse impacts of climate change and to enhance beneficial impacts, but will incur costs and will not prevent all damages." Furthermore, it is argued that human and natural systems will, to some level, adapt autonomously and that planned adaptation can supplement autonomous adaptation. However, "for adaptation of human systems, choices and incentives are greater than for adaptation to preserve natural systems" (IPCC 2001: 6-8).

IPCC defines adaptation as "the adaptation to a new evolving environment in natural or human systems. Climate change adaptation refers to adaptation in natural or human processes in response to, or consequences of, current or predicted climate stimuli that moderate damage or take advantage of beneficial opportunities (IPCC 2007). In physical, biological, and human environments, adaptation occurs. It contains the following things:

Changes in social and environmental processes

- Perceptions of climate risk
- Practices and functions to reduce risk
- Traveling new possible to deal with the changed world

2.7.1 Classification of Adaptation

"In response to real or anticipated climate stimuli or their consequences, changes in natural or human processes that moderate harm or exploit beneficial opportunities" (IPCC, 2018). On the basis of this definition there are three types of adaptation are distinguished:

- **Anticipatory adaptation** – Takes place before effects of climate change are apparent. It is also defined as positive adaptation.
- **Autonomous adaptation** – Adaptation that does not result from a deliberate reaction to climate stimuli but is produced by ecological changes in natural systems and by changes in human systems in the economy or welfare. It is known as spontaneous well.
- **Planned adaptation** – Adaptation that is the result of a policy judgment, based on knowledge that circumstances have changed or are about to change and that action is required to return to, preserve, or achieve a desired state.

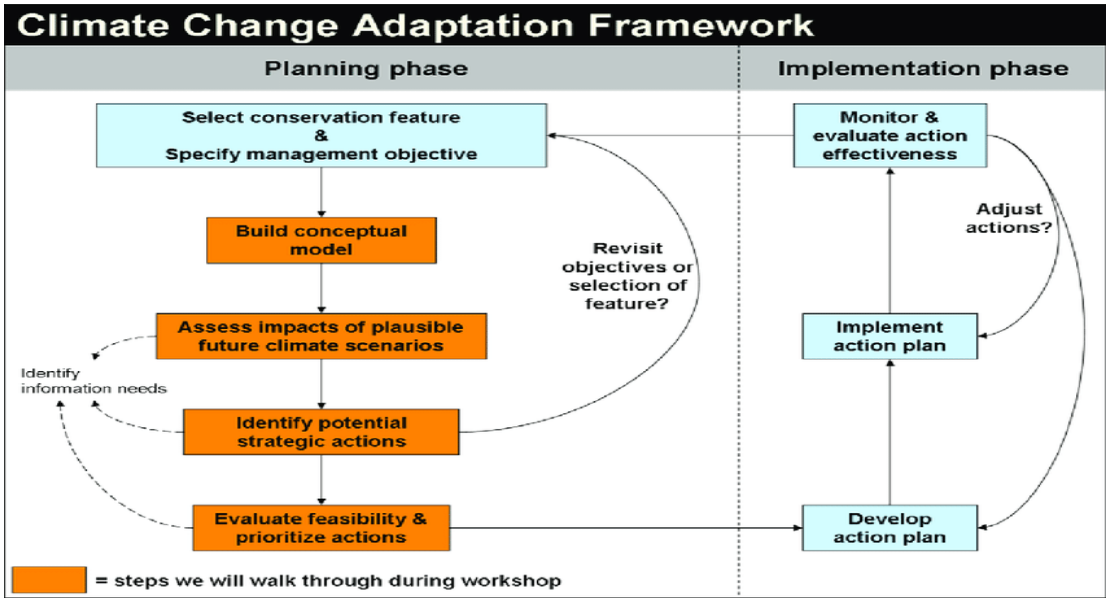
However, adaptation has been classified into different categories, such as structural adaptation, non-structural adaptation, reactive adaptation, personal adaptation and universal adaptation.

2.7.2 Climate Change Adaptation (CCA)

Climate change adaptation (CCA) is a response to global warming (also known as "climate change" or "anthropogenic climate change"). Human intervention in some natural systems may promote adaptation to the predicted environment and its effects. This transition covers a variety of fields, including infrastructure, agriculture, and education. Even if emission are stabilized relatively quick, global warming and its consequences would last for several years, and the subsequent climate changes will require adaptation. Adaptation actions can be measured as either incremental adaptation (actions where the central aim is to maintain the essence and integrity of a system) or transformational adaptation (actions that change the fundamental attributes of a system in response to climate change and its impacts). The need for adaptation varies from place to place, depending on the sensitivity and vulnerability to environmental impacts. Adaptation is especially important in developing countries since those countries are bearing the brunt of the effects of global warming. Human adaptive capacity is unevenly distributed across different regions and populations, and developing countries generally have less capacity to adapt. Adaptive potential is closely to growth in social and economic terms. For the next few decades, the economic costs of climate change adaptation are expected to cost billions of dollars annually, although the exact amount of money required is uncertain. With the magnitude and the pace of climate change, the adaptation challenge increases. The

economic and social costs of climate change with no mitigation will be very high. However, climate change would be too much to be able to adapt to certain natural habitats, such as coral reefs.

Figure 2.10: Climate Change Adaptation Framework (CCA)



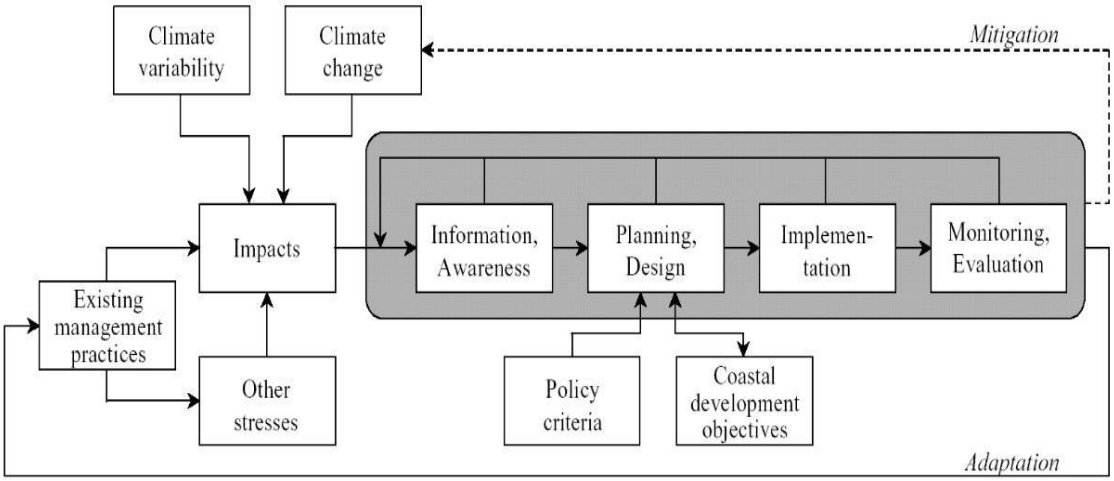
Source: Adopted from Verbruggen, 2007

2.7.3 Climate Change and Coastal Adaptation

Worldwide coastal zones face serious problems of habitat destruction, population, erosion and resource depletion owing to human economic activities and climate change impacts (FAO, 1998). The coastal area is extremely significant to most coastal base countries. Therefore, there is concern for its future, mainly regarding the status of its natural resources which provide life support and economic development opportunities to coastal communities. Global climate change by now impacts and will continue to impact coastal communities, ecosystems, and many facets of people's lives in the coastal zone where roughly 2.7 billion people over 40 percent of the world's population live (USAID, 2009). However, 28% of total populations of Bangladesh live in the coastal region and they are more vulnerable due to climate change. Coastal adaptation is an on-going and iterative procedure that will advantage from periodic assessment of performance attached with an adaptive management method to adjust operation**.** In the local context, Coastal adaptations must be "made-to-order" through a wide-ranging framework that aligns planning properties with

climate change concerns and the technological capacities and capabilities of the organizations and community stakeholders of the region. Due to low laying area and adverse effects of climate change, it is very difficult to adaptation on the coast and also challenge for managing coastal resource uses and must be 'mainstreamed' into coastal policy at all levels. Actual adaptation will manage and reduce the risk linked with changes in climate (parallel to disaster risk reduction measures), and successful adaptation will decrease vulnerability by building on and establishment current coping appliances (IEDCR, 2011).

Figure 2.11: Conceptual Framework for Coastal Adaptation.



Source: Adopted from Klein et al.,1999

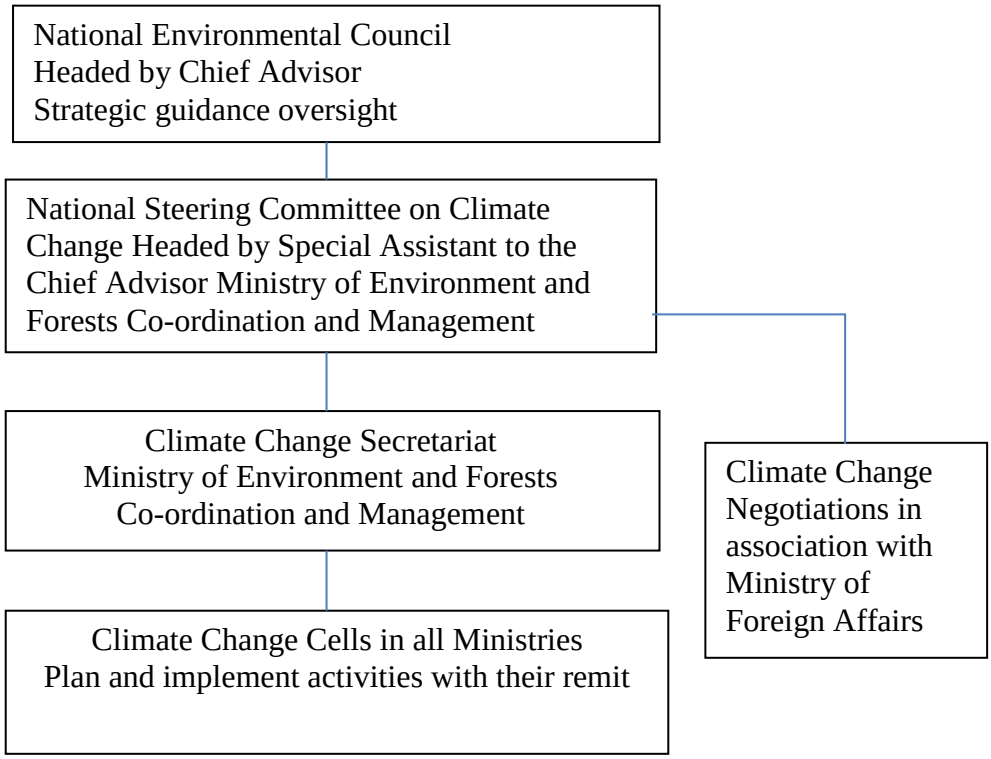
Adaptive ability depends on economic well-being, ecological well-being, the degree of reliance on natural resources, infrastructure (human-built or natural), effectiveness of institutions and governance structures, insurance, stable land tenure and mediation initiatives,, and information and communication systems. A community with the capacity to adapt is likely to be more resistant to impacts or able to recover from stressful events and conditions (USAID, 2009).

2.7.4 Bangladesh Climate Change Strategy and Adaptation Plan

Climate change is now the most burning and greatly alarmed issue for Bangladesh. The socio-economic moments of climate change, storm surge, coastal erosion, sea level rise, salinity intrusion and its effects have been addressed earlier, causing vulnerabilities in various parts of the world through comparative study of salinity intrusion. (IPCC, 2002). The Bangladesh Government (GoB) has addressed climate

change issues, including adaptation. Vision 2021, which provides all states' national policy papers with strategic guidance. "All measures will be taken to protect Bangladesh, including planned migration abroad, from the adverse effects of climate change and global warming." Bangladesh Climate Change Strategy and Action Plan first prepared in 2008, customized and approved by the Government in 2009 with wide consultation with Government and non -government sector, community based organization, development partners, experts, academia etc. NAPA prepared Climate Change Strategy and Adaptation in 2005 and updated in 2009. Figure 2.16 show the present Climate Change Strategy and Adaptation Plan of Bangladesh.

Figure 2.12: Climate Change Strategy and Adaptation Plan of Bangladesh 2009



Source: Bangladesh Climate Change Strategy and Adaptation Plan, 2009

Over the years, the people of Bangladesh have adapted to the challenges of floods, droughts and cyclones. They lift their house on the banks above the usual flood level in areas where flooding is a possibility, and change their cropping patterns to take advantage of the flood waters. Farmers in all parts of the country adapt to local flooding and rainfall patterns by growing a range of indigenous and high-yielding varieties of rice and other crops. Rural bridges, roads, paths, tracks and other services,, such as schools, are also high above the level flooding, if likely.

The challenge Bangladesh now faces is to scale up these investments to create a suitable environment for the economic and social development of the country and to safe the well-being of our people, particularly the poorest and most vulnerable groups, including women and children. The mission of the Government of Bangladesh's is to eliminate poverty and achieve economic and social well-being for all individuals. This will be achieved through a pro-poor, Climate Change Strategy, which prioritizes adaptation and disaster risk reduction, and also discourses low carbon development, mitigation, technology transfer and the provision of appropriate finance.

2.8 Critical Literature Review

The following section has been prepared on the basis of annotated references and bibliography. Here I have carefully reviewed the thesis topic related books, published journals and articles, newspapers (national and local) and different types of ideas from different universities, research organizations, Govt. and NGOs offices and national & international organizations, different research organizations, freelance researcher and so on. Bangladesh with its heavily populated coastal areas is considered as one of the most vulnerable countries affected by climate change in the world, according to the Global Climate Risk Index. Whereas the 'Climate Change' issue is very much contemporary, recurrent and tested matter to local, regional, national, and international community. Owing to geographical setting, the adverse effects of climate change, vulnerability and adaptation practices are vary from country to country of the world. So, the thesis only reviewed the thesis topic related secondary information and emphasized on national or native research based citation somewhat used very much relevant citation for authenticity of arguments. Finally, here I have segregated some keys those are related to thesis topic such as '*Coastal Region', 'Climate Change', 'Climate Induced Disaster or Vulnerability', 'Adaptation Strategy', 'Vulnerability Index'* and *'Community Based Sustainable Disaster Management'.* The above mentioned Keywords have been demarcated the boundary of the reviews of literature in this thesis. So, following section has been prepared on the basis of above mentioned keywords.

Brammer, H 2014. Bangladesh's dynamic coastal regions and sea-level rise, ELSEVIER Publishing, *Climate Risk Management,* 1 (2014) 51–62.

- The paper defines physical conditions within individual physiographic regions of the coastal area of Bangladesh based on ground-surveyed data and reviews potential area-specific mitigation steps to address the expected rates of sea-level rise in the 21st century. Therefore, two important conclusions are drawn: the adoption of suitable measures based on knowledge of the physical geography of potentially- affected areas could significantly decrease the currently-predicted dislocation of many millions of people; and the impacts of a slowly-rising sea-level are at present much less than those generated by rapidly increasing population pressure on Bangladesh's available land and water resources and by exposure to existing environmental hazards, and the latter problems need main concern concentration.

Islam, MR 2004. Where Land Meets the Sea - A profile of the Coastal Zone of Bangladesh, Program Development Officer for Integrated Coastal Zone Management Plan (PDO-ICZMP) and Water Resources Planning Organization (WARPO), The University Press Limited, Dhaka, Bangladesh.

- The book has been cited three criteria for the demarcation of the Coastal Zone in Bangladesh, such as tidal fluctuations, salinities (soil surface water or groundwater), and cyclone and storm surge risk. Besides, coastal zone of Bangladesh consist of
  - 19 districts including 147 upazilas and
  - The Exclusive Economic Zone (EEZ)

Further, a distinction has been made between upazilas facing the coast or the estuary and the upazilas located behind them. The exposed coast is defined as a total of 48 Upazilas in 12 districts exposed to the sea and /or lower estuaries, and the remaining 99 upazilas in the coastal districts are called interior coast.

Uddin, AMK and Kaudstaal, R 2003. Delineation of the Coastal Zone – Working Paper WP005, Program Development Office for Integrated Coastal Zone Management Plan (PDO-ICZMP), Saimon Centre, Road 22, House 4/A, 5th floor Gulshan 1, Dhaka 1212.

- The working paper has postulates a coastal zone in Bangladesh, in which the vulnerabilities and opportunities require special management approaches. The authors have emphasized the three basic natural system processes and events that govern opportunities and vulnerabilities of the coastal zone of Bangladesh are: tidal fluctuations; salinities (soil, surface water or groundwater); and cyclone and storm surge risk. Considering these three criteria, an assessment has been done on the delineation of the coastal zone. For each of these criteria, threshold values have been specified and corresponding impacted areas were determined. As per the working paper, Bangladesh's coastal zone of consists of 19 districts with 147 upazilas and an Exclusive Economic Zone (EEZ). In addition, a discrepancy was made has between upazilas facing the coast or the estuary and the upazilas located behind them.

IPCC 2007a. Climate change 2007: The physical science basis. Contribution of working group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor, H.L. Miller (Eds.). Intergovernmental Panel on Climate Change (IPCC), Cambridge University Press, New York.

- The Intergovernmental Panel on Climate Change's Fourth Assessment Report states explains that climate is influencing communities in many ways, and climate variability and change are important factors for societal growth. Global average surface temperatures have risen by 0.74 ± 0.18 °C in the past century (1906-2005). The study also notes that the Intergovernmental Panel on Climate Change (IPCC) concluded that it is 'unambiguous' that the climate system has warmed, based on measurements of global air and ocean temperatures and shifts in (among others) snow/ice extent and sea level. It is very likely that much to the warming since the middle of the 20th century (subjective like hood of >90%) would be attributed to the rise in atmospheric greenhouse gas concentrations caused by humans.

IPCC 2001. Climate Change 2001: impacts, adaptation and vulnerability, Contribution of Working Group II to the Third Assessment Report. Available at: http://www.grida.no/publications/other/-ipcc_tar/. Viewed on 24 June 24, 2019.

- The study argues that due to its natural evolution as well as sudden causes, the earth's climate history has undergone a variety of changes. The climate change measures are temperature, rainfall and the increase in sea levels. In the twentieth century, the global average air temperature rose by 0.6 ° C, and in the last millennium, the 1990s were the hottest decade. There was an apparent growing trend in the temperature in the twentieth century on all continents and oceans. The global average temperature standard deviation was 0.24 °C, the greatest difference between two continuous years was 0.29 °C (between 1976 and 1977), and the rate of temperature rise trend was 0.75 °C, faster than any other century in the history from the 11th century to the present. It is notable that the temperature has risen by 0.64 ± 0.13 °C in the last five decades, from 1956 to 2005, twice as fast as in the twentieth century.

IOM 2016. Assessing the Climate Change Environmental Degradation and Migration Nexus in South Asia, International Organization for Migration (IOM) Bangladesh, House # 13A, Road # 136, Gulshan – I, Dhaka 1212, Bangladesh.

- South Asia, comprising eight countries including Bangladesh, the Maldives and Nepal, is plagued by a number of natural disasters, including floods, glacial lake outburst floods, storm surges, droughts, cyclones and heavy rainfall. This detailed study discusses South Asia. These disasters take an immense toll on communities and regularly displace thousands of people. Bad infrastructure and economic fragility are amplifying the effects of natural hazards in the region. As a result, many millions of people in the region also depend on their livelihoods from land resources and live in environmentally vulnerable areas.

Nishat, A and Mukherjee, N 2013. Climate Change Impacts, Scenario and Vulnerability of Bangladesh, edited by Rajib Shaw, Fuad Mallick and Aminul Islam, Climate Change Adaptation Actions in Bangladesh, Springer, http://www.springer.com/series/11575

- The paper found that climate change greatly affects Bangladesh. In Bangladesh, where a growing trend and temporal variation in the mean seasonal temperature is observed within the range of 0.4 to 0.65 ° C over the past 40-year period, increasing surface air temperature is most prominent.While the lowest rainfall is encountered in the winter season, historical patterns indicate a positive pattern in 27 of the meteorological department's 32 rainfall observatories. The riverine flood (or monsoon flood) is influenced by the following phenomenon related to climate change, especially due to changes in the frequency and intensity of the event of severe rainfall, which may subsequently increase the flood intensity. The erosion of the riverbank is one of Bangladesh's major natural disasters, which is also connected to monsoon flooding. Floods also devastate physical infrastructure, especially high-intensity floods, such as road networks, educational centers, market places, administrative buildings, etc. Climate change will affect the requirements for irrigation for all three crop seasons: Rabi, Kharif-I, and Kharif-II. The western parts of Bangladesh are currently frequently hit by droughts in the winter months.

Minar, MH, Hossain, MB and Shamsuddin, MD 2013. Climate Change and Coastal Zone of Bangladesh: Vulnerability, Resilience and Adaptability, *Middle-East Journal of Scientific Research*, 13 (1): 114-120.

- It was discussed in the article that Bangladesh is one of the world's most vulnerable countries to climate change. Climate-related coastal zone shift is a possible additional stress on structures already under severe and rising pressure. Several consequences of climate change have already been experienced by the region, such as growing cyclones, flood frequency probabilities, erosion, flooding, rising water tables, intrusion of salt water, and biological effects. Mangroves, tidal deltas and low-lying coastal plains, sandy beaches, coastal wetlands, estuaries and coral reefs are coastal ecosystems that are especially at risk. These bio-geophysical possessions would have a consequent effect on habitats and ultimately have an impact on the coastal zone's socio-economic

structures. With a sea-level rise of one meter, the Sundarbans, the country's most important biodiversity, will be absolutely lost. To mitigate the effects of mitigation and adaptation, there are two choices. The study suggested that Bangladesh has both mitigation and adaptation options, although there is very limited scope for mitigation in the region.

Ali, KMB, Molla, MH, Hossain, N, Hoshen, A, Rahman, M and Billah, MM. 2015. Climate Change Induced Disasters inthe Southeastern Coastal Belt of Bangladesh, *Asian Journal of Water Environment*, Vol.2 No. 1, pp. 1-15.

- This article has been exposed that climatic elements especially annual mean temperature from1948 to 2008 and rainfall from 1970 to 2010 were gradually changed in the southeastern coastal belt of Bangladesh. Consequently, two types of disaster occur in this region. Firstly, climate change induced and secondly, non-climate change induced disasters. While climate change induced disasters are cyclone, tidal surge, flash flood, coastal erosion and trans-regression, heavy rainfall, salinity, thunderstorms, disaster borne disease, earthquake, tsunami and landslide. These disasters is recurrent and frequently happening in April to December around the whole year. Climate change induced threats were more noteworthy and their magnitude is higher than non-climate change disasters. As a result, people are altering their agricultural practices, infrastructural pattern and facing different health risks especially, disaster borne occurrences such as physical injury, vector borne, impulsive occurrences and water bore diseases particularly diarrhoea and fever.

Salequzzaman, M., Rahman, M., Moniruzzaman, M. M., Kashem, M. A., Salam, M. A., Jahan, S., Islam, M.T. and Rokunzzaman, M. 2009. Climate Change Induced Vulnerabilities and People’s Precipitation in the Southwestern Region of Coastal Bangladesh. Bhattacharya, D et al., (eds.,), in Climate Change and the Tasks for Bangladesh: Proceeding of the special Conference on Climate Change and Bangladesh Development Strategy: Domestic Policies and International Cooperation, Held in Dhaka on January 2, 2009, Published by Bangladesh poribesh Andolon (BAPA) and Bangladesh Environment Network (BEN).

Ahmed, M, Khan, MH and Islam, S 2007. Health Impacts of Climate Change in Bangladesh, Paper delivered in the Regional Workshop on Climate Change and Human Health in Asia: From Evidence to Action, Bali. Indonesia, Pp.10-12.

- Both studies have shown that climate-induced changes have occurred more regularly and unpredictably in the coastal area of Bangladesh, such as extreme cyclones, destructive tidal waves, heavy floods, treacherous river flooding, excessive precipitation, thunderstorms and overwhelming salinity intrusions.

Mirza ATM., Rahman, T., Islam, S and Rahman, SH 2015. Coping with flood and riverbank erosion caused by climate change using livelihood resources: a case study of Bangladesh, Climate and Development, 7:2,185-191.

- The manuscript has been studied that part-time jobs, restoring houses on an emergency basis, treating illness, taking temporary refuge on embankments and changing occupations are key methods used by individuals to cope with hazards. The most successful flood and riverbank erosion coping technique has been found to do part-time work. The most successful means of dealing with both hazards are physical and financial resources, while natural resources do not provide adequate help. In helping people cope with riverbank erosion, social resources are comparatively more effective, as are human resources for flooding.

Dasgupta, S., Huq, M., Khan, ZH., Ahmed, MMZ., Mukherjee, N., Khan, MF and Pandey, K 2011. Cyclones in a Changing Climate: The Case of Bangladesh, MC3-308, World Bank, 1818 H Street, N.W., Washington, DC 20433.

- This paper incorporates climate change knowledge, hydrodynamic models, and geographical overlays to evaluate the vulnerability of Bangladesh's coastal areas to greater storm surges and sea-level rises by 2050. The method recognizes flood-prone polders, coastal populations, settlements, infrastructure and economic activity, and calculates damage versus costs for a range of adaptation steps. A 27-centimeter sea-level rise and a 10 percent increase in wind intensity from global warming mean that the vulnerable zone increases in size by 69 percent with a flood depth of +3 meters and by 14 percent with a flood depth of +1 meter. Estimates suggest that improvements will cost more than $2.4 billion

with an annual recurring cost of more than $50 million, including the strengthening of polders, foreshore afforestation, additional multi-purpose cyclone shelters, cyclone-resistant private housing, and further strengthening of the early warning and evacuation system. These forecasts would serve as a prototype of the cost of adaptation to extreme weather events in climate negotiations.

Rahman, MA 2018. Climate Change Induced Disasters and Displacement Pattern in Coastal Area of Bangladesh, A Journal of Social Change, Vol. 8, No 1, 2018.

- The study found that in the coastal area of Bangladesh, which depends on the coastal regions, a total of seven types, mainly flood, cyclone and storm surge, bank erosion, salinity, tidal fluctuation, sea level rise and changing precipitation behavior of climate change-induced disasters, have been recurrent. The research also shows that the relationship between climate-induced catastrophe and displacement or migration of coastal people is important (*null hypothesis-H_o is rejected*). The hypothesis also mentioned that the leading triggers for the displacement of coastal people from their original places are cyclone or storm surge and bank erosion.

Barua, P, Rahman, SH and Molla, MH 2017. Sustainable Adaptation for resolving Climate Displacement issues of South Eastern Islands in Bangladesh, International Journal of Climate Change Strategies and Management, Emerald Publishing Limited, Vol.9, No.6, pp.790-810, DOI 10.1108/IJCCSM-02-2017-0026.

- In view of the socioeconomic disparities between the past and the present position of living places for island dwellers on the south-east coast of Bangladesh, this study has recognized sustainable adaptation steps to solve the displacement problem caused by climate change. The study also found that numerous natural disasters, such as cyclones, tidal waves, tidal floods and coastal erosion, exacerbated by climate change, were recurrent in the study areas and responsible for mass displacement.

IOM 2016. Assessing the Climate Change Environmental Degradation and Migration Nexus in South Asia, International Organization for Migration (IOM) Bangladesh, House # 13A, Road # 136, Gulshan – I, Dhaka 1212, Bangladesh.

- South Asian nations, including Bangladesh, the Maldives and Nepal, are vulnerable to a number of climate-induced hazards. Nepal is prone to flash floods and floods from glacial lake outbursts. The Maldives is primarily impacted by the increase in sea level, cyclones, salinization and coastal erosion. A wide range of natural hazards, including floods (riverine floods, flash floods), droughts, cyclones, storm surges, sea level rise and water and soil salinization, are affecting Bangladesh. Environmental degradation, temperature and rainfall fluctuations are also a matter of concern for all three countries. Other natural hazards also lead to the movement of people, such as earthquakes, landslides, tsunamis, epidemics, and non-climatic causes.

Yeasmin, S and Sattar, MA 2015. Human Security and Climate Change Induced Disaster: Bangladesh Perspective, NU Journal of Humanities, Social Sciences & Business Studies Vol. 2, No. 1.

- The study found that the rising occurrence of natural disasters is a major concern for human security around the world. As a country prone to disasters, Bangladesh is concerned with human security. The geophysical location and high population density and other factors are creating a catastrophe caused by the country's climate.

IPCC Third Assessment Report (TAR) 2001, Climate adaptation refers to the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damage, to take advantage of opportunities, or to cope with the consequences. Adaptation to climate change refers to adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities.

UNFCCC 2004, Report of the Conference of the Parties on its tenth session, held at Buenos Aires from 6 to 18 December 2004. Addendum. Part Two: Action taken by the Conference of the Parties at its tenth session. United Nations Office, Geneva, Pp.

2–6. < http://unfccc. int/resource/docs/cop10/10a01.pdf#page=2> viewed 24 June 2019.

- The Adaptation to Climate Change Study was highlighted at COP 10 (2004) in Buenos Aires, Argentina, where the Parties adopted Decision 1/CP.10: the Buenos Aires Program of Work on Adaptation and Response Measures, taking into account the outcomes of activities under Decision 5/CP.7. In Decision 1/CP.10, the Parties have agreed to establish a systematic five-year program of work on the science, technological and socio-economic aspects of climate change effects, vulnerability and adaptation, addressing the issues of methodology, data and modeling, vulnerability assessment, adaptation preparation, action and action, and incorporation into sustainable development.

Abedin, MA., Collins, AE., Habiba, U and Shaw, R 2019. Climate Change, Water Scarcity, and Health Adaptation in Southwestern Coastal Bangladesh, International Journal of Disaster Risk Science (2019) 10:28–42

- The findings of the study suggest that the local population agrees that climate change has a major effect on freshwater supplies and health. More than 70% of respondents listed diarrhea, dysentery, and skin diseases as the primary threats to waterborne health that occur due to climate-related lack of safe water. By synthesizing the ground data, through locally accessible adaptive practices such as the use of pond sand filters, rainwater harvesting, and importing potable water with the active involvement of the government, non-governmental organizations, and communities, we propose pathways to health adaptation to climate change effects and safe water scarcity.

Hossain, MSS and Saha, D 2019. An Assessment of Important Climate Change Adaptation Practices in Coastal Regions of Bangladesh, Institute of Water and Management (IWFM), Bangladesh University of Engineering and Technology (BUET), Dhaka, Bangladesh.

- Based on criteria such as geographical location, adaptation providers, sustainability and gender perspectives, vulnerability and system resilience, five significant adaptation practices have been discussed in this article. These methods are cyclone shelter building, pond sand filter (PSF), saline-tolerant

rice variety cultivation, floating garden and dyke cropping. Due to their efficacy, benefits to the stakeholders, strong public acceptance and accessibility, these activities have been found to be sustainable. They also have some obstacles, such as site selection, poor operation and maintenance, lack of resource availability, local people's lack of implementation capacity, and funds. In spite of barriers, these measures have reduced livelihood vulnerability of the local people by rising productivity and income and providing food safety. Thus, these adaptations are expected to be successful in combating future changed climate in coastal Bangladesh, once barriers are eliminated and associated policies and frameworks are implemented by the responsible authorities and organizations.

Hossain, MSS and Saha, D 2019. Major Infrastructural Adaptations in Coastal Areas of Bangladesh Considering Cyclone and Tidal Flood, 6th International Conference on Water & Flood Management (ICWFM-2017).

- In changing climate scenarios, this article aims to provide an overview of such activities. As well as the identification of various criteria responsible for the success of these activities of adaptation. In addition, the role of these adaptation practices has been studied in reducing disaster risk, reducing vulnerability, and increasing the resilience of large-scale systems. Proper operation and maintenance, community engagement, gender balance, repair and recovery time and good governance are the key criteria found to determine the efficacy and performance of these adaptations based on literature review and further study. These activities have also been funded by government and international donors on a wider scale for a long time. This article will provide useful perspectives for climate change analysis meta-analyses and can be used to track progress in adaptation to climate change based on the creation of performance criteria.

Kibria, MG., Khan, MSA and Saha, D 2016. Local Adaptation Practices in Response to a Super Cyclone in the Coastal Region of Bangladesh, Proceedings of the 3rd International Conference on Civil Engineering for Sustainable Development (ICCESD 2016), 12~14 February 2016, KUET, Khulna, Bangladesh (ISBN: 978-984-34-0265-3).

- The study shows that embankments have been seriously damaged, causing little to no crop development immediately after Aila for three years. A variety of adaptation steps have been implemented by impacted communities in response to the adverse effects of cyclones, which will help them better prepare to reduce losses due to future cyclones. Strategies include the transition from shrimp farming to crop production, improvements in crop patterns and types of crops, such as the introduction of salt tolerant and short-term cash crops such as sunflower, sesame, watermelon, etc., as well as small-scale boro rice cultivation. During the dry season, people practice storing fresh water in existing canals and on-farm reservoirs in order to provide sufficient irrigation water. Simulation of crop yield using the Aqua Crop model shows that the future prospects for these crops in the dry season are good, meaning that these local adaptation practices can succeed.

The Asia Foundation 2012. A Situation Analysis of Climate Change Adaptation Initiatives in Bangladesh, Dhaka, Bangladesh, September 2012.

- The study analyses Bangladesh's established policy and institutional structure, funding structures and major institutional players operating in the field of adaptation to climate change in order to better understand their current goals and the critical areas that are not being addressed. The study also looks into the gender dimensions of climate change adaptation projects, as well as the overall policy framework for gender and climate change. All of these issues were primarily reviewed and evaluated from a good governance perspective, focusing on issues of accountability, accountability, openness and engagement in policy-making and planning, implementation of the program, institutional structure and funding mechanisms for climate change adaptation in Bangladesh from local to national levels.

Islam, MS., Sultana, S., Saifunnahar and Miah, MA 2014. Adaptation of Char Livelihood in Flood and River Erosion Areas through Indigenous Practice: A Study on Bhuapur Riverine Area in Tangail, J. Environ. Sci. & Natural Resources, 7(1): 13-19, 2014

- The study analyzed the indigenous survival strategies of the people and evaluated variations in the capacity of people in those char villages to adopt with floods and river erosion. The study findings showed that people with high flood tendency and low socio-economic conditions in char land were more likely to fail to adopt with impacts compared to people with high and sudden flooding in areas. To adjust through this diverse circumstance, the char people use their indigenous skills. The study examines a negative reality that the people of char must devise and pursue different adaptation strategies in their own way without any organizational help. Finally, the study suggested a range of recommendations for policy planners and implementers for the potential growth of Bangladesh's charging areas. It therefore stresses the importance of taking responsibility for the destructive situation of floods and riverbank degradation on the part of the government and non-governmental organizations.

Sultana, Z and Mallick, B 2015. Adaptation Strategies after Cyclone in Southwest Coastal Bangladesh – Pro Poor Policy Choices, American Journal of Rural Development, 2015, Vol. 3, No. 2, 24-33. http://pubs.sciepub.com/ajrd/3/2/2

- This study examines the 'atlas of locally adopted approaches' in southwest coastal Bangladesh to cope with the adverse effects of cyclone Aila. In particular, this study examined community-level activities in the fields of agriculture, housing, water supplies, communication and employment. The study shows that people on raised homesteads have begun growing saline-tolerant rice and vegetables. They use dripping techniques for irrigation. For water storage, rain water harvesting and artificial aquifer tubing have been implemented. To save lives, the mud walls of the houses have been replaced by or even newly reconstructed with *Goran* wood or bamboo sticks. To save money for the next tragedy, they have formed groups and have taken out loans for small entrepreneurship ventures. People have begun to rear small animals and birds such as cattle, goats and pigeons instead of cows and buffalo

because of the fodder, pastureland and freshwater crises. Another latest breakthrough is new shrimp farming based on technology. Discussions were conducted on the pros and cons of all of the above methods that help to establish local-level long-term risk reduction planning and discuss the sustainability mantra of 'not need-based planning, but acceptance-based strategies' in the context of community-based disaster management planning. By discussing the acceptance of current disaster risk mitigation technologies, this paper adds values to the climate change adaptation sector in a historically updated approach focused on the empirical evidence of coastal livelihood research in Bangladesh.

Zamudio, AN and Parry, J 2016. Review of Current and Planned Adaptation Action in Bangladesh. CARIAA Working Paper no. 6. International Development Research Centre, Ottawa, Canada and UK Aid, London, United Kingdom. Available online at: www.idrc.ca/cariaa.

- The study found that Bangladesh is ranked among the countries most vulnerable to climate change. About two-thirds of its land area is vulnerable to floods from rivers and rainwater, and its coastlines are exposed to storm surges and tidal flooding. Such variables make the nation especially vulnerable to sea level rise, higher rainfall during the monsoon season, and glacial retreat. Bangladesh, acknowledging its vulnerability, was one of the first countries to plan a National Adaptation Programme of Action and set up dedicated institutions and funds focused on climate change. In each ministry, the government has also set up cells for climate change to encourage climate mainstreaming across sectors, policies, and plans. Climate risks have also been fully or partially integrated into national development plans and certain sectoral policies; climate change remains to be incorporated into forestry, fisheries, health and gender sectoral policies. Bangladesh has also seen a range of programs and measures undertaken to prepare for the present and potential impacts of climate change. Most of these initiatives are large-scale infrastructure projects aimed at reducing the impacts of floods, saline water intrusion, surges in sea storms and rising sea levels, mainly in the southern urban coastal areas. Other sectors and vulnerable regions of the country, such

as the livestock sector, which is essential to vulnerable communities affected by recurrent droughts, are still largely neglected.

Mallick, B., Witte, SM., Sarkar., R, Mahboob, AS and Vogt, J 2009. Local Adaptation Strategies of a Coastal Community during Cyclone Sidr and Their Vulnerability Analysis for Sustainable Disaster Mitigation Planning in Bangladesh, Journal of Bangladesh Institute of Planners, Vol. 2, December 2009, pp. 158-168.

- Social vulnerability to disasters applies to a community and its people's inability to tolerate the adverse effects of numerous pressures they are subjected to. This paper discusses the (re)action and responses of citizens during the 2007 cyclone Sidr at the Baniasanta Union of Dacope Upazila in Bangladesh using a combination of geographical and social science methods. The study shows that their adopted strategies to cope with cyclone address their vulnerability and it is needed to integrate their local wisdom of living with unnatural situation into the future planning and development process of the coastal belt. Accordingly, the plans and development should not only be obligation, but also be accepted by the local civic.

Sutradhar, LC., Bala, SK., Islam, AKMS., Hasan, MA., Paul, S., Rhaman., MM., Pavel, MAA and Billah, M 2015. A Review of Good Adaptation Practices on Climate Change in Bangladesh, 5th International Conference on Water& Flood Management (ICWFM-2015).

- The article shows that different communities and participants are already using adaption practices related with climate risks of Bangladesh. Good adaptation practices adopted by national and international NGOs in Bangladesh found fairly fit for our environment. Some examples of good adaptation practices in Bangladesh are Tidal River Management (TRM), Green Afforestation Belt, Community Based Adaptation (CBA), floating farming, homestead vegetable gardening, caged-fish culture, raised flood-proof dwellings, raised tube wells and latrines, diversified salt and flood resistant crop varieties, etc.

Sultana, M., S. Rumi, SRA and Sheikh, MAH 2013. Climate change induced flood risk and adaptation in the Padma river island, Bangladesh: a local scale approach, J. Life Earth Sci., Vol. 8: 41-48, 2013. http://banglajol.info.index.php/JLES

- A significant method for assessing the capacity of households and local communities to respond to climate change-induced flooding is the assessment of hazard characteristics, exposure, vulnerability, resilience and danger at the local level. Repeated floods of varying magnitudes under variable climatic conditions are a major disaster for people living in flood-prone regions, especially in the Islands. People, infrastructure and economy are highly exposed to flood and that results in devastating flood disaster. In the Padma river Islands frequent flooding makes the life and livelihoods of people vulnerable and this vulnerability is conditioned by different factors such as people's physical, social, economic and environmental condition. The higher is the level of vulnerability the higher is the level of flood risk. Hence, people's resilience can minimize the negative effects of flood disaster. A composite risk index (related to the probability of occurrence of the event, magnitude of the event, quantity and cost of the element at risk, vulnerability and resilience) was prepared to understand the climate change induced flood disaster risk. Some adaptive approaches are explored to adapt with climate change induced flood risk. Finally, Local Scale Disaster Risk Model (LSDR) was proposed to present the framework of climate change induced flood disaster risk and adaption at a local measure.

Amjad, K 2016. Challenges of Climate Change: GO and NGO Approaches in Bangladesh, Unpublished M.Phil Dissertation, Institute of Social Welfare and Research, University of Dhaka, Dhaka-1205.

- The study tried to study the way GO and NGO working towards addressing this challenge and what are their lacking and how it can be developed. The study also attention on how the effective collaboration can be made by exchanging and sharing resources and expertise to better cope with the condition and to effectively address the problem. The findings of the study revealed that while plethora of GO and NGOs are working towards introducing the problem their needs to be better synchronization among and between the organizations is needed. In this regard strategic partnership

specially sharing of experiences, ideas and resources, taking insights from international and experiential knowledge, community involvement can play pivotal role in coping with the condition.

Uddin, JM., Rahim, AM., Rahman, SM., Satter, AM and Dutta, N 2015. Community Perception on Climate Change and Adaptation Scenarios in Southern Part of Bangladesh, Journal of Health and Environmental Research, 2015; 1(2): 12-18.

- The study explored the community awareness and experience in climate change adaptation related to water and environment, local adaptation techniques of the defined study area. The key findings of the study are climate change impact on agriculture, fisheries, water, environment, livelihood and copping strategies such as use floating garden, homestead gardening, rearing poultry, crop diversification, raising water pump, pond embankment, use cyclone shelter to cope with climate change in the study area. The study also found that climate change in recent years has increased. Water-borne diseases related to climate change are impacting the population. Proper adaptation steps should be taken in time to ensure the safety of local people in the region.

Abedin, MA.,Collins, AE., Habiba, U and Shaw, R 2019. Climate Change, Water Scarcity, and Health Adaptation in Southwestern Coastal Bangladesh, Int J Disaster Risk Sci (2019) 10:28–42. https://doi.org/10.1007/s13753-018-0211-8

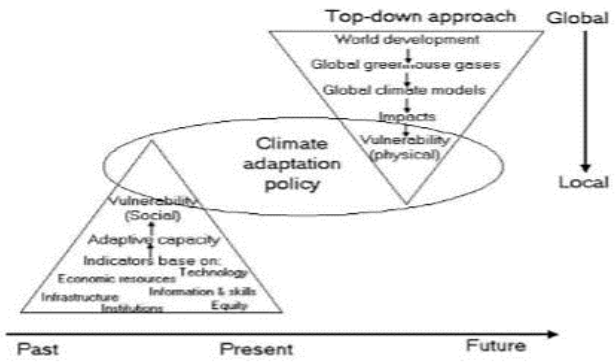
- The study examined the impacts of climate change on water resources and human health in a coastal area. A questionnaire survey was carried out in two villages of Shymnagar upazila on the southwestern coast to investigate the present status of safe water sources and health care facilities and their impacts on the local community. The findings indicate that climate change is believed by the local population to have a direct effect on freshwater supplies and health. More than 70% of respondents listed diarrhea, dysentery, and skin diseases as the primary threats to waterborne health that occur due to climate-related lack of safe water. By synthesizing the ground data, we suggest pathways to health adaptation to climate change effects and safe water scarcity through locally available adaptive practices such as the use of pond sand filters, rainwater harvesting, and importing potable water with the active

participation of the government, nongovernmental organizations, and communities.

United Nations Framework Convention on Climate Change (UNFCC), 2008. Compendium on methods and tools to evaluate impacts of, and vulnerability and adaptation to climate change.UNFCCC Secretariat. Available at: http://unfccc.int/files/adaptation/nairobi_workprogramme/compendium_on_methods_tools/application/pdf/2008 0307_compendium_m_t_complete.pdf

- The United Nation Framework Convention on Climate Change (UNFCC, 2008) mentions two types of vulnerability assessment framework: impacts (top-down) and adaptation (bottom-up) (Figure 2.13). Impacts frameworks are also referred to as 'first generation'. They were mainly designed to understand the potential long-term impacts of climate change. The main elements of an impacts framework is the baseline socio-economic and environment situations, climate change scenarios. Biophysical impacts (sensitivity) are assessed based on them, thus vulnerability can be estimated. After that climate adaptations policy can be examined. On the other hand, the adaptation frameworks also referred as 'second generation' and have developed in recent years, focus on involving stakeholders and addressing adaptation. The framework contains technical papers, engaging stakeholders, assessing vulnerability, assessing current and future climate risks, assessing changing socio-economic conditions based on indicators, then assessing adaptive capacity. Finally formulating a climate adaptation strategy, and continuing the adaptation process. It is important to remember that the process works from the bottom of the figure to the top involving stakeholder at each stage. As different frameworks have different strengths.

Figure 2.13: Framework approach by UNFCC



Denevan, W 1983. Adaptation, variation and cultural geography, Professional Geographer, Vol. 35, Pp. 406–412

- Adaptation to climate change is understood to consist of policies and interventions aimed at reducing the vulnerability of natural and human systems to the impact of real or anticipated climate change. Since the early 1990s, the word "adaptation" has been used in the climate change community, but among conservation practitioners, no single definition has commonly been accepted. Most of the concepts given in the literature represent in some way that adaptation to climate change requires "initiatives and measures designed to reduce the vulnerability of natural and human systems to the actual or anticipated effects of climate change." In the sense of climate change, however, the term adaptation is not yet well-understood by the general public. The term has created confusion in part because the same word refers to the mechanism by which organisms adapt naturally over time to thrive in a new environment, although it is predicted that the rapid pace of climate change would exceed the ability of many organisms to adapt in this classical context.

Klein, JTR, ROBERT J. Nicholls, JR and Mimura, N 1999. Coastal adaptation to climate change: can the IPCC technical guidelines be applied, Mitigation and Adaptation Strategies for Global Change, Vol. 4, Pp.239–252.

- This paper evaluated the IPCC Technical Guidelines for Assessing Climate Change Effects and Adaptations with respect to the guidance offered for coastal-adaptation assessment. It explored that the IPCC Technical Guidelines focus strongly on implementation. This study used both conceptual and empirical information is used in this paper to show that coastal adaptation holds more than selecting one of the “technical” options to respond to SLR (retreat, accommodate or protect). Besides, coastal adaptation is a more complex and iterative process with a series of policy cycles. To be effective, an expanded adaptation framework involving four steps is suggested, including (i) information collection and awareness raising; (ii) planning and design; (iii) implementation; and (iv) monitoring and evaluation. These four steps in current coastal-adaptation assessments constrains the development of adaptation strategies that are supported by the relevant actors and combined into current management.

Barua, P, Rahman, SH and Molla, MH 2017. Sustainable Adaptation for resolving Climate Displacement issues of South Eastern Islands in Bangladesh, International Journal of Climate Change Strategies and Management, Emerald Publishing Limited, Vol.9, No.6, pp.790-810, DOI 10.1108/IJCCSM-02-2017-0026.

- 11 basic criteria and 4 concepts of sustainable adaptation options were prescribed in the study to solve the issue of climate displacement. In addition, seven adaptation practices demonstrated high sustainability, ten demonstrated medium sustainability and five demonstrated low sustainability in terms of effectiveness, efficiency and capacity to implement. By combining environmental, economic and social harmony with regard to the Sustainable Development Goals, the study would help to establish sustainable adaptation measures.

Smit, B., I. Burton, I, Klein, RJT, Street, R 1999. The science of adaptation: A framework for Assessment. *Mitigation and Adaptation Strategies for Global Change*, Vol.4, Pp. 199-213.

Smit, B, Burton, I, Klein, RJT, Wandel, J 2000. An anatomy of adaptation to climate change and variability. *Climatic Change*, Vol.45, Pp.223-251.

- Both articles have been indicates that the some dimensions that distinguish various climate adaptation approaches: purposefulness (planned versus autonomous adaptation3), timing (anticipatory versus reactive adaptation), temporal scope (short-term versus long-term), spatial and/or institutional extent (localized versus widespread), form (technological, behavioral, financial, institutional, informational), and function/effects (retreat, accommodate, protect; prevent, tolerate, spread, change, restore). Spatial and institutional level may also relate to the issue of problem ownership; i.e. who is accountable for taking specific climate adaptation measures: national governments, municipalities, companies, or citizens?

Du, YD, Cheng, XH, Wang, XW 2013. A review of assessment and adaptation strategy to climate change impacts on the coastal areas in South China. Adv. Climate. Change Res., Vol. 4(4), doi: 10.3724/SP.J.1248.2013.201.

- This paper reviews evaluation of climate change effects on economy, society and ecological environment in the coastal areas of South China. It also

proposes suitable adaptation strategies and countermeasures. Review illustrate that climate change has resulted in SLR in the coastal areas of South China, rising the occurrence and intensity of storm surges, aggravating the influence of saltwater intrusion, coastal erosion, urban drainage and flood control, threatening the coastal facility and infrastructures, inundating lowland areas, offsetting mudflat silting, and degrading mangroves and coral reef ecosystem. In order to decrease the adverse impacts of climate change and to support the sustainable development in the coastal areas of South China, it is critical to improve the monitoring and early warning system, improve prevention criteria, fortify coastal protection engineering, strengthen salt tide prevention, and reinforce the ecological restoration and protection.

Laila, Fariya, 2013. Assessment on Social Vulnerabilities to Climate Change – a Study on South-Western Coastal Region of Bangladesh. Master thesis in Sustainable development at Uppsala University, No. 154, 38, Pp, 30.

- This research has been assessed the social vulnerability of the south-western coastal communities of the country, which is becoming more vulnerable, trying to understand the underlying social conditions of coastal people who are dependent on limited natural resources. Besides, vulnerability indicators of exposure, sensitivity and adaptive capacity. The study found that a group of people in the area have close dependency on natural resources such as water, mangrove forest and also has a limited set of livelihood options.

Goosen, H., Hasan, T., Saha, SK., Rezwana, N., Rahman, MR., Assaduzzaman, M., Kabir, A., Dubois, G and Scheltinga, CTV 2018. Nationwide Climate Vulnerability Assessment in Bangladesh, Federal Ministry of Economic Cooperation and Development (BMZ), Germany.

- Mainly, the study focus on the ‘Why a Nationwide Climate Vulnerability Assessment’, ‘Current and future vulnerability: a climate change perspective’, ‘Routes to decrease vulnerability’, ‘Perspective of action for Bangladesh’, ‘A continuous process and a national capacity’ and ‘Potential adaptation options. In addition, this assessment was led by a team of foreign and national experts and was carried out by applying participatory methods through a systematic step-by-step approach. For eight sectors at Upazila level, climate vulnerability

was assessed: agriculture, livestock, fisheries, navigation, transport and infrastructure, water supplies, biodiversity, natural disasters and human health.This assessment will be integrated into the update of the Bangladesh Climate Change Strategy and Action Plan (BCCSAP) 2009 and can potentially contribute background information for project and policy documents addressing vulnerability, such as the National Adaptation Plan (NAP). Moreover, to increase the resilience of the country in the long run, an integrated approach is needed: decreasing sensitivity and increasing adaptive capacity of all sectors by elaborating strategies and implementing adaptation measures. A great potential for decreasing sensitivity lies in efforts focused on improving spatial planning, using nature-based solutions, enhancing gender equality, etc. Promising strategies to increase adaptive capacity are education and research, training, access to finance for investment, integration of local and regional initiatives into strategic plans, etc. The Nationwide Climate Vulnerability Assessment (NCVA) has intended to provide the Government of Bangladesh with a tool to assess climate change vulnerable areas. Other users, such as civil society organizations, research institutions and the private sector may be secondary beneficiaries of the NCVA.

Cutter, SL, Boruff, BJ and Shirley, WL 2003. Social Vulnerability to Environmental Hazards, University of South Carolina, *Social Science Quarterly*, Volume 84, Number 2, June 2003.

- The study mainly explored the socioeconomic and demographic data were used to construct an index of social vulnerability to environmental hazards, called the Social Vulnerability Index (SoVI) for the United States based on 1990 data. The analysis also used a factor analytic approach, reducing 42 variables to 11 independent factors that accounted for approximately 76 percent of the variance. To compute a summary ranking, the Social Vulnerability Index, these variables were placed in an additive model. In addition, the analysis found that in the SoVI, with the most vulnerable counties concentrated in metropolitan counties in the eastern, southern Texas, and Mississippi Delta areas, there are some distinct spatial trends.

Granados, A. 2012. Estimate Social Vulnerability Index to Climate Change in Mexico, Universidad Nacional Autónoma de México (UNAM), P.10.

- This research uses different findings in the literature on vulnerability in relation to climate change, mainly "New Indicators of Vulnerability and Adaptive Capacity, which provides factors to determine the social vulnerability", and also estimate correlations on the effects of weather events over the past in Mexico. The research also intends to demonstrate that natural disasters have a differential impact on the territory, depending on regional social vulnerability. However, six dimensions, namely health, education, physical infrastructure, government, demographic and geographic factors and dependence on agriculture, are built on the Vulnerability Index for 2000 and 2010. Six dimensions are developed on the basis of these sectors and the same for the calculation of the Human Development Index (HDI), with minimum and maximum values (limit values) being calculated for each indicator to be converted into indices with values between 0 and 1. In contrast to those closer to 0, which have less vulnerability in the region, values close to 1 imply increased vulnerability. The normalization is as follows

$$\text{Dimension Index} = \frac{\text{actual value} \;\; \text{minimum value}}{\text{maximum value} \;\; \text{minimum value}}$$

Cooley, H, Moore, E, Heberger, M and Allen, L 2012. Social Vulnerability to Climate Change in California,A White Paper from the Californ ia Energy Commission's California Climate Change Center,California Energy Commi ssion and Pacific Institute, Pacific Institute – 653, 13th St. Oakland, CA 95814.

- The researchers developed a new climate vulnerability index to indicate the social vulnerability of a region's population to climate-related harm. The index combines 19 indicators into one overall climate vulnerability score and includes factors specially related to climate impacts such as air conditioner ownership, childhood obesity, percentage of tree cover, pre-term births, works in outdoor occupations and others. The research paper describes that where there are large numbers of people exposed to a climate-related threat and where there is high social vulnerability, the most important danger from climate change exists.

Cutter, SL., Boruff,BJ, Shirley,WL 2003. “Social Vulnerability to Environmental Ha zards.” Social Science Quarterly, Vol. 84 (2), Pp.242-261.

- The study explained that vulnerability of a system to climate change is determined by its exposure, physical setting, ability and opportunity to adapt to change. “Social vulnerability is partially the product of social inequalities—those social factors that influence or shape the vulnerability of various groups to harm and that also govern their ability to respond. However, it also involves location disparities, the features of populations and the built environment that contribute to the social insecurity of places, such as the degree of urbanization, growth rates, and economic vitality.

Flanagan, BE, Gregory, EW, Hallisey, EJ, Heitgerd, JL and Lewis, B 2011. A Social Vulnerability Index for Disaster Management," *Journal of Homeland Security and Emergency Management*, Vol. 8: Issue. 1, Article 3. DOI:10.2202/1547-7355.1792

- The study examined that social vulnerability refers to the socio-economic and demographic variables that influence group resilience. It also clarified that resolving social vulnerability efficiently eliminates both human suffering and economic losses related to the provision of social services and post-disaster public assistance. This paper describes the creation of a social vulnerability index (SVI) for use in emergency management, from 15 census variables at the census tract level. By analyzing the effect of Hurricane Katrina on local communities, it also explores the possible importance of the SVI.

Rahman, S., Md. Touhiduzzaman, M and Hasan, I 2017. Coastal Livelihood Vulnerability to Climate Change: A Case Study of Char Montaz in Patuakhali District of Bangladesh, *American Journal of Modern Energy*, 2017; 3(4): 58-64

- The study tried to explore that the climate change has affected the 70% people’s agricultural livelihood in many ways. It has also formed a state of unemployment among the people of coastal communities. As a result, the impacted people are losing their livelihoods and are forced to use a variety of alternative livelihoods to cope with the adverse effects of disasters linked to climate change. Also, the study identifies the livelihood adaptation strategies adapted by the affected communities in Char Montaz area. Besides, the coastal

community people try to solve their problems through adopting and exploring alternative employments.

Ahmad, H 2019. Bangladesh Coastal Zone Management Status and Future Trends, Journal of Coastal Zone Management, Vol. 22 Iss. 1 No: 466.

- The study tried to Identify the coastal zone management context, scope, coastal development rationality, challenges, structure, environmental impacts, and potential trends. The study emphasized the some requirements an combined management of Coastal Zones to establish a mutual interaction among coastal community, policy, environment to achieve sustainable development of Coastal Zone (CZ). Coastal Zone also stated that it has opportunities for growth that can reduce coastal poverty and contribute to Bangladesh's local and overall economic development.

Mahmood, R and Mahbub, AQM 2018. Building Vulnerable Islander Resilience to Natural Hazard: A Participatory Approach

- The study explores 8 major vulnerability issues and 17 urgent priority interference issues for building vulnerable islander resilience. Also, recognized that attempts in reducing vulnerability in inhabitation and livelihood is the starting point of being resilient, and it can be promoted further by undertaking interventions such as local infrastructure development and improvement in society facilities, i.e., long-term adaptation at community level, not only the post disaster responses. Finally, this research provides guideline of how resilience of coastal islanders can be promoted one step forward in the face of natural hazards and disasters.

Coastal Zone Policy 2005. 2005. Ministry of Water Resources, Government of the People’s Republic of Bangladesh.

- The policy mainly highlighted the three reasons for initiating the policy on the coastal region, namely a). In several areas of socio-economic growth, the coastal zone is lagging behind; b). Bad efforts to deal with numerous disasters and gradual environmental deterioration; and c). There is the potential for the coastal zone to contribute greatly to national growth. Also explored the existing policies, coastal zone management including area of management and Integrated Coastal Zone Management (ICZM), policy structure

comprising economic growth, basic needs and opportunities for livelihoods, reduction of susceptibilities, sustainable management of natural resources, reasonable distribution, empowerment of communities, women's development and gender equity, conservation and enhancement of critical ecosystem and enabling institutional environment.

Ali, KMB, Molla, MH, Hossain, N, Hoshen, A, Rahman, M and Billah, MM. 2015. Climate Change Induced Disasters in the Southeastern Coastal Belt of Bangladesh, *Asian Journal of Water Environment*, Vol.2 No. 1, pp. 1-15.

- The study explores that coastal people are using indigenous knowledge for coping purpose although they are more fatalistic about uncertain occurrences. Also this study recommended bottom-up approach for reducing the vulnerability of every occurring disaster in the southeastern coastal belt of Bangladesh. The findings of the study also recommended a list of trees for salinity resistance which ensure green belt at coastal area and reduce coastal erosion in coastal area of Bangladesh.

Rashid, KI. 2015. Climate Induced Disaster Management: A case Study on Patharghata Upazila, Barguna District, Unpublished PhD thesis, Department of Geography and Environment, Jahangirnagar University, Savar, Dhaka – 1342.

- The research mentioned that traditional disaster management approach includes rescue, relief and rehabilitation. These approach are important that will increase the capacity of quick recovery from any disaster of the community. However, early warning system and emergency preparedness is very important. And the community awareness towards these is equally important. Besides, Community Risk Assessment (CRA) is a participatory process for assessing hazards, vulnerability, risks, ability to cope, preparing coping strategies and finally preparing a risk reduction options implementations plan by local community. Moreover, CRA uses scientific information and participatory discussion to identify, analyses and assess risk environment of a particular society, reach consensus amongst the community on action that are needed to manage the risk environment.

Bass, S., Ramasamy, S., De Pryck, DJ and Battista, F. 2008. Disaster Risk Management Systems Analysis – A guide Book, Environment, Climate Change and

Bioenergy Division Food and Agriculture Organization of the United Nations Rome, Januar.

- This Guide provides a set of tools to assess existing structures and capacities of national, district and local institutions with responsibilities for DRM in order to get better the effectiveness of DRM systems and the integration of DRM concerns into development planning, with exacting reference to disaster-prone areas and vulnerable sectors and individual groups. It is anticipated that the strategic use of the Guide will increase awareness of the strengths, vulnerabilities, opportunities and challenges facing current institutional frameworks of DRM and their consequences for on-going processes of institutional reform. It also highlights the complex institutional linkages between various actors and sectors at different levels. Author mentioned that it will help to recognize gaps within the existing DRM institutions and/or systems including sectoral line agencies that are often responsible for implementing the technical aspects of DRM (e.g. agriculture, water and health sectors).

  The assessment and analysis process outlined in the Guide is thus a first step towards strengthening existing DRM systems. The major areas of application are:

  - Strengthening national and/or decentralized institutional and technical capacities for DRM;
  - Integrating key aspects of DRM in emergency rehabilitation programmes;
  - Design and promotion of Community Based Management of Disaster Risks (CBDRM);
  - Operationalizing the paradigm shift from reactive emergency relief to pro-active DRM; and
  - Mainstreaming DRM into sectoral planning and development (e.g. agriculture).

Sarker, S and Hossain, SM 2012. Climate Change Disaster and Community Based Mitigation Options at Ramgati Coast, Bangladesh, *Agricultural Science Research Journal*, Vol. 2(6) pp. 346 – 354, June 2012.

- The study exposed that river bank erosion (88%) is the most severe disaster followed by tidal surge (84%) and tropical cyclone (35%). The vector of effectiveness showed that disasters made people's livelihood fragile by making homeless with the consequences of land less, income less, food crisis, water crisis, cattle death, disease outbreak, migration and salinity intrusion. Also, the shelter center and neighbors/relatives house, formation of temporary cluster house on embankment, buy land in upward areas and migrate to nearby urban districts are coping selections for further settlement. In addition, take loan from money lender, relief, selling liquid assets, borrow money from relatives, utilize previous saving, mortgage land are also declared by the interviewee. The current temporary coping option are shifting to cyclone shelter and neighbor/relative house as well as prepare cluster shed on embankment, where moved to upward level and migration to urban areas are the resettlement options. In addition, the last attempts before leaving the generation-old village are to get loans and sell house hold properties. This study aims to address community-based adaptation practices to climate change threats by defining localized climate change disasters with impact severity and examining indigenous coping mechanisms.

Rahman, MA and Rahman, S 2015. Natural and traditional defense mechanisms to reduce climate risks in coastal zones of Bangladesh, *ELSEVIER Publication, Weather and Climate Extremes*, 7(2015)84–95.

- This study revealed that during the current decades there has been enormous plantation sand construction of embankment and polderization but these and other measures have been found to be impractical and in effective in reducing disasters in coastal areas. There is a need for integration of traditional coping practices and wisdoms with modern approaches. Available knowledge on some of the traditional practices has been documented forest abolishing a sustainable policy for management of coastal zones of Bangladesh. The impact of natural and climate change-induced disasters can be minimized by integrating conventional and scientific management of the

coastal environment with mangroves and other plants through triple-tier processes and ecosystems.

Delaporte, I and Maurel, M 2016. Adaptation to Climate Change in Bangladesh, Working paper 145, Development Politics.

- The paper calculate the impact of climatic shocks on the household agricultural income and subsequently, on farmers 'adaptation process. Also, a one percentage point climate induced refuse in agricultural income pushes households to adapt by almost 3 % points. On the other hand, confident strategies are too expensive and cannot be afforded in bad times. For those techniques, we provide evidence of barriers that constrain the development and deployment of adaptive actions, noticeably access to electricity and wealth.

Huq, SMS. 2016. Community Based Disaster Management Strategy in Bangladesh: Present Status, Future Prospects and Challenges, *European Journal of Research in Social Sciences*, Vol. 4 No. 2, 2016.

- The research rough idea the society's participation is the most successful elements to achieving sustainability in dealing with natural disaster risks. As a disaster post rate country Bangladesh is affected by various types of natural hazards like tropical cyclones, tidal bores, floods, tornados, river bank erosions, earthquakes etc. almost every year and destroy many lives and resources of people. It is surrounded by thousands of rivers, in the North the Himalayan range and in the South the Bay of Bengal creates harsh weather especially for a large number of poor people live in the southern part of Bangladesh making them as common victim of natural calamities, sometimes the vulnerability is so miserable that they must resettle themselves in the newly accreted land. The negative consequences of these natural hazards that affect the socio-economic situation must be reduced for sustainable development. The prevention of occurrence of natural disasters influenced by natural causes may be impossible but it can be reduced by proper planning, management and human collective participation. From realization of this reality, the government of Bangladesh has adopted disaster management

plans and programs for the mitigation of disaster and its possible adverse impacts.

Vincent, K and Cull, T. 2010, A Household Social Vulnerability Index (HSVI) for Evaluating Adaptation Projects in Developing Countries , *PEGNet Conference 2010: Policies to foster and sustain equitable development in times of crises*, Midrand, 2-3rd September 2010 .

- A potentially guided index of social vulnerability to climate change was outlined in the report. The household social vulnerability index is built on the basis of the sustainable livelihoods system from the weighted average of five composite sub-indices: financial capital (20%); human capital (20%); social capital (20%); natural capital (20%); and physical capital (20%) (20 percent).Whilst in this paper the index has been presented with indicators and weightings as appropriate to one village in Limpopo province, South Africa, the theoretical nature of the index means that it is appropriate for modification and use in other rural settings. This fills an important policy and practical need in terms of the growing field of climate change adaptation. Since the effectiveness of adaptations are only realised after exposure to the hazard in question, development agencies, funders and NGOs need a way of both targeting their interventions, and then monitoring and evaluating their success. By using the HSVI to rank households at the beginning of the interference, the most vulnerable can be targeted. And then reapplying it during the interference and afterwards display how the relative vulnerability of targeted households changes relative to others in the location.

Sanam, K. Aksha , Luke Juran, Lynn M. Resler and Zhang, Y, 2019. An Analysis of Social Vulnerability to Natural Hazards in Nepal Using a Modified Social Vulnerability Index, *Int. Journal of Disaster Risk Sci,* 10:103–116 www.ijdrs.com https://doi.org/10.1007/s13753-018-0192-7 ,www.springer.com/13753

- The objective of this study was to quantify social vulnerability at the local level using indicators relevant to Nepal's distinct social and physical landscapes. Following Cutter et al.'s (2003) SoVI methodology, we derived seven components that contribute to social vulnerability in Nepal (see Table 2). Component and total SoVI scores are not evenly distributed across the

country, and clustering is evident. A main finding of this study is that areas with similar hydro-meteorological and geophysical characteristics may exhibit differences in social vulnerability. Marked differences are observed in the spatial distribution of social vulnerability among the three ecological regions. The central and Western Mountain, western Hill, and central and eastern Tarai regions show relatively higher social vulnerability, while the central and eastern Hill regions reveal comparatively less vulnerability. This result is interesting because, within each ecological zone, elevation, natural hazard risk, and geophysical and hydro- meteorological regimes are similar, but social vulnerability is not. Similar. Although populations residing in each area are therefore subject to similar natural environments (and thus exhibit similar exposure to the same natural hazards),

Thomsen, D. C., T. F. Smith, and N. Keys. 2012. Adaptation or manipulation? Unpacking climate change response strategies. Ecology and Society 17(3): 20. http://dx.doi.org/10.5751/ES-04953-170320.

- The study stressed that adaptation is a key characteristic of sustainable social and ecological systems. They are exposed to diverse environments and precursors for adaptation as societies traverse different temporal and spatial scales. But a closer analysis of the sense of adaptation and its relation to concepts of resilience, vulnerability, and sustainability reveals that societies simply exploit rather than adapt to their social-ecological contexts in many cases. It may be argued that manipulative behaviors are a subset of a larger suite of adaptive behaviors, but this paper shows that there are radically different motivations and effects of manipulative behaviors. In particular, the inherent dignity of social-ecological structures is respected by adaptive behaviors and adjustment is geared towards internal or self-regulating alteration. By comparison, in order to make self-regulation unnecessary, deceptive practices appear to ignore the integrity of social-ecological structures and rely on external reform or exploiting the larger environment. In addition, adaptive behaviors are long-term resilience-building techniques, while manipulative behaviors are short-term strategies with unpredictable impacts on resilience, vulnerability, and social-ecological systems' sustainability.

Chapter 3

METHODOLOGY OF THE STUDY

The term ‘research methodology’ describes the systematic approach used to classify the experimental methods used to analyze research problems (Smith et al.,2012). Analysis methodology is a way of systematically observing the different steps a researcher normally takes in studying his research problems, along with the reasoning, conclusion and justification behind them (Islam, 2014). The research methodology is a way to solve methodically the research problem (Kothari, 1990). The methodology is a coherent set of rules and procedures which can use to investigate a phenomenon or situation (within the framework dictated by epistemological[1] and ontological[2] ideas) (Kitchin and Tate, 2000). The qualitative and quantitative researches are directly taught in geography through applying qualitative and quantitative approaches. So, geographers directly operated of using for various kinds of methodology in research purpose. But geography as an independent discipline has its own research methodology, tools and techniques. Although, the researcher is a reader and learner of geography and has used different types of approaches, tools and techniques in the research work, but firstly, the study has emphasized the inherent techniques.

3.1 Introduction

To formulate the theoretical framework of my research work I have been applying multi-surveying techniques to have done this work (Table 3.1). Quantitative and qualitative approaches were applied during collecting, classifying, analyzing, and interpretation of required data. These data were collected from two sources, primary and secondary. Primary data were gathered from two different sources, namely quantitative and qualitative data sources. Besides, quantitative data were collected through questionnaire survey method. Instead, qualitative data were collected from in-depth interviews, Key Informant Interviews (KIIs), Focus Group Discussions (FGDs), Participant Observation and Photography methods. These methods have been used for the triangulation of the opinion of the respondents (Table 3.2).

[1] ***Epistemology:*** how knowledge is derived or arrived at; the assumptions about how we can know the world (what can we know? How can we know it?).

[2] ***Ontology:*** the set of specific assumptions underlying a theory of system of ideas (what can be known?).

Table 3.1: Methodological Approaches Adopted for this Research

Research Approach	Name of Method	Applying techniques	Determination things
Quantitative data	Questionnaire method	The Questionnaire surveying on local coastal dwellers	The questionnaire survey method has been applied to ▪ Explore the people's perception about Climate Change Induced Disasters (CCIDs). ▪ Assess the social vulnerability index. ▪ Find out existing facilitating adaptation practices.
Qualitative Data	Key Informant Interviews (KIIs)	The KIIs checklist were conducted with local and national level governmental bodies and officials.	The KIIs checklist survey has been accelerated to formulate community based sustainable disaster management and promote modern technology based adaptation practices in coastal regions of Bangladesh. Besides, triangulation of others collected data.
	Focus Group Discussion (FGD)	The FGDs checklist survey was accomplished with community people at local level.	The FGDs checklist survey has explored the community opinion about different issues of the current study. It also helps triangulation of others collected data.
	Participant observation	Visual and Psychological assessment	The method helps to limit the severity and magnitude of disasters and level of damages of local resources. It also helps to identify the sectors that are more vulnerable than others.
	In-depth interview	The in-depth interviews checklist survey was done with local and national level expertise, though the expertise are non-government officials, freelance researchers, local elite and elderly people and so on.	The method enriches questionnaire collected data and also triangulation of others collected data. In addition, it explores existing CCIDs, their severity and magnitude, adaptation practices and helps to formulate community based sustainable disaster management.
	Photography	Visualized physical appearance of affected areas.	Imaging of different study areas and damages.

Source: Prepared by the Author, 2019

Table 3.2: Importance of Methods Applied for this Research

What?	Who?	Why?	How?
Questionnaire method	Coastal People	These people are directly affected due to climate change and collected personal opinion	Door to door survey
Key Informant Interviews (KIIs)	Key actors of state & non-state	These people are engaged with management and planning process and collected personal and institutional opinion and attempts	One to One interview after fixed the schedule
Focus Group Discussion (FGD)	Homogenous group of coastal people	These people are directly affected due to climate change and collected collective opinions and attempts	Maximum 10 coastal people engaged with each FGD
Participant Observation	Researcher physically observed the living condition of the coastal people	These people are directly affected due to climate change and realized the severity and magnitude of the disasters	Researcher physically visited the sampling areas and observed the daily lifestyle of the coastal people
In-depth interview	Key actors of local dwellers those who are experienced about disasters longtime	These people are knew about the Indigenous Knowledge or Local Knowledge	One to one Interview
Photography	Researcher captured the different events about the living conditions of the coastal people	Means of Verification (MoV) and showed the authenticity and witness of the study	Researcher captured the research objective based photos

Source: Prepared by the Author, 2019

3.2 Consideration of Research Questions and Objectives

The objectives of this research study are achieved using a chronological exploratory mixed method approach (Creswell, 2003, Mc Murray et al., 2004, Babbie, 1990). Another facet to consider when choosing appropriate research methods is the nature of the research questions and objectives of the study (Bryman, 2008). Yin (2004) classified research questions based on whether they are why‘, how ‘or what ‘questions in order to decide upon the use of quantitative or qualitative methods. Why ‘and how ‘questions are best answered over qualitative approaches whilst what ‘questions are

best answered through quantitative attitudes. The research methods used to answer the research questions and meet the research objectives of this study are presented in table 3.3.

Table 3.3: Research Methods Used for Research Questions and Objectives

Research Questions	Research Objectives	Research Method
What types of CCIDs occurred in the study area?	Investigate the climate change induced disasters and their spatial variation.	Owing to data triangulation, opinion clarification and authenticity, research has been conducted by the mixed method approach. So, researcher has used different data collection tools, for instance questionnaire as quantitative method as well as KII, FGD, In-depth Interview, Contributor observation and photography methods as qualitative methods.
What are the spatial variation of Climate Change Induced Disasters (CCIDs) in the study area?		
What are the present scenario of social vulnerability and their locational differences in the study area?	Assess the social vulnerability and their locational differences in the study area.	
What are the scenarios of existing adaptation practices in the study area?	Find out the existing adaptation practices and their regional variation in the study area.	
What is considered successful adaptation in line with CCIDs?		
How do the proposed strategies fit with the existing one for comprehensive climate change induced disasters management plan?	Formulate community based sustainable disaster management obtaining scientific and indigenous knowledge along with adaption strategy.	

Source: Prepared by the Author, 2019

3.3 Critical Literature Review

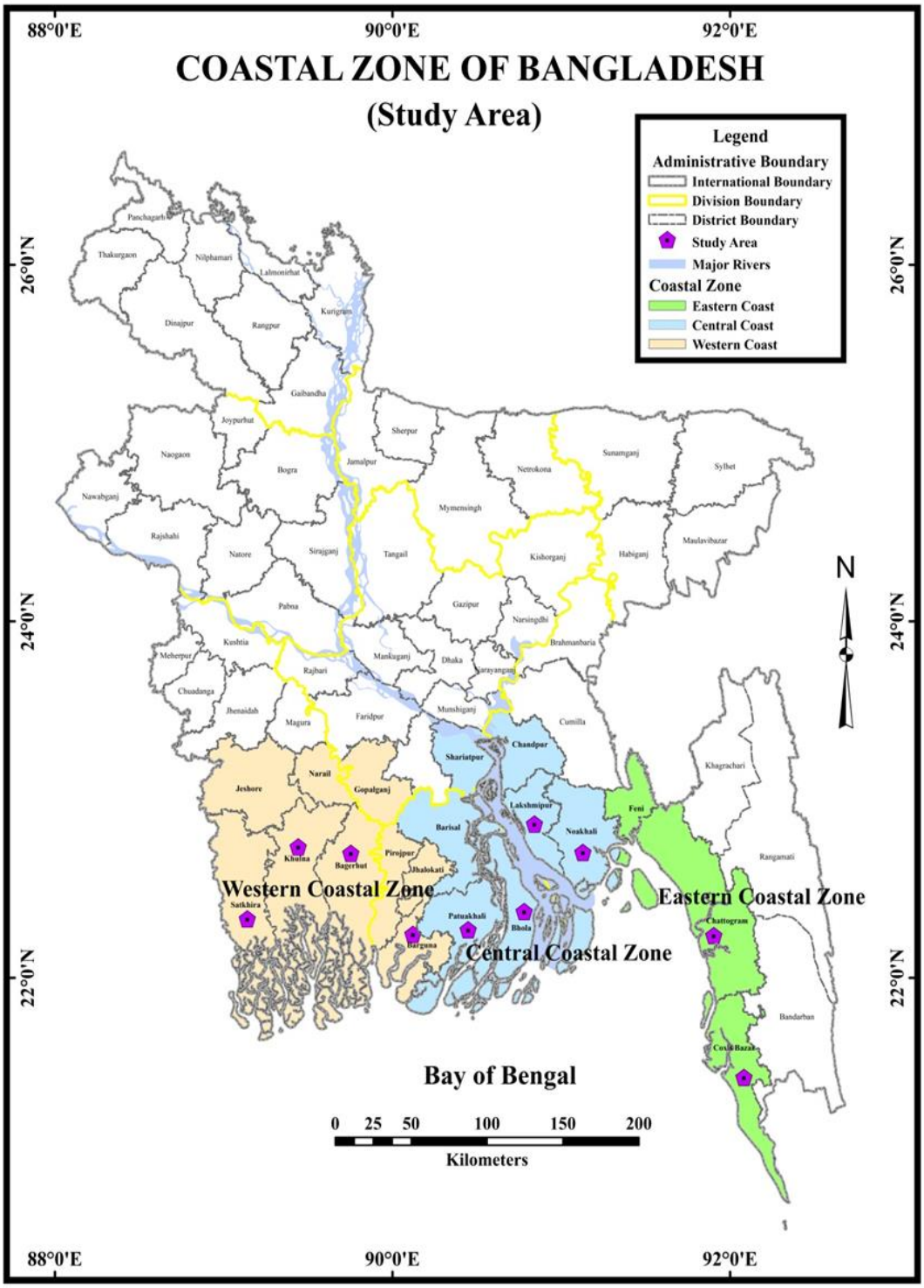
An integral part of every scientific study is the analysis of literature. Author conducted literature review survey about current research topic oriented problems from different Governmental autonomous bodies, institutes and concerning

department, academic institutions and departments, universities, departments and libraries, various research organizations, Non-Governmental Organization (NGO) and Google and Google scholar, etc. (Figure 3.3).

3.4 Selection of the Study Area

The selection of study area depends on their ability to illuminate the research questions in the study and their ability to collect comprehensive data (Yin, 2009). Climate change induced disaster is the recurrent and generalized hazardous phenomena in the coastal belt of Bangladesh but there is no universal uniform method for coast delineation in Bangladesh. There has a huge research gap. However, there are many criteria that can be chosen for delineating the coastal region, such important criteria are as follows; the extent of salinity, the extent of tidal activity, the extent of coastal activity, the extent of coastal morphology and coastal flora and fauna and the administrative and managerial criteria (Islam, 2004). The monotonous topography, shoreline geometry, coastal dynamics and biodiversity make the coastal belt of Bangladesh special. Geomorphologically distinguished by funnel-shaped, extensive river networks, powerful tidal and wind activity and massive river discharge laden with bed and suspended sediment (Islam, 2001). The Bangladesh coast is approximately 710 km long, (Snead, 1985) as determined by calculating the distance between the Indian and Myanmar borders around the Bay of Bengal. The total shoreline of Bangladesh can be thousands of kilometers long if the length of the tidal estuarine coast is considered. However, Citing from Pramanik (1983), Anwar (1993), Shamunnay (1997) and Ali (1999), Nazem and Mahboob, (1992), defined that Bangladesh's coastal area is broadly divided into three regions; (1) The Eastern Region , (2) The Central Region , (3) The Western Region, (Map-3.1). On the respect of physical importance, population density, economical importance, intensity of climate induce vulnerability around the coastal district of Bangladesh, It has considered the Ali's division of Coastal belt of Bangladesh as my study area.

Map 3.1: Location of the Study Area



Source: LGRD, 2018 and Field survey 2018-19

3.5 Research Follow Chart/Design

A research design/ follow chart is the plan for a study and the plan by which the approach is to be approved out. ”Research design refers to the overall strategy utilized to carry out research” (Creswell, 2014). A flow chart is a figure showing movements and actions in a complicated system. The methods and procedures for data collection, calculation and analysis are defined in the research design. It is a blueprint that outlines each procedure from the hypothesis to the analysis. The following figure 3.1 illustrates the follow chart/design of methodology of this research. So, the research has been conducted by the following research follow chart/ design with followed the research objectives.

Figure 3.1: Follow Chart of Research Methodology

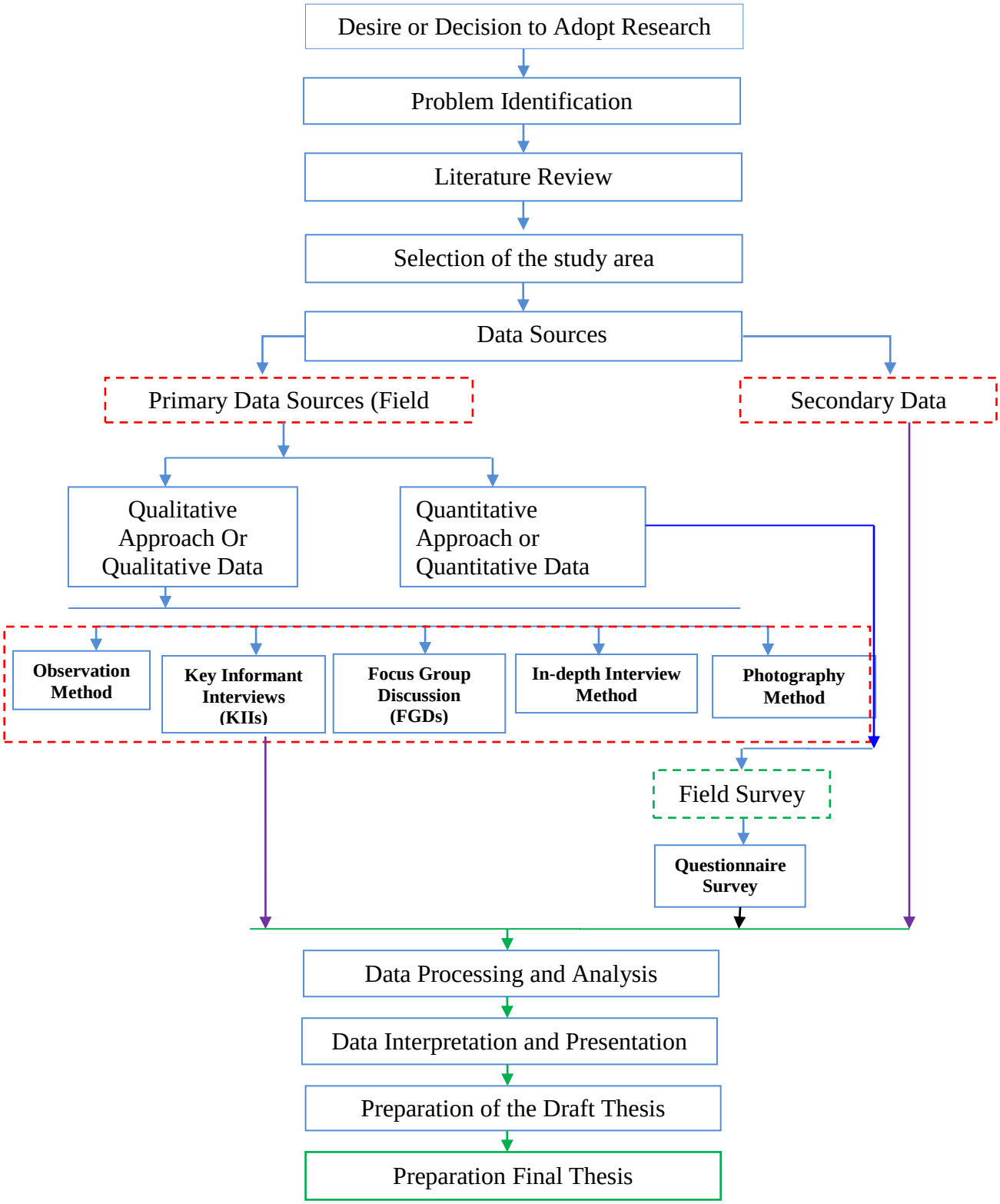


Table 3.4: Research Methods Corresponding with Research Objectives

Research Objectives	Data sources	Action Taken
Investigate the CCIDs and their spatial variation in the study area.	***Secondary sources*** Literature relevant sources. ***Primary Sources*** Questionnaire survey KIIs FGDs In-depth Interviews Participant Observation	Relevant literature has been collected from authentic relevant secondary sources. Besides, questionnaire and checklist survey from targeted stakeholders.
Assess the social vulnerability and their locational differences with comparison in the study area.	***Secondary sources*** Literature relevant sources. ***Primary Sources*** Questionnaire survey KIIs FGDs In-depth Interviews Participant Observation	Relevant literature has been collected from authentic relevant secondary sources. Besides, questionnaire and checklist survey have been from targeted stakeholders.
Find out the existing adaptation practices and regional variation in the study area.	***Primary Sources*** Questionnaire survey KIIs FGDs In-depth Interviews Participant Observation	Data have been collected through questionnaire and checklist survey from targeted stakeholders.
Formulate community based sustainable disaster management obtaining scientific and indigenous knowledge along with adaption strategy.	***Primary Sources*** KIIs FGDs In-depth Interviews Participant Observation	Data have been collected through checklist survey from targeted stakeholders.

Source: Prepared by the Author, 2019

3.6 Sources of Data

There are two types of data sources gathered for data compilation such as primary and secondary data.

3.6.1 Primary Sources of Data

Basically, current research is based on primary data sources, but for problems identification or the rationality of study somewhat secondary data were used.

The present study has been carried out from January 2018 to April 2019. Mainly primary data sources were divided into two approaches such as qualitative and quantitative.

3.6.1.1 Qualitative Data

Qualitative data[3] help to measure the qualitative characteristics of the particular problem in this study. Qualitative data were collected by five methods such as Participant Observation, in-depth interview, KII (Key Informant Interviews), FGD (Focus Group Discussion) and Photography methods.

i. Participant Observation Method

Contributor observation method was the first method used for collecting qualitative data and it was done in physically by the researcher. This method helped to gather primary information about the study area. Observation method helped not only to inspect the study area but also to visualize the existing vulnerable conditions of the social and cultural infrastructures. Participant observation was done for close monitoring the damages of resources of coastal people in coastal areas.

ii. In-depth Interview Method

In-depth interview[4] was another familiar method for collecting qualitative data and researcher physically done this. Multi-sectoral autonomous bodies such as non-governmental bodies, journalists, social workers, political leaders, civil society and individuals were involved in the formation, development, management and planning process activities in coastal areas of Bangladesh. After selecting expert groups for conducting in-depth interview, address and cell phone number of the respondents have been collected. Before conducting the interview, the researcher tried to fixed schedule with expertise for taking the interviews. For conducting the in-depth interview, a checklist have been prepared through selective questions related to conducting research work (Appendix -I). To operate research work, six groups consist of ten experts, ten professionals, five policymakers, fourteen public representatives, ten academicians, and eight journalists were considered as follows:

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[3] Qualitative methods can be used to explore substantive areas about which little is known (Stem, 1980) like people's lives, experiences, behaviors, emotions and feelings (Strauss and Corbin, 1998).

[4] In-depth interviewing involves asking open ended questions, listening to and recording the answer and then following up with additional relevant questions.

- Climate Experts – 10 (National level, will considered the government and NGO expert)
- Professionals -10 (National level – ICCCAD, BCAS, YPSA, UNDP, C3ER, ULAB, COAST Trust, SUSILON and so on.
- Policymakers -5 (National level)
- Public representatives -14 (one the basis on survey areas: locally)
- Journalist -8 (eight study areas: local and nation newspapers)
- Academicians – 10 (Regional and nation level: University- CU, DU, JU, NSTU, KU, and JSTU.

iii. Key Informant Interviews (KII)

In this technique, the researcher carefully conducted ten (10) Key Informant Interviews on different expert level, for instance Deputy Commissioner (DC), Upazila Chairman, Upazila Nirbhahi Officer (UNO), Upazila Project Implementing Officer (PIO), Union Chairman and Member, Freedom Fighter, Teacher, Imam of mosque. These types of expert were directly involved with rehabilitation programs and duty bearer in coastal areas of Bangladesh. Total nine (09) selective questions have been asked of every expert during KII survey through interview process (Appendix-II).

iv. Focus Group Discussion (FGD)

Total twenty FGD was conducted in three coastal areas (Appendix-III) which shows the complete information of every FGD in the study area.

v. Photograph Method

A number of photographs were captured for visual presentation of the severity and magnitude of recurrent disaster in study area.

3.6.1.2 Quantitative Data

Quantitative data[5] were helpful to measure the quantitative variables or characteristics of coastal disturbances in the whole coastal areas.

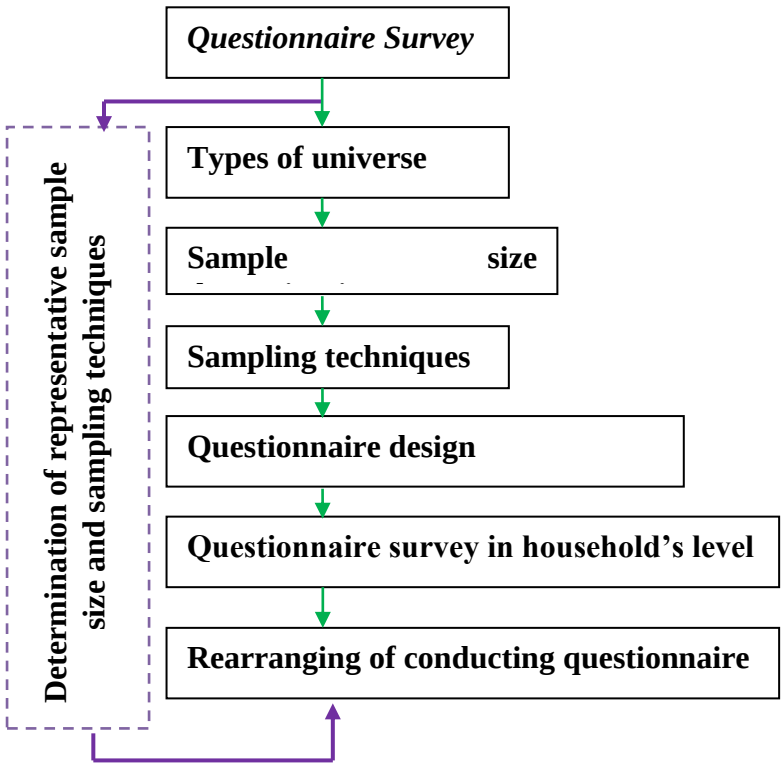
Questionnaire Survey

Questionnaire survey method is very much popular for collecting quantitative or

[5] Quantitative data are obtained when a quantitative variable is measured on each experiment unit.

numerical variables or data. A questionnaire was prepared before going to the study area. However after completing the observation and in-depth interview surveys, question pattern had been rearranged on the questionnaire with concerned my supervisor (Appendix-IV). Firstly, a questionnaire was prepared in English, but for better understanding of the respondents this was translated into Bengali during conducting at household's level. After gathering the whole questionnaire with every answer was translated from Bengali to English for final attachment in this thesis. Following procedure (Figure- 3.2) was followed during questionnaire survey.

Figure 3.2: Methodological Framework of Questionnaire Survey



Determination of Representative Sample Size and Sampling Techniques

The researcher has the careful determination of representative sample size and sampling techniques. For determination of representative sample size and sampling techniques, I have followed following things such as

i. Types of Universe

Types of the universe[6] are the first steps in developing sample design to clearly define the set of objects to be studied. Questionnaire survey method was used for investigating the perception of coastal people about the CCIDs and their impacts on local resources and also find out the existing adaptation practices in the coastal areas of Bangladesh. A questionnaire survey was done in total 19 administrative districts around whole coastal region of Bangladesh. According to literature review and definition of coast, 19 administrative districts are considered the coastal district which districts are directly response to the climate induced disasters. For determination of the universe, I have determined the population sizes of the districts. Total number of households in 19 selective coastal districts was 8421000 and total population was 38526000 (BBS, 2013) (Table 3.5). For determination of the sample size, I have consulted with academicians, researcher and planner.

Sample size Determination

Types of the universe were selected after the collection of total population structure in three coastal belt of Bangladesh. After collecting the population data and made data sheet on coastal zone wise then researcher has developed a source list or sampling frame. The sampling frame (Table 3.5 and Table 3.6) was helpful in the selection of sampling procedure. The sample size has been chosen on the respect on statistical considerate method which was proposed by Islam in 2014 (Appendix- IV).

$$n_0 = (\frac{z^2 pq}{d^2})$$

Where, $\mathbf{n}_0$ = desired sample size.

z = standard normal deviate usually set at 1.96, which corresponds to the 95% confidence level. (z = 1.96)

p = assumes proportion in the target population estimated to have a particular characteristic. (p = 0.5)

q = proportion of the opinion of population. (q =0.5)

d = acceptable maximum error in estimating a population proportion. (0.05)

[6] Types of universe can be finite or infinite. In finite universe the number of items is certain but in case of an infinite universe the number of items is infinite. The population of a city is finite or the number of stars in the sky is infinite.

Table 3.5: Sample Selection for Questionnaire Survey among Wards on the Basis of Desire Sample

Coast of Bangladesh		**No. of Household ('000)**	**No. of Population ('000)**	**Sample Size**	**No. Of Districts**
Zone-I	Western	2862	16997	170	**9** (Satkhira to Borguna)
Zone-II	Central	3333	10186	102	**7** (Barisal to Feni)
Zone-III	Eastern	2226	11343	113	**3** (Feni to Cox's Bazar)
Total		8421	38526	385*	19 Districts

Source: BBS, 2013

Table 3.6: Sample Selection for Questionnaire Survey among Wards on the Basis of Desire Sample (in details)

Coast of Bangladesh		**Sample Size**	**No. Of Districts**	**Study Area**	**Tentative sample**	**FGD (homogenous group)**	**In-depth Interview/KII**
Zone-I	**Western**	170	**9** (Satkhira to Borguna)	Satkhira	44	2	Climate Expats - 10 Professionals -10 Policymakers -5 Public representatives -14 Journalist -8 Academician - 10
				Dacope /khulna	44	2	
				Bagherhat	44	2	
				Borgana	44	2	
Zone- II	**Central**	102	**7** (Barisal to Feni)	Patuakhali	30	2	
				Bhola	30	2	
				Noakhali	30	2	
				Laxmipur	30	2	
Zone-III	**Eastern**	113	**3** (Feni to Cox's Bazar)	Chattrogram	60	2	
				Cox's Bazar	60	2	
Total		**385***	**19**		**416**	**20**	**55**

Source: Compiled by the Author, 2019

[a] sample size: sample size has been redistributed on the respect on district population.

***385**: According to Islam, 2010: Research Methodology; He postulated that 385 sample sizes were representing the fifty (50%) percent population of any total population.

[a] Sample size will be selected by the Stratified random sampling, (Islam, 2010). Stratified Random sampling measured by the following method:-

Desired samples were selected by on the formula. Sample size **was** selected by the random sampling, (Islam, 2010). Random sampling was measured by the following method,

$$\text{Random sampling, } Nj = (\frac{n}{N})Ni$$

Where,

Nj = represents the sample size
N = total population size, (N = ni + nii + niii +……+ nn)
Ni = population size
n= desired Sample Size

For example,

$$\text{Zone-1 (Western)} = (\frac{\text{Desire Sample size}}{\text{Total Population}}) \times \textit{AreaPopulation}$$

$$\text{Zone-1 (Western)} = (\frac{385}{38526000}) \times 16997000$$

$$\text{Zone-1 (Western)} = 170 \text{ (Desired Sample Size)}$$

ii. **Sampling Techniques**

After the determination of representative sample size, I have chosen Random Sampling techniques on the basis of the types of universe. Random Sampling Techniques (RST) were adopted successfully for operating of 400 questionnaires at a household level in local coastal dwellers in three coastal zone in Bangladesh.

iii. **Questionnaire Design**

A questionnaire was designed in three sections and approximate thirty five leading questions that were asked of each respondent includes socio-economic and demographic information of the costal dwellers: question number 11. Climate Change Induced Disasters (CCIDs) related questions were 6; vulnerability of social sectors related questions were 18 respectively (Appendix-IV).

iv. **Questionnaire Survey in Household's Level**

To collect field level data, a semi-structured questionnaire was created. A total of 400 questionnaires in three coastal zones were performed. According to Islam, 2014, 385 sample sizes or questionnaire represent 50% of any population structure. Due to time and budgetary constraints, I completed 400 samples those represented total 52% population of coastal dwellers in three

coastal areas. During the questionnaire survey, the householders were considered for conducting the questionnaire survey. In a special case, when householders were absent that time interviewee was considered second householder for conducting surveys. Those were the householders' wife or his elder son/daughter.

v. **Rearranging of Conducting Questionnaire**

After completing the questionnaire survey, it was essentially needed to re-edit and re-code of operating questionnaire. Some coding was omitted and some new coding was added in operating final questionnaires.

Table 3.7: Source of Primary Data

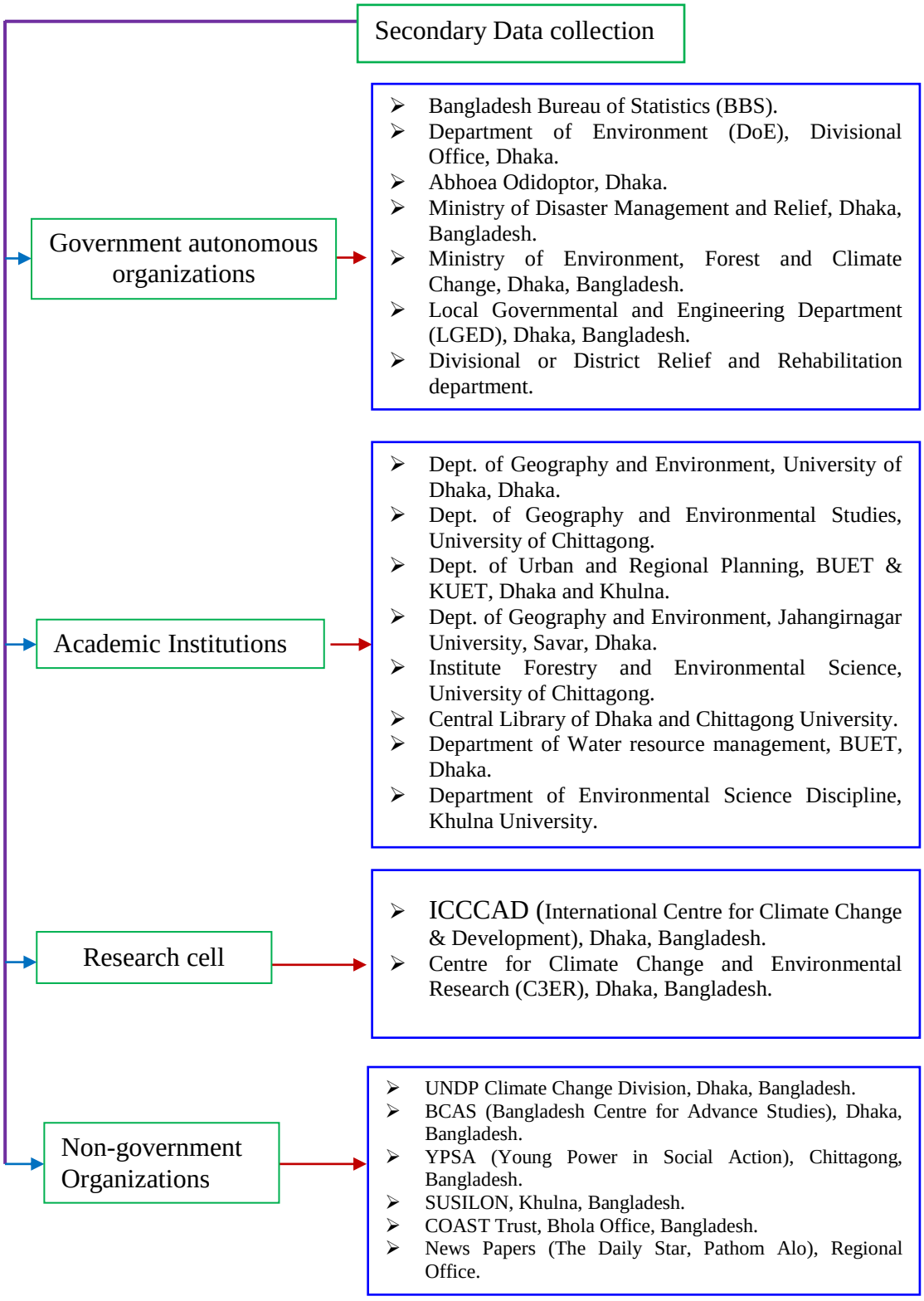
Data types	Methods	Source	Level
Qualitative Data	Key Informant Interviews (KII)	Formal or Institutional based (government Officials)	Total 10 KIIs were conducted with the expert and decision makers' levels.
	Focus Group Discussion (FGD)	Field based	Total 20 FGDs were done at 10 coastal points among three coastal zones.
	Participant Observation	Field based	Climate Change Disaster affected communities in the study area
	In-depth Interviews	Informal based (Non-government Officials)	Total 50 In-depth Interviews were conducted with the local and national level expertise.
	Photography	Field based	At whole study area
Quantitative Data	Questionnaire survey	Field based	Total 400 Coastal dwellers were interviewed at their household level in the study area.

Source: Compiled by the Author, 2019

3.6.2 Secondary Sources of Data

Local authorities, universities. Government and non-governmental organizations and some renowned research cells have gathered important secondary information o climate change induced disasters (CCIDs) and current adaptation practices.

Figure 3.3: Different sources of secondary data



Climate Change Induced Disasters (CCIDs) related findings, papers, journals, books, magazines, newspaper, and other recent publications and Internet were reviewed. Also, intensive care was taken regarding the applicability, reliability and validity of the collected information. The above chart includes all types of secondary data sources. However, secondary data has been collected into two sources, these are as follows;

Secondary Data from Primary Sources (first hand source)

This data have been collected from particular organization such as Space Research and Remote Sensing Organization (SPARRSO), SAARC Meteorological Research Center (SMRC), Dhaka Meteorological Organization (DMO), Abhoea Odidoptor, Dhaka & Regional Abhoea Odidoptor Office (Branch Office).

Secondary Data from Secondary and Tertiary Sources (second and third hand source)

Various types of qualitative and quantitative data/information has been collected from books, published journals and articles, newspapers and different types of ideas from different universities, research organizations, Govt. and NGOs offices and national & international organizations.

3.7 Data Processing and Analysis

Qualitative and quantitative - primary and secondary nature-were the data obtained from field surveys and secondary sources. These data were sequentially amended, coded, categorized and tabulated.

Editing

A lot of qualitative and quantitative data were gathered for finding out the proposed solutions measures in a particular problem. In respect of current aim and objectives I have carefully edited the collected data. This task helped not only to build a structural framework of essential data, shaped of final data, data consistency, accuracy and homogeneity, but also helped with the omitted miscellaneous or less important data before starting interpretation activities.

Coding

Meaningful data were coded for convenience of interpretation with the help of

familiar statistical tools and techniques. Nature of data classified into two categories such as data view and variables view. Data view represented the numerical or quantitative nature and variables views were represented nominal or qualitative nature.

Classification

After coding of consequential data, all the results were classified data on the respect on objectives, the nature of the data (qualitative and quantitative), data homogeneity, common characteristics and related issues oriented of the current study.

Tabulation

After classification, essential data were summarized & placed in a table (i.e., in the form of statistical tables) for final analysis. Tabulation and data processing were done by both manual and computer technique software with the help of MS Excel and Statistical Package for The Social Science (SPSS: version-20). Tables, maps, graphs, diagrams, figures and images, etc. have been analyzed and presented with the help on the above mentioned software and techniques.

3.8 Data Analysis and Interpretation

Data analysis and interpretation were depending on the nature of data. Both qualitative and quantitative data were used for finding proposed a solution about sustainable management of Climate Change Induced Disasters (CCIDs) and strengthening existing adaptation practices in three coastal zones in Bangladesh. Qualitative data were explained with the assist of two theories such as-

1. Grounded theory; and
2. Narrative Analysis.

Grounded theory uses the inductive approach which relies on observations to develop understandings or empirical phenomena and ultimately aims for construction of substantive and formal theory (Lindbcrg, 2000; Grbich, 2007). Grounded theory is now a widely used framework for analyzing qualitative data in the social sciences and a methodological literature has developed to accompany its use (Anncllls, 1996; Barnes, 1996; Benoliel, 1996; Strauss and Corbin, 1997 incited Paul, 2009).

Narrative is both a mode of representation and a mode of reasoning, shaping our perceptions of ourselves and impacting our lives, culture and society in general

(Richardson. 1990; Betger, 1997). Narrative analysis is a valuable tool for geographers and others who are striving to interpret the 'in place' experiences of different individuals and groups, and how they understand and attach meaning to situate experiences, and produce the places in which their experiences occur (Wiles *et al,* 2005 incited Paul, 2009).

3.9 Chi Square (χ^2) Test

For statistical analysis of probability sampling or justification of hypothesis, the research has been prudently applied chi-square test. Following equation has been used for determination of the chi-square test.

$$\chi^2 = \Sigma \frac{(O-E)^2}{E}$$

Where, O means the total number of observation or sample size or observation value and E means the expected value.

For statistical clarification, the null hypotheses *(H_o)* were adopted for determining the relationship between 'climate induced disaster and coastal livelihood, mainly conditions of social safety net programs, health care facilities & communication system (road)' in the coastal regions of Bangladesh. In addition, the age structure of the respondents is an important variable for articulation and clarification of the problem, in particularly issues related to climate change, since the average weather conditions of 30 to 40 yeare reflect the climate state in any region. So, the from those individuals who are more than 30 years old, the study strictly considered respondents.

3.10 Weightage Scale Analysis for Satisfaction level of Coastal People

After the result datasheet has been found, according to the desired questionnaire than we applied Likert scales method (Vagias, 2006) that is common ratings format for surveys. The comparative study of the livelihood scenario and living status of displaced people between before and after displacement have been determined by Likert scale technique and the format of a typical five-level Likert item is: **1.** Strongly disagree, **2.** Disagree with, **3.** Neutral, **4.** Agree and **5.** Strongly agree.

The authors rate the weight rating as 3 as result of respondent argument, primarily in Strongly Dissatisfied Below 3, Neutral 3.00 and Strongly Satisfied Above 3.

3.11 Vulnerability Index

In measuring human vulnerability at different scales, hazard researchers have used a large number of variables because many of these variables are strongly correlated; most of these researchers have developed a composite measure of vulnerability in general and social vulnerability in particular. The social vulnerability is a relative measure of the overall social vulnerability for each study area. In this research quantitative technique will be used as composite indicator framework method and it will be employed to determine the factors influencing the household's vulnerability based on the vulnerability index developed. Health, factors, education factors, physical infrastructure factors, government activities factors, demographic and geographic factors, dependence on agricultural factors have been built with the vulnerability index. Based on these sectors have been generated with determination of minimum and maximum values (limit values) for each indicator to transform them into directories with values between 0 and 1. The values close to 1 denote increased vulnerability, as opposed to those closer to 0, which denote less vulnerability in the region (Cutter, et al, 2003). The basic calculation is based on the following method:

Formula: $$\text{Indicator Vulnerability index} = \frac{\text{Xi - Xmin}}{\text{Xmax - Xmin}}$$

Where Xi= original value for the community/ Actual value.
Xmin = the lowest value of the community/ Minimum value.
Xmax = the highest value of the community/ Maximum value.

Formula:

$$xij = \frac{Xij - {}_{i}Min\{Xij\}}{{}_{i}Max\{Xij\} - {}_{i}Min\{Xij\}}$$

Where,

xij ……. Actual dimension

${}_{i}Min\{Xij\}$…….. Minimum values

${}_{i}Max\{Xij\}$ **…..** Maximum values

Formula

$$\text{Indicator Vulnerability index} = \frac{\text{Xi - Xmin}}{\text{Xmax - Xmin}}$$

Where Xi= original value for the community/ Actual value.
Xmin = the lowest value of the community/ Minimum value.
Xmax = the highest value of the community/ Maximum value.

It is clear that all these scores will lie between 0 and 1. The value 1 will correspond to that region with maximum value and 0 will correspond to the region with minimum

value. The values close to 1 imply increased vulnerability, as opposed to those closer to 0, which have less vulnerability in the region.

The Vulnerability Index is Constructed for the Six Measurements:

Health: Health is important issue to adopt with climatic disaster. Inadequate health results in people being less able to handle with disasters, at least in the short term. Households caring for the sick has less time, money and energy to mitigate the impacts of extreme risks. In terms of cause and effect disease and poverty are closely linked. The percentage of the population not eligible to health services is the variable used.

Education: The less educated are more vulnerable to climate risk by geographical location and quality of life. They have little participation in politics and tend to rely on economic activities associated with climate, such as agriculture. Furthermore, adaptation is sometimes associated with conflicts of interest, people with more education are in a better position negotiate equitable solutions (Cutter et al, 2003). Education levels play a crucial role in decreasing social vulnerability due to climate change.

Physical Infrastructure: Transport and communication systems, infrastructure and the settlements determine the physical vulnerability to extreme events, because rain, floods and storms have differentiated effects on the territory. The variables used in the percentage of private homes do not have a public water supply.

Government Activities: State organizations stimulus the level of vulnerability. Their inefficiency or corruptions are linked with a lack of adequate health care. In this sense, we used the National Index of Corruption and Good Governance 2014 by Transparency Bangladesh, which measures the corruption affecting households and maintains a record of corruption in public services which are offered by the levels of Government (State, Region and Municipal) and private firms.

Demographic and Geographic Factors: Coastal or Low-lying areas are more vulnerable to flooding from extreme rainfall events associated to higher altitude regions. The selected variable is population density, because high densities are related with amplified risk of illness due to certain natural disasters, the result of pollution of

water supplies with human waste and the proximity of individuals to each other, which simplifies the blowout of disease.

Dependence on Agriculture: Associated with climate variability and change drought is one of the main risks. The main climate-sensitive economic activity is agriculture in most parts of the world. It contains percentage of population employed in livestock, forestry, fishing, hunting mining and agriculture.

3.12 General Characteristics of the Respondents

Age structure and duration of living of the respondents are fundamental issues of this research work. Because 'Age Structure' helps to represent the strength about the actualities. That's why; above 30 years of the age structure of the respondents was selected. This age structure makes it easier for people to express and explain the topic o climate change related problems. In other words, 'length of life' means the validity of the response given by respondents. Because the average weather conditions for 30 to 40 years reflect climate change in any region.

3.13 Reliability and Validity

The credibility of the findings in a research project lies in the reliability and validity of the data collection and analysis process undertaken (Maxwell, 2005, Maykut and Morehouse, 1994, Yin, 2009). Reliability and validity were assured by choosing a sample population that was from various different organizations, coastal communities of Bangladesh. Using the mode of the data to select critical propositions enabled the reflection of the majority views of the sample population. Reliability refers to minimizing errors and biasness in research studies allowing the attainment of the same or similar result if the test was repeated (Yin, 2009). Validity refers to the credibility of the results obtained (Yin, 2009). Maxwell (2005) suggests validity and reliability to be assured through techniques such as long-term data collection via in-depth interviews, FGD and from the organizations about the data collected and results obtained from the participants as well as other expert validators and triangulation, where data is collected from multiple sources. The findings were further validated by incorporating the explanatory comments provided by the respondents. The restriction placed in the survey so that respondents were only able to respond to questions in areas where they had experience and expertise in also ensured the reliability of the data. This research study used all of the above techniques to ensure reliability and

validity of data in the qualitative phase. Further validation of data was achieved in the quantitative phase conducted following the qualitative phase.

3.14 Referencing

In this research, author strictly followed the *"Harvard Referencing Style"* to acknowledging the sources of information and ideas that he has used in his research.

3.15 Philosophical Challenges

Evaluation, as applied analysis, helps to create information to account for the services used and also to add to expertise to minimize the failure of future programmes (Clarke, 1999). While the methodology for development evaluation has grown since the 1970s with the introduction of the OECD criteria, it is fascinating to note that evaluation of gentle action does not have a methodology of its own. It relies on the social science methodology. This lends itself to philosophical questions which are dominant in social science research - about what assessment is, whether it is a science or art and what constitutes as knowledge in evaluations. These questions are significant if teaching learned from gentle evaluations is to add knowledge in construction disaster adaptation.

The design and implementation of evaluation process is based on certain assumptions regarding the nature of knowledge, reality and existence. Clarke (1999) identifies four key elements to knowledge construction. Firstly, there are issues surrounding the methods and procedures such as data collection and analysis techniques. Secondly, there is need to consider general methodology, which relates to the overall logic of inquiry and the general principles by which research tools and techniques are applied. Thirdly, there are questions on ontology, which are concerned with the being and nature of reality. Finally, there are questions of epistemology, which are concerned with knowing and nature, and limits of knowledge. The first two are alarmed with the sensible aspects of knowledge building while the later on consider the philosophical assumptions fundamental research and perform.

There are two main 'world views' to theory development, positivism and subjectivism. Central to the debate of these two (deviating) paradigms are the relative merits and demerits of each of them. The positivist paradigm takes an epistemological position known variously as traditional, conventional, scientific, experimental, (Bryman, 2008), empiricist and hypothetic-deductive. The subjectivist approach takes an epistemological position known variously as naturalistic, humanistic,

constructivist, interpretivist, post positivist, holistic-deductive and alternative (Clarke, 1999). The positivist paradigm tends to adopt the quantitative methodology while the subjectivist tends to adopt the qualitative methodology. This study did not take a pedant one-sided view of either positivism or subjectivism. Methodological appropriateness (Patton, 2002) was adopted to increase the concrete and practical methodological options that were available. Moreover Selection of data collection and analysis techniques, choose the research methodology and methods, prove the reality of the research, source of availability of real knowledge/ data and information about the proposed research work, create the knowledge on unknown mater, prove the logical clarity of my thinking about the research work was main the philosophical challenge to conduct the research. Finally, for specific example of the application of this methodological structure and its underlying philosophy, however has been illustrated in the early section of research follow chart/design of the present study (vid. Figure 3.1).

3.16 Ethical Considerations

Adhering to and considering ethical boundaries when collecting data is important to uphold the integrity of research findings (Maxwell, 2005). Since this study was mainly based on the primary and field survey, so all measures were taken to inform the respondents / stakeholders about the aim and objectives of this ongoing study especially;

- I wrote a letter and the letter was certified from honorable chairman and supervisor of my department about me for data provider of different institutes, departments and research cells and I showed this letter before meeting with the authorities.
- I informed government related ministry, division and department to need secondary information and ethical approval for my research work by formal consent letter, this latter recommended by the chairman of the department and of my supervisor.
- I told Upazila, Union Chairman and ward commissioners, and also every expert about my research before conducting checklist survey.
- I talked to my every respondent about aim and objectives of my research before doing the questionnaire survey on household's level before conducting the questionnaire. Often respondents avoided conducting a questionnaire for an interview or the midpoint and they said they were busy stopping conducting

the questionnaire for that time and further selected fresh respondents with the new questionnaire.

- Sometime respondents asked the question ‘what benefit from doing this’ that time I said firstly it helped to get my award or degree and secondly conducting research, explore behind the reasons and author informed concerned authority for taking proper management and planning and further it helps to take future planning, policy adopt for the sustainable management of existing adaptation practices and applied modern technology to reduce the severity and magnitude of CCIDs.

- I have carefully and clearly acknowledged of all experts, authors, scientists, departments, institutes and organizations and their quotations, ideas, speech, methods and techniques in this research those were cited in my research.

- Systematic research procedures (Figure 3.1) were fully followed and obliged during the study period and for any inconvenience necessary alterations were made to the study dimension discussing with my supervisor.

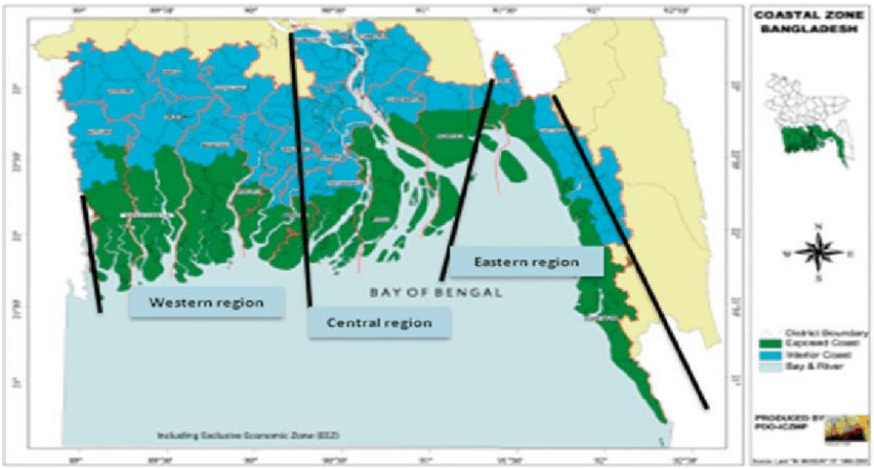
3.17 Description of the Study Area

On the northern border of the Bay of Bengal, Bangladesh is a tropical maritime nation. The coastal region lies between latitude 21° to 23° north latitude and 89° to 93° east longitude. The coastline is approximately 710 kilometres long and the coastal zone covers an area of about 2.85 million hectares, representing 23 % of the total area of the country (UNFCCC, 2002). Offshore islands, mudflats, chars and new accretions are comprised of the coastal region. The coastal areas of Bangladesh are densely populated because of the large population (140 million) in a very small country (147 570 square kilometers). There are over 35.10 million people living here. Due to the geomorphology of the area, the coastal zone is particularly susceptible to tropical storms and tidal surges which occur frequently in the Bay of Bengal. These natural calamities ravage the area almost regularly and are considered the greatest hindrance to the development of the region and the country as a whole. For this reason, mangroves as coastal shelterbelts are considered most important for the country. Major disasters include the flood, cyclone, water logging and so on. There are more than 300 islands in this country out of which 186 are documented. These islands are inhabited by thousands of people whose

livelihood is solely dependent on the coastal environment and influenced by climate change. A delta of flood plains, Bangladesh is a land of rivers and canals. From north to the south the country slops gently and meets the Bay of Bengal, at the southern end. The entire coast runs parallel to the Bay of Bengal, forming a coastline that is 710 km long (CZPo, 2005). According to the Government of Bangladesh's coastal zone policy (CZPo, 2005), 19 out of 64 districts are in the coastal zone, covering a total of 147 upazillas (Map -1) of the country. Of these 19 districts, only 12 districts are directly linked to the sea or lower estuary.

The coastal zone occupies 47,201 square kilometers of land, which is 32 % of the country's total landmass (Islam, 2004; p. xvii). The area covered by water includes 370.4 km (200 nautical miles) of coastline (UNCLOS, 1982; Article 57), estuaries and inland river waters. It also treats the Exclusive Economic zone (EEZ) as a maritime zone of its own. The southern part of Bangladesh comes under the coastal region, where many rivers, including the Ganges-Brahmputra-Meghna (GBM) river system, are discharged, forming one of the world's most active ecosystems. All parts of the coastal region, except Chittagong-Cox's Bazar, are plain land with extensive river networks and accreted land, known as char land in Bangladesh. India is on the western side of the area, while Myanmar is on the eastern side of the coast.

Map 3.2: Costal Belt of Bangladesh



Source: Islam, 2001

3.17.1 Geomorphology of Coastal Bangladesh

Bangladesh's coastal geomorphology of is distinguished by its funnel shaped, vast river network, heavy tidal and wind activity and immense bed-laden river discharge,

and suspended sediments. The application of remote sensing techniques has promoted the understanding of coastal geomorphology and coastal processes over the last 20-25 years (e.g. Paramanik, 1983, Jabber,1979,1992, Ali, 1999). Ali (1999) divided the coastal belt of Bangladesh into three separate regions, namely, the Eastern Region, the Central Region and the Western Region based on the information available (Map 3.2)

The eastern area consists of a small strip of plain land between the ChittagongHills and the sea, along with the Halda, the karnafully and the Sangu Rivers the flood plains. This coast is normal, unbroken and not very prone to erosion (Mofizuddin, 1992), and is covered by mudflats and submerged sand along the shore. Sandy beaches, coastal dunes and mudflats are significant geomorphic landforms (Umitsu, 1997). A long sea beach, most popular, worthwhile and attractions of the world, the cox's bazaar sea beach, a continuous strip of sand has developed.

The central region occupies the tidal plains of the Meghna estuary covering the districts of Patuakhali, Bhola, Barisal, Chandpur,Sariatpur, Madaripur, Laxmipur and Noakhali. The coastline is most irregular, highly broken and consists of a series of Islands (*char*) formed by the deposition of sediment. Some of these *char* are less than 30 years old; the older part of Sandwip, Hatia and Ramgati *char* are in parts as much as 200 years old (FAO, 1988).

The western area is composed of the greater Khulna and part of Patuakhali. The shoreline, it is in general, transverse to the continental margin structure. The region is relatively stable, largely covered by mangroves forests, and the tidal rivers and tidal creeks are distinguished by crisscrossed pattern. Tidal flats, mangrove swamps, natural levees, sandy beaches, dunes and beach ridges are important geomorphic characteristics (Khan, 1990; Umitsu, 1997).

The major features of the coastal morphology are diverse and specific to areas. Ali (1991) describes that the coastal zone in Bangladesh has low coastal bottom topography and land topography with a large network of rivers, tidal channels and streams. He also said that these rivers supply a large amount of sediments. The Swatch of No Ground plays a enormous role in the coastal environment of Bangladesh. The coast is open to the sea through a funnel shaped region.

3.17.2 Coastal Climate

With the Bay of Bengal and Indian Ocean to the south and the Himalayan and Arakan mountain ranges to the east and north respectively, Bangladesh is situated I the heart

of the South Asian monsoon zone (Ali, 1999). Bangladesh's low-lying coastal zone of is highly vulnerable to both the usual tidally enhance monsoon floods and the frequent effects of tropical cyclones.

3.17.3 Temperature

Maximum Temperature

Table-3.9 describes the monthly daily maximum temperatures (°C) of 17 BMD observatories. The magnitudes of typical peak temperatures in April and May are are found to be very close to each other. At Patuakhali, it is equal. In April, it is the highest at Barisal, Bhola, Feni, Jessore, and Maijdi Court. In all locations, it is the lowest in January.

Table3.8: Monthly Average Normal Maximum Temperature (°C) for Different Observatories of BMD (1981-2010) in the Coastal Region of Bangladesh

Month / Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Barisal	25.5	28.5	32.4	33.5	33.4	32.0	31.2	31.4	31.7	31.7	29.8	26.8
Bhola	25.6	28.5	31.9	33.0	32.9	31.7	30.8	31.2	31.4	31.7	29.8	26.9
Chandpur	24.6	27.9	31.7	33.1	33.2	32.2	31.5	31.8	31.8	31.6	29.5	26.2
Chittagong	26.0	28.3	30.8	31.9	32.4	31.7	31.0	31.4	31.8	31.7	30.0	27.2
Cox'sBazar	27.1	29.1	31.5	32.7	32.8	31.2	30.5	30.8	31.5	32.0	30.6	28.1
Feni	25.7	28.3	31.3	32.2	32.3	31.3	30.6	31.1	31.5	31.5	29.8	27.0
Hatiya	25.3	27.9	30.9	32.1	32.2	30.9	30.1	30.5	30.9	31.0	29.3	26.4
Jessore	25.5	28.9	33.4	35.8	35.4	33.8	32.6	32.7	32.9	32.5	30.3	26.9
Khepupara	25.8	28.7	31.8	32.8	32.9	31.5	30.7	30.8	31.1	31.3	29.6	26.9
Khulna	25.4	28.8	32.9	34.7	34.7	33.2	32.0	32.2	32.4	32.1	29.9	26.6
Kutubdia	25.6	27.5	30.1	31.8	32.3	31.0	30.3	30.7	31.1	31.4	29.9	27.2
M. Court	25.3	28.5	32.6	34.2	34.0	32.7	31.9	32.1	32.3	32.2	30.0	26.7
Mongla *	25.3	28.9	32.8	34.8	34.5	32.8	31.8	31.9	32.0	31.6	29.5	26.6
Patuakhali	25.6	28.7	32.3	33.4	33.4	31.8	31.0	31.3	31.6	31.7	29.6	26.8
Sandwip	25.4	27.6	30.3	31.5	31.7	30.8	30.1	30.6	31.0	31.3	29.5	26.6
Satkhira	25.6	28.8	33.0	35.1	35.2	33.6	32.2	32.3	32.3	32.2	30.1	26.9
Teknaf	26.6	28.9	31.4	32.3	32.5	31.4	30.6	31.3	31.8	32.1	30.4	27.8

Source : BMD,2016 *indicate data 1989-2010

Minimum Temperature of the Coastal Bangladesh

The monthly normal minimum temperatures (°C) of 17 BMD observatories are recorded in section 3.10. Table 3.10 indicates that the in the monsoon months of June, July, August and September, the magnitudes of normal minimum temperatures are higher and they are very close to each other. In the winter months of December, January and February, it is lower and January the lowest. The range from 10.0-15.4,

12.5-17.6, 17.3-22.0, 21.1-25.0, 22.9-26.0, 24.6-26.5, 24.8-26.3, 24.8- 26.4, 24.6-26.0, 22.2-24.5, 16.7-21.1 and 12.1-17.0°C in January, February, March, April, May, June, July, August, September, October, November and December respectively.

Table 3.9: Monthly Average Normal Minimum Temperature (°C) for Different Observatories of BMD (1981-2010) in the Coastal Region of Bangladesh

Month / Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Barisal	12.0	15.4	20.5	23.8	24.9	25.8	25.7	25.8	25.4	23.7	18.9	13.6
Bhola	12.6	16.0	21.0	24.1	25.2	26.1	25.9	26.1	25.7	24.0	19.4	14.4
Chandpur	13.5	16.1	20.7	23.7	24.8	25.9	25.9	26.1	25.8	24.3	20.0	15.4
Chittagong	14.0	16.3	20.5	23.6	24.9	25.4	25.2	25.3	25.2	24.1	20.3	15.8
Cox'sBazar	15.4	17.6	21.2	24.2	25.3	25.4	25.3	25.3	25.1	24.5	21.1	17.0
Feni	12.7	15.8	20.4	23.4	24.5	25.4	25.3	25.3	25.1	23.5	19.1	14.4
Hatiya	14.1	16.8	21.1	24.0	25.1	25.8	25.5	25.6	25.4	24.4	20.3	15.8
Jessore	11.3	14.7	19.6	23.6	25.0	26.0	26.0	26.0	25.5	23.1	17.8	12.6
Khepupara	13.6	16.9	21.8	24.8	25.7	26.3	25.9	26.0	25.7	24.3	20.1	15.3
Khulna	12.2	15.6	20.5	24.2	25.3	26.2	26.2	26.3	25.9	24.1	19.4	14.0
Kutubdia	15.0	17.4	21.2	24.3	25.4	25.7	25.5	25.6	25.5	24.5	20.8	16.7
M. Court	12.3	15.3	20.1	23.5	24.6	25.9	26.0	26.3	25.9	23.8	19.3	14.1
Mongla *	13.9	17.5	22.0	25.0	26.0	26.5	26.3	26.4	26.0	24.5	20.6	15.7
Patuakhali	13.6	16.7	21.2	24.2	25.4	26.2	26.0	26.1	25.8	24.3	20.1	15.2
Sandwip	14.2	17.0	21.5	24.4	25.3	25.8	25.4	25.5	25.4	24.4	20.4	15.9
Satkhira	12.1	15.9	20.7	24.4	25.6	26.4	26.2	26.2	25.7	23.5	18.4	13.3
Teknaf	15.0	17.0	20.7	24.1	25.4	25.5	25.2	25.1	25.2	24.3	21.0	16.9

Source: BMD *indicate data 1989-2010

3.17.4 Rainfall

Table 3.11 shows that normal rainfalls are higher during the monsoon months, but almost all places except at Barisal, Bhola, Syedpur, Sylhet and Srimongal where, normal rainfall is higher in June. Are the highest in July. But during the winter months, the normal rainfall is lower, and in January it is the lowest. For both times, distribution trends are almost similar, suggesting an almost consistent pattern of annual rainfall over the coastal region of Bangladesh during those decades are almost similar, is the indication of almost consistent pattern of annual rainfall on coastal area of Bangladesh during these decades.

Table 3.10: Monthly Usual Rainfall (cm) period: 1981-2010 in the Coastal Region of Bangladesh

Month / station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Barisal	10.3	26.1	52.4	103.7	199.0	401.7	409.9	342.6	284.4	185.5	48.5	5.9
Bhola	8.2	26.5	47.9	115.8	233.0	461.0	442.7	361.5	307.3	185.1	41.8	6.7
Chandpur	6.0	23.0	62.0	143.0	268.0	371.0	420.0	349.0	285.0	165.0	38.0	7.0
Chittagong	7.3	25.0	55.5	136.4	314.0	591.3	735.6	513.9	239.3	197.8	59.5	14.1
Cox's Bazar	5.1	22.2	31.2	99.3	327.1	859.9	933.4	665.5	401.9	217.8	91.8	14.8
Feni	5.6	27.8	64.6	163.5	355.7	529.5	705.5	496.5	357.8	201.6	46.4	8.9
Hatiya	5.1	20.5	42.4	116.9	269.7	627.8	727.8	538.2	437.4	267.2	51.0	12.4
Jessore	13.9	26.0	44.1	71.6	182.0	314.8	325.4	266.7	278.1	134.5	31.0	11.5
Khepupara	9.6	27.3	44.1	87.2	251.2	504.7	631.9	453.3	398.5	268.0	60.2	8.2
Khulna	12.8	35.1	50.4	77.5	177.2	330.8	322.4	295.6	289.7	152.1	38.0	6.3
Kutubdia*	6.8	24.4	43.9	81.7	272.2	633.3	767.2	500.8	324.0	206.3	70.8	8.7
M. Court	10.9	26.0	71.0	142.9	327.0	571.1	723.4	588.3	399.9	211.6	45.7	6.6
Mongla *	10.2	29.0	43.4	56.8	172.0	346.0	368.5	305.8	331.3	178.8	42.6	2.7
Patuakhali	8.8	26.6	42.5	111.3	227.4	538.1	578.8	439.3	378.5	218.0	47.4	4.3
Sandwip	10.5	24.7	63.5	138.5	359.2	691.7	855.4	607.3	476.2	277.4	56.0	7.8
Satkhira	13.2	33.1	85.6	154.2	294.3	333.8	290.4	299.1	141.4	32.2	39.9	7.0
Teknaf	3.5 1	14.7	15.1	60.2	281.3	1007.6	1120.1	896.1	446.3	250.9	81.9	15.1

Source: BMD, * indicate data from 1885 - 1986

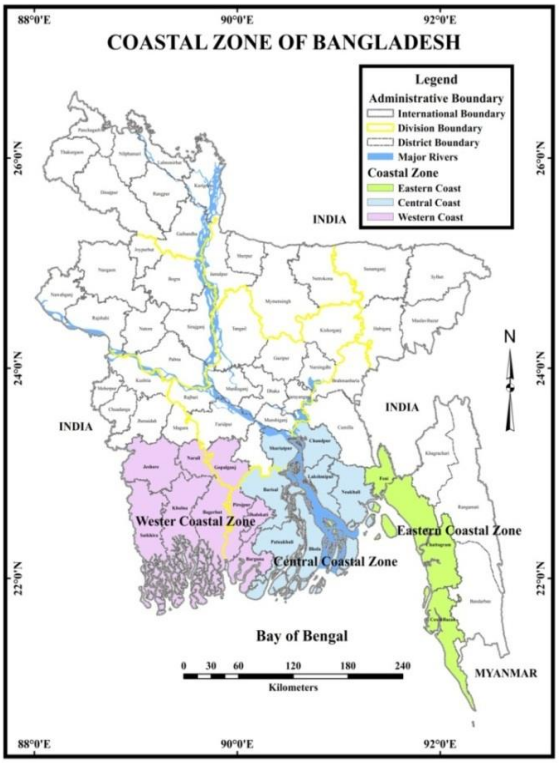
3.17.5 Coastal Environment

Every coastal region of the world bears some especial and separate characteristics, Bangladesh also like that. Bay of Bengal is located in south side of Bangladesh with a large water body. The shoreline of Bangladesh is highly prejudiced by climate change which has impact on the way of life and livelihood of the people living in the coastal areas. The disasters and hazards faced by these people are inundation of low-lying coastal settlement, coastal wetlands and mangrove forest, water logging, drainage congestion, backwater effect, prolonged flooding, cyclone, land erosion, salt water intrusion and so on (UNFCCC 2002). However, the shape of the coastal zone is quite unstable and changing time to time due to erosion and accretion.

3.17.6 Coastal Zone of Bangladesh

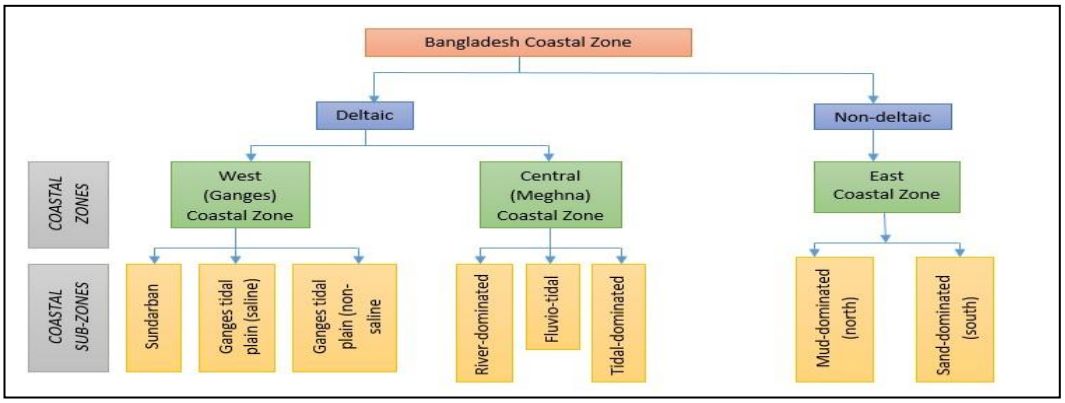
The coastal zoned in Bangladesh (Map 3.3) have their specific coastal landform and distinct characteristics. The coastline of Bangladesh is divided into three zones (Barua, 1991). These are: 1. The Western coastal zone; 2.The Central coastal zone; and 3.The Eastern coastal zone.

Map 3.3: Types of Coastal zone of Bangladesh



Source: Prepared by author

Figure 3.4: Bangladesh Coastal Zone Sub Division (Source: Warrick, 2001)



Eastern coastal zone

The eastern coastal zone begins at Bodormokam, the southern tilt of mainland to the estuary of the Feni River. This place is very narrow and street like. This region is matched by a series of small hills.In this area, the Karnafully, Sangu and Matamuhury River fall into the Bay of Bengal. The Naf River falls into the Bay of Bengal, separating Myanmar from Bangladesh. Eastern coastal zone Soil characteristics are dominated by submerged sands and mudflats (Islam, 2001; p.9). The submerged sand of the zone has formed a long sandy beach of 145 km from Cox's Bazar towards Teknaf. Two of the country's most important sandy beaches from tourists' point of view, specifically Patenga and Cox's Bazar are located in this coastal zone. Fish farming, fishing in the bay, salt production, industrial production and tourism are main economic activities of the zone.

Central coastal zone

The central coastal zone stretches from estuary of the Feni river to the eastern corner of the Sundarbans, and includes the districts of Noakhali, Barisal, Bhola and Patuakhali. The zone receives a wide discharge volume from the river system of Ganges-Bhrahmputra-Meghna creating a high volume of silty deposition. More than 70% of the region's sediment load is silt, with an additional 10% of the sand (Coleman, 1969; cited in Allison et al., 2003). "Because of the sediment discharge and strong current, the morphology of the zone is very dynamic and thus erosion and accretion rates in the area are very high. Numerous islands are located in the area including the country's only island district Bhola. Many islands have been formed in last few years in the area by the process of land accretion. At the same time many have been eroded or disappeared" (Rahman et al. 1993; Pramanik 1988, Cited in SDNP 2004). Kuakata, an attractive sandy beach is located at the zone under Khepupara upazilla of Patuakhali district.

Western coastal zone

The Sundarbans mangrove forest, which covers the greater Khulna and part of the Patuakhali district, covers the western coastal region.The region is relatively stable in terms of soil erosion due to the presence of Mangrove forests. The zone's features are mangrove swamps, tidal flats, natural levees and tidal creeks. "Mangroves of the area

support feeding and breeding grounds for fish and shrimps species, enriching the area in fisheries bio-diversity. The area lies at 0.9 to 2.1 metre above mean sea level" (Iftekhar & Islam, 2004). Soil characteristics of the western coastal zone are silty loams or alluvium. Islam (2003) mentioned that mangrove dominated coastal areas have developed on soil formations of recent origin consisting of alluvium washed down from the Himalayas. The zone also has tourist attraction in the Sundarbans.

Major Characteristics of Coastal Zone of Bangladesh

The coastal region of Bangladesh is the unique in geological structure and also Community activities. The following table 3.12 shows the Major Characteristics of the coastal region of Bangladesh.

Table 3.11: Coastal Region of Bangladesh and Major Characteristics

Name of the Region	Area	Major Characteristics
The Eastern Region	"The coastline from the Baro Feni river to Badar Mukam along Chittagong is known as the eastern region" (Alam and Datidar, 2003).	"The coast is regular unbroken and not very susceptible to erosion and is protected along the sea by mud flat and submerged sand" (Mafizuddinn, 1992).
The Central Region	"The central region occupies the tidal plain of the Meghna estuary covering the district of Patuakhali, Barisal, Bhola and Noakhali" (Akter, 2004).	"The coastline is most irregular, highly broken and consists of a series of islands formed by deposition of sediment. Some of these islands are less than 30 years old; the older parts of Sandwip, Hatia and Ramgati are as much as 200 years old". (FAQ, 1998).
The Western Region	"The western region covers the coastline westward from the Tetulia river to the international boundary (India) located at the Hariabangha river" (Alam and Dastidar, 2003).	The area is relatively stable, mostly covered by mangrove forests and is characterized by a crisscrossed pattern of tidal rivers and tidal cricks. The significant geomorphic features are tidal flats, mangrove swamps, natural leave, sandy beaches, dunes and beach ridges (Khan, 1990; Umitsu, 1997).

Source: Islam, 2004

Classification of Coastal Areas of Bangladesh (administrative)

Based on the connection with the coast the administrative coastal districts of Bangladesh have been classified into two types. These are:

1. Exposed; and 2. Interior coast.

Exposed Coast

The districts those are directly connected with the coast are called the exposed oastal districts. In Bangladesh, there are twelve districts or forty eight upazilas are defined as the exposed coast (Map 3.4).

Interior Coast

There are several areas in Bangladesh that are influenced by the coastal environment, though do not have direct contact with the sea. There are ninety-nine upazila out of 147 coastal upazilas go under this category. The following table 3.13 shows the exposed and interior upazilas of Bangladesh (Map 3.4).

Table 3.12: Exposed and Interior Coast of Bangladesh

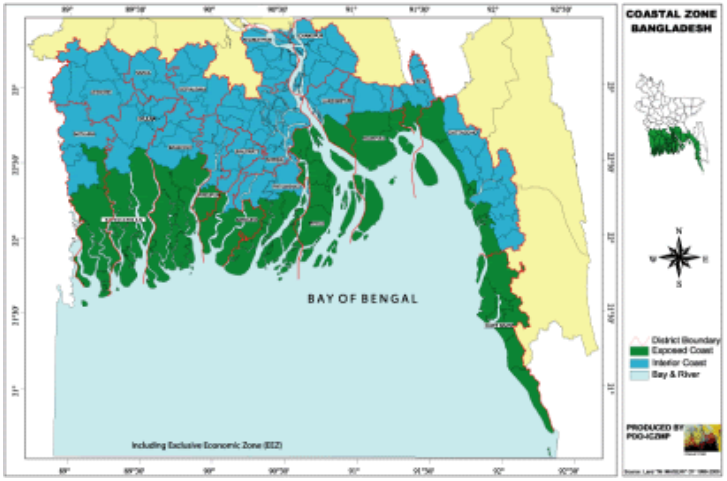
District	Upazilas	
	Exposed	**Interior**
Satkhira	Assasuni, shyamnagar	Debhata, Kalaroa, kaliganj, Satkhiia Sadar, Tala
Khulna	Dacope, Koyra	Batiaghata, Daulatpur, Dumuria, Dighalia, Khalishpur, Khan Jahan Ali, Khulna Sadar, Paikgachha, Phultala,
Bagerhat	Mongla, Saran Khola, Morrelganj	Bagerghat Sadar, Chitalmari, Fakirhat, Kachua, Mollahat, Rampal
Jashore		Baher Para, Chaugachha, Jhikargachha, Manirampur,
Narail		Lohagara, Narail Sadar, Kalla, Narigati
Barguna	Amtali, Barguna Sadar, Patharrghata,	Betagi
Barisal		Agailjhara, Babuganj, Bakerganj, Gaurnadi, Hizla, Mehendiganj,

Table 3.13: Exposed and Interior Coast of Bangladesh

District	Upazilas	
	Exposed	**Interior**
Bhola	Bhola Sadar, Burhanuddin, Char Fasson, Daulatkhan, Lalmohon, Manpura, Tazumuddin	
Patuakhali	Dashmina, Rangabali, Galachipa, Kala Para	Bauphal, Mirzaganj, Patuakhali, Sadar
Jhalokhati		Jhalokhati, Sadar, Kanthalia, Nalchity, Raiaour
Pirojpur	Mathbaria	Bhandaria, Kawkhali, nazirpur, Piiojpur Sadar, Nesarabad (Swraupkhati)
Gopalganj		Gopalganj Sadar, Kashimari, Kotali Para, Muksudour, Tungipara
Sharitpur		Bhederganj, Damudya, Goshairhat, Naria, Palong, Zanjira
Chandpur		Chandpur Sadar, Faridganj, Haimchar, Hajiganj Kachua,Matlab,
Lakshmipur	Ramgati	Lakshmipur Sadar, Raipur, Ramganj
Noakhali	Companiganj, Hatiya, Noakhali	Chatkhil, Senbag. Begumganj
Feni	Sonagazi	Chhagalnaiya, Feni Sadar, Parshuram, Daganbhuiyan
Chittagong	Anawara, Banshkhali, Chittagong Port, Double Mooring.	Boalkhali, Chandanaish, Lohagara, Rangunia, Chandgaon, Fatikchhari, Hathazari, Patiya, Raozan, Satkania,
Cox's Bazar	Chakaria, Cox's Bazar Sadar, Kutubdia, Ukhia, Maheshkhali,	

Source: PDO-ICZMP, 2003

Map 3.4: The Exposed and Interior Coast of Bangladesh.



Source: PDO-ICZMP, 2003

3.17.7 Coastal Islands

The huge sediment carried by the rivers is deposited at the wider channels and gives birth of islands and up to date about 60 islands are identified in the coastal zone. Most of those islands are located in the central coastal zone, because of the dynamic river flow of the Ganges- Brahmputra-Meghna river system. Hatia, Sandweep and Maishkhali are three upazilas and Bhola, an administrative district are four bigger islands in the zone. Some islands are limited to only in a small village with a very few number of residents and fishing is the only source of livelihood support with very poor living standard.

3.17.8 Coastal Community and Livelihood

Nineteen coastal districts have three geo-physical features that differentiate the coastal zone from rest of the country and the distinguished by: tidal interplay, soil and water salinity, and cyclone and storm surge; with economic and social impacts on the population (PDO-ICZMP, 2003a). Such identical geo-physical outline has introduced a complete unusual livelihood outline in the coastal regions, and concerned with selected coast based economic activities like fishing, salt production or fry collection from the sea. This particular coastal community is habituated to face the natural disaster and locally trained up to cope with the coastal environment and calamity, as they are very much identical with that particular area. A brief introduction about the demography and livelihood of the coastal community (Table 3.14) is as follows.

Table 3.13: Basic Demographic Information of the Coastal Community of Bangladesh

Socio-Economic Aspects	Costal Community's Status		National Status
Total Population	38.51 million	wz = 17.07 million cz =10.19 million ez= 11.35 million	149.77 million
Population Density	807		1015/km^2
Total Household	8421000		32174000
Household Size	4.7		4.4
Population Increase Rate	1.36%		1.48%
Gov. University	8		42
Sex-Ratio	99.33		100.2
Ethnic communities(Number)	10		47
Dependency Ratio	0.90		0.83
Literacy Rate	42.03		48.37
Poor Population	30.42%		23.4%
Per Capita GDP	129663BDT		137578BDT
Labor Force	19.25 million		61.2 million

Source: Census 2011, BBS 2018 and Economic Survey 2018
N.B: wz- western zine. cz- central zone, ez- eastern zone

Based on national population census 2011, the total costal population is about 32% of the total population. The household size in the coastal zone is higher than other part of the country. The people from the coastal region generally migrate from the coastal parts to the urban areas for better livelihood and obviously after any natural calamity. The out-migration has changed the sex ratio in the coastal regions and such changes really affect social structure in the coastal areas. It is also estimated that the female-headed households has increased in the coastal areas in last decade (from 11.1 in 1991 to 12.7 in 1998) (Islam 2004 and Ahmed 2003).

The income and profession tapping of household is also different than other parts of the country, because of the equal character of the setting and physical character. Coastal region houses more than one-third of the national labor force (33 %), where more than one-third is female (37 %). In the coastal zone, the quantity of non-farm households is lower and that of small farmers is higher than other parts of the country.

The percentage of non-farm households (landless) is higher in the Chittagong-Cox's Bazar area, where the households are much more intricate with primary economic (fishing, fish processing and salt production) activities and lower in Barisal-Barguna-Pirojpur area. Lakshmipur, Barisal and Chandpur have higher concentration of small farmers, while Patuakhali and Barguna have relatively higher quantities of large farmers, because the physical characteristics of the land. Those coastal regions are much more productive land for agricultural production. The coastal region is comparatively income-poor likened to the rest of the country.

There are 10 different ethnic groups living in the coastal regions and they have a complete different culture and livelihood pattern. Though those ethnic communities are completely dependent on the coastal natural resources for their livelihood. Locally, most of these ethnic groups are known as Chakma, Khiyang,Marma, Munda, Murang, Rakhaine, Tanchangya, Tripura, Mahato and Pundra Khatrio. This ethnic minority population was estimated to be 0.2 million in 1991 (Kamal, Quazi and and Akhter, 2001). In a coastal area of complex vulnerabilities and opportunities, more than one-fourth of the country's population stays. Their desolation and dream, their difficulty and struggle, their vulnerability and resilience, are uniquely situated in a difficult ecological and social setting that to a significant degree of their livelihoods characteristic from other parts of the country.

3.17.9 Coastal Forest

The coastal zone Bangladesh has wide areas of both natural and planted mangrove forest. Natural forest includes the Sundarbans, the Chakaria Sundarbans and tassel mangroves along the eastern coast. The Sundarbans is the world's largest mangrove forest area and the richest forest in the world in terms of mangrove biodiversity; it is a Ramsar site, part of which has been listed as a World Heritage site. The Sundarbans have enjoyed the status of reserved forest for about a century and have been managed for its artistic value.

3.17.10 Coastal Economy

The coastal areas of Bangladesh are also rich with diverse resources of flora and fauna which can be used in increasing eco-tourism. Several types of animals are found in the forest, particularly in the Sundarbans area. The coastal communities

depend on these resources for their survivals. The major economic activities are fishing, crop agriculture, shrimp culture and livestock husbandry (Huq *et al.*, 1995). Three major sea port of Bangladesh (Chittagong sea port, Mongla sea port and Pira se port) located within the coastal belt of Bangladesh and also about 10 special economic zone located within this area. The main occupation in the region is agriculture. Fisheries and salt production are other important occupations. The coastal region has the potential to make a noteworthy contribution to the national economy with regard to natural resources such as gas and minerals and further forecasts for agriculture, fisheries, salt production.

3.17.11 Infrastructures in the Coastal Region of Bangladesh

The coastal zone has 35,712 km of roads, including the rural earthen paths (BBS, 2013). But because of the river network, some of the far-flung parts of the region are still out-of-the-way by road transport. For that reason, water ways in the coastal zone of Bangladesh are the main mode of transportation. Almost all of the area's small and large cities are linked by waterways to the capital city Dhaka In the Fauzderhat sector, 20 km South-west to Chittagong district, 16 km long sea beach , there are also ship-breaking industries (Anderson et al., 2000). The industry is the second largest ship breaking facilities in the world, behind livelihood to about 100,000 people. Chattogram and Khulna are the two largest industrializion area of Bangladesh located within the coastal area of Bangladesh. On the other hand Chattrogram, Mongla and Peyra sea port are also located within the coastal area of Bangladesh.

3.18 Conclusion

This chapter discusses and justifies the research methods used in this analysis to fulfill the goals and address the research questions. It clarified the use of a chronological mixed method attitude, starting with a qualitative analysis process followed by a quantitative phase. Including study area selection, data collection and data analysis techniques, the quantitative and qualitative research stage were explained in detail. The following chapters from chapter 5 to chapter 8 describe the special variation of climate change induced disaster, social vulnerability measurement, finding existing adaptation strategy with climate change induced disaster and also illustrated and formulate community based sustainable disaster management obtaining scientific and indigenous knowledge along with adaption strategy and approaches.

Chapter 4

DEMOGRAPHIC AND SOCIO-ECONOMIC CHARACTERISTICS OF THE RESPONDENTS

4.1 Introduction

The demographic and Socio-economic characteristics of the respondents are identified when discussing the findings of the study. This chapter has been furnished the information on the demographic and socio-economic characteristics of sample respondents of the study. The study involves of 400 respondents of males and females. Age structure, literacy rate, family size and duration of living is essential for exploring problem identification and current situation in a particular area. General information or demographic conditions doesn't only represent the characteristics of the respondent's but also reflect the validity and accuracy of primary data.

4.2 Age Structure of the Respondents

Age structure is significant demographic criteria of the respondents for this research work. Table 4.1 illustrates zone wise age structure n the study area. In western zone (Zone A) maximum respondents were from 30 to 40 age groups, which constitute 41% of total respondents while only 0.6% respondents were above 70 years of age. Besides, in central zone (Zone B) most of the respondents were from 41 to 50 age groups, which found 32% of the total respondents while only 1.5% respondents were above 70 years of age. Moreover, in eastern zone (Zone C) maximum respondents were from 30 to 40 age groups, which constitute 42% of total respondents while only 2% respondents were above 70 years of age. Overall, 30 to 40 age group respondents are leading and found considerable in percentage for this study.

Table 4.1: Age Structure of the Respondents

Age Structure	*Zone A % n=170*	*Zone B % n=110*	*Zone C % n=120*	*Total % n=400*
>30	22.4	16.2	9.0	17.00
30-40	41.2	29.2	42	37.5
41-50	23.5	32.3	24	26.5
51-60	8.3	11.5	17	11.5
61-70	4.2	9.3	6	6.25
Above 70	0.6	1.5	2.0	1.25
Total	100	100	100	100

Source: Field Survey 2018-19

4.3 **Gender Status of the Respondents**

While collecting data head of the household (H/H) were considered as a respondent. In the absence of head of the household other senior member of the same family were considered as a respondent. Gender standing of the respondents in table 4.2 depicts that more contributes about 73.50% of the total respondents which is nearly three times of female respondent. Table 4.3 illustrates zone wise gender position of the respondents in the study area. In western zone (Zone A) maximum respondents were male, which constitute 82.4% of total respondents while only 17.6% respondents were female. Besides, in central zone (Zone B) maximum respondents were male, which constitute 78.18% of total respondents while 21.82% respondents were female. Moreover, in eastern zone (Zone C) maximum respondents were male, which constitute 56.66% of total respondents while 43.34% respondents were female. It is mentionable that Male household heads were frankly talked and better knowledgeable about the climate change and its socioeconomic impacts. But female respondents didn't talk freely, they were feeling shy and also they were not easy to understand climate change and impacts of social sectors.

Table 4.2 Gender Status of the Respondents

Nature of the respondents	**Western Zone**		**Central Zone**		**Eastern Zone**		**Total**	
	f	*%*	*F*	*%*	*f*	*%*	*f*	*%*
Male	140	82.4	86	78.18	68	56.66	294	73.50
Female	30	17.6	24	21.82	52	43.34	106	26.50
Total	170	100	110	100	120	100	400	100

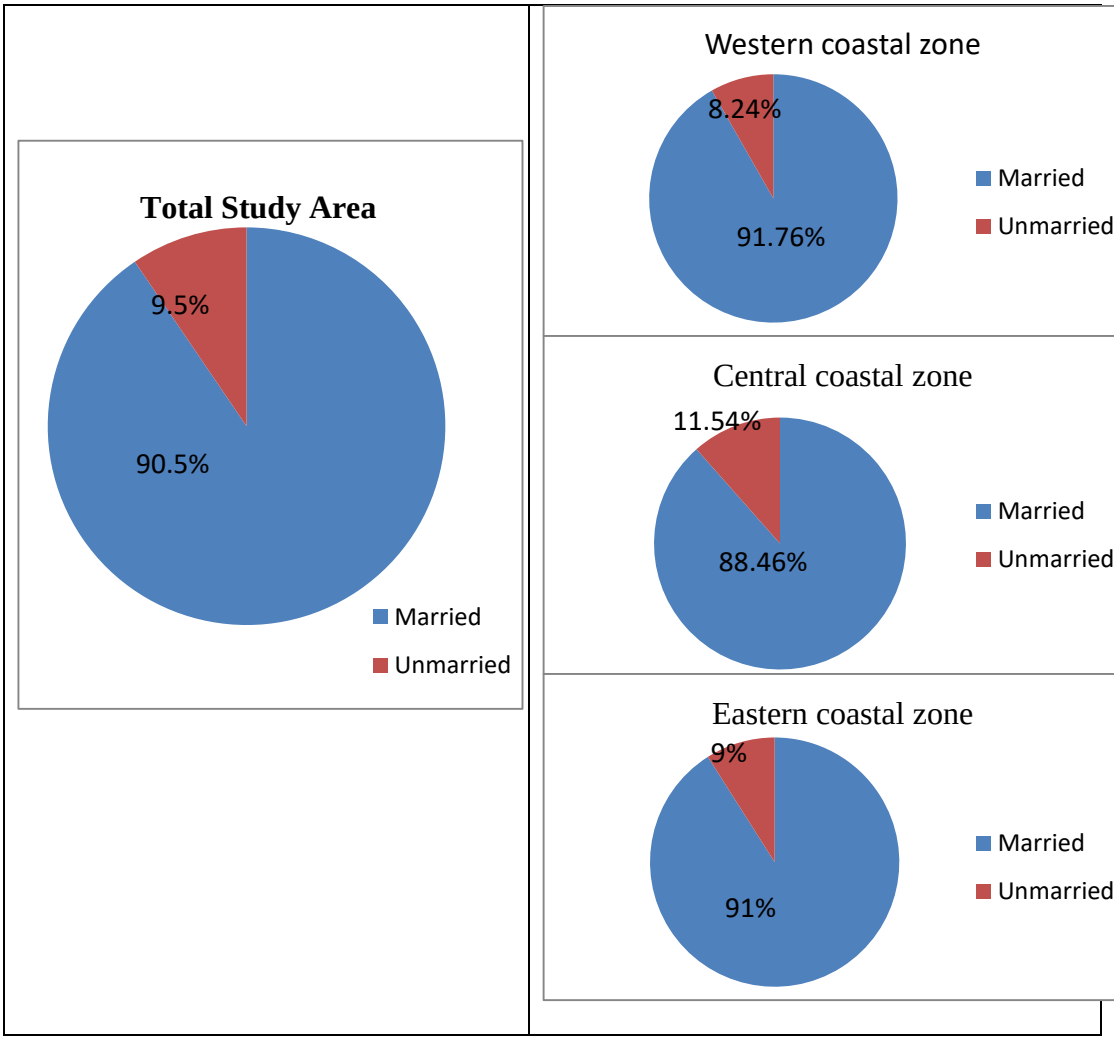
Source: Field Survey 2018-19

4.4 Marital Status of the Respondents

While collecting data head of the household (H/H) were considered as a respondent. In the absence of head of the household other senior member of the same family were considered as a respondent. Marital status the respondents in figure 4.1(Left side) depicts that in the study area more contributes about 90.5% of the total respondents were married which is nearly ten times of unmarried respondent. Figure 4.1 (Right side) illustrates zone wise marital standing of the respondents in the study area. In western zone (Zone A) maximum respondents were married, which constitute 91.76%

of total respondents while only 8.24% respondents were unmarried. Besides, in central zone (Zone B) 88.46 respondents were married and 11.54% respondents were unmarried. Moreover, in eastern zone (Zone C) 91% respondents were married and 9 % respondents were unmarried. It is mentionable that maximum respondents were more than 30 years old (Table 4.2) that's why big portion of the respondents were married.

Figure: 4.1 Marital Status of the Respondents



Source: Field Survey 2018-19

4.5 Number of Family Members of the Respondents

Table 4.3 explores that number of family members of the respondent's. Present investigation found that most (46.75%) of the respondent's family status were 5-7 persons , it denoted middle types of family structure, 36% respondent's family status were 2-4 persons, it denoted single family structure. It was noticed that 17.25% family

status was extended family structure those were contained above 7 person's family members in their family. Table 4.4 also illustrates zone wise family member's position of the respondents in the study area. In western zone (Zone A) maximum respondent's family members were 5-7 persons, which found 41.18% of total respondents, on the other hand 40% respondent's family members were 2-4 person and also 18.82% respondent's family members were above 7 persons. Besides, in central zone (Zone B) maximum respondent's family members were 5-7 persons, which found 53.64% of total respondents, on the other hand 27.27% respondent's family members were 2-4 person and also 19.09% respondent's family members were above 7 persons. Moreover, in eastern zone (Zone C) maximum respondent's family members were 5-7 persons, which found 48.33% of total respondents, on the other hand 38.33% respondent's family members were 2-4 person and also 13.34% respondent's family members were above 7 persons. It is mentionable that national family size of Bangladesh is 4.4 persons but in the present study area maximum respondent's family members more than 4.4 person (Table 4.3).

Table 4.3 Number of Family Members of the Respondents

No of Family Members	**Western Zone**		**Central Zone**		**Eastern Zone**		**Total**	
	f	***%***	***F***	***%***	***f***	***%***	***f***	***%***
2-4	68	40.00	30	27.27	46	38.33	144	36.00
5-7	70	41.18	59	53.64	58	48.33	187	46.75
Above 7	32	18.82	21	19.09	16	13.34	69	17.25
Total	170	100	110	100	120	100	400	100

Source: Field Survey 2018-19

4.6 **Educational Status of the Respondents**

Educational qualification of the respondents not only helps to collect authentic data, but it also helps to mitigate or adopt proposed recovery measures from any vulnerability. Table 4.4 illustrates the educational status of the respondents among the study areas. Which shows that maximum respondents found 'Can Sign' in category and share 28.34% of the total respondents while very few respondents are illiterate?

Table 4.4 Educational Status of the Respondents

Education status	Western Zone		Central Zone		Eastern Zone		Total	
	f	*%*	*F*	*%*	*F*	*%*	*f*	*%*
Can Sign	40	23.5	23	20.90	50	41.66	113	28.34
Class 1-5	19	11.2	18	16.36	23	19.17	60	15.00
Class 6-9	27	15.9	15	13.66	17	14.17	59	14.75
SSC	28	16.5	13	11.82	15	12.50	56	14.00
HSC	21	12.4	17	15.45	9	7.50	47	11.75
Hon's/ Degree	22	12.9	11	10.00	2	1.67	35	8.75
Masters	12	7.1	5	4.55	4	3.33	21	5.25
Diploma agriculturist	1	.6	--	0.00	--	--	1	0.25
Illiterate	--	--	6	5.45	--	--	6	1.50
Dental technologist	--	--	2	1.82	--	--	2	0.50
Total	170	100	110	100	120	100	400	100

Source: Field Survey 2018-19

4.7 Occupational Status of the Respondents

Various occupations of the respondents are found in the study area. Although, occupational characteristics were same at among the locations, but few differences were also found in the final result. Following table 4.5 shows the occupation patterns of the respondents in among the study areas. Table 4.5 depicts that maximum respondent's (21.75%) occupation is housewife. besides small businessman (18.25%), farmer (14.00%), employer (10.75%), day labor (10.75%), and fisherman (6.00%), unemployed (5.50%),garments labor (2.75%) and others respondents (10.25%) are engaged with various occupations in the study area. In western zone (Zone A) maximum respondent's (21.80%) occupation is day labor while small businessman (21.20%), housewife (15.30%), unemployed (11.20%), farmer (10%), employer (10%), garments labor (2.90%) fisherman (2.40%), others respondents (5.20%) are engaged with various occupations. Besides, in central zone (Zone B) maximum respondent's (22.72%) occupation is small businessman while farmer (19.18%), housewife (17.27%), employer (16.36%), fisherman (7.27%),day labor(3.66%),

unemployed (2.77%) and others respondents (10.77%) are engaged with various occupations. Moreover, in eastern zone (Zone C) maximum respondent's (35%) occupation is housewife while farmer (15.83%), fisherman (10%), small businessman (10%), employer (6.67%), garments labor (5%), dry fish worker (5%),students (3.33%), Don't any worker (3.33%) and others respondents (10.84%) are engaged with others occupations. It is mentionable that many male household head was not available at home at the time of household survey so other senior member of the same family (female) was considered as a respondent that's why as occupation housewife is more than that of others.

Table 4.5 Occupational Status of the Respondents

Occupational Status	**Western Zone**		**Central Zone**		**Eastern Zone**		**Total**	
	f	*%*	*F*	*%*	*F*	*%*	*f*	*%*
Farmer	17	10.0	20	19.18	19	15.83	56	14.00
Fisherman	4	2.4	8	7.27	12	10.00	24	6.00
Day Labor	37	21.8	4	3.66	2	1.67	43	10.75
Rickshaw/ Van/ Auto Driver	2	1.2	1	0.90	1	0.83	4	1.00
Garments/ Industry Labor	5	2.9	--	--	6	5.00	11	2.75
Construction workers	1	.6	--	--	2	1.67	3	0.75
Small businessman	36	21.2	25	22.72	12	10.00	73	18.25
Housewife	26	15.3	19	17.27	42	35.00	87	21.75
Employer	17	10.0	18	16.36	8	6.67	43	10.75
Unemployed	19	11.2	3	2.77	--	--	22	5.50
Student	2	1.2	2	1.82	4	3.33	8	2.00
Councilor	2	1.2	--	--	--	--	2	0.50
Priest	1	.6	--	--	--	--	1	0.25
Rural physician	1	.6	--	--	--	--	1	0.25
Don't any worker	--	--	1	0.90	4	3.33	5	1.25
Dry fish worker	--	--	--	--	6	5.00	3	0.75
Boat man	--	--	2	1.82	2	1.67	4	1.00
Retired	--	--	2	1.82	--	--	2	0.50
Dental physician.	--	--	1	0.90	--	--	1	0.25
Social worker	--	--	2	1.82	--	--	2	0.50
Transportation Driver/ Helper	--	--	2	1.82	1	0.83	3	0.75
CNG Driver	--	--	2	1.82	--	--	2	0.50
Total	170	100	110	100	120	100	400	100

Source: Field Survey 2018-19

4.8 Monthly Income Level of the Respondents

Monthly income is the main socioeconomic parameter of the respondents. It's not only reflecting the purchasing ability, but also the economic solvency of the family.

Table 4.6 Monthly Income Levels of the Respondents

Income Range	Western Zone		Central Zone		Eastern Zone		Total	
	f	*%*	*f*	*%*	*f*	*%*	*f*	*%*
<5000 tk.	30	17.64	18	16.36	21	17.50	69	17.25
5001-10000	60	35.29	41	37.27	30	25.00	131	32.75
10001-15000	40	23.53	30	27.27	38	31,67	108	27.00
15001-20000	20	11.76	7	6.36	7	5.83	34	8.50
20001-25000	11	6.47	8	2.27	11	9.17	30	7.50
25000 above	9	5.29	6	5.54	13	10.83	28	7.00
Total	170	100	110	100	120	100	400	100

Source: Field Survey 2018-19

Table 4.6 explored that monthly income of the respondents in the study areas. Maximum respondents monthly income almost same and they are belong to the low and middle income groups in our society. According to Islam (1990), the income group of rural area of Bangladesh is divided into three household income levels, higher income group (above 20,000), middle income group (5,000 to 20,000) and lower income group (less than 5,000 tk.). In the study area majority respondent's (77%) monthly income less than 15000 Tk and also our national level. At present, our annual per capita income 2073 US Dollar or 15202 Tk. per head p/m. (Economic Review 2019). In western zone (Zone A) maximum respondent's (76.46%) monthly income less than our national level. Besides, in central zone (Zone B) maximum respondent's (80.90%) monthly income less than our national level. Moreover, in eastern zone (Zone C) maximum respondent's (73.92%) monthly income less than our national level.

4.9 Housing Condition of the Respondents

Table 4.7 shows the housing type of the respondents in the study areas. Maximum (33%) respondents house are built by mud, fence and tin. Followed by semi-pacca (19.75%), wood fence, tin roof (14.75%), brick or pacca (13.75%), mud house (12.50%), hut/straw build (5.75%) and tin fence, tin roof (0.50%) house in the study area. In western zone (Zone A) Maximum (34.70%) respondents house are built by mud, wood fence, tin roof. Followed by mud house-soil, fence, tin roof (26.50%), semi-pacca (17.60%), brick or pacca (12.9%), mud house-soil, fence and straw (5.9%), hut/straw build (2.4%) house in the western coastal zone. Besides, in central zone (Zone B) Maximum (48.18%) respondents house are built by mud house- soil, fence, tin roof. Followed by brick or pacca (22.73%), semi-pacca (19.09%), hut/straw build (6.36%). mud house-soil, fence and straw (1.82%), tin fence, tin roof (1.82%) house in the central coastal zone. Moreover, in eastern zone (Zone C) Maximum (32%) respondents house are built by mud house- soil, fence, straw. Followed by mud house-soil, fence and tin roof (28%), semi-pacca (23%), hut/straw build (10%) brick or pacca (7%) house in the eastern coastal zone.

Table 4.7: Housing Condition of the Respondents

Types of house	**Western Zone**		**Central Zone**		**Eastern Zone**		**Total**	
	F	*%*	*f*	*%*	*f*	*%*	*f*	*%*
Hut/ Straw build	4	2.4	*7*	6.36	12	10.0	23	5.75
Mud house (Soil fence, Straw)	10	5.9	*2*	1.82	38	32.0	50	12.50
Mud house (Soil fence, Tin roof)	45	26.5	*53*	48.18	34	28.0	132	33.00
Semi-pacca	30	17.6	*21*	19.09	28	23.0	79	19.75
Pacca	22	12.9	*25*	22.73	8	7.0	55	13.75
Wood fence, Tin roof	59	34.7	--	--	--	--	59	14.75
Tin fence, Tin roof	--	--	*2*	1.82	--	--	2	0.50
Total	170	100	110	100	120	100	400	100.

Source: Field Survey 2018-19

4.10 Duration of Living of the Respondents in the Study Area

Duration of living of the respondents found different in three zone of the study area (Table 4.8). Maximum (32%) of the respondents are living in the study area by birth. Followed by 30 or equal years (22.25%), 31-40 years (16.25%), 41-50 years (11.75%), above 60 years (11.75%) and 51-60 years (6.00%) live in the study area. In

western zone (Zone A) Maximum (26.50%) respondents are living by birth. Followed by above 60 years (20%), 31-40 years (15.9%), 41-50 years (15.90%), 30 or equal years (15.3%), 51-60 years (6.5%), respondents are living in the western coastal zone. Besides, in central zone (Zone B) Maximum (37.27%) respondents are living by birth. Followed by 31-40 years (24.55%), 30 or equal years (20.91%), 41-50 years (9.09%), above 60 years (455%) and 51-60 years (3.66%) respondents are living in the central coastal zone. Moreover, in eastern zone (Zone C) Maximum (35%) respondents are living by birth, Followed by 30 or equal years (33.33%), 31-40 years (9.17%), 41-50 years (8.33%), 51-60 years (7.50%) and above 60 years (6.67%) respondents are living in the eastern coastal zone.

Table 4.8 Duration/ Length of living in the Study Area of the Respondents

Length of living (Year/s)	Western Zone		Central Zone		Eastern Zone		Total	
	f	*%*	*f*	*%*	*f*	*%*	*f*	*%*
By birth	45	26.5	41	37.27	42	35.00	128	*32.00*
30 or equal	26	15.3	23	20.91	40	33.33	89	*22.25*
31 to 40	27	15.9	27	24.55	11	9.17	65	16.25
41 to 50	27	15.9	10	9.09	10	8.33	47	11.75
51 to 60	11	6.5	4	3.66	9	7.50	24	6.00
Above 60	34	20	5	4.55	8	6.67	47	11.75
Total	170	100	110	100	120	100	400	100

Source: Field Survey 2018-19

4.11 Source of Drinking Water

Table 4.9 illustrates that source of drinking water of the respondents in the study areas. Almost fifty percent of the respondents are received their drinking water from tube-well while 18 % take water from pond/Lake. Followed by through rain water harvesting (14.45%), from pipe line (14.43%), from river/ cannel (1.44%), from P.S.F (1.24), from well (0.41%) of the respondents collected their drinking water in the study area. In western zone (Zone A) Maximum (40.72%) respondents collect drinking water from pond/lake. Followed by tube-well (25.26%), rain water (25.26%), pipe line (5.67%), P.S.F (3.09%) respondents collect their drinking water in the western coastal zone. Besides, in central zone (Zone B) Maximum (81.82%)

respondents collect drinking water from tube-well. Followed by pipe line (8.39%), river/cannel (4.90%), rain water (2.80%), pond/lake (2.10%) respondents collect their drinking water in the central coastal zone. Moreover, in eastern zone (Zone C) Maximum (50%) respondents collect drinking water from tube-well. Followed by pipe line (33.11%), rain water (11.49%), pond/Lake (3.38%), well (1.35%) respondents collect their drinking water in the central coastal zone. It is mentionable that 98.2% people of Bangladesh take fresh or tube-well water (Economy Survey, 2019).

Table 4.9: Source of Drinking Water

Source of Drinking Water	Western Zone		Central Zone		Eastern Zone		Total	
	f	%	f	%	f	%	f	%
Tube well	49	25.26	117	81.82	75	50.67	241	49.70
Pond/Lake	79	40.72	3	2.10	5	3.38	87	17.94
Rain water	49	25.26	6	4.20	17	11.49	72	14.85
Pipe line	11	5.67	10	7.00	49	33.11	70	14.43
P.S.F	6	3.09	--	--	--	--	6	1.24
River/ Cannel	--	--	7	4.90	--	--	7	1.44
Well	--	--	--	--	2	1.35	2	0.41
Total	194	100	143	100	148	100	485	100

Source: Field Survey 2018-19 N.B: Multiple answers considered

4.12 Sanitation Condition of the Respondents

Table 4.10 illuminates the sanitation condition of the respondents in the study area. Maximum respondents (80.25%) are used healthy or hygiene latrine while 10.75% respondents used open space for toilet purpose. Followed by open latrine (6.00%), Neighbor's Latrine (2.25%), drain (0.25) used for toilet purpose in the study area. In western zone (Zone A) Maximum respondents (96.50%) used healthy or hygiene latrine. Followed by open space (3.5%), use as latrine in the western coastal zone. Besides, in central zone (Zone B) Maximum respondents (90.91%) used healthy or hygiene latrine. Followed by open space (4.55%), open latrine (3.66%), neighbor's latrine (0.90%), use as latrine in the central coastal zone. Moreover, in eastern zone (Zone C) Maximum respondents (47.50%) used healthy or hygiene latrine. Followed

by open space as latrine (27.63%), open latrine (16.66%), neighbor's latrine (6.67%), drain/open space and open latrine (1.66%), use as latrine in the eastern coastal zone.

Table 4.10: Sanitation Condition of the Respondents

Sanitation Condition	**Western Zone**		**Central Zone**		**Eastern Zone**		**Total**	
	f	***%***	***f***	***%***	***f***	***%***	***f***	***%***
Open space	6	3.50	5	4.55	32	27.63	43	10.75
Healthy	164	96.50	100	90.91	57	47.50	321	80.25
Neighbor's Latrine	--	--	1	0.91	8	6.67	9	2.25
Open latrine	--	--	4	3.66	20	16.66	24	6.00
Drain	--	--	--	--	1	0.83	1	0.25
Open space and Open latrine	--	--	--	--	1	0.83	1	0.25
Total	170	100	110	100	120	100	400	100

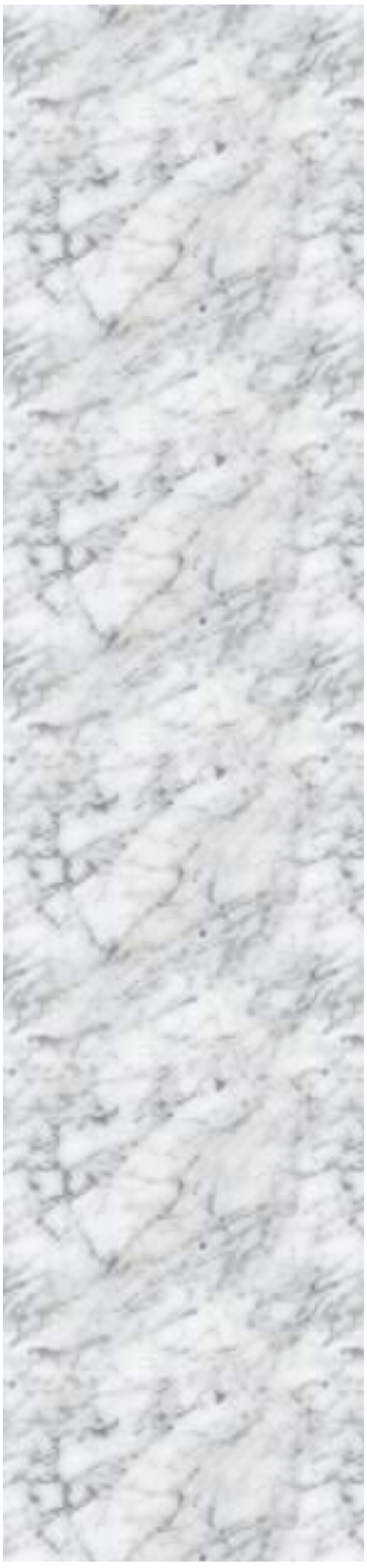
Source: Field Survey 2018-19

4.13 Conclusion

Demographic and Socio-economic conditions of the respondents show the accuracy of the research. Respondents were young and adult aged structure and maximum were male gender group. Educational qualification was moderately good and they engaged with day labor and small business activities. Middle class income generating group were dominated their family. Most respondents were local. Main sources of drinking water is tub-well, pond and rain water. Present time sanitation system is good most proposition of the respondents use healthy sanitation system. Housing structure found pucca, *semi-pucca and Katcha* as well. Bangladesh is mainly vulnerable to climate change because of its geographic location and poor socio-economic standing of the people. Most of the coastal people of Bangladesh live with poor socio-economic status and due to that they are vulnerable to CCIDs.

Chapter 5

CLIMATE CHANGE INDUCED DISASTER AND THEIR SPATIAL VARIATION IN THE STUDY AREA



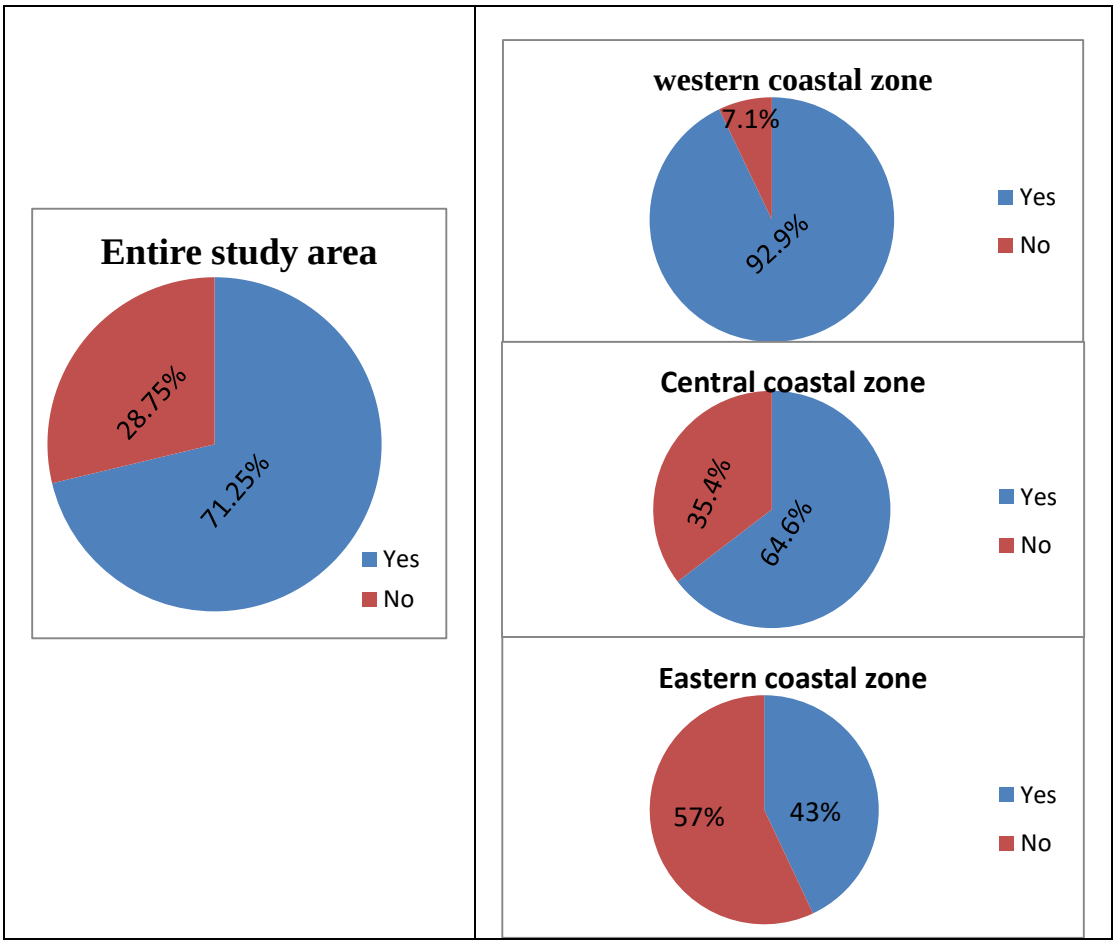
5.1 Introduction

Bangladesh is generally regarded as the worst victim of climate change and is plagued by salinity intrusion, river destabilization, increased severe weather events, the submergence of a large part of the country and the spread of diseases and epidemics (Islam, 2009). Disaster such as extreme cyclone, destructive tidal waves, heavy flooding, treacherous river erosion, excessive rainfall, thunderstorm and overwhelming salinity intrusions that occur more regularly and unpredictably in the coastal area of Bangladesh have trigger climate change (Salequzzaman, *et al.,* 2009; Ahmed, *et al.,* 2007, Ali, *et al.,* 2015, Rahman, 2016 and Rahman, 2018). This chapter explores the present situation of climate induced vulnerabilities and their spatial variations along with hypothesis testing between climate changes induced disasters and social livelihood of coastal dwellers. Association between CCIDs and livelihood of coastal community are also discussed in this chapter.

5.2 Idea about Climate Change of the Respondents

Three quarters of surveyed people are well up to date about the idea of climate change. Due to the diffusion of communication technology. Yet, roughly one quarter of people aren't idea of climate change in the coastal region of Bangladesh. Among three coastal zones, a very large proportion (93%) of the western zone people has idea about climate change which is 43% in the eastern coastal zone as 65% in the central zone of the study area (Figure 5.1).

Figure 5.1: Idea about Climate Change of the Respondents



Source: Field Survey 2018-19

Nowadays, climate change and disasters related issues are usually broadcast by local and national radio and telecast almost every television channel as well as every print and electronic newspapers said by experts. At the present time, local administrative body, Community Based Organization (CBOs), Civil and Social Organizations (CSOs), religious leaders, Disaster Management committees from the national level to local level and disaster volunteers are enough active while organize any disasters or disaster related incidences in the coastal areas of Bangladesh.

5.3 Perception of Understanding Climate Change of the Respondents

Owing to climate change vulnerabilities, coastal inhabitants are frequently faced thirteen types of symptoms in the whole coastal belt of Bangladesh. Among them flood, cyclone, Increase rainfall, Seasonal change, Increase of salinity and Temperature change found more which share (79.30%) together. Nearly 3% dwellers do not mention any symptom during the survey period.

Table 5.1: Measures of Understanding about Climate Change of the Respondents

Type of symptoms	Western Zone		Central Zone		Eastern Zone		Total	
	f	*%*	*f*	*%*	*f*	*%*	*F*	*%*
Temperature change	11	3.77	7	4.49	12	7.19	30	4.60
Increase of salinity	31	10.62	14	7.25	20	11.98	65	9.97
Seasonal change	24	8.22	33	17.10	10	5.99	67	10.28
Increase rainfall	42	14.38	13	6.74	15	8.98	70	10.74
Thunderstorm	2	0.68	4	2.04	2	1.20	8	1.23
Flood(tidal flood)	36	12.33	39	20.21	42	25.15	117	17.94
Water-borne diseases	2	0.68	10	5.18	3	1.80	15	2.30
Cyclone	96	32.88	32	16.58	40	23.95	168	25.77
Changing coping pattern	0	0.00	15	7.77	3	1.80	18	2.76
Sea level rise	14	4.79	8	4.15	9	5.39	31	4.75
Over Winter	4	1.37	0	0.00	1	0.60	5	0.77
Drought	16	5.48	9	4.66	0	0.00	25	3.83
River bank erosion	2	0.68	6	3.11	6	3.60	14	2.15
Don’t Know	12	4.11	3	1.55	4	2.40	19	2.91
Total	292	100	193	100	167	100	652	100

Source: Field survey, 2018-19 Multiple Answers Considered

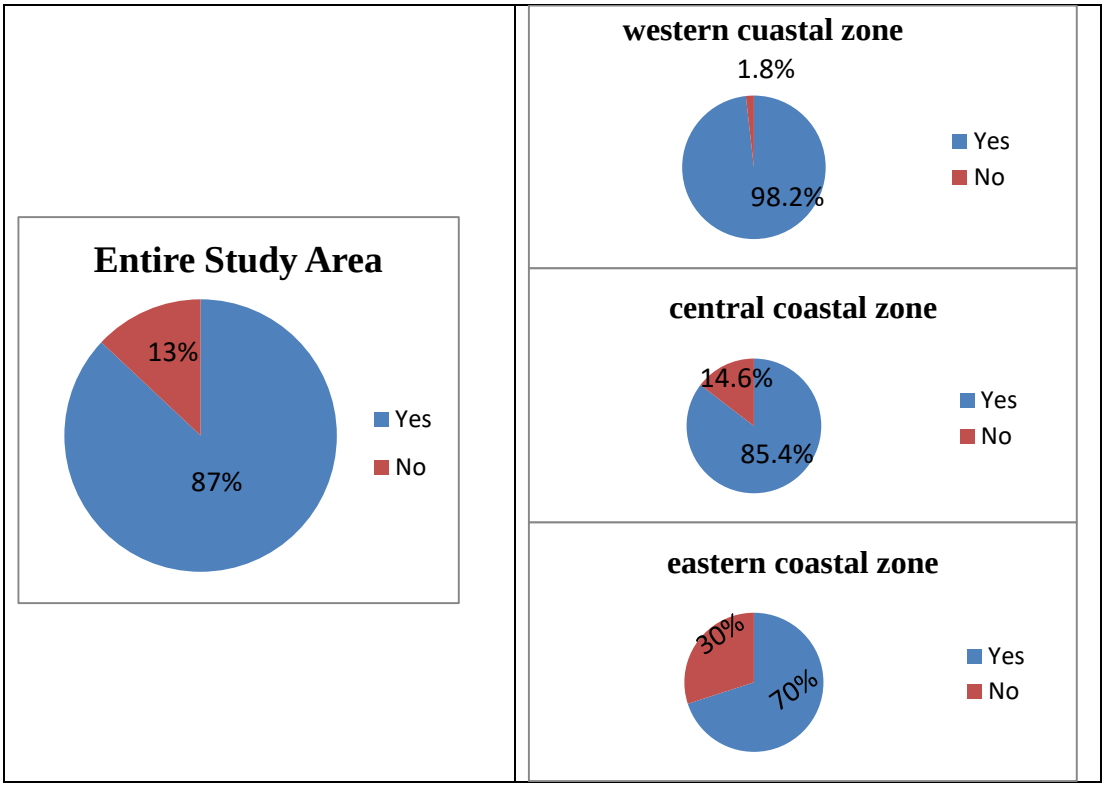
Respondents opine cyclones, increasing found of rainfall, flood and salinity as a main symptoms of the climate induced disasters in the western coastal belt of Bangladesh (Table 5.1). Flood, changing duration of season, changing coping patterns and increasing of rainfall are the leading symptoms of the climate induced disasters in the central coastal belt of Bangladesh. One quarter of the people do not perceive any symptoms during the survey period. Flood, cyclone and temperature change are observed as a main primary symptoms of the climate induced disasters in the eastern coastal region of Bangladesh as per respondents perception. However, nearly 3% of the total respondents of the study area do not perceive any symptoms during the survey period.

5.4 Idea about Climate Change Induced Disaster of the Respondents

A very large proportion (87%) of the respondents are familiar with the idea about climate change induced disaster in the coastal belt of Bangladesh (Figure 5.2). In western zone, roughly every respondent (98%) are acquainted with the idea about

climate change induced disaster. Eighty seven percent of the respondents are aware about the idea about CCIDs in the central zone of Bangladesh. In coastal zone nearly three quarters of the respondents (70%) are noted the idea about CCIDs.

Figure 5.2: Idea about Climate Change Induced Disasters of the Respondents



Source: Field survey 2018-19

Due to the lacking of promotion of the information or knowledge sharing channel from central point in countryside areas. Though the local administrative bodies, related agencies, department, NGOs, CBOs, CSOs and religious leaders are very much familiar about climate change induced disasters but still, 13% coastal occupants do not have idea about the climate change induced disasters in the coastal belt of Bangladesh.

5.5 Types of Climate Change Induced Disaster in Bangladesh

In consequence of climate change vulnerabilities, respondents opine that natives are faced eleven types of climate change induced disasters. Respondents observed that cyclone (17%) as a main climate induced disaster in Bangladesh. Whereas flood (16%) as second climate induced disaster in Bangladesh than increase of temperature (11%), river bank erosion (11.80%), storm surge (10.60%), SLR and salinity int.

(9%), waterborne diseases (6%), Changing rainfall behavior (6&) thunderstorm (6%), Tornado (4%) and *kala fever* (1%) respectively are climate induced disasters in Bangladesh (Table 5.2).

Table 5.2: Types of CCIDs in Bangladesh (opinion of the respondents)

Types	Western Zone		Central Zone		Eastern Zone		Total	
	F	***%***	***F***	***%***	***f***	***%***	***F***	***%***
Cyclone	154	17.52	101	12.58	102	27.95	357	17.44
Flood	120	13.65	105	13.08	110	30.14	335	16.37
Increase of temperature	120	13.65	93	11.58	10	2.74	223	10.89
River bank erosion	79	8.99	88	10.96	54	14.80	221	10.80
Storm surge	90	10.14	102	12.70	25	6.85	217	10.60
SLR and Salinity intrusion	101	11.49	59	7.35	27	7.40	187	9.14
Water-borne diseases	56	6.37	68	8.47	5	1.37	129	6.30
Changing rainfall behavior	29	3.30	84	10.46	15	4.11	128	6.25
Thunderstone	99	11.26	11	1.37	17	4.66	127	6.20
Tornado	28	3.19	59	7.35	--	--	87	4.25
Kala fever	--	--	24	2.99	--	--	24	1.17
No Comment	3	0.34	9	1.12	--	--	12	0.59
Total	879	100	803	100	365	100	1928	100

Source: Field Survey, 2018-19 Multiple Answers Considered

In western zone, respondents observed that cyclone (17.52%) as a main climate induced disaster. Whereas flood (14%) and increase of temperature as second climate induced disaster in western coastal zone than SLR and Salinity int. (11.49%), thunderstorm (11%), storm surge (10%), river bank erosion (9%), Waterborne diseases (6%), changing rainfall behavior (3%),Tornado (3%) respectively are climate induced disaster. Moreover, in the central zone, folks claimed that the flood (13%) is the main climate induced disaster. Followed by storm surge (13%), cyclone (12.58%), increase of temperature (11.58%), river bank erosion (11%), changing rainfall behavior (10.46%), SLR and Salinity intrusion and Tornado (7.35%) are the notable climate induced disasters out of eleven disasters. Furthermore, in the eastern zone, the silent majority supposed that flood (30%), cyclone (28%), river bank erosion (15%) and sea level rise (7.40%) are the major climate induced disasters out of eleven disasters in Bangladesh (Table 5.2).

While eleven types of CCIDs are noted in the study area the world faced fourteen types (Ali, 1999) for instance cyclone, floods, drought, irregular rainfall, salinity intrusion, sea level rise, riverbank erosion, landslide, storm surge, tornadoes, blizzard/snowstorm, wildfire, various diseases and pest attract. Besides, IUCN (International Union for Conservation of Nature), 2009 denoted that five types of climate change induced disaster in Bangladesh, such as cyclone, flood, drought, riverbank and coastal erosion and storm surge. Bangladesh Delta Plan -2100 has mentioned six challenges, like climate change, floods, drought, riverbank erosion, sea level rise and salinity intrusion and cyclone and storm surges, while eleven types of climate induced disasters has been identified through this research in the coastal areas of Bangladesh.

5.6 Types of Climate Change Induce Disaster in the Study Area

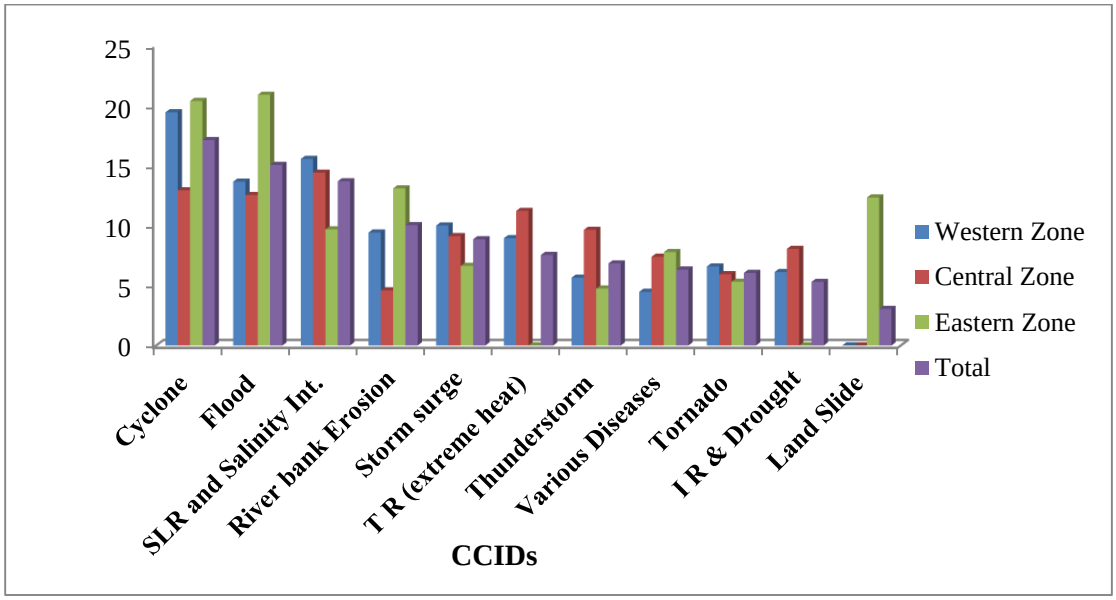
In consequence of climate change vulnerabilities, respondents are faced eleven types of CCIDs in the study area. Respondents observed that cyclone (17%) as a main climate induced disaster in the study area. Followed by Flood (15%), Sea Level Rise and Salinity intrusion (14%), River Bank Erosion (10%), Storm Surge (9%), Temperature rise (extreme heat) (7.5%), Thunderstorm (7%), Various Diseases (6%), Tornado (6%), Irregular Rainfall & Drought (5%), and Land Slide (3%) are found as CCIDs in the study area (Table 5.3 & Figure 5.3).

Table 5.3: Types of CCIDs in the Study Area

CCIDs	Western Zone		Central Zone		Eastern Zone		Total	
	f	***%***	***F***	***%***	***f***	***%***	***f***	***%***
Cyclone	165	19.45	98	12.96	102	20.39	365	17.14
Flood	116	13.68	95	12.56	110	20.91	321	15.07
SLR and Salinity Intrusion	132	15.57	109	14.42	51	9.70	292	13.71
River bank Erosion	80	9.43	65	4.60	69	13.12	214	10.05
Storm surge	85	10.02	69	9.13	35	6.65	189	8.87
Temperature Rise	76	8.96	85	11.24	--	--	161	7.56
Thunderstorm	48	5.66	73	9.66	25	4.75	146	6.85
Various Diseases	38	4.48	56	7.41	41	7.80	135	6.34
Tornado	56	6.60	45	5.95	28	5.32	129	6.06
IR & Drought	52	6.13	61	8.07	--	--	113	5.31
Land Slide	-	-	-	-	65	12.36	65	3.05
Total	848	100	756	100	526	100	2130	100

Source: Field Survey, 2018-19 Multiple Answers Considered

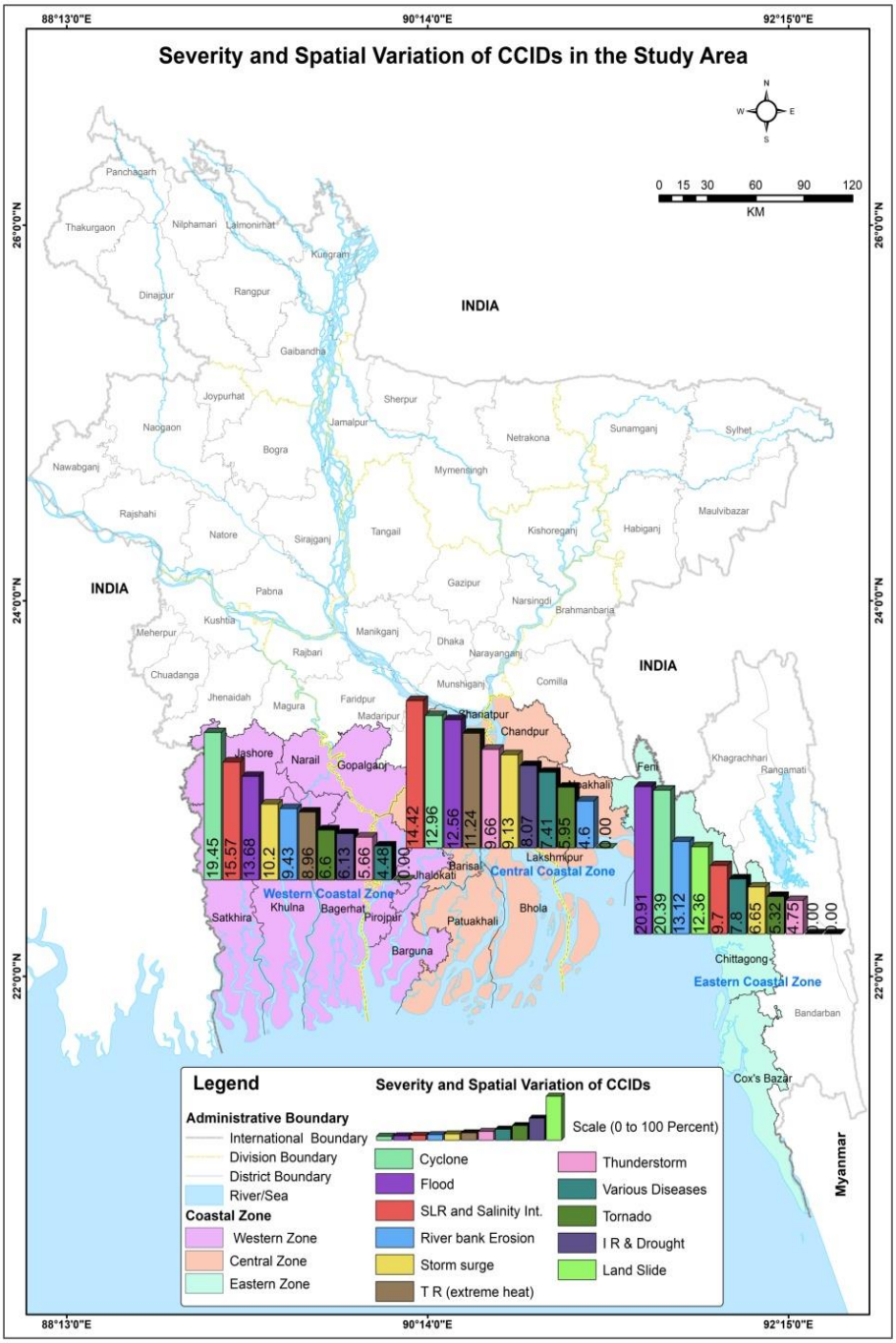
Figure 5.3: Climate Change Induced Disaster in the Study Area
(opinion of the respondents)



Source: Field Survey, 2018-19 Multiple Answers Considered

While concerning spatial variation of CCIDs in the study area it is observed that highest percentage (19.45%) of the respondent's opine cyclone as a main CCID in the western coastal zone. Followed by SLR and Salinity Intrusion (15.57%), Flood (13.68%), Storm surge (10 %), IR & Drought (8%), River bank Erosion (9.43%), Temperature Rise (8.96%), Tornado (6.60%), Thunderstorm (5.66%) and Various Diseases (4.48%). However the western coastal zone is flood plain area, so land slide is not available CCIDs in this area. Whereas highest percentage (14.42%) of the respondent's opine SLR and Salinity Int. as a main CCID in the central coastal zone. Followed by cyclone (12.96%), Flood (12.56%), Temperature Rise (11.24%), Thunderstorm (9.66%) Storm surge (9%), Various Diseases (7.41%). IR & Drought (6.13%), Tornado (5.95%), River bank Erosion (4.60%). Though the central coastal zone is flood plain area, so land slide not happened in this area. In Eastern Coastal Zone highest percentage (20.91%) of the respondent's opine flood as a main CCID in this zone. Followed by cyclone (20.39%), River bank Erosion (13.12%). land slide (12.36%) SLR and Salinity Int. (9.70%), Various Diseases (7.80%). Storm surge (6.65%), Tornado (5.32%) and Thunderstorm (4.75%). The eastern coastal zone is a hilly area, that's why land slide are happing in this area (Map- 5.1).

Map 5.1: Severity and Spatial Variation of CCIDs in the Study Area



Source: Prepared by the Author

5.7 Relationship between Idea about Climate Change and Climate Change Induced Disasters and their Regional Differentiation

Table 5.4 displays that there is a significant relation between the idea about climate change of coastal dwellers and climate change induced disasters in the study areas. In order to analyze the data more strictly an attempt has been made to statistically interpret the relationship between the idea about climate change of coastal dwellers

and climate change induced disasters in the study areas. For this aspect a null hypothesis (H_o): ***there is no association between the idea about climate change of coastal dwellers and climate change induced disasters in the study areas.***

Table 5.4: Relationship between the Idea about Climate Change of Coastal Dwellers and CCIDs

1st Variable	2nd Variable	Chi-square (χ^2)				
		Cal value	**Tab value**	**Result**	**df**	**Sig.***
Idea about Climate Change	Flood	55.437	15.50	39.94	8	S
	Cyclone or storm surge	63.28	18.30	44.98	10	S
	Tornado	13.17	12.59	0.58	6	S
	River erosion	84.41	19.67	64.74	11	S
	Salinity or salinization	36.70	16.91	19.79	9	S
	Temperature rise (extreme heat)	41.27	16.91	24.36	9	S
	Tidal water intrusion	74.43	16.91	57.52	9	S
	Change in seasonal patterns of rain	25.10	14.06	11.04	7	S
	Sea Level Rise	27.57	16.91	10.66	9	S
	Thunderstorm	23.70	19.67	4.03	11	S
	Fever (Kala-azar)	28.64	15.50	13.14	8	S
	Water Born Disease	22.79	16.91	5.88	9	S

*S= Significant, *NS = Not Significant, *df* = degree of freedom, significance at the level of 0.05 [Appendix- V].

Chi square (χ^2) test has been performed after cross tabulation. Table 5.4 shows the results with the levels of significance for the chi-square (χ^2) test. After cross table analysis, it is found that the null hypothesis is rejected and there is close association between idea about climate change of coastal dwellers and CCIDs in the coastal areas of Bangladesh. The chi-square (χ^2) test results indicate that a significant relation between the variables, that means Hypothesis (H_o) = Cal $_{value}$ $\rangle$ Tab $_{value}$ = Significant in the whole coastal belt of Bangladesh. This analysis has been referred that coastal people are knowing about CCIDs in the coastal areas of Bangladesh. Basically, the idea about climate change means that the coastal people are well introduced and experienced with these disasters. However, table 5.4 has tried to explore the relationship between the idea about climate change and climate change induced disasters regarding on regional differentiation in the coastal areas of Bangladesh.

Table 5.5: Relationship between Idea about Climate Change and CCIDs Regarding on Regional Differentiation (Applying **Chi-square (χ^2) test)**

1st Variable	2nd Variable	Zone One – Western Coastal area					Zone Two – Central Coastal area					Zone Three – Eastern Coastal area				
		Chi-square (χ^2)					Chi-square (χ^2)					Chi-square (χ^2)				
		Cal value	Tab value	Result	df	Sig.*	Cal value	Tab value	Result	df	Sig.*	Cal value	Tab value	Result	df	Sig.*
Idea About Climate Change	Flood	12.59	11.07	1.52	5	S	17.02	14.06	2.96	7	S	4.76	9.48		4	NS
	Cyclone or storm surge	17.54	16.91	0.63	9	S	24.06	15.50	8.56	8	S	26.82	11.07	15.75	5	S
	Tornado	12.76	5.99	6.77	2	S	18.72	12.59	6.13	6	S	0.43	3.84	-3.41	1	NS
	River erosion	13.72	15.50	-1.78	8	NS	30.79	16.91	13.88	9	S	16.81	9.48	7.33	4	S
	Salinity or salinization	11.14	7.81	3.33	3	S	29.50	15.50	14.00	8	S	13.23	7.81	5.42	3	S
	Temperature rise (extreme heat)	0.68	12.59	-11.91	6	NS	29.57	16.91	12.66	9	S	Data Not Detected				NS
	Tidal water intrusion	12.91	9.48	3.43	4	S	18.66	14.06	4.60	7	S	17.78	7.81	9.97	3	S
	Change in seasonal patterns of rain	0.55	7.81	-7.26	3	NS	23.22	12.59	10.63	6	S	Data Not Detected				NS
	Sea Level Rise	10.36	5.99	4.37	2	S	25.16	14.06	11.10	7	S	17.79	7.81	9.98	3	S
	Thunderstorm	1.66	15.50	-13.84	8	NS	17.38	18.30	-0.92	10	NS	8.26	7.81	0.45	3	S
	Fever (Kala-azar)	0.55	5.99	-5.44	2	NS	25.29	14.06	11.23	7	S	Data Not Detected				NS
	Water Borne Disease	0.15	9.48	-9.33	4	NS	24.85	14.06	10.79	7	S	Data Not Detected				NS

*S= Significant, *NS = Not Significant, *df* = degree of freedom, significance at the level of 0.05

Table 5.5 Illustrates that relationship between the idea about climate changes and climate change induced disasters regarding on regional differentiation in the coastal areas of Bangladesh. In order to analyze the data more strictly an attempt has been made to statistically interpret the relationship between the idea about climate change and climate change induced disasters regarding on regional differentiation. For this aspect a null hypothesis is as, ***H_o: there is no significant relation between the idea about climate change and climate change induced disasters of coastal people regarding on regional differentiation.***

After the cross table analysis, it is explored that the idea about climate change of coastal dwellers differ by geographical location. Actually, coastal people are introduced which disaster those are familiar or recurrent nature in their localities. Therefore, the significant level has been differentiated on the basis of the coastal areas.

5.8 Spatio-temporal Variation of CCIDs in the Study Area

"Bangladesh has a sub-tropical humid climate characterized by wide seasonal variations in rainfall, moderately warm temperatures and high humidity" (Rashid, 1991). Four distinct seasons can be recognized in Bangladesh from the climatic point of view: (1) the dry winter season from December to February, (2) the pre-monsoon hot summer season from March to May, (3) the rainy monsoon season from June to September and (4) the post-monsoon autumn season which lasts from October to November. Rainfall variability in space and time is one of the most relevant characteristics of the climate of Bangladesh.

The following table 5.6 explores the organizing period of different vulnerabilities throughout the year in the study areas. However, the distribution and impact of these disasters are uneven and responding to physical sitting or geographical locations. These are occurring due to climate change affect; for a moment its severity depends on the intervention of human. Most of the CCIDs in the study area occurred within the month of April to October *i.e.* mid of pre monsoon to early of post monsoon but Salinity intrusion occurred whole the year except September and October *i.e.* late of rainy monsoon to early of post monsoon.

Table 5.6: Spatio-temporal Variation of CCIDs in the Study Area

CCIDs	Study Area	Season and Month											
		Dry Winter			Pre Monsoon			Rainy Monsoon				Post Monsoon	
		D	J	F	M	A	M	J	Jul	A	S	O	N
Cyclone	WC												
	CC												
	EC												
Flood	WC												
	CC												
	EC												
Tornado	WC												
	CC												
	EC												
RBE	WC												
	CC												
	EC												
SLR and Salinity	EC												
	CC												
	EC												
TR	WC												
	CC												
	EC												
Thunder storm	WC												
	CC												
	EC												
IR & Drought	WC												
	CC												
	EC												
Various Diseases	WC												
	CC												
	EC												
Storm Surge	WC												
	CC												
	EC												
Land Slide	WC												
	CC												
	EC												

N.B: RBE= River Bank Erosion, SLR= Sea Level Rise, TR= Temperature Rise, IR= Irregular Rainfall WC= Western Coast, CC= Central Coast, EC= Eastern Coast.

Source: Considering the perception of the respondents from quantitative and qualitative sources, author has prepared this map, 2018-19

In western coastal zone, total eleven types of CCIDs have been identified in the coastal area of Bangladesh out of that ten types CCIDs are available in this zone. Cyclone is the recurrent, not fortuitous nature and occurred in a specific period. Besides, cyclones hit this area almost every year, usually April to November around the whole year. It is occurring naturally and catastrophic nature. So, its cruelty and degree is very high, but devastating period is very short. Flood is the recurrent, not fortuitous nature and occurred in a specific period. The coastal topography gentle slope forward northwestern to southeastern, that's why sometimes it occurred by natural processes and sometimes artificial causes, Every often flood is the associate disaster through others disasters, for instance sea level change, synchronization of tidal water and upper catchment water, cyclone, storm surge and catastrophic tidal fluctuation. A flood starts as late April and can continue until early October. Tornado has occasionally occurred in this area during the March to June (summer: pre-monsoon hot season), especially it occurs little bit far from the coastal line. While it has occurred in limited areas, wherever they hit, they make a complete devastation. Furthermore, river bank and coastal erosion have been occurring from April to September (pre monsoon to early post monsoon season). The unpredictable shifting behave of the river course and fluctuation of water level, high tide, storm surge of the shore line of coast are accelerating the bank erosion in this area. In addition, SLR and salinity intrusion means saline water intrusion into the freshwater ecology; it usually occurred November to July (mid post monsoon to mid rainy monsoon). Actually, this disaster occurred due to sea level rise and happened many disasters, like tidal inundation, cyclone, storm surge, erosion of shore line and catastrophic tide as well. Additionally, sea level change (Trans- Regression) is the noticeable event for the local inhabitants. Before 30 years coast and normal tidal water position are 1 or 1.5 km far from the present shoreline, but nowadays it is gradually forwarding towards the land. Basically, sea level change is the average effect of all climatic induced disasters such as flood influx the huge melting water on the shoreline at every year and cyclone and storm surge inflow of balk of water into the coast. TR (extern heat) generally occurs in western zone within March to August *i.e.* late pre monsoon to late rainy monsoon. As well, thunderstorm is the unexpected and sudden disaster occurring during the April to October in the whole year. Respondents opined that Irregular rain & drought, now a day it is a common CCIDs in the coastal area of Bangladesh. In the month of May to July respondents are affected by irregular rain & drought *i.e.* per monsoon to

mid rainy monsoon. In the month of April to December people are affected by different sort of diseases like, 'Kala Fever' and water borne diseases *i.e.* happened by mid of pre monsoon to early of dry winter. In addition, storm surge generally occurs in this zone within March to October every year *i.e.* early pre monsoon to early post monsoon. Finally, out of eleven CCIDs of western coastal zone land slide is not available in this zone because it is a deltaic and flood plain area. Usually land slide occur in hilly region (Table 5.6).

In the central coastal zone is followed the western coastal area because here also identified total ten types of CCIDs out of eleven CCIDs. SLR and salinity intrusion is the recurrent, not fortuitous nature and occurred in a specific period. SLR and salinity intrusion means saline water intrusion into the freshwater ecology; it usually occurred November to July (mid post monsoon to mid rainy monsoon). Actually, this disaster occurred due to sea level rise and happened many disasters, like tidal inundation, cyclone, storm surge, erosion of shore line and catastrophic tide as well. Additionally, sea level change (Trans- Regression) is the noticeable event for the local inhabitants. Before 30 years coast and normal tidal water position are 1 or 1.5 km far from the present shoreline, but nowadays it is gradually forwarding towards the land. Basically, sea level change is the average effect of all climatic induced disasters such as flood influx the huge melting water on the shoreline at every year and cyclone and storm surge inflow of balk of water into the coast. Besides, cyclones hit this area almost every year, usually April to November around the whole year. It is occurring naturally and catastrophic nature. So, its cruelty and scale is very high, but devastating period is very short. Flood is the recurrent, not fortuitous nature and occurred in a specific period. The coastal topography gentle slope forward northwestern to southeastern, that's why sometimes it occurred by natural processes and sometimes artificial causes, Every often flood is the associate disaster through others disasters, for instance sea level change, synchronization of tidal water and upper catchment water, cyclone, storm surge and catastrophic tidal fluctuation. A flood starts as late April and can continue until September, *i.e.* mid pre monsoon to rainy monsoon. Tornado has occasionally occurred in this area during the March to September (summer: pre-monsoon to rainy monsoon), especially it occurs little bit far from the coastal line. While it has occurred in limited areas, wherever they hit, they make a complete devastation. Furthermore, river bank and coastal erosion have been occurring from April to August (pre monsoon to middle rainy monsoon season). The unpredictable

shifting behave of the river course and fluctuation of water level, high tide, storm surge of the shore line of coast are accelerating the bank erosion in this area. In addition, TR (extern heat) generally occurs in western zone within March to August *i.e.* late pre monsoon to late rainy monsoon. As well, thunderstorm is the unexpected and sudden disaster occurring during the March to August (*i.e*. pre monsoon to mid rainy monsoon) in the whole year. Respondents opined that Irregular rain & drought, now a day it is a common CCIDs in the coastal area of Bangladesh. In the month of May o July respondents are affected by irregular rain & drought *i.e.* per monsoon to mid rainy monsoon. In the month of June to December people are affected by different sort of diseases like, 'Kala Fever' and water borne diseases *i.e.* happened by early rainy monsoon to early of dry winter. In addition, storm surge generally occurs in this zone within April to October every year *i.e*. early pre monsoon to early post monsoon. Finally, out of eleven CCIDs of coastal region land slide is not available in central coastal zone because it is a deltaic and flood plain area like western coastal zone. Usually land slide occur in hilly region (Table 5.6).

In the eastern coastal zone also identified total ten types of CCIDs out of eleven CCIDs. Flood is the recurrent, not fortuitous nature and occurred in a specific period. Every often flood is the associate disaster through others disasters, for instance sea level change, synchronization of tidal water and upper catchment water, cyclone, storm surge and catastrophic tidal fluctuation. A flood starts as early April and can continue until October *i.e.* mid pre monsoon to early post monsoon. Besides, cyclones hit this area almost every year, usually April to November around the whole year. It is occurring naturally and catastrophic nature. So, its severity and degree is very high, but devastating time is very short. The coastal topography gentle slope forward northwestern to southeastern, that's why sometimes it occurred by natural processes and sometimes artificial causes, Tornado has occasionally occurred in this area during the May to August (summer: pre-monsoon to late rainy monsoon), especially it occurs little bit far from the coastal line. While it has occurred in limited areas, wherever they hit, they make a complete devastation. Furthermore, river bank and coastal erosion have been occurring from April to August (pre monsoon to middle rainy monsoon season). The unpredictable shifting behave of the river course and fluctuation of water level, high tide, storm surge of the shore line of coast are accelerating the bank erosion in this area. SLR and salinity intrusion means saline water intrusion into the freshwater ecology; it usually occurred November to July

(mid post monsoon to mid rainy monsoon). Actually, this disaster occurred due to sea level rise and happened many disasters, like tidal inundation, cyclone, storm surge, erosion of shore line and catastrophic tide as well. Additionally, sea level change (Trans- Regression) is the noticeable event for the local inhabitants. Before 30 years coast and normal tidal water position are 1 or 1.5 km far from the present shoreline, but nowadays it is gradually forwarding towards the land. Basically, sea level change is the average effect of all climatic induced disasters such as flood influx the huge melting water on the shoreline at every year and cyclone and storm surge inflow of balk of water into the coast. In addition, TR (extern heat) generally occurs in western zone within May to August *i.e.* late pre monsoon to late rainy monsoon. As well, thunderstorm is the unexpected and sudden disaster occurring during the March to August (*i.e.* pre monsoon to mid rainy monsoon) in the whole year. Respondents opined that Irregular rain & drought, now a day it is a common CCIDs in the coastal area of Bangladesh. In the month of May o July respondents are affected by irregular rain & drought *i.e.* per monsoon to mid rainy monsoon. In the month of June to October people are affected by different sort of diseases like, 'Kala Fever' and water borne diseases *i.e.* happened by early rainy monsoon to early post monsoon. In addition, storm surge generally occurs in this zone within April to October every year *i.e*. early pre monsoon to early post monsoon. Finally, land slide is available in central coastal zone like Chattogram and cox's bazaar because it is a hilly region. As well, land slide is the unexpected and sudden disaster occurring during the June to August (*i.e*. during rainy monsoon) in the eastern coastal zone (Table 5.6).

Qualitative findings explore that the coastal topography of Bangladesh is different somewhere flat, somewhere active and somewhere stable. That's why different type of disasters occurred in different places also this process has accelerated the distinct coastal physiography in whole coastal areas of Bangladesh. The semi-active delta is in the western region, and is crisscrossed by several channels and creeks. It has a very low and flat topography. In addition, the most active and continuous accretion and erosion processes are going on here in the central region. In the area lies the very active Meghna River estuary. The most destructive efforts of tropical cyclones and storm surges in the world have been seen in this estuary area, and it is very vulnerable to such calamities. In addition, the eastern region is more stable, being surrounded by hilly regions.

5.9 Frequency of Observing the CCID through the Whole Year in the Coastal Region of Bangladesh by the Respondents

Bangladesh is the world's most endangered country because of climate change. In the coastal area of Bangladesh, disasters such as cyclones, floods, storm surge, sea level rise and salinity intrusion, riverbank erosion, storm surge, tornado, thunderstorm, erratic rainfall and drought, various types of diseases etc., are caused every year by different types of climate change. The coastal people observing these types of disasters several times throughout the year (Table 5.7).

Table 5.7: Frequency of Observing the CCID through the Whole year in the Coastal Region of Bangladesh by the Respondents

Coastal Zones	Disaster / Time	Cyclone (%)	Flood (%)	S L R & SI (%)	RBE (%)	Storm Surge (%)	TR (*ext. heat*) (%)	Thunderstorm (%)	Various Diseases (%)	Tornado (%)	*I R & Drought* (%)	*Land Slide* (%)
Western Zone, n=170	One - Two	25.25	42.35	45.50	37.65	22.25	66.00	56.75	60.20	78.25	95.75	-
	Three-Four	64.75	48.82	43.25	42.95	55.30	30.25	42.25	37.20	21.75	4.25	-
	Five-Six	8.00	7.15	6.25	16.75	20.20	2.50	1.00	2.60	--	--	-
	More than six	2.00	1.68	5.00	2.65	2.25	1.25	--	--	--	--	-
	Total	100	100	100	100	100	100	100	100	100	100	-
Central Zone, n=110	One - Two	30.75	74.62	60.54	56.90	29.75	74.25	60.54	53.00	76.15	96.50	-
	Three-Four	56.85	22.31	36.54	36.15	52.35	24.50	26.75	38.50	22.35	3.50	-
	Five-Six	10.75	3.07	2.92	5.50	15.30	1.25	10.71	33.50	1.50	--	-
	More than six	1.65	--	--	1.45	2.60	--	2.00	8.50	--	--	-
	Total	100	100	100	100	100	100	100	100	100	100	-
Eastern Zone, n=120	One - Two	36.75	74.25	69.75	72.00	63.00	--	45.15	28.00	54.10	--	57.25
	Three-Four	52.00	24.00	28.00	21.75	29.00	--	35.00	36.00	23.40	--	36.75
	Five-Six	10.00	1.75	2.25	5.75	6.25	--	15.50	22.50	17.00	--	5.75
	More than six	1.25	--	--	0.50	1.75	--	4.35	13.50	5.50	--	0.25
	Total	100	100	100	100	100	--	100	100	100	--	100

Sources: Field Survey, 2018-19 Multiple Answers Considered

Cyclone: While considering cyclone frequency in the study area it is found that frequency varies from zone to zone. In the western zone, more than sixty four percent (64.75%) of surveyed folks said that cyclone occurred in three to four times in a year, almost a quarter (25.25%) said that one to two times and 8% opined five to six time in a year. In addition, in the central zone, nearly 57 % of surveyed people said that cyclone occurred in three to four times, 31% said one to two times and about 11% said five to six times in the whole year of their locality. Moreover, in the eastern zone, just over a half (52%) of the coastal people said they are facing cyclone at three to four times and nearly 37% people faces one to two times, 10% respondents opined that they are facing cyclone at five to six times in a year in their locality (Table-5.7).

Flood: Considering flood frequency in the study area it is found that frequency varies from zone to zone. In the western zone, more than forty eight percent (48.82%) of surveyed folks said that flood occurred in three to four times in a year, almost about forty two percent (42.35%) said that one to two times and 7% opined five to six time in a year. In addition, in the central zone, nearly 75% of surveyed people said that flood occurred in one to two times, 22% said three to four times and about 3% said five to six times in the whole year of their locality. Moreover, in the eastern zone, nearly 74% of the respondents said they are facing flood at three to four times and nearly 24% people are facing flood one to two times in a year in their area (Table-5.7).

SLR and Salinity Intrusion: In the western region, more than 45% participants said they are experienced one to two times SLR and salinity intrusion in their area and it's followed by the central coastal zone nearly 61%. However, in the central zone, just nearly 70% participants opined that they are experienced SLR and salinity intrusion at one to two times in their locality. In this circumstance, experts said that the central region is active by fluvial processes and large volume of water emitted during rainy season. As a result this area people are easily understood the sea level rise. However, the increase in sea level does not sustain the period it is a continuous way, because in the entire coastal areas of Bangladesh it is a prime disaster due to climate change (Table-5.7).

River Bank Erosion: In the western zone, people said that they are facing river bank erosion at three to four time (43%) and one to two times (38%), five to six times (17%) in their area respectively. This area is deltaic region, so fluvial activity is so little there. Further, in the central zone, majority surveyed people (57%) said that

bank erosion occurred in over one to two times, three to four times (36%) of their locality. Moreover, in the eastern zone, majority of the respondents (72%) opined they are facing bank erosion at one to two times, three two times (22%) in their locality per year. It is significant that, the central coastal region is the presence of active fluvial activity; eastern region is Island dominated also fluvial activity exists here while western region is a little bit more active than other two coastal regions of Bangladesh (Table-5.7).

Storm surge: In the western zone, more than two quarters (55%) of surveyed folks said that storm surge occurred a problem in three to four times and 22% said that one to two times, 20% respondents opined that they observed five to six times storm surge in their locality in a year. In addition, in the central zone, more than half (52%) of surveyed people said that storm surge occurred as problem in three to four times, nearly 30% respondents opined that they observed one – two times storm surge as disaster and 15% said five to six times in the whole year of their locality. Moreover, in the eastern zone, 63% of the respondents said they are facing storm surge at one to two times and 29% people faces three to four times and also 6% respondents opined that they facing storm surge at five to six times in their locality per year (Table-5.7).

Temperature Rise (Extreme Heat): While considering Temperature Rise (Extreme Heat) frequency in the study area it is found that frequency varies from zone to zone. In the western zone, sixty six percent surveyed folks said that TR (extreme heat) occurred in one to two times in a year, almost 32% opined that three to four times and 2.5% opined five to six time in a year. In addition, in the central zone, nearly 74% of surveyed people said that TR **(**extreme heat) occurred in one to two times, 24.50%% said three to four times in the whole year of their locality. Moreover, in the eastern zone, the surveyed people said that they are not facing that type of CCIDS (Table-5.7)

Thunderstorm: in the western zone, about 57% of the respondents are facing one to two times with thunderstorm. On the other hand about 42% respondents opined that they observed thunderstorm three to four times in their area in a year. Moreover, in the central zone, 61% people said that thunderstorm occurs in one to two times whereas 27% respondents opined that three to four times in their locality. Additionally, in the eastern zone, about 45%% of the respondents said that they are

facing thunderstorm at one to two times in their area per year, 35% opined three to four times and also more than 15% respondents said that they are facing with thunderstorm in their locality (Table-5.7).

Various Diseases [Kala Fever and Water Borne Diseases]: According to WHO, the world facing various types of newly diseases due to climate. In the western zone, nearly 60% of the respondents said that they are facing with various types of diseases which mentioned one to two time per year, on the other hand 37% of the respondents opined that they are facing with various diseases at three to four times in a year in their locality. Whereas, in the central zone majority (53%) respondents said that every year three to four times they are facing with various diseases like *kala –ager (fever)* however , more than 33% respondents opined that they are facing with various diseases at three to four times in their area. However, in the central zone, 36% participants said that they are facing by three to four times with various diseases in a year. On the other hand 28% one to two times and nearly 22% of the respondents three to four times and more than 13% participant observed various types diseases in a year (Table-5.7).

Tornado: in the western zone, a very large proportion (78%) of participants said that tornado occurs in their area and it's followed by the central coastal zone (76%) of Bangladesh. However, in the eastern zone, nearly 54% participants said that they are experiencing a tornado a one to two times in the area and 17% said five to six times in their locality (Table-5.7).

IR & Drought (Irregular Rainfall & Drought): While considering IR & Drought frequency in the study area it is found that frequency varies from zone to zone. In the western zone, more than seventy eight percent (78.25%) of surveyed folks said that IR & Drought occurred in three to four times in a year, almost a quarter (25.25%) said that IR & Drought happened in their locality one to two times and 21.75% opined three to two times. In addition, in the central zone, nearly 96 % of surveyed people said they are facing one to two times with IR & Drought (Irregular Rainfall & Drought. Moreover, in the eastern zone, respondents are not comment on IR & Drought (Table-5.7).

Land Slide: While considering Land slide disaster frequency in the study area it is found that frequency varies from zone to zone. In western zone and central zone are in equal due to Land slide because this two zone This two region are in floodplain area that's why this region is not affected by land slide, but the eastern region affected by land slide because of its landform. In addition, in the eastern zone, nearly fifty seven percent (57.25) respondents said that they face one to two times by land slide disaster, 37% at three to four times and also nearly 6% respondents opined that they face with landslide disaster at five to six times in a year (Table-5.7).

5.10 Climate Change Induced Disaster Related Risk in the Study Area

Bangladesh is an innocent climate change survivor. The popular scenario is that the coastal people are dealing with the natural calamities because of this change. They have been put at several risks by repeated natural disasters. Table 5.8 shows the risks created by climate change in all coastal areas of Bangladesh. The survey data show that nearly all respondents are facing food crises (98%, Rank-1) and scarcity of pure drinking water. Food is now seen as an acute problem in the climate change affected areas while the coastal people are unable to find due to scarcity of pure drinking water. On the other hand, availability of saline water has been increased due to sea level rise which creating water logging in the coastal Bangladesh. Salinity intrusion has devastated the cultured fisheries and it has destroyed the crop production resulting food scarcity, malnutrition and poverty among the poor and ultra-people. The coastal community, in some cases, are planting trees and increasing homestead forest to mitigate the unfavorable impacts of natural calamities. Disasters such as cyclones, flooding and the rise of the sea level have damaged the pond and washed away fish. Like cyclone and floods, *chingri ghers* were overwhelmed by tidal surge and swept away. Coastal residents are still unable to pay for the health care services due to these losses. It is also apparent that people facing climate change are more vulnerable to climate risks.

Table 5.8: Climate Change Induced Disasters Related Risk in the Study Area

CCIDs Related Risk Sectors	Western Coast n=170		Central Coast n=110		Eastern Coast n=120		Total	
	%	R	%	R	%	R	%	R
Food Security	98.82	1	97.69	2	96.66	2	97.72	1
Health Security	94.00	4	98.46	1	98.00	1	96.42	2
Destroyed the standing crops	95.00	3	92.30	4	95.25	3	94.18	3
Scarcity of pure drinking water	97.00	2	92.30	5	90.25	4	93.18	4
Sanitation facilities	88.23	5	92.30	4	87.25	6	89.26	5
Safety	63.52	6	97.69	2	96.66	2	85.96	6
Creating water logging	56.00	11	98.46	1	76.00	7	76.82	7
Saline water devastated the cultured fisheries	60.58	10	79.23	6	76.00	7	71.94	8
Education	59.41	9	66.15	7	70.00	8	65.19	9
Loss of crops due to salinity	43.00	12	64.00	8	55.15	10	54.05	10
Shrimp *Gher* have been inundated and washed away due to intrusion of tidal water	63.00	7	11.53	10	69.53	9	48.02	11
Transportation	61.76	8	96.00	3	88.10	5	41.95	12
Others	20.58	13	44.00	9	43.34	11	35.97	13

Source: Field Survey 2018 Multiple Answers Considered

N.B: Rank size was demarcated considering the percentage of questionnaire survey

5.11 Relationship between CCIDs and Livelihood in the Study Area

Table 5.9 illustrates that there is no significant relation between climate changes induced disasters and social livelihood. An attempt has been made to statistically interpret the relationship between CCIDs and coastal people's livelihoods in the entire coastal belt of Bangladesh in order to examine the data more strictly. For this aspect a null hypothesis (***H_o): there is no significant relation between CCIDs and livelihood.***

Table 5.9: Relationship between CCIDs and Livelihood in the Study Area

1st Variable	2nd Variable	Chi-square (χ^2)				
		Cal value	**Tab value**	**Result**	**df**	**Sig.***
Climate Induced Disasters	Social Safety Net Programs[1]	47.479	9.488	37.991	4	S
	Initiatives of Health Care Facilities	21.534	9.488	12.046	4	S
	Condition of Road and Communication	25.289	9.488	15.801	4	S

*S= Significant, *NS = Not Significant, *df* = degree of freedom, significance at the level of 0.05 [Appendix –VI (whole coastal area)].

After cross tabulation, the Chi square (χ^2) test has been performed. The findings are shown in table 5.9 with the significance levels for the chi-square (χ^2) test. Rejecting the null hypothesis (***H*****$_o$**) *i.e.* no association has been acknowledged CCIDs and coastal people's livelihood in alternative hypothesis between study areas. The chi-square (χ^2) test results show that in the entire coastal belt of Bangladesh a significant difference between CCIDs coastal peopl's livelihoods. Table 5.9 explains that 'Social Safety Net Programs', 'Initiatives of Health Care Facilities' and 'Condition of Road and Communication' is significant [Hypothesis (H_o) = Cal $_{value}$ $\rangle$ Tab $_{value}$ = Significant] in the whole coastal belt of Bangladesh.

Experts opined that due to different sorts of inequalities, inadequate access of basic needs, absence of equal resource mobilization and distribution, development activities interrupted by local politics and recurrent disasters are the main reasons of poverty of coastal people. In this circumstance, government of the people's republic of Bangladesh has established 'Social Safety net program'. The SSNP have led to poverty and insecurity reduction by targeting a wide variety of demographic groups by multiple means of assistance. These include the provision of income protection for the elderly, widows and persons-with-disabilities, the provision of temporary employment for men and women of working age, and the promotion of healthy growth for young mothers and children. Most of the time, these initiatives are

[1] Social Safety Nets (SSNs) are non-contributing programmes that aim the poor and vulnerable segment of people and are intended to lessen poverty and inequality, facilitate better social investments, better community risk administration, and deal social security to those living under the poverty line (Ferdous, 2014).

interrupted by CCIDs in the coastal areas of Bangladesh. Thus, these activities are interrupted by climate induced disasters. Besides, climate change induced disasters are disturbed the initiatives of health care facilities in the coastal areas. Additionally, disasters are collapsing the total communication system in countryside areas. Sometime disconnected with others upazilas and districts. At that time, government service providing departments cannot provide their services to coastal dwellers in the coastal area of Bangladesh. However, this condition depends on the physical sitting, i.e. somewhere flat, active and stable and also some areas are hard to reach. Similarly, the coastal area are crisscrossed by tidal creeks, stream and rivers.

5.12 Zonal Variation in Relationship between CCIDS and Livelihood in the Study Area

Table 5.10 indicates that there is no essential relationship between CCIDs and livelihoods in terms of regional distinction. In order to examine the data more strictly an attempt has been made to statistically interpret the relationship between CCIDs and coastal people's livelihoods in terma regional differentiation. For this aspect a null hypothesis (***H_o***): ***there is no significant relation between CCIDs and livelihood of coastal dwellers regarding on regional differentiation.***

After cross tabulation, the Chi square (χ^2) test has been performed. The findings are shown in table 5.10 with the significance levels for the chi-square (χ^2) test. Rejecting the null hypothesis- there is no relationship between CCIDs and livelihood of the coastal people regarding on regional differentiation. The chi-square (χ^2) test results point out that a significant difference between CCIDs and livelihoods of the coastal people regarding on regional differentiation. Table 5.10 explains that 'Social Safety Net Programs', 'Initiatives of Health Care Facilities' and 'Condition of Road and Communication' are significant [Hypothesis (H_o) = Cal $_{value}$ $\rangle$ Tab $_{value}$ = Significant] in the among coastal belt of Bangladesh. As a result, the null hypothesis (H_o) is rejected and the alternative hypothesis (H_1) is accepted. Besides, Social Safety Net Programs', 'Initiatives of Health Care Facilities' and 'Condition of Road and Communications are non-significant. [Hypothesis (H_o) = Cal $_{value}$ $\langle$ Tab $_{value}$ = Non-significant] in among coastal zone areas. Consequently, the null hypothesis (H_o) is accepted and the alternative hypothesis (H_1) is rejected.

Table: 5.10 Zonal Variations in Relationship between CCIDs and Livelihood in the Study Area

1st Variable	2nd Variable	Zone One – Western Coastal area					Zone Two – Central Coastal area					Zone Three – Eastern Coastal area				
		Chi-square (χ^2)					Chi-square (χ^2)					Chi-square (χ^2)				
		Cal_{value}	Tab_{value}	Result	df	Sig*	Cal_{value}	Tab_{value}	Result	df	Sig*	Cal_{value}	Tab_{value}	Result	df	Sig*
Climate Induced Disasters	Social Safety Net Programs	3.688	7.815	- 4.127	3	NS	5.791	9.488	-3.697	4	NS	15.366	9.488	5.878	4	S
	Initiatives of Health Care Facilities	1.540	9.488	-7.948	4	NS	18.233	9.488	8.745	4	S	22.045	9.488	12.557	4	S
	Condition of road and communication	12.190	7.815	4.375	3	S	4.986	9.488	-4.502	4	NS	24.066	9.488	14.578	4	S

***S= Significant, *NS = Not Significant, *df* = degree of freedom, significance at the level of 0.05** [Appendix- VII (Western, Central and Eastern Coastal Area)].

In the western coastal region, the null hypothesis is rejected and alternative hypothesis is accepted with regard to SSNP and health care facilities projects, whereas the null hypothesis is accepted and alternative hypothesis is rejected with regard to road and communication conditions. However, focusing hypothesis is significant on the situation of road and communication, but fixing hypothesis is non-significant on social safety net programs and initiatives of health care facilities. Qualitative findings explore that this are situated in deltaic regions which mainly comprises active, moribund and mature deltaic areas. Similarly, world largest mangrove forest situated here. Local people mostly engaged commercially shrimp forming and sometime shrimp cum fish farming. Due to shrimp farming, local people make a dike from the Bay of Bangle to inland fallow land or low-lying cultivate land. Thus, the fresh water ecology has been converted to saline water ecology. Last three decades, this area called the 'White Gold' area and created a commercial fish business hub of Bangladesh. Along site situated the 'Port of Mongla'. That's why, these area social safety net programs are implement properly and health care facility is good. However, adjacent area of coast, a number of tidal creeks, streams and rivers crisscrossed here. So, the condition of road and communication is not so good. Also, after extremely severe cyclone storm Sidr in 2017, the area was too much affected. At hat time the storm surge reached the entire towns of Satkhira, Patuakhali, Barguna and Jhalokati district, and the Sunderbans World Heritage site was damaged.

Besides, in the central zone, the null hypothesis is rejected and alternative hypothesis is accepted regarding on social safety net programs and condition of road and communication while the null hypothesis is accepted and alternative hypothesis is rejected considering on the initiatives of health care facilities. However, focusing hypothesis is significant on the initiatives of health care facilities, but fixing hypothesis is non-significant on social safety net programs and Situation of road and communication. Experts said that this area is situated in the central zone of Bangladesh. In terms of the Brahmaputra-Jamuna, the Ganges-Padma, and the Surma-Meghna water discharge in this region, the major river confluences. Hence, this area is fluvial dominated and active. It extend from Patuakhali district to Feni districts. Huge number of the Island exist here. So, health care facility providing department did not ensure their services every area in this zone. Sometimes the communication system totally disrupted and islands area scattered during disaster period.

Moreover, in the eastern zone, the null hypothesis is rejected and alternative hypothesis is accepted regarding on social safety net programs, initiatives of health care facilities and condition of road and communication respectively. So, addressing hypothesis is significant on social safety net programs, initiatives of health care facilities and condition of road and communication. Qualitative checklist survey (KIIs and FGDs) reveals that this area is situated from Feni District to Teknaf Upazila. This area is the meeting zone of hills and Bay of Bangle. The long distance is highly vulnerable due to flesh flood, coastal flood, cyclone, river bank erosion and exist three remarkable Islands namely i.e. Sandwip, Kutubdia and Maheskhali as well as population densely is high. Thus, the severity and magnitude of the disasters is very high than others two zones. The commercial capital means Chittagong city and tourist capital means Cox's Bazar city are situated in this coastal belt. Owing to that a huge number of populations living here for different purposes. Therefore, while occurred any disaster here that time the possibility of damages is higher than other coastal zones.

5.13 Relationship among CCIDs and livelihood in the study area

Table 5.11 shows that there is no significant relation between CCIDs and livelihood in the study area. In order to examine the data more severely an attempt has been made to statistically interpret the relationship between CCIDS and livelihood of coastal dwellers. For this aspect a null hypothesis (***H_o***): ***there is no association among CCIDs and livelihood of coastal community in the study area.***

After cross tabulation the Chi square (χ^2) test has been performed. The findings are shown in table 5.11 with the significance levels for the chi-square (χ^2) test. Rejecting the null hypothesis- there is no relationship between CCIDs and livelihood of the coastal people regarding on regional differentiation. The chi-square (χ^2) test results indicate that a significant difference between CCIDs and livelihood of the coastal people regarding on regional differentiation. Table 5.10 explains that 'Social Safety Net Programs', 'Initiatives of Health Care Facilities' and 'Condition of Road and Communication' are significant [Hypothesis (H_o) = Cal $_{value}$ $\rangle$ Tab $_{value}$ = Significant] in the among coastal belt of Bangladesh. As a consequence, it refuese the null hypothesis (H_o) supports the alternative hypothesis (H_1). Besides, Social Safety Net Programs', 'Initiatives of Health Care Facilities' and 'Condition of Road and Communication' are non-significant [Hypothesis (H_o) = Cal $_{value}$ $\langle$ Tab $_{value}$ = Non-significant] in among coastal zone areas. The null hypothesis (H_o) is then accepted and the alternative hypothesis (H_1) is ignored.

Table 5.11: Relationship among the CCIDs and Livelihood in Study Area

First Variable	Second Variable	Chi-square (χ^2)				
		Cal $_{value}$	**Tab$_{value}$**	**Result**	**df**	**Sig.***
Cyclone	Social Safety Net Programs	65.39	18.30	47.09	10	S
	Initiatives of Health Care Facilities	84.74	55.75	28.99	40	S
	Situation of Road and Communication	1.28	55.75	-54.47	40	NS
Flood	Social Safety Net Programs	78.39	15.50	62.89	8	S
	Initiatives of Health Care Facilities	1.19	45.77	-44.58	32	NS
	Situation of Road and Communication	87.44	45.77	41.67	32	S
Sea-level Rise	Social Safety Net Programs	6.13	16.91	-10.78	9	NS
	Initiatives of Health Care Facilities	45.11	47.77	-2.66	36	NS
	Situation of Road and Communication	1.02	47.77	-46.75	36	NS
Salinity Intrusion	Social Safety Net Programs	25.78	16.91	8.87	9	S
	Initiatives of Health Care Facilities	1.30	47.77	-46.47	36	NS
	Situation of Road and Communication	1.07	47.77	-46.7	36	NS
Thunderstorm	Social Safety Net Programs	31.86	19.67	12.19	11	S
	Initiatives of Health Care Facilities	1.48	57.59	-56.11	44	NS
	Situation of Road and Communication	98.55	57.59	40.96	44	S
Temperature rise (extreme heat)	Social Safety Net Programs	35.84	16.91	18.93	9	S
	Initiatives of Health Care Facilities	1.09	47.77	-46.68	36	NS
	Situation of Road and Communication	1.03	47.77	-46.74	36	NS
Tidal water intrusion	Social Safety Net Programs	1.38	16.91	-15.53	9	NS
	Initiatives of Health Care Facilities	1.54	47.77	-46.23	36	NS
	Situation of Road and Communication	1.25	47.77	-46.52	36	NS
Tornado	Social Safety Net Programs	9.12	12.59	-3.47	6	NS
	Initiatives of Health Care Facilities	27.55	36.41	-8.86	24	NS
	Situation of Road and Communication	47.37	36.41	10.96	24	S
Irregular rainfall	Social Safety Net Programs	10.53	14.06	-3.53	7	NS
	Initiatives of Health Care Facilities	32.88	41.33	-8.45	28	NS
	Situation of Road and Communication	59.09	41.33	17.76	28	S
Water Born Disease	Social Safety Net Programs	5.78	16.91	-11.13	9	NS
	Initiatives of Health Care Facilities	38.39	47.77	-9.38	36	NS
	Situation of Road and Communication	53.66	47.77	5.89	36	S
Fever (Kala-azar)	Social Safety Net Programs	11.60	15.50	-3.9	8	NS
	Initiatives of Health Care Facilities	29.85	45.77	-15.92	32	NS
	Situation of Road and Communication	26.42	45.77	-19.35	32	NS
CCIDs	Social Safety Net Programs	47.479	9.488	37.991	4	S
	Initiatives of Health Care Facilities	21.534	9.488	12.046	4	S
	Situation of Road and Communication	25.289	9.488	15.801	4	S

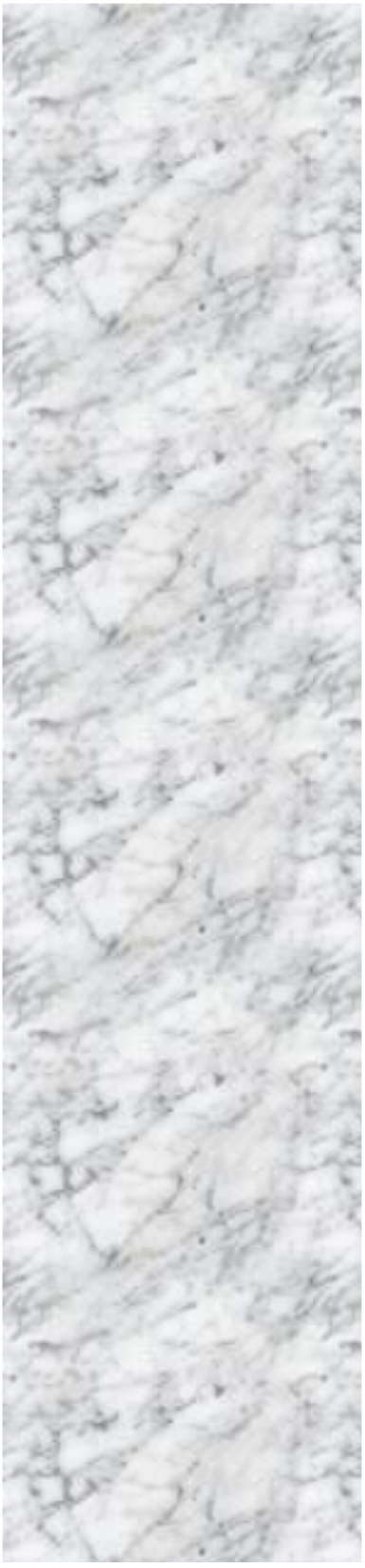
*S= Significant, *NS = Not Significant, *df* = degree of freedom, significance at the level of 0.05.

5.14 Conclusion

Currently, the age is called the age of information. In this age of information consequently, people get the news from different sources easily using modern information technologies like for instance, internet, online version of print and electronic media and social media. Yet, one quarter of the coastal people is lack behind about the climate change. However, almost 87% people informed about CCIDs in the study area. Cyclone, bank erosion, flood and salinity are the main CCIDs in Bangladesh, while these disasters differ from zone to zone in the coastal region of Bangladesh. The more effectible CCIDs are found cyclone, SLR and both cyclone and flood together in western, central and eastern zone of the study area respectively. The nature of disasters varies on the basis of the coastal reigns of Bangladesh and directly respond on the seasonal variation. Moreover, the climate induced disasters have significant relation with livelihood patters of the coastal people. Nonetheless, the relationship has been fluctuated by the region to region. Notwithstanding, the eastern coastal belt very worse than others two zones of Bangladesh.

Chapter 6

SOCIAL VULNERABILITY AND THEIR LOCATIONAL DIFFERENCES IN THE STUDY AREA



6.1 Introduction

Bangladesh is experiencing various types of CCIDs, such as tropical cyclones, storm surge, coastal erosion, flooding and droughts and facing heavy loss of life and property which affects the development activities in every year. There are also faces many problems facing Bangladesh such as high population density, land scarcity, food security, human health, illiteracy, and so on. Most of the climate change disasters that affects Bangladesh is likely to come from the south, the Bay of Bengal and the North Indian Ocean bordering it. The causes of tropical cyclones and storm surges, coastal erosion, monsoon wind, monsoon rainfall evaporation, floods, and droughts are these. Available observational evidence shows that regional changes in climate, particularly temperature rises, have already affected a number of physical and biological systems in many parts of the world (IPCC, 2001). In these consequences, a certain population remained poverty cycle, particularly coastal people. In this situation, social safety net program is the main weapon and it being in a straight line operated by the Government the People's Republic of Bangladesh. These programs try to deal with both human poverty and income poverty. On the other hand, while income-generating and employment-generating initiatives are being run, some other programs are also working under the slogan of assisting human development by ensuring settlement, education, health, nutrition, sanitation and fresh water. The Government of Bangladesh focuses primarily on the elimination of poverty and inequity in the perpetration of its development policy, prioritizing activities targeting the extreme poor, women in poverty, landless poor, and other vulnerable classes. A strong and strengthened social safety net in this regard is the key of the current government's vision to shield the vulnerable from all types of social, economic and natural shocks (GoB, 2009).

However, this chapter tried to explore the mathematical explanation of social vulnerability index and tried to knew the social vulnerability on particular social issues, used by few prominent scholars those who utilized the 'Social Vulnerability Index' in the research (Table 6.1).

Table 6.1: Familiar Research Works Related with Social Vulnerability

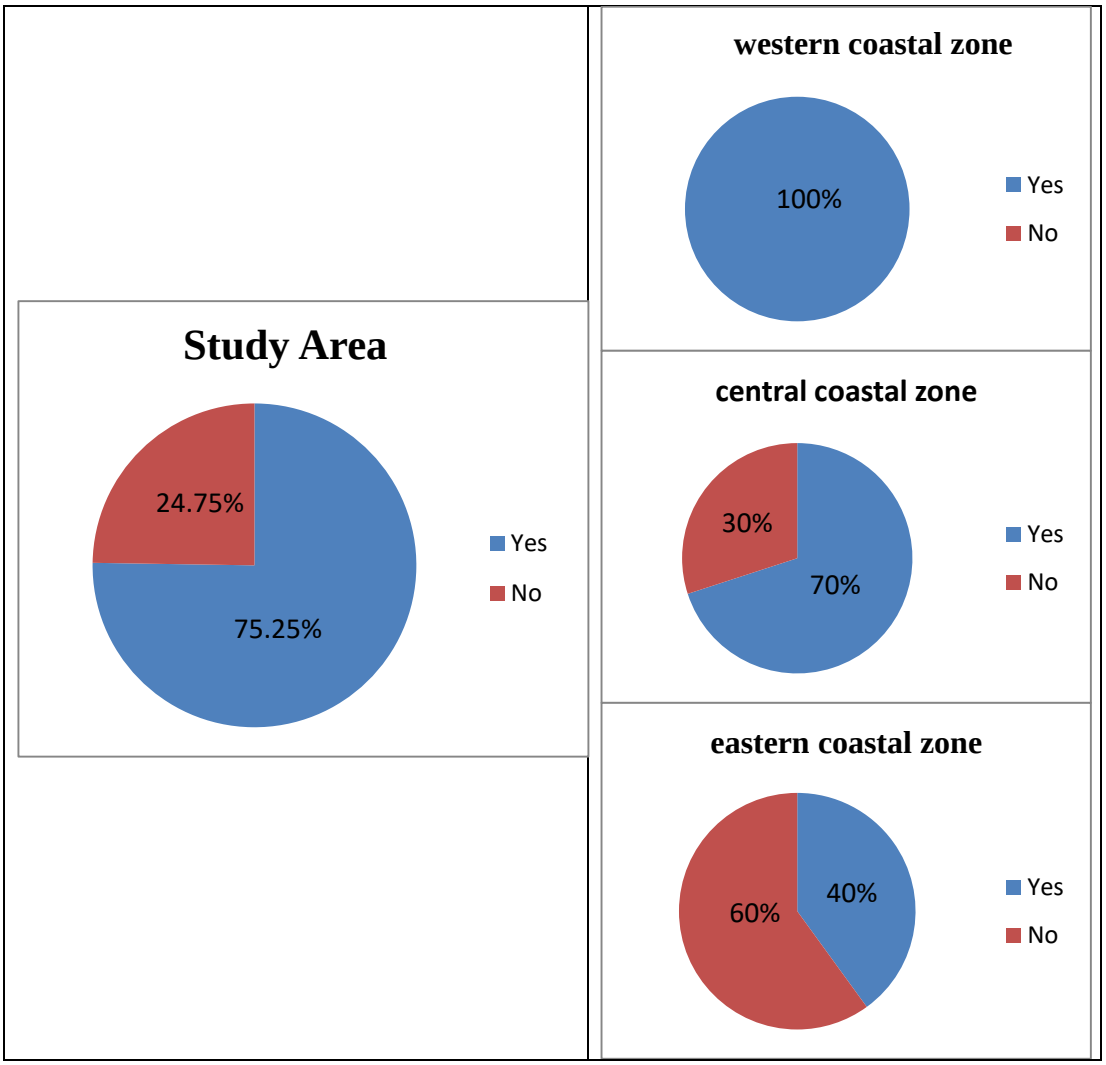
Name of Scholar and Year	Research works
Fussel, Hans-Martin. 2009	"Review and Quantitative Analysis of Indices of Climate Change Exposure"
UNDP. 2006	"Human development report"
Adger, *et al.* 2004	"New Indicators of Vulnerability and Adaptive Capacity"
Cutter, Susan L., *et al.* 2003	"Social Vulnerability to Environmental Hazards"
Chris Easter. 2000	"The Common Wealth Vulnerability Index"
Adger, W.N. 1999	Social Vulnerability to Climate Change and Extremes in Coastal Vietnam
Atkins, J., S. Mazzi, and C.Ramlogan. 1998	A Study on the Vulnerability of Developing and Island States: A Composite Index
Abraham,G.2012	Estimate Social Vulnerability Index to Climate in Mexico

Source: Prepared by the Author

6.2 Awareness about Social Safety Net Program of the Respondents in the Study Area

In pursuance of the previous literature review, Social Safety Nets (SSNs) are non-contributing programmes that aim the poor and vulnerable segment of people and are intended to lessen poverty and inequality, facilitate better social investments, better community risk administration, and deal social security to those living under the poverty line (Alam, 2015).

Figure 6.1: Awareness about Social Safety Net Program of the Respondents



Source: Field Survey, 2018-19

Figure 6.1 shows the awareness about social safety net program of the respondents in the study area. Nearly three quarters of the coastal people are very aware about the social safety net program that is operating in the coastal areas. Yet, exactly one quarter of the coastal people do not know about this program. However, awareness about SSNP varies from zone to zone in the study area. For instance, in the western coastal belt almost every people are aware about the social safety net program, whereas only 40% of the people are aware in the eastern coastal belt. In central zone 70% people are aware about SSNP. Observation for last two decades shows the western coastal belt as more vulnerable than others. Notable that Cyclone Sidr (2007), Rashmi (2008), Aila & Bijli (2009),Viyaru (2013), Komen (2015), Roanu (2016), Mora (2017), Fani & bulbul (2019) and so on directly hit in the western

coastal belt namely Satkhira, Bagherhat, Khulna, Pautakhali, Barguna, Pirozpur and Jhalokati districts and also in central and eastern coastal belt of Bangladesh. In these consequences, government bodies and related departments have given more emphasis the social safety net program in this area. In reality, program implementing bodies of the government are very active in those places where these disasters hit frequently and cue to that income inequality and poverty varying from zone to zone in the study area.

6.3 Types of Existing Social Safety Net Programs in the Study area

Out of one hundred fifty SSNP in Bangladesh ten SSNP are active in the study area from where peoples are getting benefit (Table 6.2). Among the ten SSNP people opine that VGD and VGF provide maximum benefit (25.71%, R-1) followed by health facilities (17.94%, R-2), awareness buildup (11.86%, R-3), education related (11.72%, R-4), adult allowance (7.91%, R-5), free medicine (6.73%, R-6), and Freedom fighter allowance (6.07%, R-7) are the leading and easily accessible benefits those get people from this program in the study area. In the western coastal zone, VGD & VGF (27.30%, R-1), health facilities (17.71%, R-2), freedom fighter allowance (10.70%, R-3) and free medicine and education related (10.33%, R-4) are the main accessible benefits get from this program. Besides, in the central zone, awareness buildup (25.23%, R-1), awareness buildup (18.35%, R-2), health facilities (16.51%, R-3), adult allowance (9.63%, R-4) and education related (8.72%, R-5) are the major benefits those people access easily from this program. Furthermore, in the eastern zone, adult allowance (24.20%, R-1), health facilities (19.63%, R-2), education related (16.44%, R-3), awareness buildup (11.42%, R-4), adult allowance (8.68%, R-5), free medicine (8.22%, R-6) and widow allowance (5.94%, R-7), are the important benefits those accesses from this program. Rank (R) size was demarcated considering the percentage of questionnaire Survey.

Table 6.2: Types of Existing Safety Net Programs in the Study Area

Types of safety net programs	Western Zone, n=271		Central Zone, n=218		Eastern Zone, n= 219		Total n= 708	
	%	*R*	*%*	*R*	*%*	*R*	*%*	*R*
VGD (Vulnerable Group Development) and VGF(Vulnerable Group Feeding)	27.30	1	25.23	1	24.20	1	25.71	1
Health Facilities	17.71	2	16.51	3	19.63	2	17.94	2
Awareness buildup	7.01	5	18.35	2	11.42	4	11.86	3
Education related	10.33	4	8.72	5	16.44	3	11.72	4
Adult allowance	4.06	6	9.63	4	8.68	5	7.91	5
Free Medicine	10.33	4	3.67	8	8.22	6	6.73	6
Freedom fighter allowance	10.70	3	4.23	7	2.28	8	6.07	7
Widow allowance	3.70	7	3.21	9	5.94	7	4.24	8
Allowance for disabled people	3.32	8	5.50	6	1.37	10	3.39	9
Medical allowance	2.21	9	2.29	11	1.83	9	2.19	10
No Answer	1.45	10	2.75	10	0	11	1.41	11
Total	100		100		100		100	

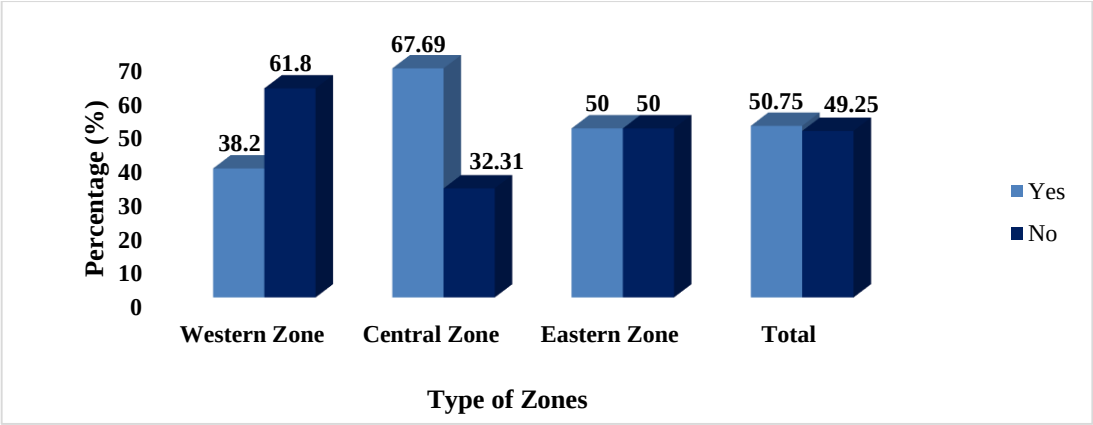
Source: Field Survey 2018-19 N.B: Multiple answer considered, R= Rank

N.B: Rank size was demarcated considering the percentage of questionnaire Survey

6.4 Getting Benefit from the Social Safety Net Program

Findings of questionnaire survey more than half of the respondents of coastal dwellers are getting benefit from the SSNP. Nearly 68% of the coastal dwellers in Central Coastal Zone are getting benefit from SSNP followed by 50% in Eastern Coastal Zone and 38.2% in Western Coastal Zone of the study area. Getting less benefit from SSNP happens due to the interruption of local influential people (Figure-6.2).

Figure 6.2: Getting Benefit from the Social Safety Net Programs



Source: Field Survey, 2018-19

6.5 Reasons for not Getting the Benefit from the Social Safety Net Program

Disaster is the predestined misfortune for the whole nation, because of our physiographical setting as well as few human induced interfaces increase the severity of these disasters. The study has explored five reasons which directly and indirectly interrupted to getting benefits from social safety net program (Table 6.3) in the study area. Nearly 67% of the coastal people argued that local influential people interrupted this program in the coastal areas. Followed by local authority do not inform (16.67%), corruption and nepotism of local authority (14.25%) another leading reason those interrupted the implementation of this program properly. Nevertheless, a half of the surveyed people in the eastern zone said that they do not recognize about this program.

Table 6.3: Reasons for not Getting the Benefit from the SSNP

Reasons	**Western Zone**		**Central Zone**		**Eastern Zone**		**Total**	
	f	*%*	*f*	*%*	*f*	*%*	*f*	*%*
Lack of consciousness of people about social safety net program	16	9.41	6	5.54	20	16.67	42	10.5
Corruption and nepotism of local authority	20	11.76	19	17.27	18	15.00	57	14.25
Local authority do not inform	--	--	7	6.36	13	10.83	20	16.67
Absence of authority	--	--	3	2.77	11	9.17	14	3.50
Local influential people interrupted the program	134	78.82	75	68.19	58	48.33	267	66.75
Total	170	100	110	100	120	100	400	100

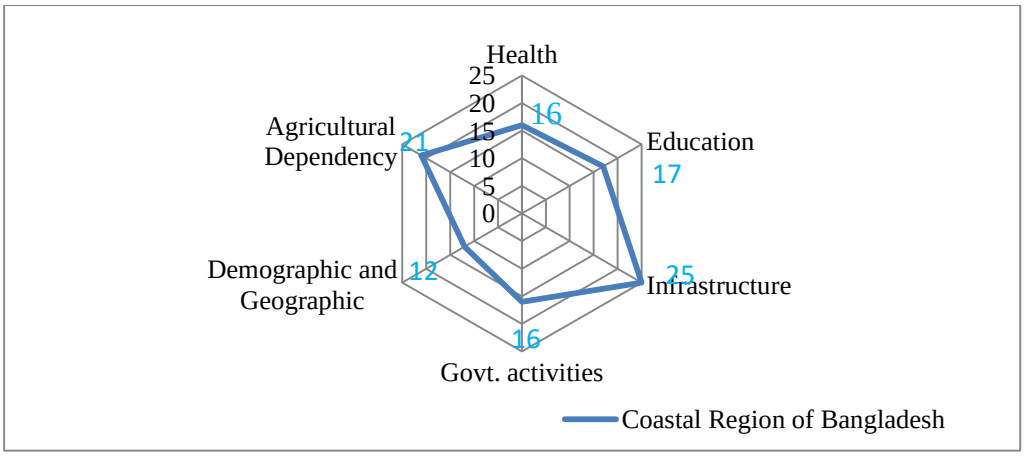
Source: Field Survey, 2018-19

Qualitative findings explored that every local area has a body, this body operated by any influential person or group and they created a circle in their territory. While any organization either government or non-government implement any development program or project that time implementation party must consider the representative preference who are working for influential person or group. These people or group not only try to operate the program, but also control the program activities. They directly or indirectly involve the corruption and sometime preference their relative and thyself as a beneficiary of this development program. Unluckily, the social safety net program as a weapon not popularize all zones in the coastal areas of Bangladesh. Experts believe that, can we perfectly implement the social safety net program in the coastal region of Bangladesh without corruption, interruption and control nepotism. Than it possible to reduce the disaster vulnerability and ensure proper pre-preparedness among disasters in the coastal zones of Bangladesh.

6.6 Risk Sector (due to Climate Change) in the Study Area

Granados (2012) social vulnerability has considered six types of sectors such as health, education, infrastructure, govt. activities, and demography and agricultural depended respectively. After that author have been following these sectors to this research. The study observed that nature of coastal structure and human activities variation hole coastal region of Bangladesh are not in same risk (Figure 6.3). The following sub-sections have been explores the sectors are highly risky owing to climate change among coastal zones of Bangladesh. Twenty five percent of the respondents of the study area opined that infrastructure sector is in more risk due to CC followed by agricultural dependency sector (21%), education sector (17%), health sector (16%), govt. activities sector(16%). demographic and geographic sector (12%). Due to its Geographical location, flat and low-lying terrain, Bangladesh is highly vulnerable to natural disasters. The flood plain Coastal Zone of Bangladesh is in more risk due to climatic disaster like Flood, Cyclone, River bank or shoreline erosion, flash flood, coastal flooding, SLR and Salinity Intrusion etc. As a result, infrastructural sector is more affected due to bad effect of such climatic disaster on the other hand agricultural lands are easily inundated by the synchronization of upper catchment water flow and tidal fluctuation creates coastal flooding. Coastal low-lying arable areas inundated easily agricultural field and inundated the crop land before harvesting crops.

Figure 6.3 Risk Sector (due to Climate Change) in the Study Area

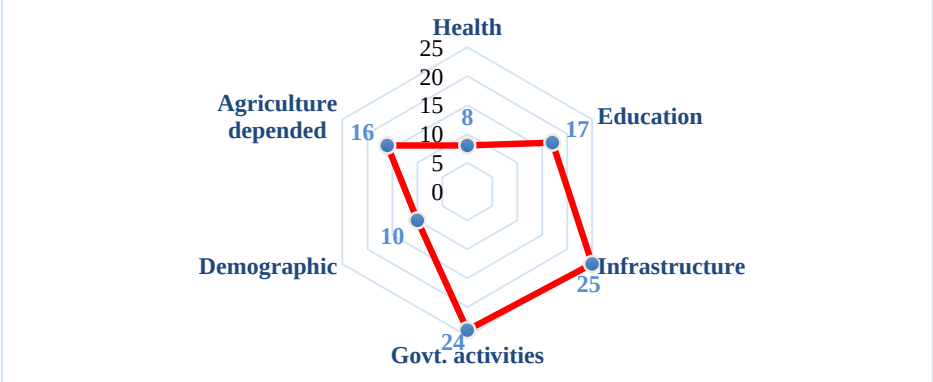


Source: Field Survey, 2018

6.6.1 Risky Sector Due to Climate Change (Western Coastal Zone)

In the western zone, disasters are mainly damages the infrastructure in this area. Twenty five percent of the respondents of the study area opined that infrastructure sector is in more risk due to CC followed by govt. activities sector(24%), education sector (17%), agricultural dependency sector (16%), demographic and geographic sector (10%) and health sector (8%),(Figure 6.4). Expert opinion explored that the western coastal zone is more susceptible than other two regions since 2000. Cyclone *Akash* to Cyclone Bulbul, nearly ten cyclones occurred in Bangladesh during 2000 to 2019. At that time, occurring disasters are mainly affected on the western coastal belt of Bangladesh. Experts believe that the occurring disasters are more devastation like cyclone 1991. But the existence of *the Sundarbans* (the world largest mangrove forest situated in the western coastal belt of Bangladesh) and proper pre-preparedness could not make these disasters damaging.

Figure 6.4: Risk Sector due to Climate Change (Western Coastal Zone)

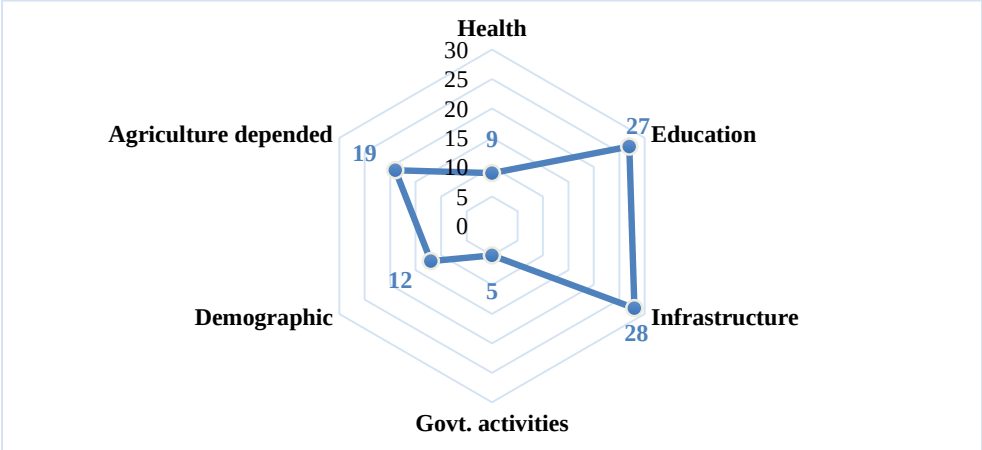


Source: Field Survey, 2018-19

6.6.2: Risk Sector Due to Climate Change (Central Coastal Zone)

In the central coastal belt, Twenty eight percent of the respondents of the study area opined that infrastructure sector is in more risk due to CC followed by education sector (27%), agricultural dependency sector (19%), demographic and geographic sector (12%) health sector (9%), govt. activities sector(5%), (Figure 6.5). Qualitative findings found that this coastal zone is mostly affected by fluvial processes. Bangladesh's largest river course, the four major river systems in the area, such as the Brahmaputra-Jamuna, the Ganges-Padma, and the Surma-Meghna discharge water. So, fluvial process is very active in this area. During flooding time, schooled children do not go to school and tremendously affected the infrastructural here. Similarly, agricultural fields are inundated before harvesting the crops.

Figure 6.5: Risk Sector Due to Climate Change (Central Coastal Zone)



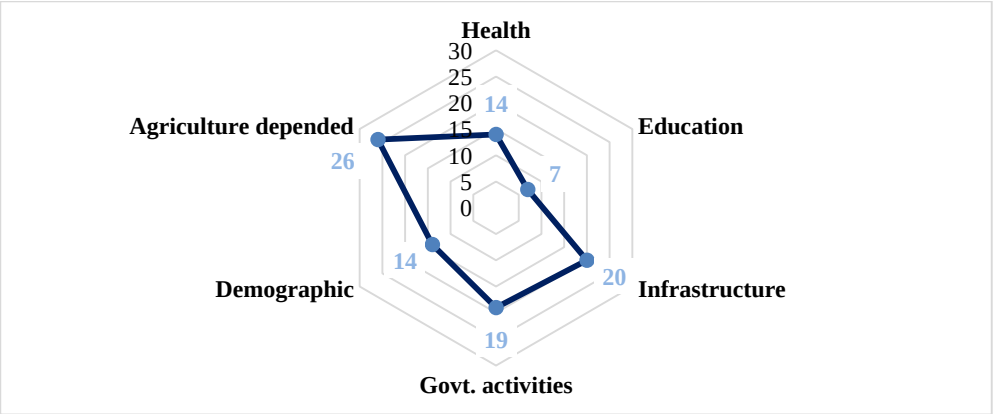
Source: Field Survey, 2018-19

6.6.3: Risk Sector due to Climate Change (Eastern Coastal Zone)

In the eastern zone, Twenty six percent of the respondents of the study area opined that agricultural dependency sector is in more risk due to CC followed by infrastructure sector (20%), govt. activities sector(19%), demographic and geographic sector (14%) health sector (14%) and education sector (7%),(Figure 6.6). River bank or shoreline erosion, flash flood, coastal flooding, cyclone is the common disasters here. As a result, agricultural lands are easily inundated by the synchronization of upper catchment water flow and tidal fluctuation have been created coastal flooding. By this reason, coastal low-lying arable areas are easily inundated and inundated the crop land before harvesting crops. Besides, owing to economic and recreational

purposes, huge population living in this area. While creating any depression, as a result a huge number of coastal inhabitants are potentially vulnerable in this area. So, a high proportion of coastal people are living vulnerable conditions here. Furthermore, this area is contained three big Islands like, Sandwip, Moheskhali and Kutubdia, a huge number of people inhabited in these Islands.

Figure 6.6: Risk Sector Due to Climate Change (Eastern Coastal Zone)



Source: Field Survey, 2018-19

6.7 Social Vulnerability in the Study Area

Vulnerability and adaptive capability metrics, which include variables to assess their interactions'' (Fussel, 2009). Vulnerability is the susceptibility of exposure to adverse stresses and the capacity to respond to these stresses in relation to climate change, It is subjective and must always be correlated with particular hazards and sensitivity to the consequences of the hazards''(Mertz, et al., 2009:746). The coastal area of Bangladesh is not same in social vulnerability issue due to different of their physical and socio-economical characteristics. In this sub sector researcher has tried to explain the social vulnerability position (applying vulnerability index on social issues) of he study area.

6.7.1 Social Vulnerability (applying vulnerability Index on Social issues) in Western Coastal Zone

Applying vulnerability index on social issues, social vulnerability has been analyzed in different zones of the study area. Table 6.4 shows the social vulnerability position in the Western Zone of the study area. General health, Child health, Mother Health and Pregnancy health are considered under health sector and variance among variables of this sector varies from 0.944 to 2.575. Likewise vulnerability varies from

0.00 to 1.00 scale which indicates that Child health is more vulnerable and Mother health along with Pregnancy health are less vulnerable. School going students, Infrastructure (Road), School infrastructure and Transportation are considered under education sector and variance among variables of this sector varies from 0.450 to 1.261. Likewise vulnerability varies from 0.00 to 1.00 scale which indicates that School going students is more vulnerable and transportation is less vulnerable (Table 6.5).Accommodation, Educational institute, Communities institute, Road, Bridge and Culvert, Shelter center and Embankment are considered under infrastructure sector and variance among variables of this sector varies from 0.464 to 2.987. Likewise vulnerability varies from 0.00 to 1.00 scale which indicates that educational institute along with embankment are more vulnerable and shelter center is less vulnerable (Table 6.5). Asset distribution, Relief Program, Relocation, Khas land distribution, Human Right, Basic needs and Justice are considered under government activities sector and variance among variables of this sector varies from 0.00 to 0.094. Likewise vulnerability varies from 0.00 to 1.00 scale which indicates that relocation along with basic needs are more vulnerable and asset distribution along with relief program, *khas land* distribution, human right and justice are less vulnerable (Table-6.4). Population Density, Migration, Security of live and Livelihood, Geological Characteristics, River, Location of Sea and Altitude are considered under Demographic & Geographic sector and variance among variables of this sector varies from 0.029 to 0.198. Likewise vulnerability varies from 0.00 to 1.00 scale which indicates that migration along with altitude are more vulnerable and Security of live and Livelihood along with geographical characteristics are less vulnerable (Table-6.4). Drought, Excess rainfall, Occupation, Livestock, Forestry and Fishing are considered under Agricultural sector and variance among variables of this sector varies from 0.670 to 3.254. Likewise vulnerability varies from 0.00 to 1.00 scales which indicate that migration along with altitude are more vulnerable and Security of live and Livelihood along with geographical characteristics are less vulnerable (Table-6.4).

Experts opined that children are more sensitive to disease in the coastal areas of Bangladesh. They are easily affected through their breast feeding mother. Because children's health depends on the mother's health. Due to disasters, coastal people are losses their resources and they cannot stay one occupied for a long time. They are bound to change their profession on the base of environmental change. The western coastal zone of Bangladesh, maximum people is engaged in shrimp cultivation. In this situation, cyclone and coastal flooding are flowing out their boundary of the plot. As a result, fish businessman face big amount of money in every year.

Table 6.4: Social Vulnerability (applying vulnerability index on social issues) in Western Coastal Zone

Sectors		Variance among Variables	Minimum Variance ${}_{i}Min\{Xij\}$	Maximum Variance ${}_{i}Max\{Xij\}$	Vulnerability $xij = \frac{Xij - {}_{i}Min\{Xij\}}{{}_{i}Max\{Xij\} - {}_{i}Min\{Xij\}}$
Health	General Health	1.767	0.944	2.575	0.50
	Child Health	2.575			1.00
	Mother Health	0.951			0.00
	Pregnancy Health	0.944			0.00
Education	School going students	1.261	0.450	1.261	1.00
	Infrastructure Road	0.896			0.55
	Schools infrastructure	1.088			0.79
	Transportation	0.450			0.00
Infrastructure	Accommodation	2.480	0.468	2.987	0.80
	Educational Institute	2.987			1.00
	Communities Institute	2.436			0.78
	Road	1.401			0.37
	Bridge and Culvert	1.965			0.59
	Shelter centers	1.177			0.28
	Embankment	2.987			1.00
Government	Asset distribution	0.000	0.000	0.094	0.00
	Relief Program	0.000			0.00
	Relocation	0.094			1.00
	Khas land distribution	000			0.00
	Human Right)	000			0.00
	Basic needs	0.094			1.00
	Justice	000			0.00
Demographics and	Population Density	0.076	0.029	0.198	0.28
	Migration	0.198			1.00
	Security of live and Livelihood	0.059			0.18
	Geological Characteristics	0.059			0.18
	River	0.175			0.86
	Location of Sea	0.175			0.86
	Altitude	0.198			1.00
Agricultural	Drought	2.206	0.670	3.254	0.59
	Excess rainfall	2.995			0.90
	Occupation	3.254			1.00
	Livestock	0.737			0.03
	Forestry	0.670			0.00
	Fishing	1.862			0.46

Source: Field Survey, 2018-19

To calculate the Social Vulnerability index, For instance-

General Health

Variance among variable (general health = X_{ij}) = 1.767
Minimum Variance ${}_i Min\{Xij\}$ = 0.944 [Calculated by SPSS]

Maximum Variance ${}_i Max\{Xij\}$ = 2.575 [Calculated by SPSS]

Vulnerability $xij = \frac{Xij - {}_i Min\{Xij\}}{{}_i Max\{Xij\} - {}_i Min\{Xij\}}$

$$= \frac{1.767 - 0.944}{2.575 - 0.944}$$

$$= \frac{0.82}{1.631}$$

General health = 0.50

This value (0.50) of social vulnerability index relating with table 6.5 sector health and sub sector general health].

6.7.2 Social Vulnerability (applying vulnerability Index on Social issues) in Central Coastal Zone

Applying vulnerability index on social issues, social vulnerability has been analyzed in different zones of the study area. Table 6.5 shows the social vulnerability position in the Central Zone of the study area. General health, Child health, Mother health and Pregnancy health are considered under health sector and variance among variables of this sector varies from 1.970 to 2.844. Likewise vulnerability varies from 0.00 to 1.00 scale which indicates that General health is more vulnerable and Mother health is less vulnerable. School going students, Infrastructure (Road), School infrastructure and Transportation are considered under education sector and variance among variables of this sector varies from 1.739 to 2.034. Likewise vulnerability varies from 0.00 to 1.00 scale which indicates that School going students is more vulnerable and school infrastructure is less vulnerable (Table 6.5). Accommodation, Educational institute, Communities institute, Road, Bridge and Culvert, Shelter center and Embankment are considered under infrastructure sector and variance among variables of this sector varies from 1.739 to 2.034. Likewise vulnerability varies from 0.00 to 1.00 scale which indicates that shelter center is more vulnerable and embankment is less vulnerable (Table 6.5). Asset distribution, Relief Program, Relocation, Khas land distribution, Human Right, Basic needs and Justice are considered under government activities sector and variance among variables of this sector varies from 1.739 to

2.034. Likewise vulnerability varies from 0.00 to 1.00 scale which indicates that relocation is more vulnerable and asset distribution is less vulnerable (Table-6.5). Population Density, Migration, Security of live and Livelihood, Geological Characteristics, River, Location of Sea and Altitude are considered under Demographic & Geographic sector and variance among variables of this sector varies from 0.573 to 1.130. Likewise vulnerability varies from 0.00 to 1.00 scale which indicates that altitude is more vulnerable and migration is less vulnerable (Table-6.5). Drought, Excess rainfall, Occupation, Livestock, Forestry and Fishing are considered under Agricultural sector and variance among variables of this sector varies from 0.926 to 1.441. Likewise vulnerability varies from 0.00 to 1.00 scale which indicates that fishing is more vulnerable and excess rainfall is less vulnerable (Table-6.5). The professional group said that this area is highly responsive to fluvial processes, tidal fluctuation, down cutting of rive and level of water and so on. These causes are responsible to create vulnerable conditions of the living beings of coastal inhabitants. Due to climate change, the water level or altitude is highly fluctuating i.e. ups and downs here, however, experts are calling it sea level rise. As well as, fishing sector is more vulnerable, because increased unscheduled change of water level.

Table 6.5: Social Vulnerability (applying vulnerability index on social issues) in Central Zone

Sectors		Variance among Variables	Minimum Variance ${}_i Min\{Xij\}$	Maximum Variance ${}_i Max\{Xij\}$	Vulnerability $xij = \frac{Xij - {}_i Min\{Xij\}}{{}_i Max\{Xij\} - {}_i Min\{Xij\}}$
Health	General Health	2.844	1.970	2.844	1.00
	Child Health	2.088			0.14
	Mother Health	1.970			0.00
	Pregnancy Health	2.103			0.15
Educatio	School going students	2.034	1.739	2.034	1.00
	Infrastructure Road	2.002			0.89
	Schools infrastructure	1.739			0.00
	Transportation	1.987			0.84
Infrastructure	Accommodation	2.888	2.605	3.309	0.40
	Educational Institute	2.801			0.28
	Communities Institute	3.302			0.99
	Road	2.846			0.34
	Bridge and Culvert	3.280			0.96
	Shelter centers	3.309			1.00
	Embankment	2.905			0.85

Table 6.5: Social Vulnerability (applying vulnerability index on social issues) in Central Zone (Continued)

Sectors	Variance among Variables	Minimum Variance $_{i}Min\{Xij\}$	Maximum Variance $_{i}Max\{Xij\}$	Vulnerability $xij = \frac{Xij - _{i}Min\{Xij\}}{_{i}Max\{Xij\} - _{i}Min\{Xij\}}$	
Government activities	Asset distribution	1.040	1.040	1.606	0.00
	Relief Program	1.259			0.39
	Relocation	1.606			1.00
	Khas land distribution	1.086			0.08
	Human Right)	1.321			0.50
	Basic needs	1.411			0.66
	Justice	1.353			0.55
Demographics and Geographic	Population Density	0.663	0.573	1.130	0.16
	Migration	0.573			0.00
	Security of live and Livelihood	0.829			0.46
	Geological Characteristics	0.807			0.42
	River	0.959			0.69
	Location of Sea	0.865			0.50
	Altitude	1.130			1.00
Agricultural Dependency	Drought	1.098	0.926	1.441	0.33
	Excess rainfall	0.926			0.00
	Occupation	1.269			0.67
	Livestock	1.371			0.86
	Forestry	1.219			0.57
	Fishing	1.441			1.00

Source: Field Survey, 2018-19

6.7.3 Social Vulnerability (applying vulnerability index on social issues) in Eastern Coastal Zone

Applying vulnerability index on social issues, social vulnerability has been analyzed in different zones of the study area. Table 6.6 shows the social vulnerability position in the Eastern Coastal Zone of the study area. General health, Child health, Mother health and Pregnancy health are considered under health sector and variance among variables of this sector varies from 0.648 to 2.024. Likewise vulnerability varies from 0.00 to 1.00 scale which indicates that General health is more vulnerable and Mother health is less vulnerable. School going students, Infrastructure (Road), School infrastructure and Transportation are considered under education sector and variance

among variables of this sector varies from 0.654 to 1.456. Likewise vulnerability varies from 0.00 to 1.00 scale which indicates that infrastructure (road) is more vulnerable and school infrastructure is less vulnerable (Table 6.6). Accommodation, Educational institute, Communities institute, Road, Bridge and Culvert, Shelter center and Embankment are considered under infrastructure sector and variance among variables of this sector varies from 1.121 to 2.273. Likewise vulnerability varies from 0.00 to 1.00 scale which indicates that educational institute is more vulnerable and embankment is less vulnerable (Table 6.6). Asset distribution, Relief Program, Relocation, Khas land distribution, Human Right, Basic needs and Justice are considered under government activities sector and variance among variables of this sector varies from 0.384 to 0.779. Likewise vulnerability varies from 0.00 to 1.00 scale which indicates that basic needs is more vulnerable and relief program is less vulnerable (Table-6.6). Population Density, Migration, Security of live and Livelihood, Geological Characteristics, River, Location of Sea and Altitude are considered under Demographic & Geographic sector and variance among variables of this sector varies from 0.02 to 0.972. Likewise vulnerability varies from 0.00 to 1.00 scale which indicates that population density is more vulnerable and location of sea is less vulnerable (Table-6.6). Drought, Excess rainfall, Occupation, Livestock, Forestry and Fishing are considered under Agricultural sector and variance among variables of this sector varies from 1.080 to 2.632. Likewise vulnerability varies from 0.00 to 1.00 scale which indicates that drought is more vulnerable and livestock is less vulnerable (Table-6.6). Qualitative findings explored that the eastern coastal belt is unique physiography among two coastal belt in Bangladesh. This coastal belt extends from Feni district to Cox's Bazar district. However, the national highways i.e. Chattogram to Cox's Bazar separated between the shoreline and piedmont areas. One side is hilly areas and the other side is the Bay of Bengal. As a result, the physiography becomes a gentle slope from the eastern part to southern part. Also covered three big Island like, Sandwip, Moheshkhali and Kutubdia. Huge population is settling in this belt, due exclusive economic zone, tourism purposes and accumulated climate induced displaced people in the every upazila in terms of municipalities and Chattogram Metropolitan city.

Table 6.6: Social Vulnerability (applying vulnerability index on social issues) in Eastern Coastal Zone

Sectors		Variance among Variables	Minimum Variance ${}_i Min\{Xij\}$	Maximum Variance ${}_i Max\{Xij\}$	Vulnerability $xij = \frac{Xij - {}_i Min\{Xij\}}{{}_i Max\{Xij\} - {}_i Min\{Xij\}}$
Health	General Health	2.024	0.648	2.024	1.00
	Child Health	1.085			0.32
	Mother Health	0.648			0.00
	Pregnancy Health	1.427			0.57
Education	School going students	1.142	0.654	1.456	0.61
	Infrastructure (Road)	1.456			1.00
	Schools infrastructure	0.654			0.00
	Transportation	1.037			0.48
Infrastructure	Accommodation	1.589	1.121	2.273	0.41
	Educational Institute	2.273			1.00
	Communities Institute	1.804			0.59
	Road	1.905			0.68
	Bridge and Culvert	1.205			0.07
	Shelter centers	1.644			0.45
	Embankment	1.121			0.00
Government activities	Asset distribution	0.627	0.384	0.779	0.62
	Relief Program	0.384			0.00
	Relocation	0.627			0.62
	Khas land distribution	0.634			0.63
	Human Right)	0.600			0.55
	Basic needs	0.779			1.00
	Justice	0.687			0.77
Demographics and Geographic	Population Density	0.972	0.020	0.972	1.00
	Migration	0.079			0.06
	Security of live and Livelihood	0.495			0.50
	Geological Characteristics	0.495			0.50
	River	0.452			0.45
	Location of Sea	0.020			0.00
	Altitude	0.079			0.06
Agricultural Dependency	Drought	2.632	1.080	2.632	1.00
	Excess rainfall	1.663			0.38
	Occupation	2.161			0.70
	Livestock	1.080			0.00
	Forestry	1.162			0.05
	Fishing	1.395			0.20

Source: Field Survey, 2018-19

6.7.4 Zone wise Spatial Variation of the Social Vulnerability in the Study Area.

The zone wise spatial variance of social vulnerability in the study area is shown in table 6.7. Data have been generated on the basis of this sector to determine minimum and maximum values (limit values) for each indicator, in order to turn them into indices with values between 0 and 1. In comparison to those closer to 0, which have less vulnerability in the area, values close to 1(one) mean increased vulnerability?

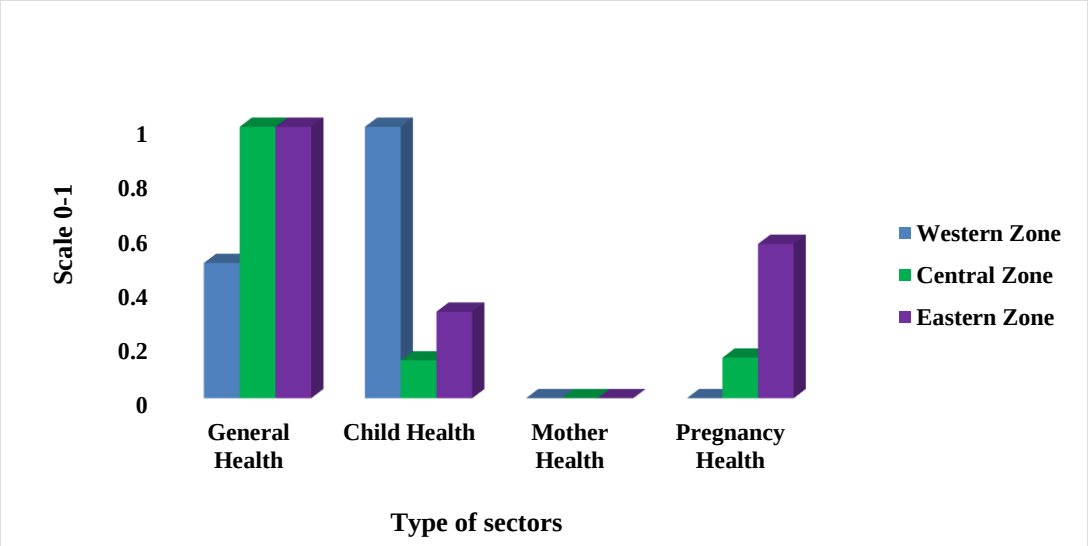
Table 6.7: Zone wise Spatial Variation of the Social Vulnerability (applying social vulnerability index) in the Study Area.

Sectors		Vulnerability / $xij = \frac{Xij - {}_i Min\{Xij\}}{{}_i Max\{Xij\} - {}_i Min\{Xij\}}$		
		Western Zone	**Central Zone**	**Eastern Zone**
Health	General Health	0.50	1.00	1.00
	Child Health	1.00	0.14	0.32
	Mother Health	0.00	0.00	0.00
	Pregnancy Health	0.00	0.15	0.57
Education	School going students	1.00	1.00	0.61
	Infrastructure Road	0.55	0.89	1.00
	Schools infrastructure	0.79	0.00	0.00
	Transportation	0.00	0.84	0.48
Infrastructure	Accommodation	0.80	0.40	0.41
	Educational Institute	1.00	0.28	1.00
	Communities Institute	0.78	0.99	0.59
	Road	0.37	0.34	0.68
	Bridge and Culvert	0.59	0.96	0.07
	Shelter centers	0.28	1.00	0.45
	Embankment	1.00	0.85	0.00
Government activities	Asset distribution	0.00	0.00	0.62
	Relief Program	0.00	0.39	0.00
	Relocation	1.00	1.00	0.62
	Khas land distribution	0.00	0.08	0.63
	Human Right)	0.00	0.50	0.55
	Basic needs	1.00	0.66	1.00
	Justice	0.00	0.55	0.77
Demographics and Geographic	Population Density	0.28	0.16	1.00
	Migration	1.00	0.00	0.06
	Security of live and Livelihood	0.18	0.46	0.50
	Geological Characteristics	0.18	0.42	0.50
	River	0.86	0.69	0.45
	Location of Sea	0.86	0.50	0.00
	Altitude	1.00	1.00	0.06
Agricultural Dependency	Drought	0.59	0.33	1.00
	Excess rainfall	0.90	0.00	0.38
	Occupation	1.00	0.67	0.70
	Livestock	0.03	0.86	0.00
	Forestry	0.00	0.57	0.05
	Fishing	0.46	1.00	0.20

Source: Field Survey, 2018-19

Following section has been trying to discuss as a sector wise. **In health sector** vulnerability from 0.00 to 1.00 scale followed by the scale general health more vulnerability *i.e.* 1.00 found in Central and eastern zone and less vulnerability found in western zone (0.50). Child health is more vulnerability *i.e.* 1.00 found in western zone and less vulnerability found in central (0.14) and eastern (0.32) zone. Mother health is less vulnerability *i.e.* 0.00 found in western zone, central zone and eastern zone. Pregnancy health is less vulnerability *i.e.*0.00 found in western zone and more vulnerability found in central zone (0.15) and eastern zone (0.57) (Table 6.7, Figure-6.7), Map 6.1(6.1a, 6.1b, 6.1c and 61.d). Experts said that the health sector is the vulnerable social sector among other sectors in the whole coastal areas. Due to necessary medical services, the children, pregnant women, elderly either male or female health is most vulnerable. As well during and post disaster period, the people faces different types of water borne disease like, diarrhea, dysentery, triploid, fever, skin disease (scabies), hepatitis -B, and so on. The combination of higher temperatures and possible rise in summer rainfall may establish the conditions for many infectious diseases to become more severe or spread. The increased risk of increased flooding and cyclones to human health appears to be most likely. Increased risks to human health are expected to emerge from climate in the coastal belt of Bangladesh, especially in light of the poor state of the country's public health infrastructure. Life expectancy is just 61 years, and 61% of kids are malnourished (World Bank, 2002).

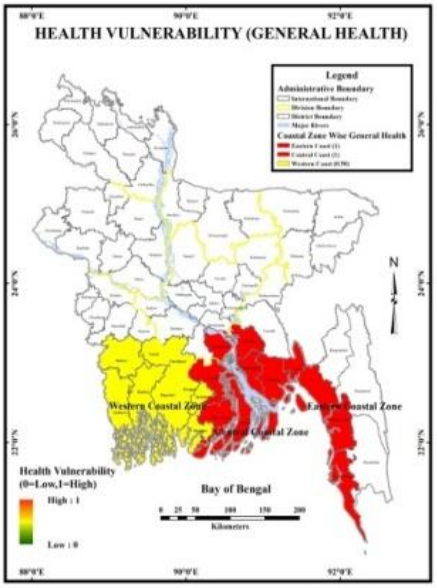
Figure 6.7: Spatial Variation of the Social Vulnerability (Health)



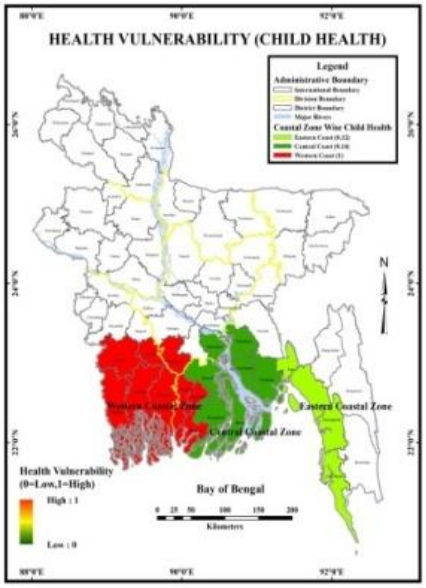
Source: Field survey 2018-19

Map 6.1: Spatial Variation of Health Vulnerability (applying social vulnerability index) in the Study Area.

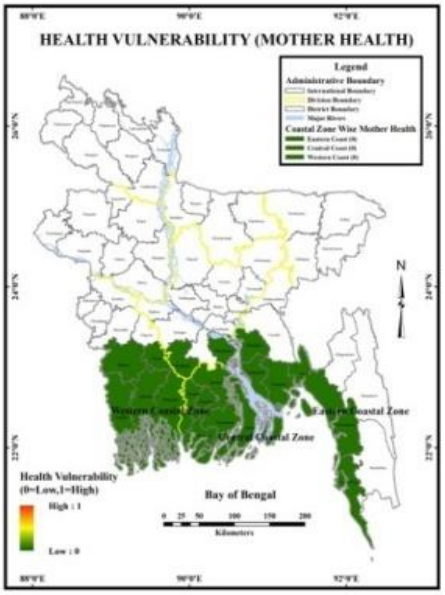
Map 6.1a: Health Vulnerability (General)



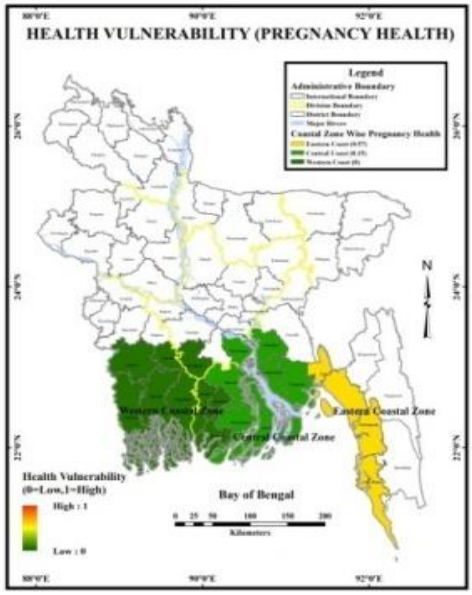
Map 6.1b: Health Vulnerability (Child Health)



Map 6.1c: Health Vulnerability (Mother Health)



Map 6.1d: Health Vulnerability (Pregnancy Health)

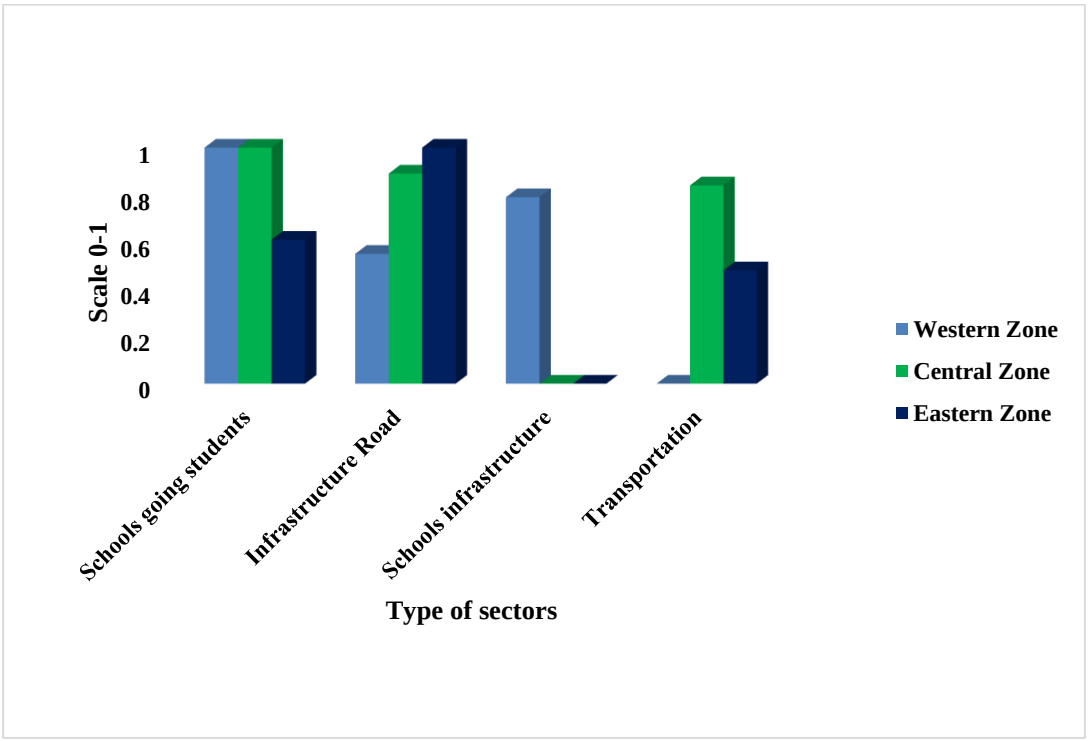


Source: Field Survey 2018-19, Prepared by the Author

In education sector vulnerability from 0.00 to 1.00 scale followed by the scale school going students more vulnerability *i.e.* 1.00 found in western and central zone and less vulnerability found in eastern zone (0.61) due to lack of attendance of students in their school. Infrastructure (road) is more vulnerability *i.e.* 1.00 found in

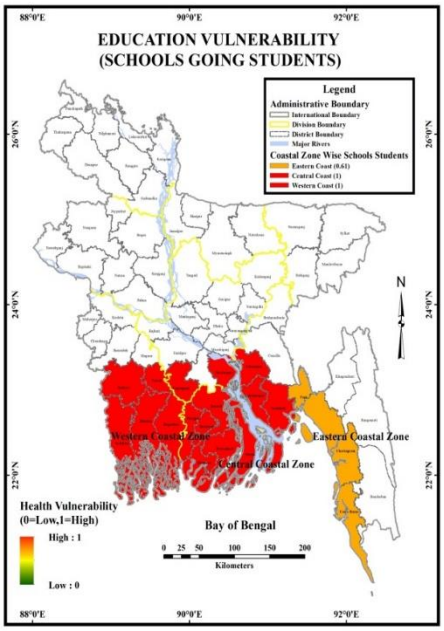
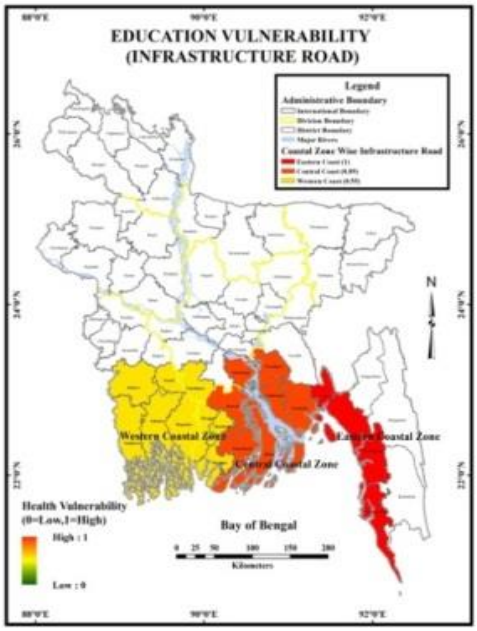
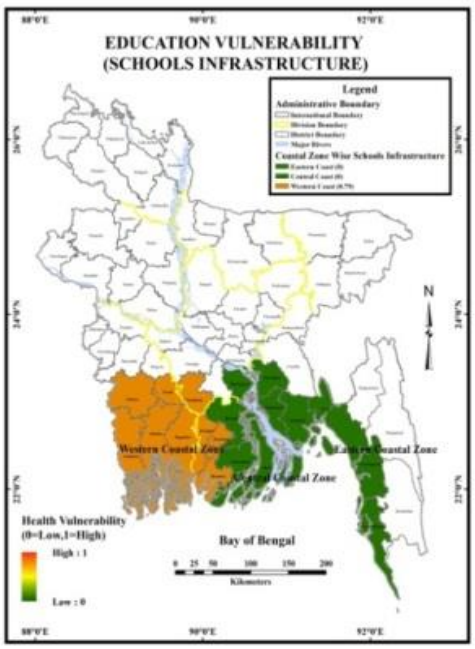
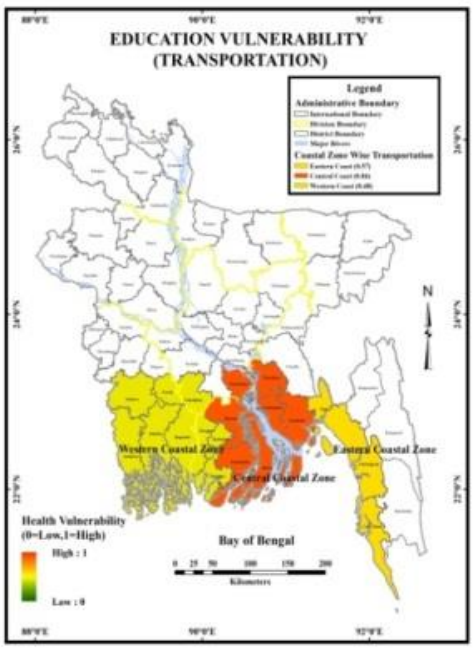
eastern zone and less vulnerability found in central (0.0.89) and western (0.55) zone. School infrastructure is less vulnerability *i.e*. 0.00 found in central zone and eastern zone and more vulnerability in western zone (0.79). Transportation is less vulnerability *i.e*.0.00 found in western zone and more vulnerability found in central zone (0.84) and eastern zone (0.48) (Table 6.8, Figure-6.4), Map 6.2 (6.2a, 6.2b, 6.2c and 6.2d). Disasters directly interrupted the schedule for school going students. Because, the rural road networks are inundated and broken, sometimes disappearing. At this moment, the school schedule has been disturbed and school authority stops the academic activity. However, the school as an institution has been used in multi-sectoral purposes. Sometime school building has been used school cum disaster shelter center in the whole coastal areas.

Figure 6.8: Spatial Variation of the Social Vulnerability (Education)



Source: Field Survey, 2018-19

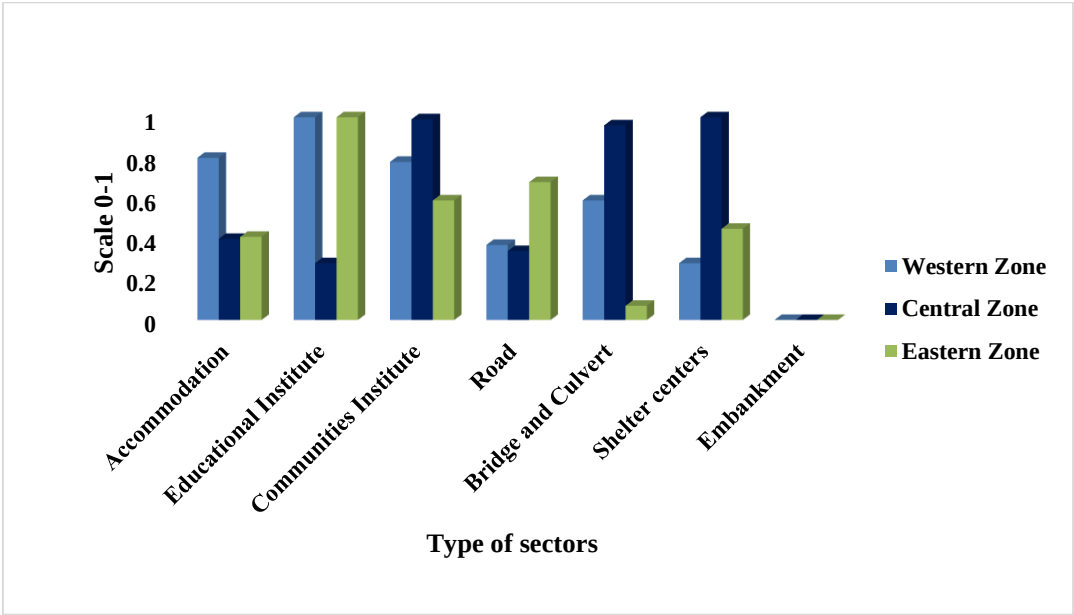
Map 6.2: Spatial Variation of Education Vulnerability (applying social vulnerability index) in the Study Area

Map 6.2a: Education Vulnerability (School Going Student)	Map 6.2b:EducationVulnerability (Infrastructure-Road)
	
Map 6.2c: Education Vulnerability (School Infrastructure)	Map 6.2d: Education Vulnerability (Transportation)
	

Source: Field Survey 2018-19, Prepared by the Author

In infrastructure sector vulnerability from 0.00 to 1.00 scale followed by the scale accommodation more vulnerability *i.e.* 0.80 found in western and less vulnerability found in eastern zone (0.41) and central zone (0.40) due to destructive activities of disaster. Education institute is more vulnerability *i.e.* 1.00 found in western zone and eastern zone and less vulnerability found in central (0.28) zone. Communities institute is more vulnerability *i.e.* 0.99 found in central zone and less vulnerability in western zone (0.78) and in eastern zone (0.59). Road is more vulnerability *i.e.* 0.68 found in eastern zone and less vulnerability found in western zone (0.37) and central zone (0.34). Bridge and culver is more vulnerability *i.e.* 0.96 found in central zone and less vulnerability in western zone (0.59) and eastern zone (0.07). Shelter centers is more vulnerability *i.e.* 1.00 found in central zone and less vulnerability found in eastern zone (0.45) and western zone (0.28). Embankment is more vulnerability *i.e.* 1.00 found in western zone and less vulnerability *i.e.*0.00 found in eastern zone, on the other hand 0.85 found in central zone. (Table 6.8, Figure-6.9), Map 6.3 (6.3a, 6.3b, 6.3c, 6.3d, 6.3e, 6.3f and 6.3g). It is a common scenario that disasters are directly affected on the infrastructural sectors as well as people can easily understand the damaging condition. However, the damaging conditions are easily calculated and it converted the price.

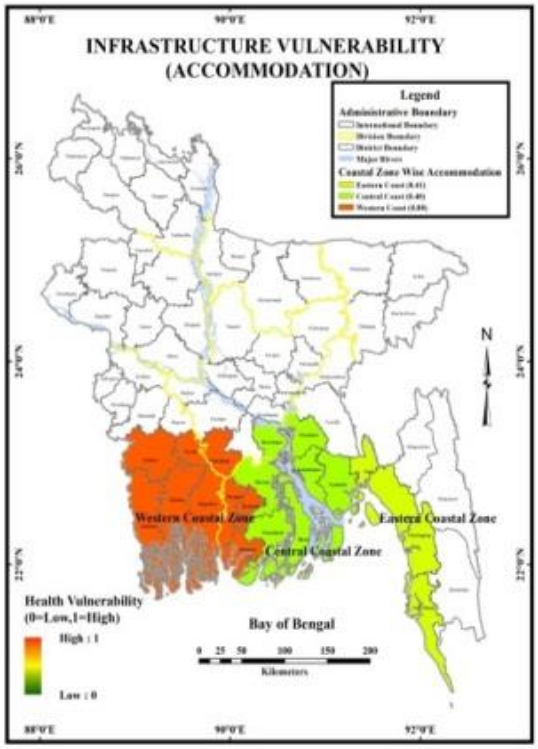
Figure 6.9: Spatial variation of the social vulnerability (Infrastructure)



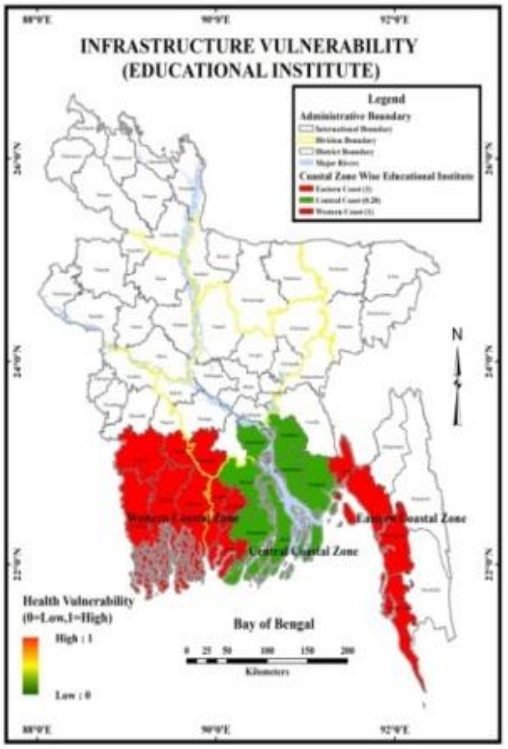
Source: Field Survey, 2018

Map 6.3: Spatial Variation of Infrastructure Vulnerability (applying social vulnerability index) in the Study Area

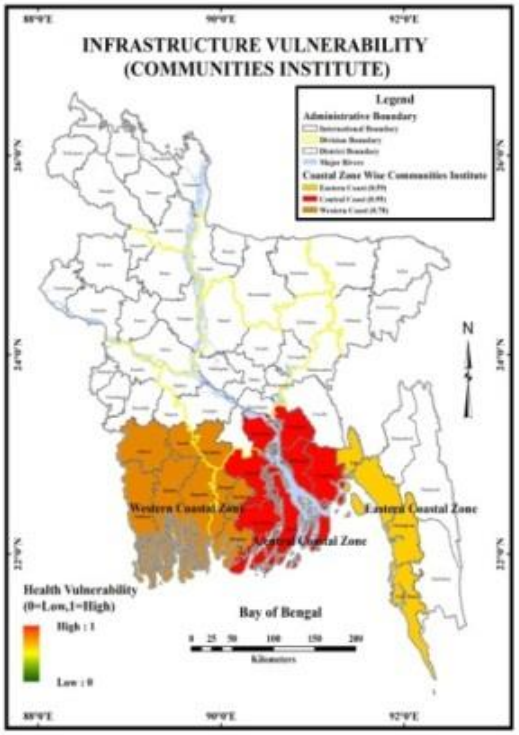
Map 6.3a: Infrastructure Vulnerability (Accommodation)



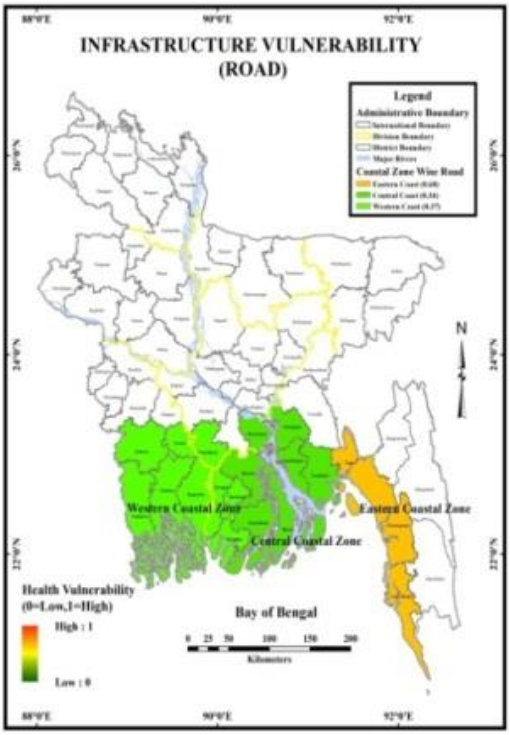
Map 6.3b: Infrastructure Vulnerability (Educational Institute)



Map 6.3c: Infrastructure Vulnerability (Communities Institute)



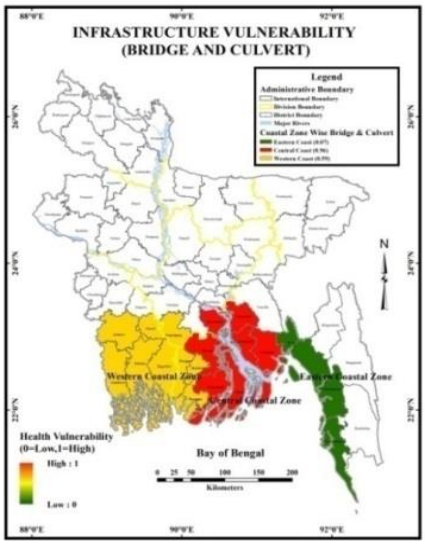
Map:6.3d: Infrastructure Vulnerability (Road)



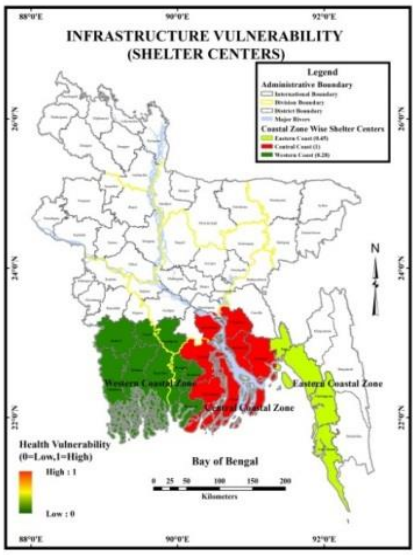
Source: Field Survey, 2018-19 Prepared by the Author

Map 6.3: Spatial Variation of Infrastructure Vulnerability (applying social vulnerability index) in the Study Area (Continued)

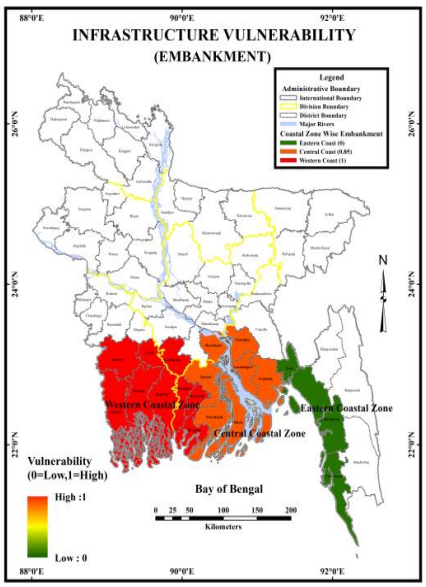
Map 6.3e: Infrastructure Vulnerability (Bridge and Culvert)



Map 6.3f: Infrastructure Vulnerability (Shelter Center)



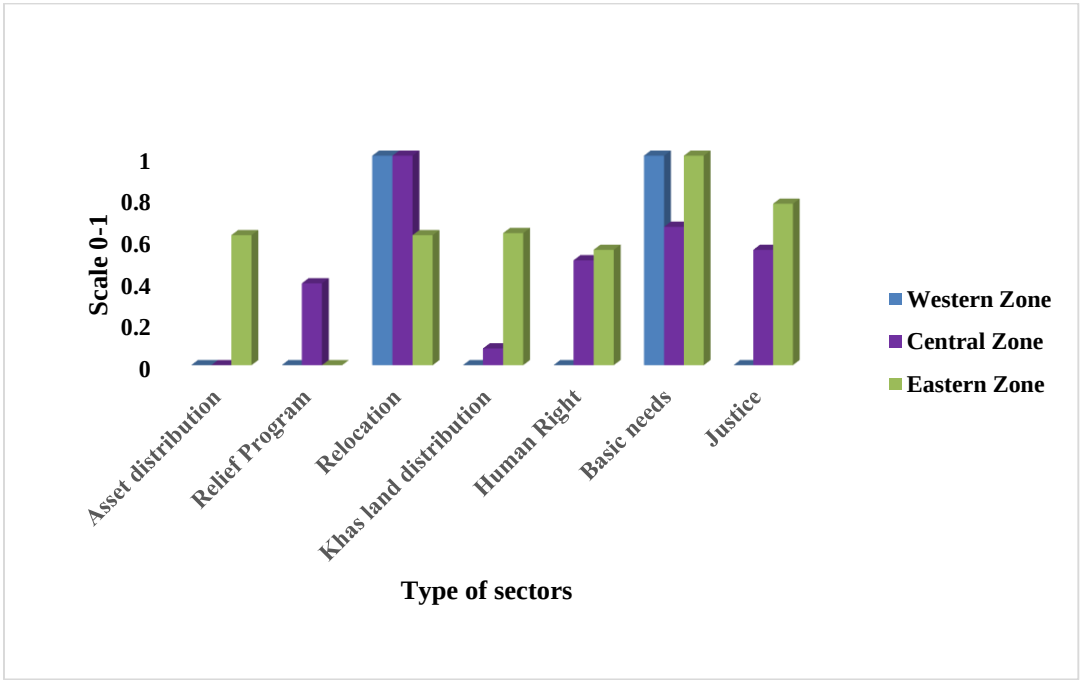
Map 6.3g: Infrastructure Vulnerability (Embankment)



Source: Field Survey 2018-19, Prepared by the Author

In Government activities sector vulnerability from 0.00 to 1.00 scale followed by the scale asset distribution is less vulnerability *i.e.* 0.00 found in western and central zone and more vulnerability found in eastern zone (0.62) due to recurrent disasters in the coastal region of Bangladesh. Relief program is fewer vulnerability *i.e.* 0.00 found in western and eastern zones and more vulnerability found in central (0.39). Relocation is more vulnerability *i.e.*1.00 found in western zone and central zone and less vulnerability in eastern zone (0.79). Khas land distribution is less vulnerability *i.e.*0.00 found in western zone and more vulnerability found in eastern zone (0.63 and central zone (0.08). Human right is less vulnerability *i.e.* 0.00 found in western zone and more vulnerability found in central zone (0.50) and eastern zone (0.55). Basic needs are more vulnerability *i.e.*1.00 found in western zone and eastern zone and less vulnerability found in central zone (0.66). Justice is less vulnerability *i.e.* 0.00 found in western zone and more vulnerability found in central zone (0.55) and eastern zone (0.77). (Table 6.8, Figure-6.10), Map 6.4 (6.4a, 6.4b, 6.4c, 6.4d, 6.5e, 6.4f and 6.4g) 6.22).

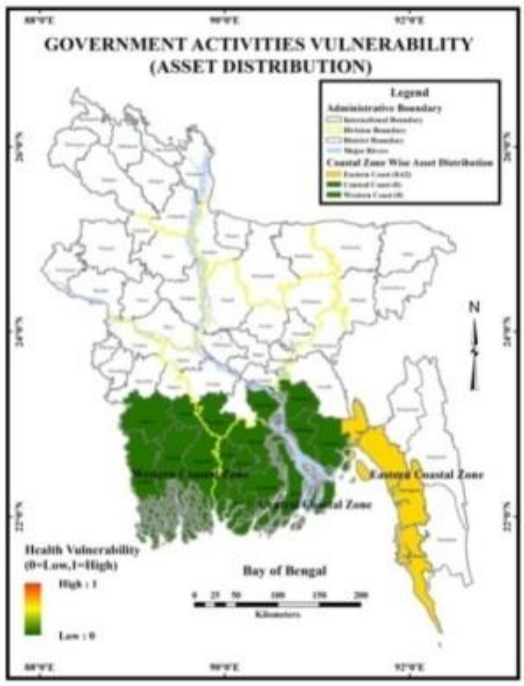
Figure 6.10: Spatial Variation of the Social Vulnerability (Government activities)



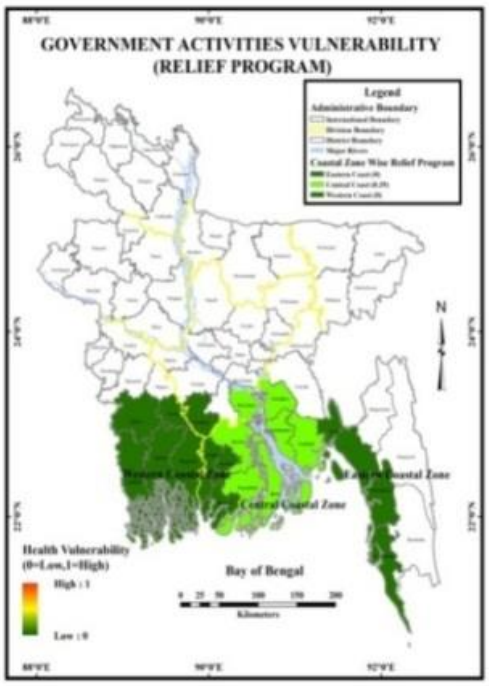
Source: Field Survey, 2018-19

Map 6.4: Spatial Variation of Government Activities Vulnerability (applying social vulnerability index) in the Study Area

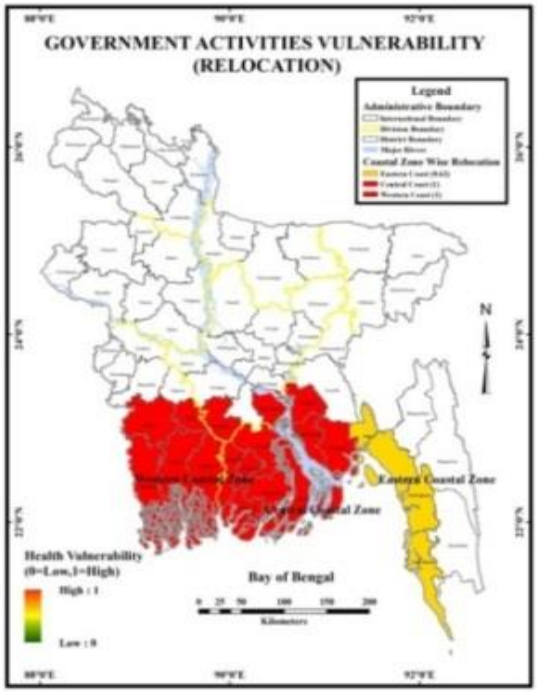
Map 6.4a: Government Activities Vulnerability (Asset Distribution)



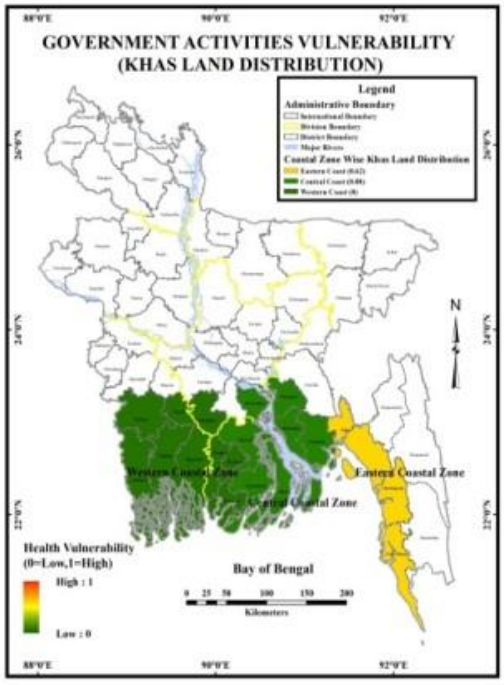
Map 6.4b: Government Activities Vulnerability (Relief Program)



Map 6.4c: Government Activities Vulnerability (Relocation)



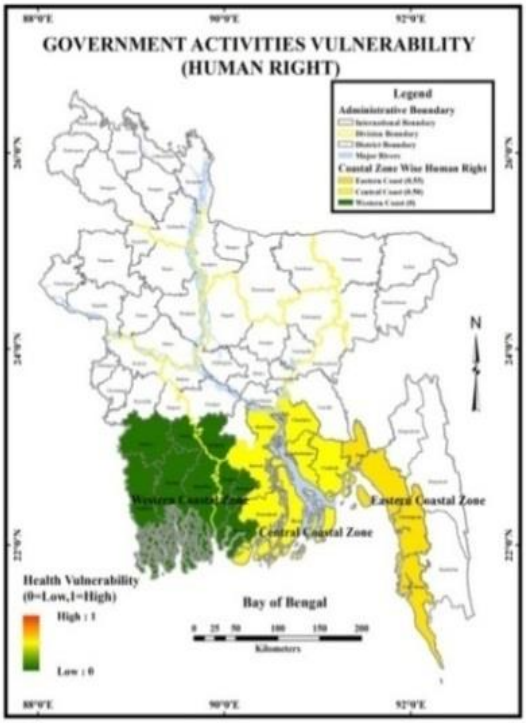
Map 6.4d: Government Activities Vulnerability (Khas Land Distribution)



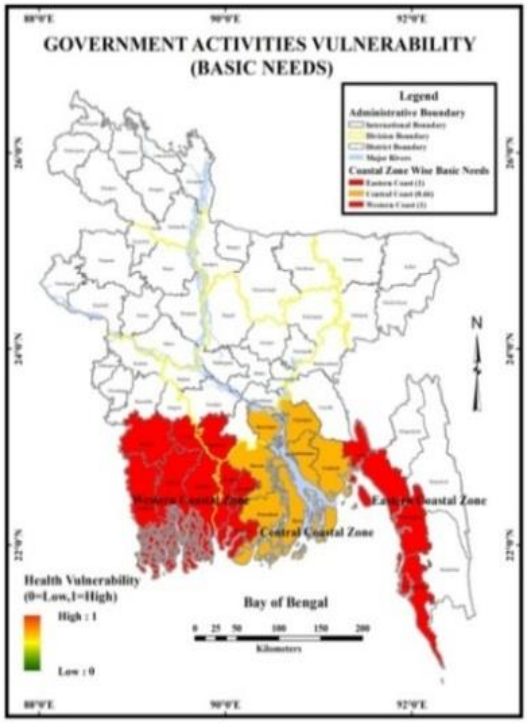
Source: Field Survey 2018-19, Prepared by the Author

Map 6.4: Spatial Variation of Government Activities Vulnerability (applying social vulnerability index) in the Study Area (Continued)

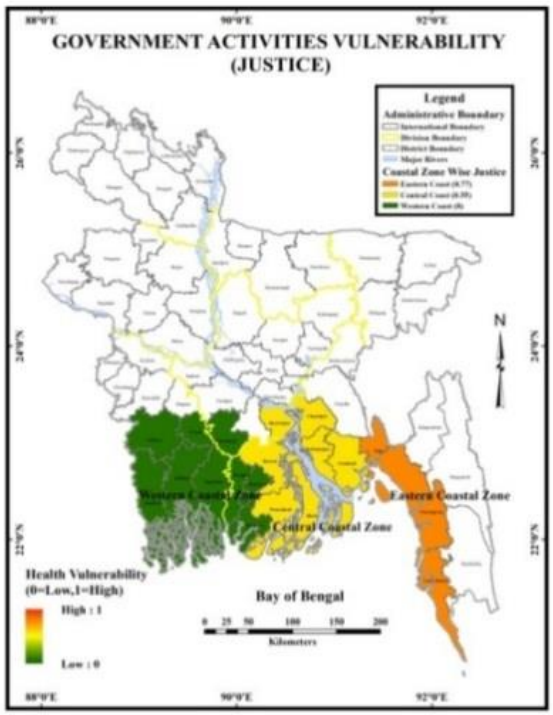
Map 6.4e: Government Activities Vulnerability (Human Right)



Map 6.4f: Government Activities Vulnerability (Basic Needs)



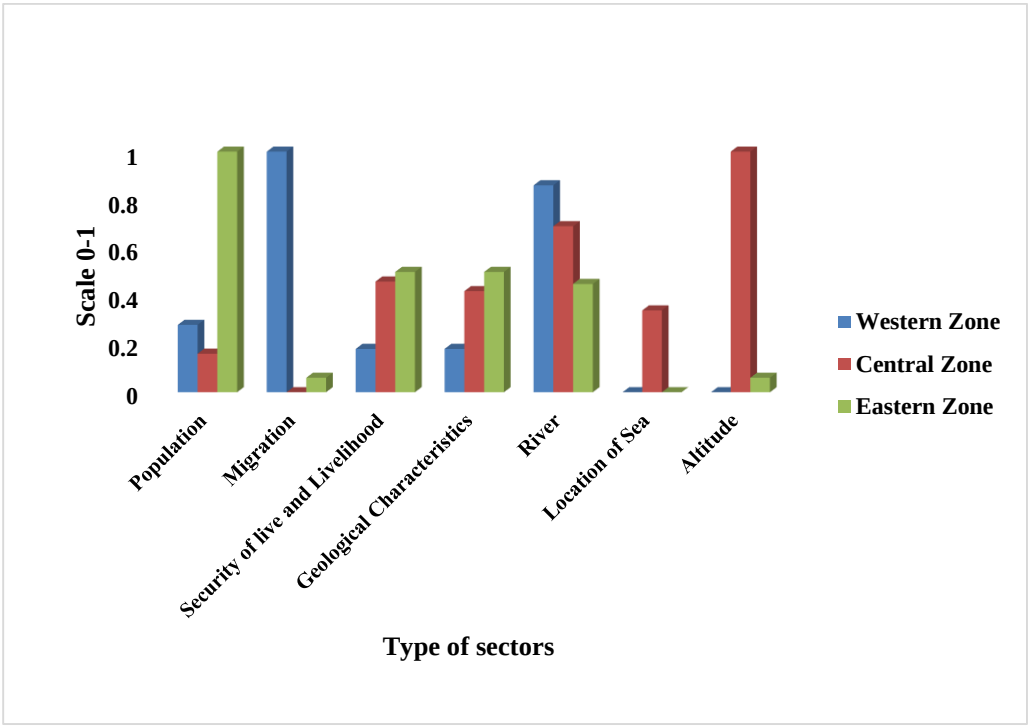
Map 6.4g: Government Activities Vulnerability (Justice)



Source: Field Survey 2018-19, Prepared by Author

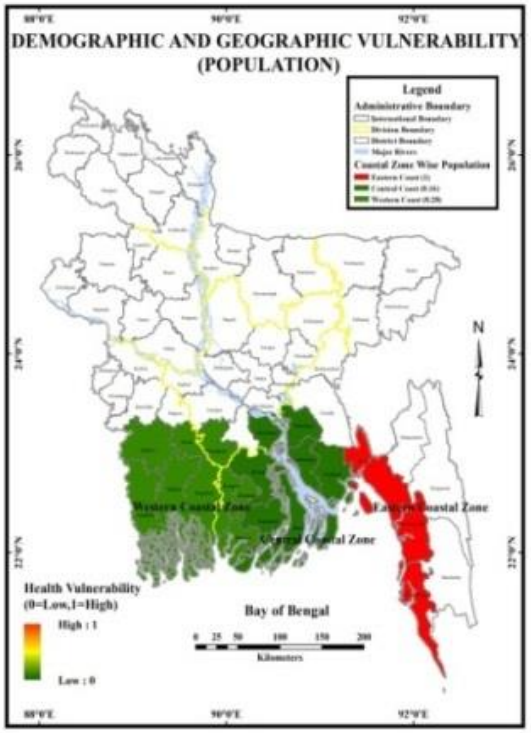
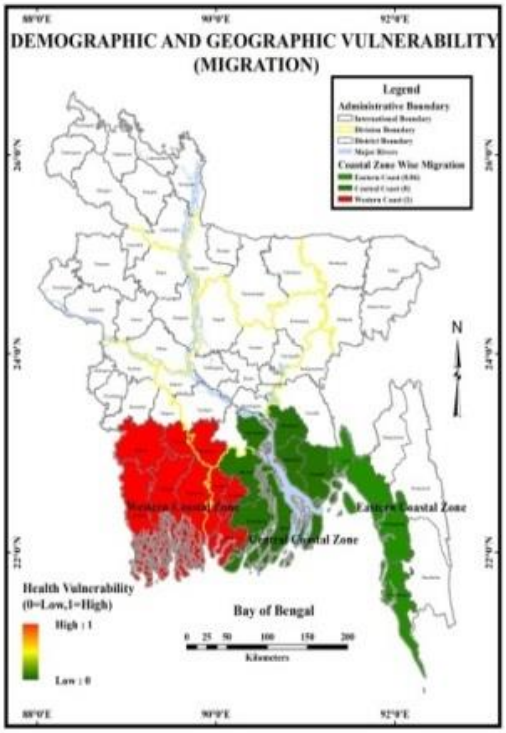
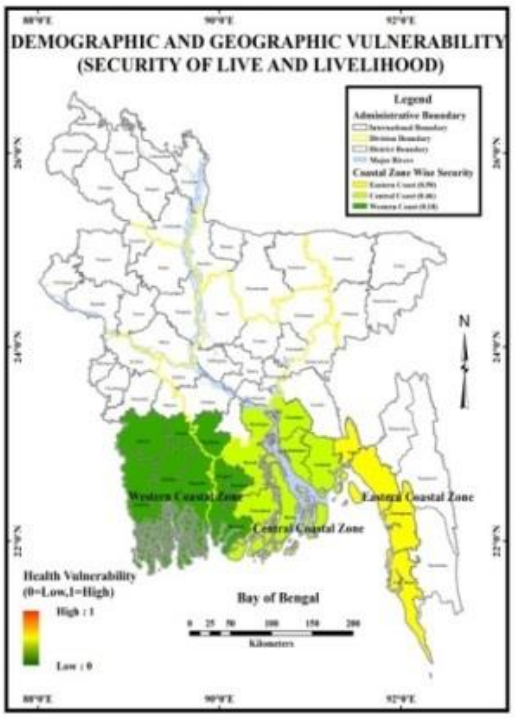
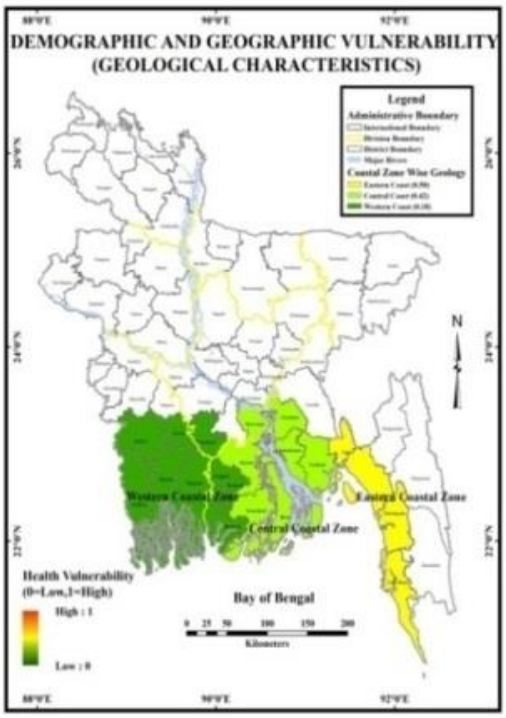
In Demographic and Geographic sector vulnerability from 0.00 to 1.00 scale followed by the scale population density is more vulnerability *i.e.* 1.00 found in eastern zone and more vulnerability found in central zone (0.16) and western zone (0.24) due to frequent effects of disasters. Migration is more vulnerability *i.e.* 1.00 found in western zone and less vulnerability *i.e.* 0.00 found in central zones and eastern zone is (0.0.06). Security of live and livelihood is medium vulnerability *i.e.*0.50 found in eastern zone and less vulnerability found in western zone (0.18) and central zone (0.46). Geological characteristics are more vulnerability *i.e.*0.50 found in eastern zone and less vulnerability found in western zone (0.18) and central zone (0.42). River is more vulnerability *i.e.* 0.86 found in western zone and less vulnerability found in central zone (0.69) and eastern zone (0.45). Location of sea is less vulnerability *i.e.*0.00 found in eastern zone and more vulnerability found in central zone (0.50) and western zone (0.60). Altitude is more vulnerability *i.e.* 1.00 found in western zone and central zone and less vulnerability found in eastern zone (0.06) (Table 6.8, Figure-6.11), Map 6.5 (6.5a, 6.5b, 6.5c, 6.5d, 6.5e, 6.5f and 6.5g).

Figure 6.11: Spatial variation of the social vulnerability (Demographic and Geographic sectors)



Source: Field Survey, 2018-19

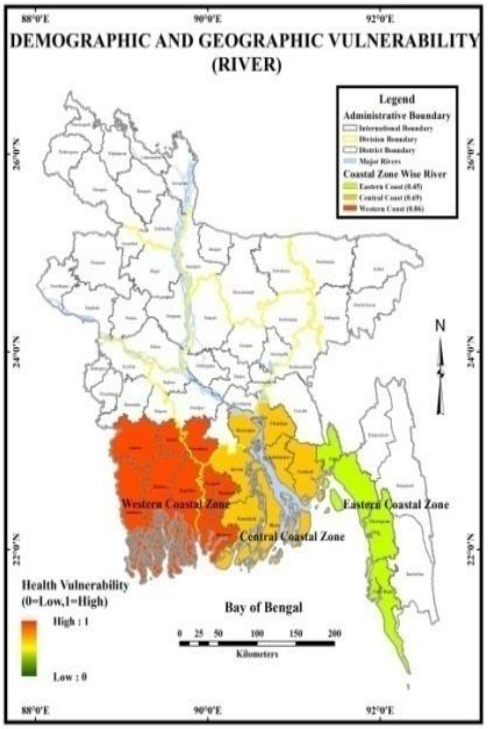
Map 6.5: Spatial Variation of Demographic and Geographic Vulnerability (applying social vulnerability index) in the Study Area

Map 6.5a: Demographic and Geographic Vulnerability (Population Density)	Map 6.5b: Demographic and Geographic Vulnerability (Migration)
	
Map 6.5c: Demographic and Geographic Vulnerability (Security of live and livelihood)	Map 6.5d: Demographic and Geographic Vulnerability (Geographical Characteristics)
	

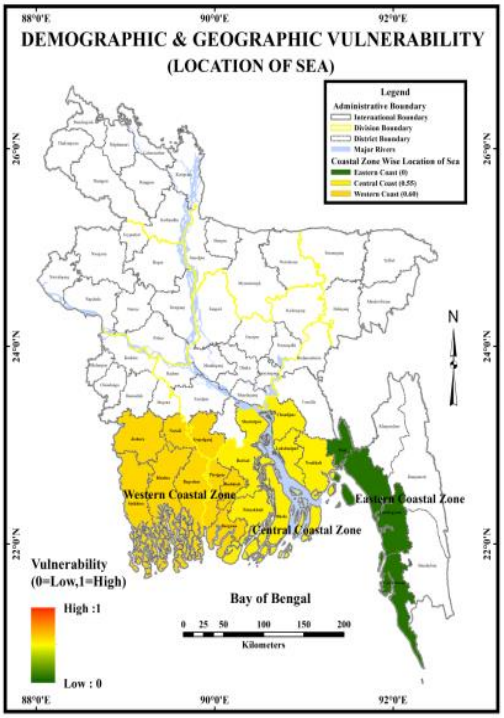
Source: Field Survey 2018-19, Prepared by the Author

Map 6.5: Spatial Variation of Demographic and Geographic Vulnerability (applying social vulnerability index) in the Study Area (Continued)

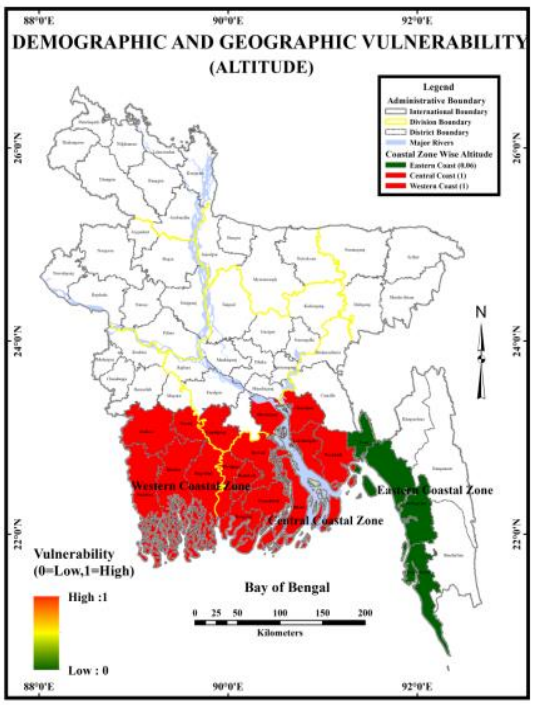
Map 6.5e: Demographic and Geographic Vulnerability(Road)



Map 6.5f: Demographic and Geographic Vulnerability (Location of Sea)



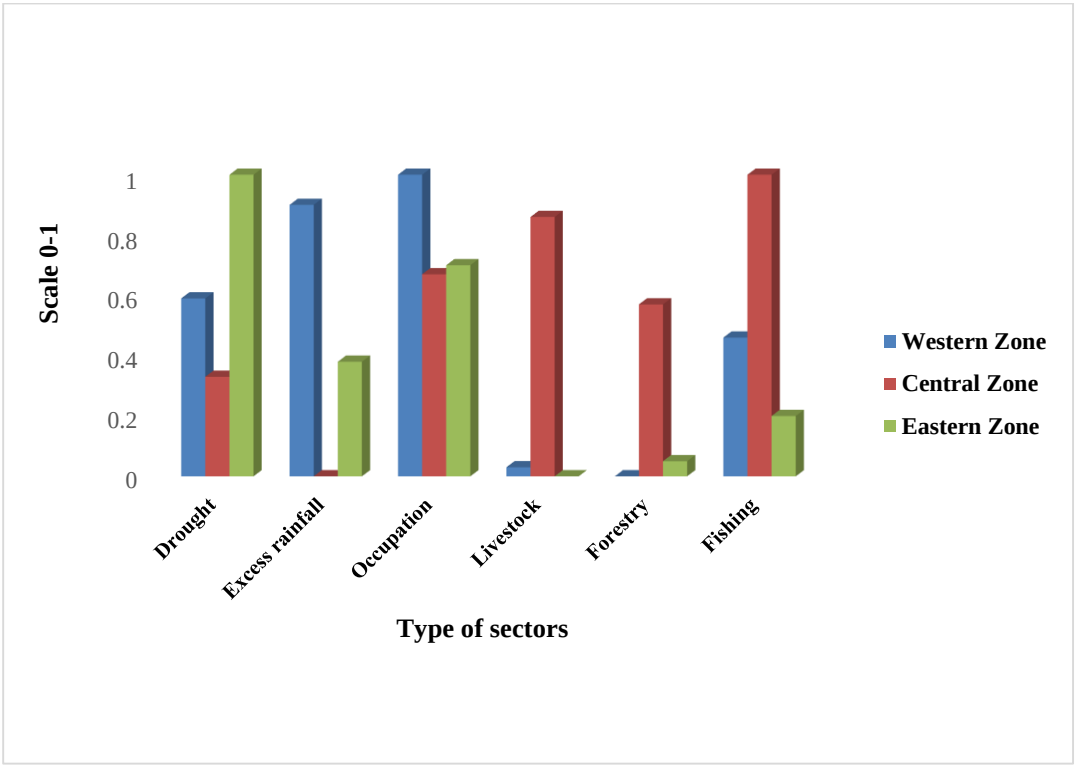
Map 6.5g: Demographic and Geographic Vulnerability (Altitude)



Source: Field Survey 2018-19, Prepared by the Author

In Agricultural dependency sector vulnerability from 0.00 to 1.00 scale followed by the scale drought is more vulnerability *i.e.* 1.00 found in eastern zone and less vulnerability found in central zone (0.33) and western zone (0.59) due to regular disasters. Excess rainfall is less vulnerability *i.e.* 0.00 found in central zone and more vulnerability found in eastern zones (0.38) and western zone is (0.90). Occupation is more vulnerability *i.e.*1.00 found in western zone and less vulnerability found in central zone (0.67) and eastern zone (0.70). Livestock is less vulnerability *i.e.*0.00 found in eastern zone and more vulnerability found in western zone (0.03) and central zone (0.86).Forestry is less vulnerability *i.e.* 0.00 found in western zone and more vulnerability found in eastern zone (0.05) and central zone (0.57). Fishing is more vulnerability *i.e.*1.00 found in central zone and less vulnerability found in eastern zone (0.20) and western zone (0.46) (Table 6.8, Figure-6.12), Map 6.6 (6.6a, 6.6b, 6.6c, 6.6d, 6.6e, 6.6f and 63.6g).

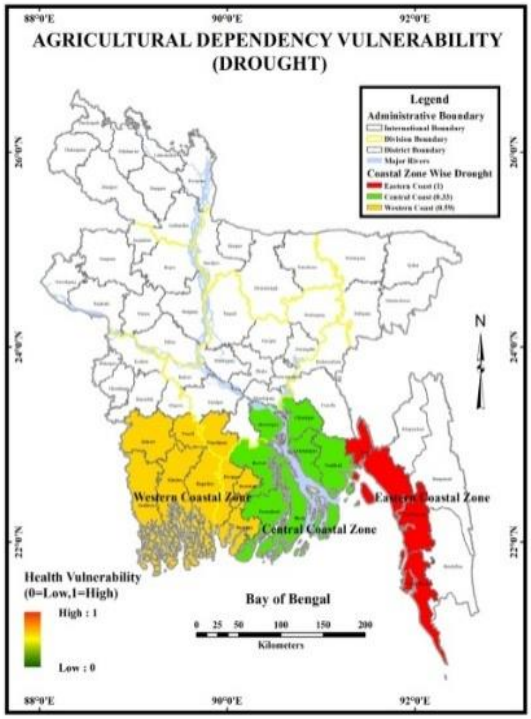
Figure 6.12: Spatial Variation of Agricultural Dependency Vulnerability (applying social vulnerability index) in the Study Area.



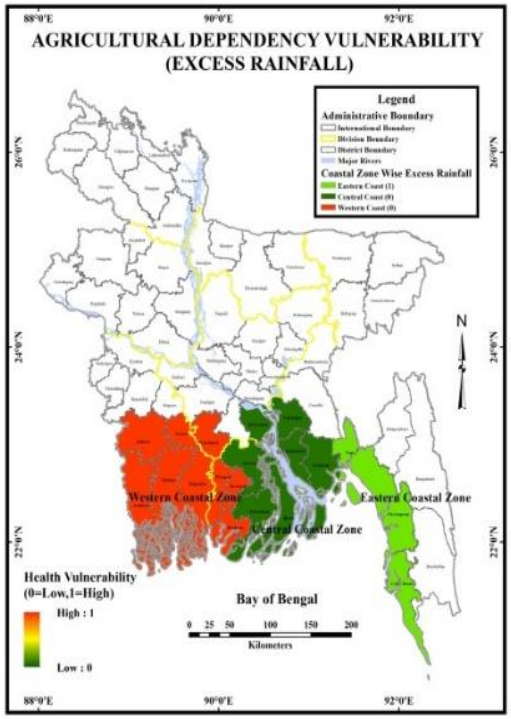
Source: Field Survey, 2018-19

Map 6.6: Spatial Variation of Agricultural Dependency Vulnerability (applying social vulnerability index) in the Study Area

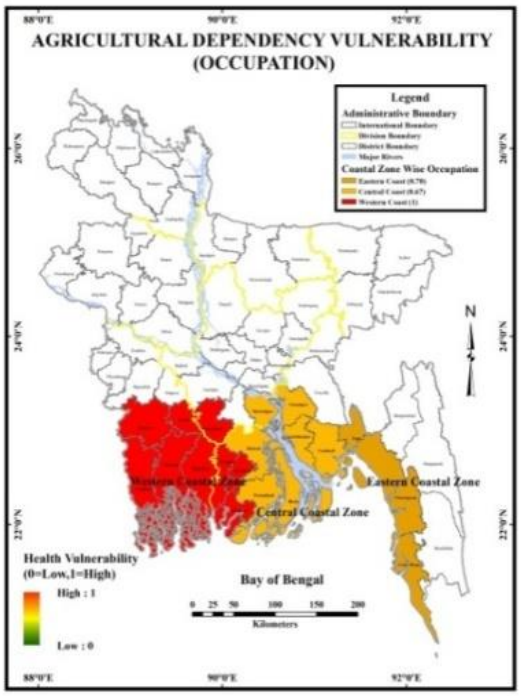
Map 6.6a: Agricultural Dependency Vulnerability (Drought)



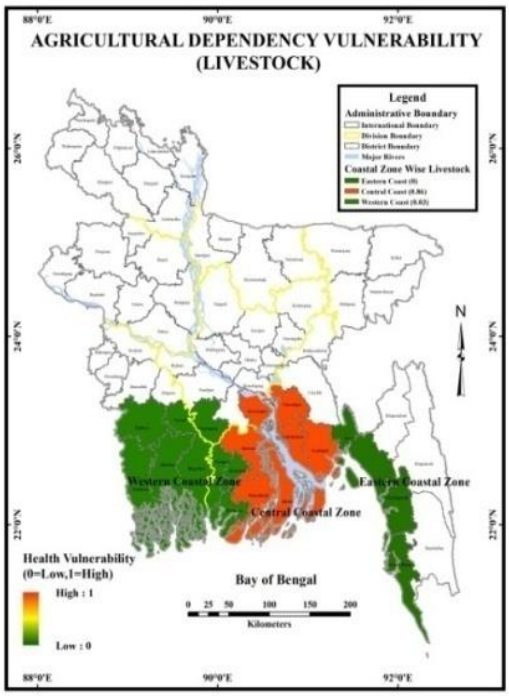
Map 6.6b: Agricultural Dependency Vulnerability (Excess Rainfall)



Map 6.6c: Agricultural Dependency Vulnerability (Occupation)

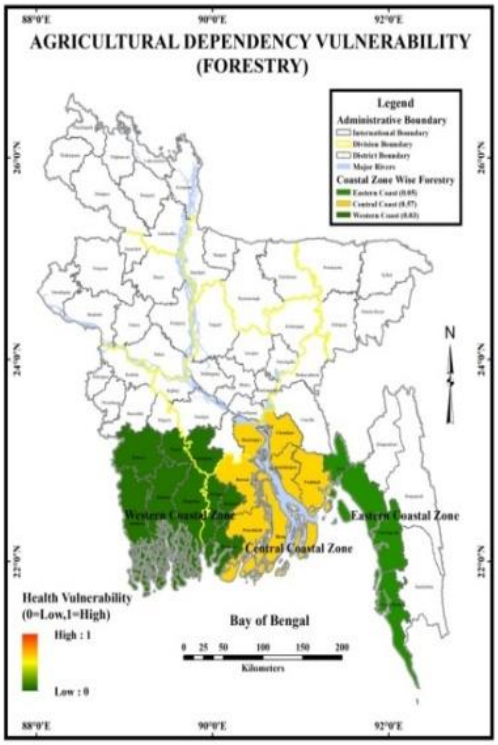
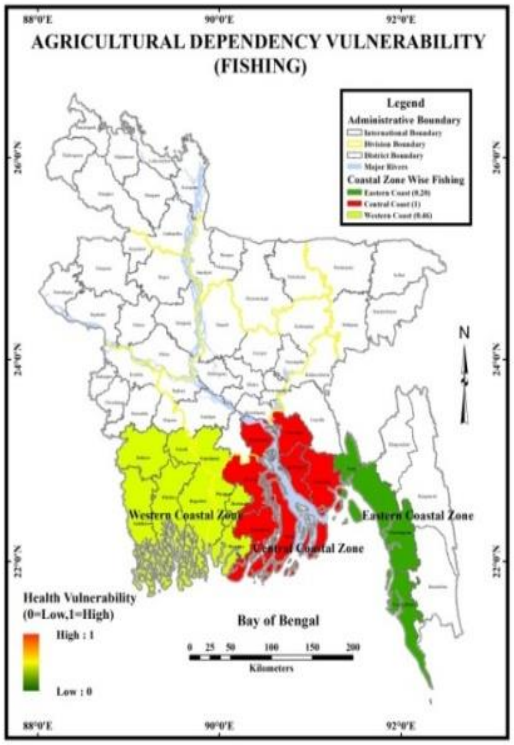


Map 6.6d: Agricultural Dependency Vulnerability (Livestock)



Source: Field Survey 2018-19, Prepared by the Author

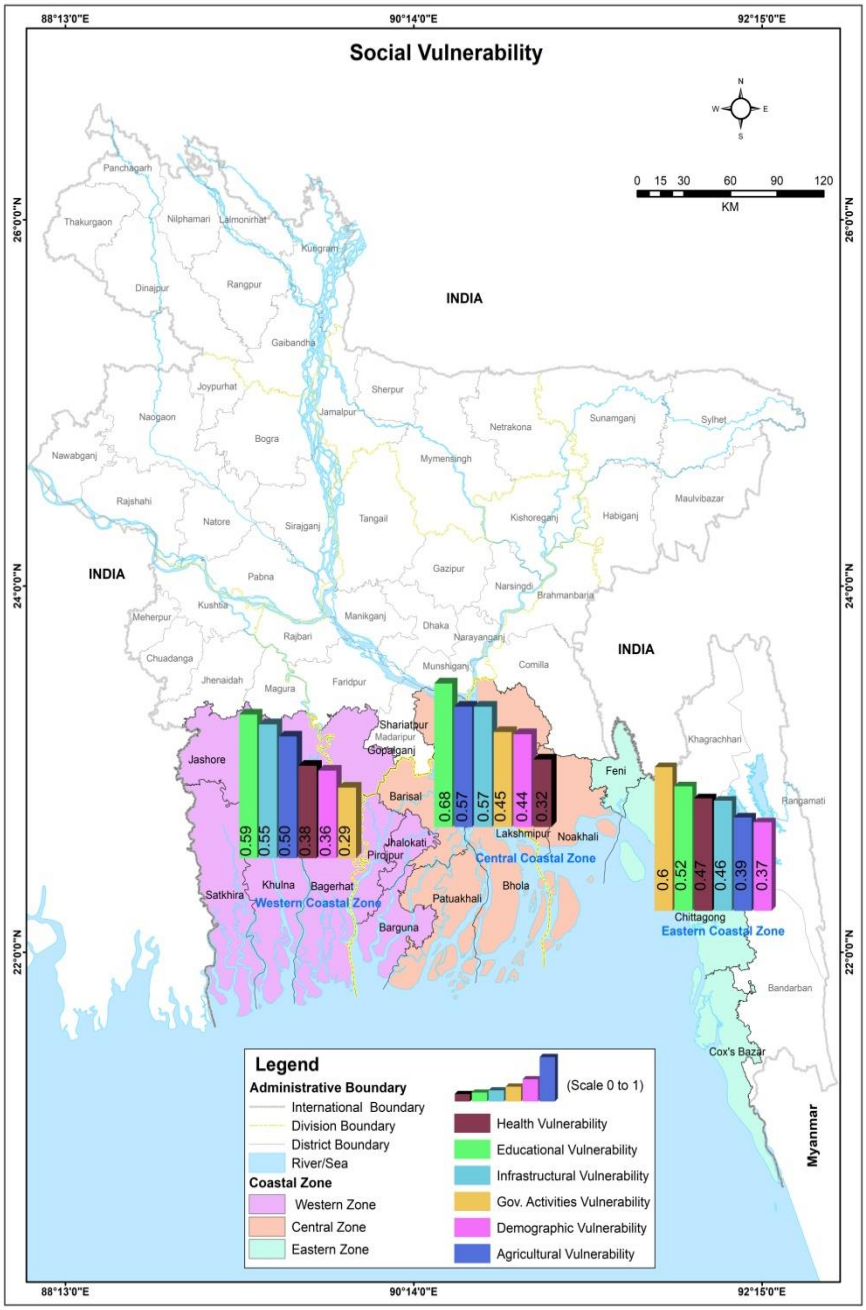
Map 6.6: Spatial Variation of Agricultural Dependency Vulnerability (applying social vulnerability index) in the Study Area (Continued)

Map 6.6e: Agricultural Dependency Vulnerability (Forestry)	Map 6.6f: Agricultural Dependency Vulnerability (Fishing)
	

Source: Field Survey 2018-19, Prepared by the Author

Owing to social vulnerability index, spatial variation of the vulnerability of social sectors in the Coastal zone of Bangladesh have been depicts by multi-technique, like Map cum bar diagram technique. Map 6.7 shows the spatial variation of the social vulnerability (0-1 scale) in the Coastal zone of Bangladesh.

Map 6.7 Spatial Variation of the Social Vulnerability in the Coastal zone of Bangladesh



Source: Field Survey 2018-19, Prepared by the Author

6.8 Climate Variability and the Nature of Social Implications in the Study Area

Social vulnerability is partly the result of social inequalities disparities, which govern or form the susceptibility of different groups to harm and also regulate their capacity to react. The study tried to use the social vulnerability index to assess social vulnerability in the coastal area of Bangladesh. Disasters triggered by climate change have broken down social order and social solidity in the affected areas and even

strained relationships with social networks. More than 98 % of respondents report disasters caused by climate change disrupt the social network that climate change is increasingly becoming irrelevant, i.e. social bandage with kin relationships and communities. As, Nasreen (1995; 2012) pointed out, women have a relationship with families. They had goods, food and services traded. Women exchanged warm curry each, which is seen on very small scale. The respondents mentioned similar items. In Bangladesh, the social implications/effects to climate variability, including health related sufferings are severe. In particular, the poor and vulnerable people affected have been suffering from diarrhea and skin diseases for decades.

Various social implications of climate variability is found in the study area (Table-6.8) like Disruption/interruption of social network (98%, R-1), Increase of water borne diseases such as dysentery, jaundice (88%, R-2), Prevalence of diarrhea (87%, R-3), Disruption of communication and transportation (86%, R-4), Interruption to movement of children (83%, R-5), Weakness to women's income and employment (80%, R-6), Occurrence of skin diseases (77%, R-7), Blowout of altered vector borne diseases like dengue, malaria (75%, R-8), Gender related vulnerability due to lack of security (66%, R-9), Absence or lack of harvesting variety (62%, R-10), Malnutrition leading kwashiorkor and marasmus (58%, R-11), Disturbance of the means of livelihood (57%, R-12), Obligatory migration (49%, R-13) and Others (31%, R-14).

As per peoples' perception Disruption/interruption of social network strode in 1st rank in the western coast of the study area. Increase of water borne diseases such as dysentery, jaundice etc., Prevalence of diarrhea, Occurrence of skin diseases, Interruption to movement of children, Gender related vulnerability due to lack of security, Weakness to women's income and employment, Absence or lack of harvesting variety, Disruption of communication and transportation, Blowout of altered vector borne diseases like dengue, malaria etc., Obligatory migration, Malnutrition leading kwashiorkor and marasmus, Disturbance of the means of livelihood, and others which stood 2nd , 3rd , 4th , 5th , 6th , 7th , 8th , 9th , 10th , 11th , 12th , 13th and 14th rank respectively (Table 6.8).

As per respondent's opinion, Disruption/interruption of social network strode in 1st rank in the central coast of the study area. Disruption of communication and transportation, Interruption to movement of children, Increase of water borne diseases such as dysentery, jaundice etc., Weakness to women's income and employment

Blowout of altered vector borne diseases like dengue, malaria etc., Prevalence of diarrhea, Occurrence of skin diseases, Gender related vulnerability due to lack of security, Malnutrition leading kwashiorkor and marasmus, Disturbance of the means of livelihood, Absence or lack of harvesting variety, Obligatory migration, and others which stood 2nd , 3rd , 4th , 5th , 6th , 7th , 8th , 9th , 10th , 11th , 12th , 13th and 14th rank respectively (Table 6.8).

On the basis on respondents opinion Disruption/ interruption of social network strode in 1st rank in the eastern coast of the study area, Disruption of communication and transportation, Prevalence of diarrhea, Spread of water borne diseases like dysentery, jaundice etc., Interruption to movement of children, Weakness to women's income and employment, Blowout of altered vector borne diseases like dengue, malaria etc., Absence or lack of harvesting variety, Occurrence of skin diseases, Disturbance of the means of livelihood, Malnutrition leading kwashiorkor and marasmus, Gender related vulnerability due to lack of security, Obligatory migration, and others which stood 2nd , 3rd , 4th , 5th , 6th , 7th , 8th , 9th , 10th , 11th , 12th , 13th and 14th rank respectively (Table 6.8).

Table 6.8: Climate Variability and Nature of Social Implications in the Study Area

Nature of social implications	Western Coast		Central Coast		Eastern Coast		Total	
	(n=189) %	*R*	*(n=154) %*	*R*	*(n=182) %*	*R*	*(n=525) %*	*R*
Disruption/interruption of social net work	97.65	1	98.46	1	98.10	1	98.07	1
Increase of water borne diseases such as dysentery, jaundice,	94.11	2	92.52	4	78.35	4	88.22	2
Prevalence of diarrhea	93.98	3	86.15	7	80.30	3	86.85	3
Disruption of communication and transportation	64.71	9	96.15	2	96.33	2	85.95	4
Interruption to movement of children	76.47	5	93.07	3	78.25	5	82.59	5
Weakness to women's income and employment	70.58	7	92.30	5	77.15	6	80.01	6
Occurrence of skin diseases	85.29	4	78.46	8	66.33	9	76.69	7
Blowout of altered vector borne diseases like dengue, malaria	61.76	10	88.46	6	73.50	7	74.58	8
Gender related vulnerability due to lack of security	72.35	6	70	9	55.35	12	65.90	9
Absence or lack of harvesting variety	70.15	8	48.46	12	67.25	8	62.10	10
Malnutrition leading kwashiorkor and marasmus	51.17	12	66.92	10	56.30	11	58.13	11
Disturbance of the means of livelihood	45.29	13	66.75	11	57.54	10	56.59	12
Obligatory migration	59.41	11	42.30	13	46.25	13	49.32	13
Others	38.23	14	32.30	14	23.15	14	31.23	14

Source: Field Survey, 2018-19 N.B: Multiple answers considered R-Rank

N.B: Rank size was demarcated considering the percentage of questionnaire Survey

On the other hand side, the disasters impacted individuals suffer from malnutrition that contributes due to disruption to *kwashiorkor* and *marasmus* and *hypernatremia* due to dehydration due to disruption of livelihood. It has been found that kids did not experience any acute physical difficulties in the previous year. Some autistic children have been seen in the research areas in recent years. Autistic children's parents have confirmed that newborn babies are increasingly becoming autistic or mentally handicapped. The study also represents that the affected women in the coastal areas are occupied in more than a few income earning activities to support their families particularly for food and security. However, they are often unable to carry out their daily jobs due to lack of security. The women further face bodily difficulties at the time of work due to food shortage and lack of health services thus, climate change impediments to women's income and employment opportunities. Indeed, both male and female are simultaneously pursuing alternative livelihoods. They travel out of the village to work in garments factories or in brick fields and on other agricultural land it they are unable to get employment or alternative livelihoods.

6.9 Climate Variability and Economic Implications in the Study Area

The idea that nations, territories, economic sectors and social classes vary in their degree of vulnerability to climate change is a popular them in climate change effects and vulnerability literature (Adger, N. and Kelly, M. 1999). Climate instability, both in the short and long term, has several physical and socio-economic impacts. Some threats, such as cyclones, are so severe that in few hours they destroy everything, while others, such as flooding and water logging, take weeks to demonstrate their range of effects. While people have to live in aggressive conditions during the disaster, when people are left with nothing, the main hardships also occur in the post disaster era.

The survey data (Table 6.9) point out that the Wage earners of household continue unemployed of around 97% in western coast, 95% in central coast and 94% in eastern coast households. It is also found that climate change causes the damage of transport and communication (85% in western coast, 95% in central coast and 88% in eastern coast), On the other hand climate change induced disaster is the causes of Disturbance of Institutional linkages (78% in western coast, 92% in central coast and 73% in

eastern coast), The study also found that Homestead Forests/community forest have been destroyed for climate change (83.52% in western coast, 68.46% in central coast and 67% in eastern coast), Animals cannot be reared due to lack of grazing fields and animal feed (74% in western coast, 85.38% in central coast and 75% in eastern coast), Seasonal crops cannot be cultured due to extreme climate change (64% in western coast, 82.30% in central coast and 76% in eastern coast), Vegetables cannot be grown due to saline water in their land (64.70% in western coast, 84.61% in central coast and 77% in eastern coast), Fertile agricultural land loss its top soil fertility due to climate change (45.88% in western coast, 68% in central coast and 69% in eastern coast), Besides these, Sweet water cultured fish cannot be cultivated (72.35% in western coast, 67% in central coast and 56% in eastern coast), Female members are unable to get jobs related to agro-based income earning actions (60.58% in western coast, 67% in central coast and 67% in eastern coast), Fruit and timber trees of more than (64.70% in western coast, 57.69% in central coast and 63% in eastern coast), households cannot be grown due to extreme climate. However, Climate change induced disasters play negative role on poultry industry and they cannot be commercially initiated due to lack of dry space. It is also observed that water logging is created in the coastal areas because of salinity intrusion resulting from sea level rise; it damage the growth potential of grass and crop variety. Even, economic risks caused by climate change have disrupted the social and institutional relations of coastal societies, such as agricultural offices, banks, NGOs etc. As a result, the economic difficulties and family struggles by climate change are raising.

Various economic implications of climate variability is found in the study area (Table- 6.9) like Wage earners of household continue unemployed (95.56%, R-1), Damage of Transport and communication (89.40%, R-2), Disturbance of Institutional linkages (81.23%, R-3), Animals cannot be reared owing to lack of grazing fields and animal feed (78.36%, R-4), Vegetables cannot be grown due to saline water (75.52%, R-5), Seasonal crops cannot be cultured due to severe climate change (74.19%, R-6), Homestead Forests/ community forest have been destroyed (73.19%, R-7), Sweet water cultured fish cannot be cultivated (65.22%,R-8), Fruit and timber trees cannot be grown (61.85%, R-9), Female members are unable to get jobs related to agro-based income earning actions (61.06%, R-10), Fertile agricultural land loss its top soil fertility owing to climate change (61.06%, R-11), Poultry and layer cannot be

commercially initiated due to lack of dry space (52.81%, R-12) and Others (38.39%, R-13).

As per respondents' opinion Wage earners of household continue unemployed strode in 1st rank in the western coast of the study area, damage of transport and communication, Homestead Forests/ community forest have been destroyed, disturbance of institutional linkages, animals cannot be reared owing to lack of grazing fields and animal feed, Sweet water cultured fish cannot be cultivated, Fruit and timber trees cannot be grown, Seasonal crops cannot be cultured due to severe climate change, Female members are unable to get jobs related to agro-based income earning actions, Poultry and layer cannot be commercially initiated due to lack of dry space, Fertile agricultural land loss its top soil fertility due to climate change, Vegetables cannot be grown owing to saline water and others which stood 2nd , 3rd , 4th , 5th , 6th , 7th , 8th , 9th , 10th , 11th , 12th , 13th and 14th rank respectively (Table 6.9).

On the basis on respondents' opinion wage earners of household continue unemployed strode in 1st rank in the central coast of the study area, Damage of Transport and communication, Disturbance of Institutional linkages, Seasonal crops cannot be cultured due to extreme climate change, animals cannot be reared due to lack of grazing fields and animal feed, vegetables cannot be grown due to saline water, homestead forests/ community forest have been destroyed, fertile agricultural land loss its top soil fertility due to climate change, Sweet water cultured fish cannot be cultivated, female members are unable to get jobs related to agro-based income earning actions, fruit and timber trees cannot be grown, poultry and layer cannot be commercially initiated due to lack of dry space, and others which stood 2nd , 3rd , 4th , 5th , 6th , 7th , 8th , 9th , 10th , 11th , 12th , 13th and 14th rank respectively (Table 6.9).

According to respondents' opinion wage earners of household continue unemployed strode in 1st rank in the eastern coast of the study area, damage of transport and communication, vegetables cannot be grown due to saline water, seasonal crops cannot be cultured due to extreme climate change, animals cannot be reared due to lack of grazing fields and animal feed, disturbance of institutional linkages, fertile agricultural land loss its top soil fertility due to climate change, homestead forests/ community forest have been destroyed, female members are unable to get jobs related to agro-based income earning actions, Fruit and timber trees cannot be grown, sweet water cultured fish cannot be cultivated, poultry and layer cannot be commercially

initiated due to lack of dry space, and others which stood 2nd , 3rd , 4th , 5th , 6th , 7th , 8th , 9th , 10th , 11th , 12th , 13th and 14th rank respectively (Table 6.9). Rank size has been demarcated considering the percentage of questionnaire Survey. A in depth interviewers Mawlana Jahangir Alam, Principal, Mongla Port Ideal Madrasha, Mongla, Bagherhat mentioned that--

"I have detected that many farmers are losing their agricultural land and also the economic activities opportunity due to cyclone, SLR and tidal water intrusion. As a result a large numbers of wage earners of household continue unemployed"

Table 6.9: Climate Variability and Economic Implications in the Study Area

Nature of social implications	Western Coast *(n=170)*		Central Coast *(n=110)*		Eastern Coast *(n=120)*		Total n= 400	
	%	*R*	*%*	*R*	*%*	*R*	*%*	*R*
Wage earners of household continue unemployed	97.05	1	95.38	1	94.25	1	95.56	1
Damage of Transport and communication	85.29	2	94.61	2	88.30	2	89.40	2
Disturbance of Institutional linkages	78.23	4	92.30	3	73.15	6	81.23	3
Animals cannot be reared owing to lack of grazing fields and animal feed	74.11	5	85.38	5	75.60	5	78.36	4
Vegetables cannot be grown owing to saline water	64.70	12	84.61	6	77.25	3	75.52	5
Seasonal crops cannot be cultured owing to extreme climate change	64.11	8	82.30	4	76.15	4	74.19	6
Homestead Forests/ community forest have been destroyed	83.52	3	68.46	7	67.75	8	73.19	7
Sweet water cultured fish cannot be cultivated	72.35	6	67.15	9	56.30	11	65.22	8
Fruit and timber trees cannot be grown	64.70	7	57.69	11	63.15	10	61.85	9
Female members are unable to get jobs related to agro-based income earning actions	60.58	9	67	10	67.60	9	65.06	10
Fertile agricultural land loss its top soil fertility due to climate change	45.88	11	68	8	69.30	7	61.06	11
Poultry and layer cannot be commercially initiated owing to lack of dry space	51.76	10	51.53	12	55.25	12	52.81	12
Others	31.17	13	37.69	13	46.30	13	38.39	13

Source: Field Survey 2018-19 N.B: Multiple answers considered, R=Rank

N.B: Rank size was demarcated considering the percentage of questionnaire Survey

6.10 Climatic Variability and Forced Migration in the Study Area

In Bangladesh, population relocation or migration is connected to extreme climatic variability that causes serious natural disasters and hazards. Since environmental change is not a new phenomenon for several reasons, people migrate from one location to another. In the coastal regions, frequent natural disasters have disrupted employment prospects for people. Due to declines in agricultural land and other income generating operations, impact individuals are losing their jobs. The study shows that (Table 6.10) due to climate change and increase of CCIDS day by day narrowing the employment opportunity in the study area as a result people are migrated to other places for batter work. According to the study 86.72% of the respondents of the study area mentioned that lack of positive employment opportunities owing to climatic variability they are migrating to appropriate places (85.25% in western coast, 84.75% in central coast and 90.15% in eastern coast). It is also found that Lack of Coping mechanism with changing climate 85.80% of the respondents of the study area mentioned that they are migrating (86.30% in western coast, 87.54% in central coast and 83.54% in eastern coast), to others suitable places of the country or even to aboard. On the other hand 76.71% respondents of the study area opined that they are migrating for suitable places to save them from salinity intrusion (it is 87.66% in western coast, 77.15% in central coast and 65.33% in eastern coast), and also looking for alternatives. A key informant interviewers Mr. Abdul Hannan, Freedom fighter (Commander), Assasunai Upazila, Satkhira mentioned that--

> *"I have found that many individuals are unable to get sufficent food, shelter, clothes, sanitation or supplementary facilities. As a result the affected people move to Dhaka, Chittagong or other parts of the country or even aboard to get alternative supplies and sustain their lives."*

It is also learnt that young people no longer interested in cultivating crops and are migrating to other places in quest of work.

Table 6.10: Climatic Variability and Forced Migration in the Study Area

Climate variability and causes of migration	Western coast (n=170)		Central coast (n= 110)		Eastern coast (n= 120)		Total	
	%	R	%	R	%	R	%	R
Lack of positive employment	85.25	3	84.75	2	90.15	1	86.72	1
Lack of Coping mechanism with changing climate	86.30	2	87.54	1	83.54	2	85.80	2
Salinity Intrusion	87.66	1	77.15	3	65.33	3	76.71	3
Others	23.25	4	21.30	4	18.25	4	20.93	4

Source: Field Survey 2018-19 N.B: Multiple answers considered R- Rank

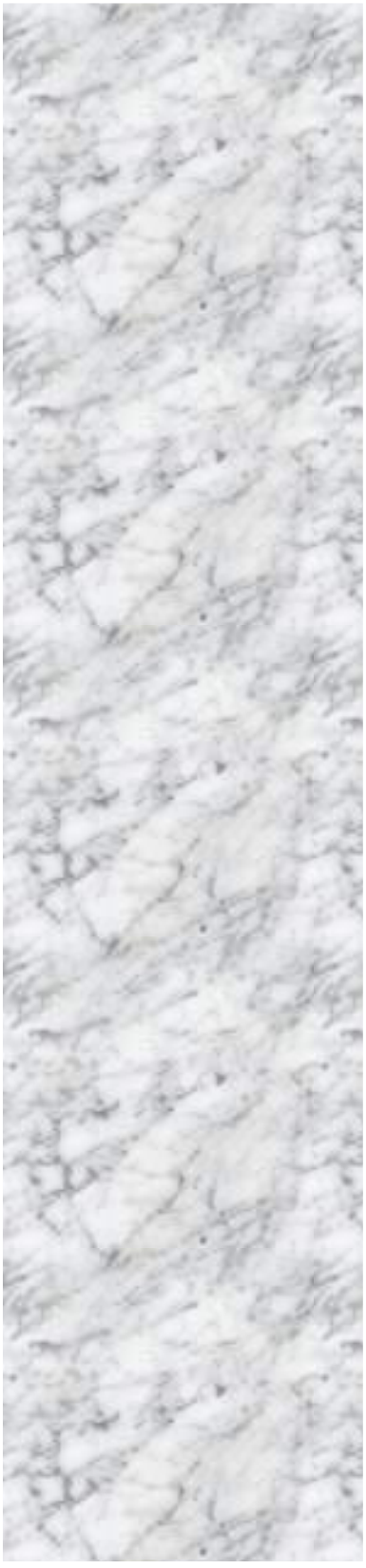
N.B: Rank size was demarcated considering the percentage of questionnaire Survey

6.11 Conclusion

Due to uneven physiography, cress crossed of tidal creeks and stream, broken and the poor communication system are general characteristics in the coastal region of Bangladesh. These unique characteristics accelerate the severity of disasters in these areas. Service providers get interrupted to provide their services even basic daily amenities to the coastal inhabitants of Bangladesh. Nearly 75% coastal people are aware about social safety net programs and 51% received the benefits from this program. Almost 10 types of benefits people can easily access. Among ten benefits the health facilities, adult allowance, VGD and VGF card, awareness building and free medicine are prominent. Coastal folks argued that local influential people as well as corruption and nepotism of local authority interrupted this program. Besides, almost one third of the coastal people said that non-government organizations are working with governmental bodies and departments. However, infrastructure is the worst vulnerable social sectors in the coastal areas of Bangladesh. These Nonetheless, general health considering on the health sector, school going students regarding on education, educational institute allowing for infrastructural sector, relocation and basic needs on the subject of government activities and occupation and fishing as regards on agricultural dependency are the subsectors those that are most vulnerable in the coastal areas of Bangladesh.

Chapter 7

EXISTING ADAPTATION PRACTICES AND REGIONAL VARIATION IN THE STUDY AREA



7.1 Introduction

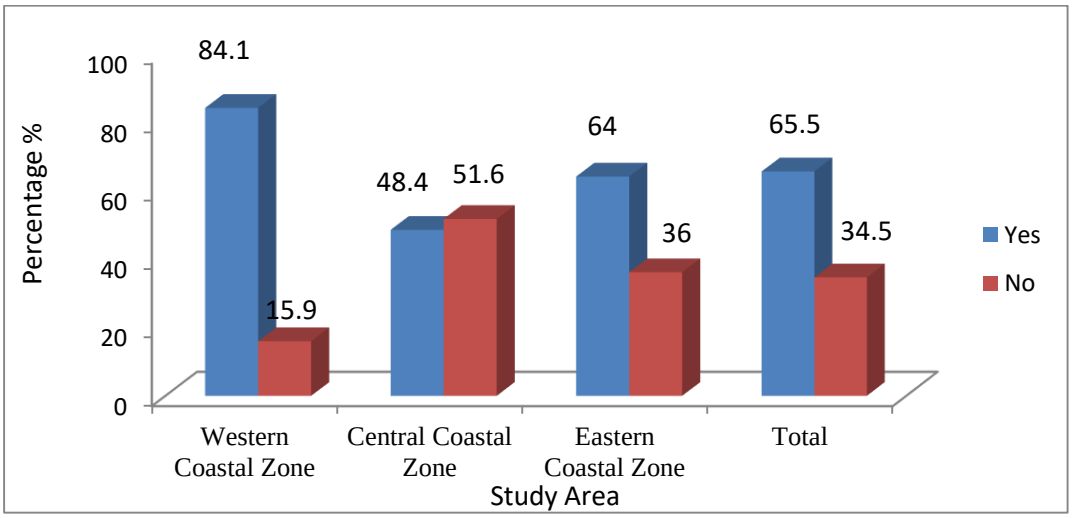
"Climate change affects human and environmental systems negatively, increases vulnerability and create a need for adaptation" (IPCC, 2007 and IPCC, 2014). The promotion of adaptation technologies has been globally recognised as an important strategy in the UNFCCC process to achieve adaptation and minimize the severity and adverse effect of climate (UNFCCC, 2010). Indigenous knowledge of communities has contributed to solutions to numerous climate problems in almost all countries and habitats, which can hopefully be repeated and implemented in areas that are likely to be impacted by climate change. (Huq & Wright, 2013: 4). UNFCCC (2013) found that many Parties prioritized indigenous/local technologies that could be applied for adaptation, in their Technical Needs Assessments (TNA's), such as traditional housing designs, bunds, levees, dikes and mangrove plantations. Wilk and Wittgren (2009), however, find that there is still a great need to differentiate the knowledge processed by local citizens. In addition, NAPA, 2009 is well associated with the BCCSAP and in terms of defining short and medium-term adaptation steps, will discuss the following thematic pillars: (a) Ensuring food safety and pro-poor social protection of disadvantaged people in climate; (b) Strengthen comprehensive disaster management programme; (c) Climate resilient infrastructure development as well as sustainable cities; (d) Mainstreaming climate change in local and national development; (e) capacity enhancement including research and knowledge management and institutional strengthening and (f) Strategic natural resource management as an adaptation reply to climate change including wise use of wetlands, rivers, flood plain system. Moreover, adaptation to climate change did not take delivery of much attention in the first years of the international climate change studies, where there was more focal point on mitigation and impacts (Kates, 2000), but adaptation has newly been covered more extensively owing to the increasing susceptibility of some countries. In fact, it has been shown that some countries will be increasingly showing to frequent and severe climatic events. In recent years, long-term changes observed by scientists include widespread changes in rainfall leaves, ocean salinity, wind patterns and severe weather, including droughts, heavy rain/ snow, heat waves and tropical cyclone strength (Smithers and Smit, 1997). The influence of climate change poses risks to agriculture, food and availability of water. Moreover, Tol (2005) argues that increasing adaptive capacity of developing

countries through development assistance is more fruitful than combating climate change. Each social system response in a crisis situation and the temporary adaptive mechanism can be transferred to the society as a permanent pattern if disasters happen again and again (Adger*et al.*, 2005). Bangladesh, however, is internationally recognized for its cutting-edge climate change achievements and has been described as 'adaptation capital of the world' (Irfanullah, 2013). Over the years, the people of Bangladesh have adapted to the threats of floods, droughts and cyclones. They raise their houses on embankments, above the usual flood level in areas where flooding is a possibility, and change their cropping patterns to take advantage of the flood waters. By growing a Varity of indigenous and high-yielding varieties of rice and other crops, farmers in all parts of the country are adapting to local flooding and rainfall patterns. Where appropriate, rural roads, paths, tracks and other facilities, such as schools, are also raised above flood level.

7.2 Attempts/Measures Taken for Disaster Adaptation by the Respondents

Attempts / measures taken for disaster by the respondents are studied in cyclone, flood, SLR and Salinity Int., river bank erosion, storm surge, temperature rise, thunderstorm, various diseases, tornado, IR & drought and land slide through different phases like pre, during and post disaster. The study results that maximum respondents (64%) took measures for disaster and very less (36%) did not take any measures for disaster (Figure 7.1). People those who are very poor and landless they did not take any measures due to their financial capability. However, key institutional actors (civil society organizations, academic and research institutes, media and private sector) said that adaptations or strategies or coping methods depend on the nature of disaster, level or indigenous knowledge of coastal people as well as geographical location of the coastal areas. In these contexts, the central coastal zone in response to fluvial activity and it is more devastating than others zone. In this situation, coastal people sometime fatalist with becoming disasters here.

Figure 7.1: Attempts/Measures for Protection from Disasters by the Respondents



Source: Field Survey 2018-19

7.2.1 Measures/Initiatives for Adaptation with Flood

A diversified approach to strategies, which can include systemic flood management initiatives, early warning systems, risk-informed land planning, nature based solutions, social protection and risk financing instruments, requires effective adaptation to rising flood risk (Aerts, *et al.*, 2014) . Besides, physical flood protection measures, such as dikes and levees, are generally cost-effective in areas with high population and asset concentrations (Ward *et al.*, 2017). In addition, the Bangladesh government has recently concentrated on both structural and nonstructural flood management strategies to mitigate flood vulnerability (Paul, 1995). Adaptation steps, however, vary from country to country, place to place, subject to risk levels, geographic location, etc. On the hand, various forms of coping strategies that can be used on a local scale to respond to climate change induced flooding in the coastal areas of Bangladesh during different times of disaster (i.e. pre disaster, during disaster and post disaster).

7.2.1.1 Pre disaster Period Adaptation Measures/Initiatives for Flood

During pre-disaster periods or before disaster period people are taken nearly twelve types of strategies or initiatives in the whole coastal areas of Bangladesh (Table 7.1). Among twelve strategies, buildup house in highland, embankment cum afforestation

and awareness building are the prime strategies to safe and save life and properties from disaster. Nonetheless, the strategies or initiatives differ on the zone to zone in the coastal region of Bangladesh (Table 7.1). To cope with a catastrophe with the least negative effects, these techniques are very relevant.

Table 7.1: Pre disaster Period Adaptation Initiatives for Flood

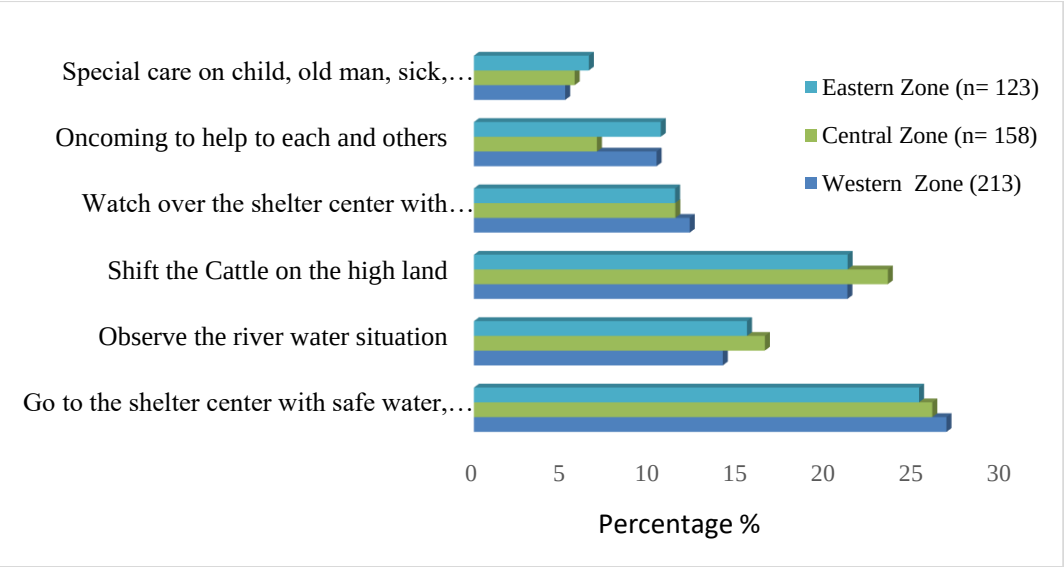
Perception about the pre disaster initiatives of flood	**Western Zone (n=251)**	**Central Zone (n=196)**	**Eastern Zone (n=130)**	**Total (n=577)**
Buildup house in highland	11.55	14.29	13.08	12.97
Preserve essential medicine (first aid box)	9.96	9.69	10.00	9.88
Preserve some dry food, salt ,candle, money, *Gur*/sugar and kerosene oil and so on	9.56	7.65	8.46	8.56
Embankment buildup	8.37	7.14	7.69	7.73
Embankment cum afforestation	10.76	11.22	9.23	10.40
Awareness building	10.36	9.18	6.92	8.82
Earn knowledge about flood vulnerability	5.18	6.12	6.15	5.82
Frequently hear the news of radio and TV	7.97	8.16	6.92	7.68
Collect good seeds of crops	7.17	7.14	8.46	7.59
Take necessary preparation for emergency situation tackling	5.98	5.61	6.92	6.17
Collect boat for emergency management	6.77	7.14	7.69	7.20
Vaccination for livestock's	6.37	6.63	8.46	7.15
Total	100%	100%	100%	100%

Source: Field Survey 2018-19 N.B: Multiple answers considered

7.2.1.2 During disaster Period Adaptation Measures/Initiatives for Flood

During a disaster, using coping mechanisms can also mitigate the negative impacts of flood disaster in Bangladesh. Figure 7.2 illustrates that coastal people are follows nearly six types of coping mechanisms in the coastal areas of Bangladesh. Among six coping strategies, go to the shelter center with safe water, food, medicine, match and candle, cloth, dish and plate etc., shift the cattle on the highland and observe the flood water situation are the major three coping strategies those are applying people in the coastal areas of Bangladesh. However, a significant proportion of the coastal people said that watch over the shelter center to community people for security purpose.

Figure 7.2: During disaster Period Adaptation Measures/Initiatives for Flood



Source: Field Survey 2018 -19 N.B: Multiple answers considered

7.2.1.3 Post disaster Period Adaptation Measures/Initiatives for Flood

During post disaster period or after passing disaster period government and non-government organization done different type of initiatives, for instance relief program and rehabilitation program. In this stage, the negative impacts of the disaster depend on the pre disaster strategies or initiatives. If people take proper strategies or initiatives then the loss and damage are limited. However, in short term of rehabilitation, but not in the long term, talking strategies in this time may be helpful. In the past disaster time most economic coping strategies are used. Table 7.2 explores that almost eleven types of strategies either relief program or rehabilitation program in the coastal areas of Bangladesh. Among them repair the houses, return to own localities and help to another for comeback are prime strategies those are applied coastal people at after disaster (Table 7.2).

Table 7.2: Post disaster Period Adaptation Measures/Initiatives for Flood

Perception about the post disaster initiatives of flood	**Western Zone (n=285)**	**Central Zone (n=194)**	**Eastern Zone (n=167)**	**Total (n=646)**
Repair the houses	18.95	17.53	19.16	18.55
Return to own localities	12.63	11.86	13.17	12.55
Help to another for come back	11.23	11.34	11.38	11.32
Repair the damaged toilet/ sanitation system	7.72	8.76	8.98	8.49
Clean the sewerage system around the house	8.07	8.25	8.38	8.23
Take necessary advice from the local health care office /doctors	11.23	9.79	9.58	10.20
Provide vaccination for livestock's	4.21	5.67	6.59	5.49
As soon as possible start the economic activities/agriculture	5.26	6.70	5.39	5.78
Repair the damaged culvert, bridge and transportation system	4.91	5.67	4.79	5.12
Repair the damaged education institutions, religious place etc.	7.02	7.73	7.19	7.31
Contact with local government or administration	8.77	6.70	5.39	6.95
Total	100%	100%	100%	100%

Source: Field Survey 2018-19 N.B: Multiple answers considered

7.2.2 Measures/Initiatives for Adaptation with Cyclone (Pre, During and Post disaster) in the Study Area

Records from the last 200 years indicate that at least 70 major cyclones struck Bangladesh's the coastal belt and nearly 900,000 people died from devastating cyclones in the last 35 years (PDO-ICZMP, 2004:14, The Asian Foundation, 2012). Whereas, cyclone is the recurrent and devastating disaster in the coast of Bangladesh. So, coastal people have needed to apply their indigenous knowledge to cope with this disaster.

7.2.2.1 Pre disaster Adaptation Initiatives for Cyclone

In response to the pre-cyclone disaster period, coastal people are applied nearly nineteen type of strategies or initiatives to protect themselves in the coastal areas of

Bangladesh (Table 7.3). Among nineteen strategies or initiatives, maximum time coastal people prefer tree plantation beside the house, roads, village and embankments, listening to weather message and know about signals. However, the proportion of the responses are not equal and it varies from zone to zone.

Table 7.3: Pre disaster Adaptation Initiatives for Cyclone

Perception about the pre disaster initiatives of cyclone	**Western Zone (n=297)**	**Central Zone (n=181)**	**Eastern Zone (n=149)**	**Total (n=627)**
Tree plantation beside the house, roads, village and embankments	14.48	20.44	21.48	18.8
Listening to weather message	12.46	18.23	18.12	16.3
Know about signals	11.11	16.02	0.00	9.0
Inform it to everyone	9.76	9.39	10.74	10.0
Elderly and children are taken to a safe place	7.74	8.29	7.38	7.8
Preserve dry food and seeds	7.41	6.08	8.05	7.2
Construction of shelter	7.07	6.08	0.00	4.4
Know the signal and inform everyone	6.06	0.00	7.38	4.5
Prepare yourself to go to the shelter center	4.04	3.31	0.00	2.5
Exam necessary goods like torch light, radio etc.	3.70	2.76	8.05	4.8
Strongly close the door and window of the house	2.69	1.66	7.38	3.9
Take light, cloth and necessary goods	2.36	1.66	0.00	1.3
Know the safe and shortcut road to go the shelter center	2.36	1.66	3.36	2.5
Put in the tubewell in highland	2.02	0.00	1.34	1.1
Collect the safe water and dry foods	2.02	1.66	3.36	2.3
Launch, strummer and boat driver must move with radio for hearing the signal	1.35	0.00	0.67	0.7
Awareness buildup to the people about cyclonic disaster	1.35	1.66	1.34	1.5
Keep the first aid box at home	1.01	1.10	1.34	1.2
Keep the seeds in proper ways	1.01	0.00	0.00	0.3
Total	100%	100%	100%	100%

Source: Field Survey 2018-19 N.B: Multiple answers considered

7.2.2.2 During disaster Adaptation Measures/Initiatives for Cyclone

In response to the during-cyclone disaster period, nearly13 types of strategies are applied to safe life and properties of the coastal people in the coast of Bangladesh (Table 7.4). Among them go to the shelter center with safe water, food, medicine, match and candle, cloth, dish and plate etc. Sifting livestock in a safe and high place;

special care of the child, old man, sick, retarded, pregnant mother and quickly send them to the shelter center is the key strategies.

Table 7.4: During disaster Adaptation Measures/Initiatives for Cyclone

Perception about the during disaster initiatives of cyclone	Western Zone (n=267)	Central Zone (n=185)	Eastern Zone (n=148)	Total (n=600)
Sifting livestock in safe and high place	13.86	15.68	15.54	15.03
Inform to everyone	5.99	7.57	7.43	7.00
Stay in the shelter center	0.00	0.00	0.00	0.00
Stay in strong home	3.37	1.62	0.00	1.66
Go to the shelter center with safe water, food, medicine , *match* and candle, cloth, dish and plate etc.	20.97	25.41	26.35	24.24
Fishermen guy their net with a strong tree	10.11	11.89	11.49	11.16
Oncoming to help to each and others	5.24	5.95	6.08	5.76
No movement of water transportation	4.87	3.78	3.38	4.01
Special care on child, old man, sick, Retarded, Pregnant mother and quickly send them to the shelter center	11.61	9.73	10.81	10.72
No movement from shelter center until fully stop of cyclone	2.62	1.62	0.00	1.41
Refill rice, dal, dry match, dry timber, water, *fitkary*, sugar. *gur*, powder milk, bandage, cotton, some oral saline in a juror plastic bag and drive into hole.	5.99	5.95	5.41	5.78
Frequently hear the news of radio, TV and obey the order	8.24	8.65	9.46	8.78
Watch over the house and resource with community people.	4.87	2.16	2.03	3.02
Move with necessary goods, Dalil/Deed, Money or trash with Polythin and drive into hole	2.25	0.00	2.03	1.43
Total	100%	100%	100%	100%

Source: Field Survey 2018-19 N.B: Multiple answer considered

7.2.2.3 Post disaster Adaptation Measures/Initiatives for Cyclone

During post disaster period or after passing disaster period government and non-government organization taken different type of initiatives, for instance relief program and rehabilitation program. In this stage, the negative impacts of the disaster depend on the pre disaster strategies or initiatives. If people take proper strategies or initiatives then the loss and damage are limited. But in short term of rehabilitation, but not in the long term, taking strategies in this time may be helpful. In the post disaster time, most economic coping methods are used. Table 7.5 explores that 12 types of strategies or initiatives have been applied to manage the life and livelihood of climate

victim in every coastal zone in Bangladesh. Among twelve categories, give relief / take relief, cleaning the house and roads and run rescues works are the foremost strategies or initiatives to climate victim at every coastal areas of Bangladesh.

Table 7.5: Post disaster Adaptation Measures for Cyclone

Perception about the post disaster initiatives of cyclone	**Western Zone (n=264)**	**Central Zone (n=183)**	**Eastern Zone (n=151)**	**Total (n=598)**
Give relief / take relief	21.59	24.59	25.83	24.00
Cleaning the house and roads	16.67	19.13	20.53	18.78
Run rescues works	15.53	15.85	16.56	15.98
Help to the people to come back home	8.33	10.38	9.93	9.55
Construction of roads	7.95	6.01	5.96	6.64
Helping the injured person	7.20	6.56	5.30	6.35
Repair the damaged house/ toilet/ sanitation system	8.33	4.37	3.31	5.34
Take necessary steps	4.17	4.92	4.64	4.58
As soon as possible start the economic activities/agriculture	2.65	2.19	1.99	2.28
Go to the near health care office/ Doctor for necessary counseling	3.41	3.28	1.99	2.89
Help the rehabilitation program of Govt. and Non-Govt. organizations	2.27	2.19	1.99	2.15
Pitch up the Dade body and expire livestock's as soon as possible	1.89	0.55	1.99	1.48
Total	100%	100%	100%	100%

Source: Field Survey 2018 -19 N.B: Multiple answers considered

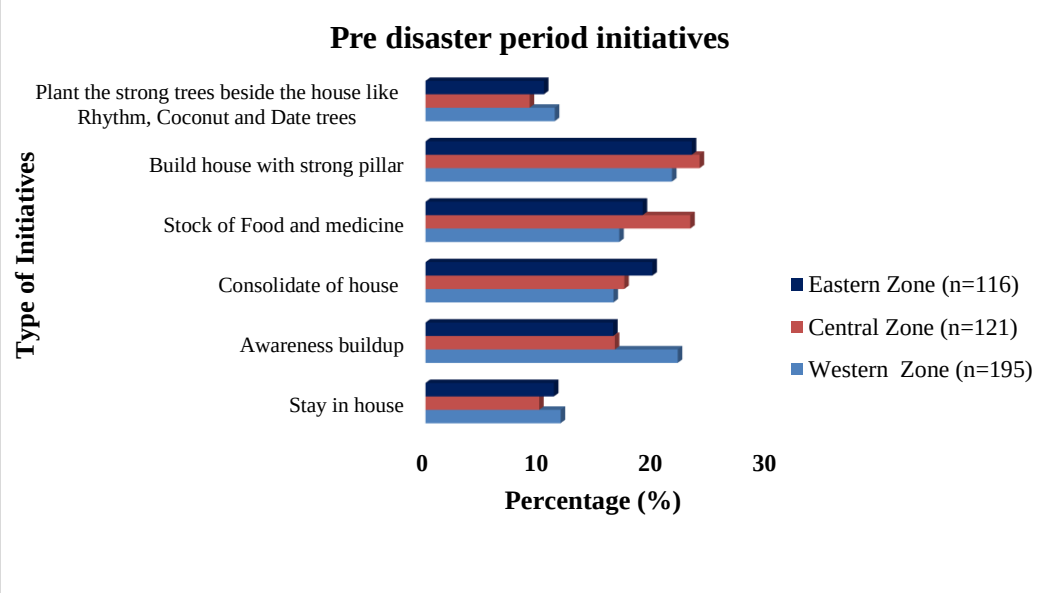
7.2.3 Measures/Initiatives for Adaptation with Tornado (Pre, During and Post disaster) in the Study Area

Bangladesh has a long history of events involving tornados. The country's first recorded tornado occurred in March 1875" (Finch, 2005). "Between 1967 and 1996, Bangladesh witnessed 191 tornadoes, while more than 100 tornadoes caused the loss of human lives. And, 6.4 tornadoes per year average. (Ono, 2001). Besides, " improved weather forecasts, alert system, tornado risk zoning maps and maintaining proper infrastructure building code help to minimize losses" (Hosen and Jubayer, 2016).

7.2.3.1 Pre disaster Adaptation Measures/Initiatives for Tornado

During a pre-disaster or before disaster period, people are taken six types of strategies or initiatives to safe themselves from tornado disaster (Figure 7.3). Among them build houses with strong pillar, stoke of food and medicine, consolidate of house and awareness building are the key strategies or initiatives to protect themselves in the Bangladesh. However, a tornado is occurring in the midland of the country. But due to physiographical modifications, i.e. plane land, valley and mountain land, sometimes tornado occurred in the adjacent areas of coast, though the originated places are so far from the coast, but the effects are easily touched the coastal areas.

Figure 7.3: Pre Disaster Adaptation Measures/Initiatives for Tornado

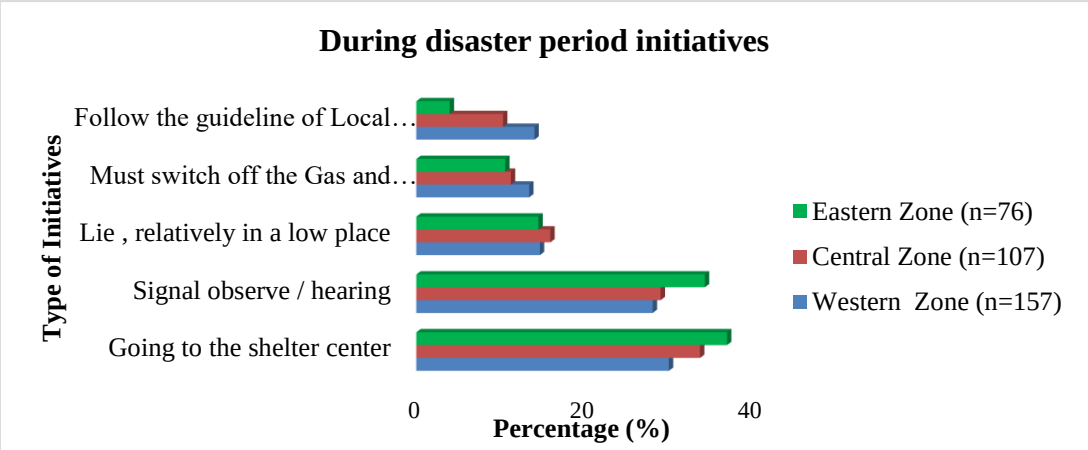


Source: Field Survey 2018-19 N.B: Multiple answers considered

7.2.3.2 During Disaster Adaptation Measures/Initiatives for Tornado

Proper coping strategies can help to minimize the negative impacts of tornado during disaster period in the study areas. Figure 7.4 shows that people are followed 5 types of coping strategies during tornado period. Among them going to the shelter center and signal observe or hearing is the leading strategies or coping techniques in the study areas.

Figure7.4: During Disaster Adaptation Measures/Initiatives for Tornado



Source: Field Survey 2018-19 N.B: Multiple answers considered

7.2.3.3 Post disaster Adaptation Measures/Initiatives for Tornado

During post disaster period or after passing disaster period relevant organizations are provided different type programs like relief and rehabilitation in the affected areas. Table 7.6 explores that people are led six types of relief and rehabilitation programs in their areas. Among them, repair the road communication; repair the damaged house/ toilet/ sanitation system and remove the plants from the road for smooth transportation are the major techniques to adopt with tornado disasters in the study areas.

Table 7.6: Post disaster Adaptation Measures for Tornado

Perception about the post disaster initiatives of tornado	**Western Zone (n= 180)**	**Central Zone (n=121)**	**Eastern Zone (n=118)**	**Total (n=419)**
Help everyone for return to home	9.44	9.92	12.71	10.69
Repair the road communication	26.11	33.88	27.97	29.32
It need, take help from local health complex	18.89	15.70	20.34	18.31
Pitch up the Dade body and expire livestock's as soon as possible	3.33	2.48	0.85	2.22
Remove the plants from the road for smooth transportation	17.78	18.18	18.64	18.20
Repair the damaged house/ toilet/ sanitation system	24.44	19.83	19.49	21.25
Total	100%	100%	100%	100%

Source: Field Survey 2018-19 N.B: Multiple answer considered

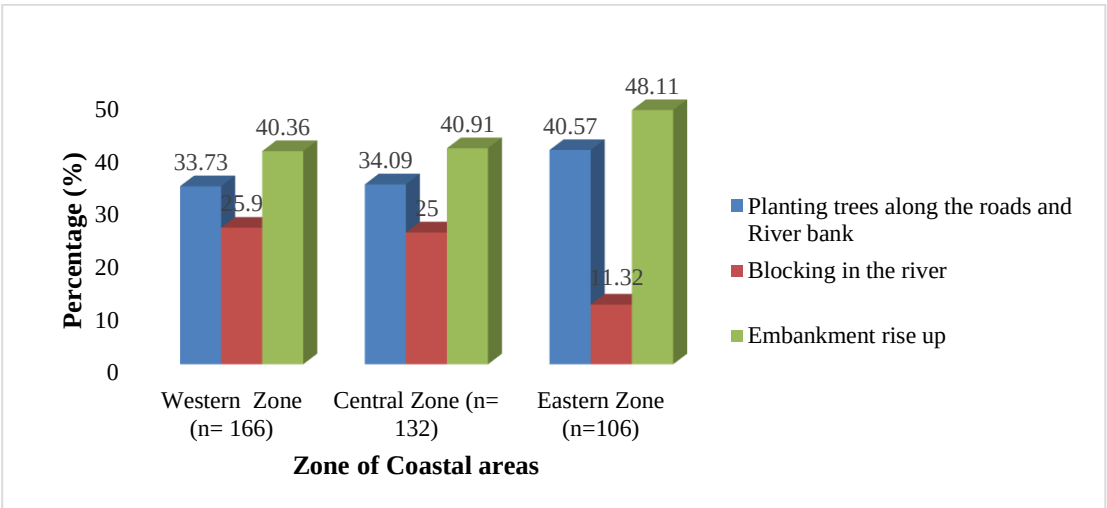
7.2.4 Measures/ Initiatives for Adaptation with Riverbank Erosion (Pre,During and Post disaster) in the Study Area

A recurrent phenomenon is river bank erosion along the major rivers (Hassan en Mahmud-ul-islam 2016). Riverbank erosion is a steady, silent disaster, ranking highest in Bangladesh in terms of losses (Shamsuddoha & Chowdhury, 2007). The major causes of riverbank erosion are surplus water from upstream, unexpected flooding, siltation on the river bed, unplanned activity. Approximately 877.90 km2 of land along the Jamuna (Brahmaputra) and 293.90 km2 along the Padma (Ganges) were eroded between 1973 and 2004 (CEGIS, 2005). About 15–20 million people are at risk from the effects of erosion in Bangladesh (Hutton &Haque, 2004).

7.2.4.1 Pre disaster Adaptation Measures/Initiatives for Riverbank Erosion

During a pre-disaster or before disaster period, coastal people are practiced three types of strategies or initiatives to safe themselves from bank erosion i.e. either bank erosion or bay erosion (Figure 7.5). Among them the height of the embankment rise up and planting trees along the roads and river bank sites are key strategies in the coastal region of Bangladesh. While few coastal dwellers argued that blocking in the river site is the effective technique to protect bank erosion in the coastal areas.

Figure 7.5: Pre disaster Adaptation Measures/Initiatives for Riverbank Erosion

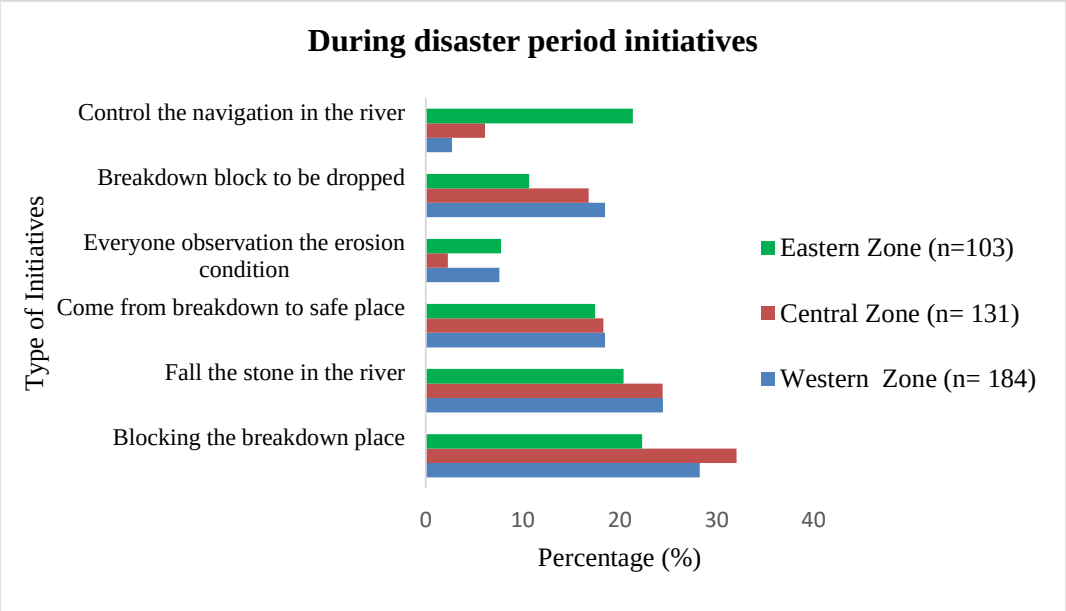


Source: Field Survey 2018-19 N.B: Multiple answers considered

7.2.4.2 During Disaster Adaptation Measures/Initiatives for Riverbank Erosion

Effective coping strategies can reduce the vulnerability of bank erosion in the coastal areas of Bangladesh. Figure 7.6 explains that six types of possible coping mechanisms those are applied by coastal people in bank erosion vulnerable areas. Among them blocking the breakdown place, fall the stone in the river and people come from breakdown to safe places are the significant coping strategies of coastal people in their areas. However, control the navigation in the river course is the prime strategies to stop the river erosion in the eastern zone of the coastal belt of Bangladesh.

Figure 7.6: During Disaster Adaptation Measures for Riverbank Erosion

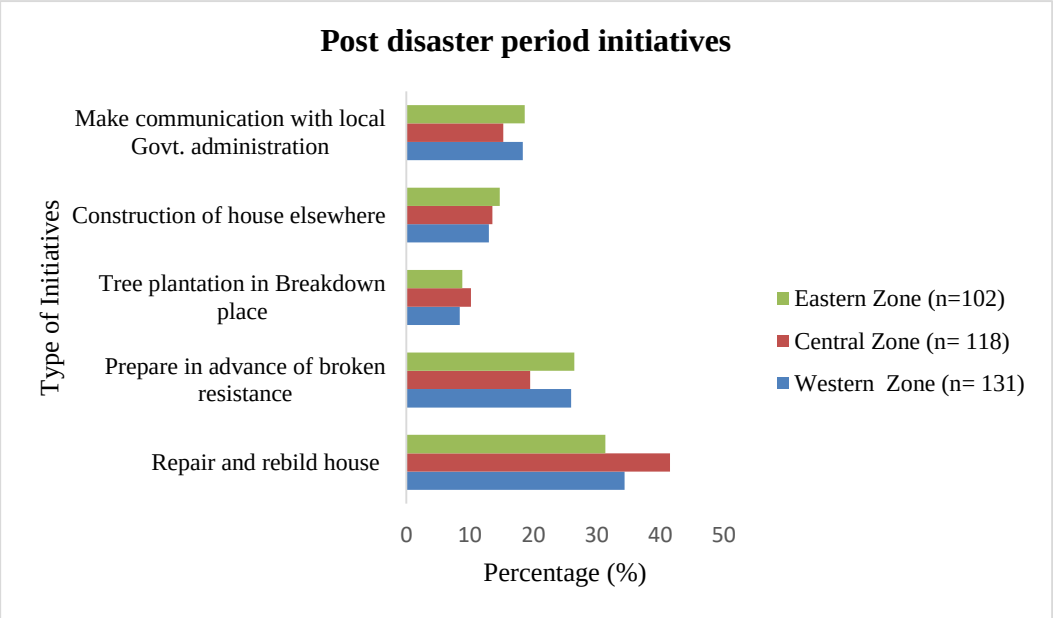


Source: Field Survey 2018-19 N.B: Multiple answers considered

7.2.4.3 Post Disaster Adaptation Measures/Initiatives for Riverbank Erosion

Actually, post disaster period or after passing disaster period is the management or action oriented stage among pre and during disaster periods. However, in post disaster period, coastal people are perform five types of actions to take protect their life and livelihood in the coastal areas of Bangladesh (Figure7.7).Among them, maximum people are done some particular attempts such as repair and rebuild house, prepare in advance of broken resistance and make communication with local govt. administration.

Figure 7.7: Post disaster Adaptation Measures/Initiatives for Riverbank Erosion



Source: Field Survey 2018-19 N.B: Multiple answers considered

7.2.5 Measures/Initiatives for Adaptation with Salinity (Pre, During and Post disaster) in the Study Area

In 1973, about 83.3 million hectares of land were affected by salinity which moved to 102 million hectares in 2000. That amount increased to 105.6 million hectares in 2009. Salinity within the country has increased to 26 percent over the last 35 years (SRDI, 2010). The intrusion of excess salinity has pushed the community living in the coastal zones to more than a few dilemmas (Habiba, 2014).

During, pre-disaster or before disaster period, coastal people are practicing seven types of strategies to safe their life and livelihood from salinity intrusion or salinization process in the coastal region of Bangladesh. Because salinity intrusion or salinization is the periodic and longtime processes. Among seven strategies, protection of fresh water sources, build effective embankment, and build an adequate sluice gate are the prime strategies in their region (Table 7.7).The perceptions and practices are differs from areas to areas.

Table 7.7: Measures/Initiatives for Adaptation with Salinity (Pre, During and Post disaster) in the Study Area

Period/*Types of initiatives*		Western Zone		Central Zone		Eastern Zone	
		f	*%*	*f*	*%*	*f*	*%*
Pre	Protection of fresh water sources	29	24.79	23	28.40	23	29.49
	Build effective embankment	25	21.37	19	23.46	18	23.08
	Build an adequate sluice gate	22	18.80	13	16.05	11	14.10
	Innovate salt tolerant crops	16	13.68	11	13.58	14	17.95
	Increase height of the edge of land	12	10.26	10	12.35	9	11.54
	Put in the tube wail in highland	8	6.84	3	3.70	0	0.00
	Plant the salt tolerant trees	5	4.27	2	2.47	3	3.85
	Total	**117**	100%	**81**	100%	**78**	100%
During	Drink safe water and try to safe water sources	31	39.24	23	36.51	29	55.77
	Production salt tolerant products like salt, shrimp and so on	23	29.11	21	33.33	12	23.08
	Close the sluice gate	25	31.65	19	30.16	11	21.15
	Total	**79**	100%	**63**	100%	**52**	100%
Post	Tree plantation	38	38.38	33	45.20	23	41.82
	Open the sluice gate	32	32.32	12	16.43	21	38.18
	Buildup the embankment	29	29.29	28	38.35	11	20.00
	Total	**99**	100%	**73**	100%	**55**	100%

Source: Field Survey 2018 -19 N.B: Multiple answers considered

During disaster period, coastal people are practicing three coping strategies in the coastal region of Bangladesh (Table 7.7). Among three strategies, maximum times people are drink fresh water and try to protect fresh water sources in the saline affected areas. Besides, in the post disaster period, coastal people try to practices three major management aspects, like tree plantation, open the sluice gate and build the embankment respectively.

7.2.6 Measures/Initiatives for Adaptation with Temperature Increase (Pre, During and Post disaster) in the Study Area

The increase of temperature is one of the major greenhouse effect induced disaster in the coastal belt of Bangladesh. This problem is the global problem; it is directly accelerating the global climate changes. However, in the coastal region of Bangladesh, people take or practice some strategies in response to temperature increase. The temperature increase is the gradual processes, but sometime its intensity is very high and sometime mild. However, every disaster have three periods in terms of pre, during and post disaster as well as mature and old stages like temperature increase.

During pre-disaster period, people think four types of strategies can be reduced the severity and magnitude of temperature increase in their areas (Table 7.8). Among them, maximum people emphasize the tree plantation is the possible solution to reduce the temperature increases. Furthermore, during disaster period people are practicing four types of coping measures in the coastal areas of Bangladesh (Table 7.8).Among them, most of the coastal people said that environmentally friendly house builds such as huts, roof with leaf helps to protect them during the disaster period. In addition, in post disaster period, five types of actions those practices after disaster in coastal areas (Table 7.8). Between five, tree plantation is the key practice to protect themselves and the environment from adverse effects of this disaster of the coastal inhabitants of Bangladesh.

Table 7.8: Measures/Initiatives for Adaptation with Temperature Increase (Pre, During and Post disaster) in the Study Area

Period/*Types of initiatives*		**Western Zone**		**Central Zone**		**Eastern Zone**	
		f	***%***	*f*	***%***	*f*	***%***
Pre	Tree plantation	74	41.34	56	43.41	51	40.8
	Comfortable arrangement	46	25.70	34	26.36	39	31.2
	Storage of sweet water	44	24.58	23	17.83	24	19.2
	Collect the necessary medicine	15	8.38	16	12.40	11	8.8
	Total	179	100%	129	100%	125	100%
During	Environmental friendly house build such as hut, roof with leaf	73	40.78	53	43.80	45	35.43
	Take rest under the big tree or near the water place	42	23.46	29	23.97	33	25.98
	Drink more safe water	39	21.79	19	15.70	31	24.41
	Take medicine if necessary	25	13.97	20	16.53	18	14.17
	Total	179	100%	121	100%	127	100%
Post	House made with leaf	32	20.12	16	13.68	11	10.19
	Tree plantation	69	43.39	55	47.01	53	49.07
	Take medicine if necessary	35	22.01	25	21.37	27	25.00
	It need, take help from local health complex	21	13.20	18	15.38	16	14.81
	Make communication with local govt. administration	2	1.25	3	2.56	1	0.93
	Total	159	100%	117	100%	108	100%

Source: Field Survey 2018-19 N.B: Multiple answers considered

7.2.7 Measures/Initiatives for Adaptation with Tidal Water Entrance (Pre, During and Post disaster) in the Study Area

Entrance of tidal water is the associated disaster of climate induced disasters for instance, tidal or coastal flood, cyclone, storm surge, catastrophic wave, sea level rise,

bank erosion and so on. Sometime its natural and sometime its man-made. This disaster has inundated the low-lying topography, salinization of top soil; destroy the freshwater ecology and damage of crop lands in the adjacent coastal areas of Bangladesh. During, pre-disaster period, coastal dwellers opined that seven types of strategies help to protect themselves in coastal areas of Bangladesh (Table 7.9). Among them embankment height rises up and tree plantation are the possible strategies to protect their life and livelihood in their areas. However, buildup house on highland in the western zone, put in the platform of tub well in highland in eastern zone are significant strategies in pre disaster period. Besides, during a disaster, people are applying four types of coping mechanism to safeguard themselves in their areas (Table 7.9). Among them, go to a safe area and bring safe drinking water are the main coping strategies among three zones in the coastal region of Bangladesh. Moreover, in post disaster time, people apply four approaches to manage the losses (Table 7.9). Among them embankment height rises up and tree plantation are the main initiatives to manage themselves after a disaster in their areas.

Table 7.9: Measures/Initiatives for Adaptation with Tidal water Entrance (Pre, During and Post disaster) in the Study Area

Period/*Types of initiatives*		**Western Zone**		**Central Zone**		**Eastern Zone**	
		f	***%***	*f*	***%***	*f*	***%***
Pre	Embankment height rise up	79	33.05	63	35.80	53	36.55
	Tree plantation	45	18.83	41	23.30	33	22.76
	Going to shelter center	3	1.26	2	1.14	5	3.45
	Put in the platform of tubewell in highland	32	13.39	21	11.93	31	21.38
	Buildup house on highland	41	17.15	28	15.91	12	8.28
	Collect the sweet water	23	9.62	12	6.82	6	4.14
	Awareness buildup	16	6.69	9	5.11	5	3.45
	Total	239	100%	176	100%	145	100%
During	Go to safe area	63	41.72	59	47.58	52	48.15
	Take safe drinking water	43	28.48	35	28.23	31	28.70
	Try to save the shrimp cultivation place/*Ghar*	23	15.23	17	13.71	14	12.96
	Try to save the agricultural land	22	14.57	13	10.48	11	10.19
	Total	151	100	124	100	108	100
Post	Embankment rise up	76	45.78	56	42.7	45	40.54
	Tree plantation	58	34.94	49	37.4	42	37.84
	Calculate of wear and tear	4	2.41	2	1.5	2	1.80
	Cultivate the salt tolerant crops	28	16.87	24	18.3	22	19.82
	Total	166	100%	131	100%	111	100%

Source: Field Survey N.B: Multiple answers considered

7.2.8 Measures/Initiatives for Adaptation with Sea Level Rise (Pre, During and Post disaster) in the Study Area

As a densely populated coastal country of smooth relief comprising wide and narrow ridges and depressions, Bangladesh is highly vulnerable to sea level rise. (Brammer*et al.,* 1993). By 2020, 2050 and 2100, the World Bank (2010) showed sea level rise of 10cm, 25cm, and 1m, affecting 2%, 4% and 17.5% of the total land mass, respectively. Adaptation, however, seeks to reduce the adverse effects on living organisms, including humans and the environment, of rising sea levels.

During pre-disaster period, coastal people argued that five types of strategies can face themselves from SLR disaster in the coastal region of Bangladesh (Table 7.10). Among them embankment buildup/rise up, tree plantation / green fence buildup and awareness buildup are the key strategies safe their life and livelihood in the coastal region of Bangladesh. Additionally, during the disaster period, four types of coping mechanism are applied coastal people in coastal areas (Table 7.10). Among them embankment repair, floating agriculture, go to shelter center are the leading coping mechanisms to protect themselves from this disaster. Moreover, in post disaster period, four types of management works are applied (Table 7.10). Among them, embankment buildup/rise up and buildup shelter on highland are the significant works to protect themselves from this disaster among three study areas.

Table 7.10: Measures/Initiatives for Adaptation with Sea Level Rise (Pre, During and Post disaster) in the Study Area

Period /*Types of initiatives*		**Western Zone**		**Central Zone**		**Eastern Zone**	
		f	***%***	*f*	***%***	*f*	***%***
Pre	Tree plantation / Green fence buildup	51	29.14	46	33.58	38	35.51
	Embankment buildup/rise up	65	37.14	54	39.42	44	41.12
	Awareness buildup	22	12.57	12	8.76	3	2.80
	Community advocacy	11	6.29	4	2.92	3	2.80
	Communicate with local forecasting office/ weather office	26	14.86	21	15.33	19	17.76
	Total	175	100%	137	100%	107	100%
During	Floating agriculture	45	25.71	33	24.09	29	27.10
	Go to the shelter center	43	24.57	23	16.79	14	13.08
	Help to each and others	24	13.71	34	24.82	22	20.56
	Embankment repair	63	36.00	47	34.31	42	39.25
	Total	175	100%	137	100%	107	100%
Post	Embankment buildup/rise up	68	37.78	55	40.15	48	40.68
	Buildup shelter on highland	45	25.00	39	28.47	37	31.36
	Put in the tube wail in highland	43	23.89	31	22.63	24	20.34
	Make communication with local govt. administration	24	13.33	12	8.76	9	7.63
	Total	180	100%	137	100%	118	100%

Source: Field Survey 2018 -19 N.B: Multiple answers considered

7.2.9 Measures/ Initiatives for Adaptation with Thunderstorm (Pre, During and Post disaster) in the study area.

Bangladesh is a playground of severe thunderstorms during the pre-monsoon season because of its unique geographical location. The thunderstorms are known as Kalbaishakhi or Nor'westers and are vulnerable to river and air navigations, agriculture and socio-economic situation of the people of Bangladesh (Karmakar*et al.,* 2016). Moreover, owing to adaptation purposes in response to thunderstorm, Government of the People's Republic of Bangladesh, under the supervision on the Ministry of the Disaster Management and Relief has planted nearly 31 lac. Palm tree across of the whole country (The Daily Ittefaq, 2020). Besides, Government of the People's Republic of Bangladesh already declared that 'Thunderstorm' is the national disaster in Bangladesh. However, here the study explains the pre, during and post disaster adaptation strategies in Bangladesh.

In pre disaster period, people argued that five types of strategies can help to safe themselves from thunderstorm in Bangladesh (Table 7.11). Among them awareness buildup among the people and palm tree planting are the key strategies to safe themselves from thunderstorm disaster in the adjacent areas of the coastal in Bangladesh. Furthermore, during the disaster period, people are applying six types of coping techniques to protect themselves from this disaster (Table 7.11). Among them, stay in a safe place / house, keep electric things off, observe the situation and do not stay under the tree are the main coping methods to safeguard themselves from this disaster. In addition, in post disaster or after disaster period people are wanting to implement five types of major attempts to safe life and properties (Table 7.11). Among them, palm or big tree plantation, treatment for injured persons and awareness buildup are the prime strategies to manage the effect of this disaster in Bangladesh.

Table 7.11: Measures/ Initiatives for Adaptation with Thunderstorm (Pre, During and Post disaster) in the Study Area

Period/Types of initiatives		Western Zone		Central Zone		Eastern Zone	
		f	*%*	*f*	*%*	*f*	*%*
Pre	Awareness buildup among the people	56	32.56	49	36.30	36	33.03
	Keep the clouded in mind	12	6.98	3	2.22	7	6.42
	Palm tree planting	52	30.23	41	30.37	32	29.36
	Buildup the safe place/house	36	20.93	27	20.00	22	20.18
	Installing the lightning bar in the house	16	9.30	15	11.11	12	11.01
	Total	172	100%	135	100%	109	100%
During	Observe the situation	32	18.60	27	21.60	25	24.04
	Stay in a safe place / house	54	31.40	32	25.60	35	33.65
	Do not stay under the tree	30	17.44	25	20.00	17	16.35
	Keep electric things off	35	20.35	31	24.80	16	15.38
	Cannot go out of the house/ open place	12	6.98	7	5.60	6	5.77
	Physiological courage buildup	9	5.23	3	2.40	5	4.81
	Total	172	100%	125	100%	104	100%
Post	Treatment for injured persons	27	19.42	24	22.22	21	25.61
	Palm or big tree plantation	75	53.96	59	54.63	43	52.44
	Help to others	12	8.63	10	9.26	3	3.66
	Awareness buildup	21	15.11	15	13.89	14	17.07
	Calculate the loss and damage (if happened)	4	2.88	0	0.00	1	1.22
	Total	139	100%	108	100%	82	100%

Source: Field Survey 2018-19 N.B: Multiple answers considered

7.2.10 Measures/Initiatives for Adaptation with Waterborne Disease (Pre, During and Post disaster) in the Study Area.

"Climate change influences the reproductive and survival of bacterial, protozoan, and viral pathogens and improve the occurrence of conditions that promote the spread of waterborne diseases" (DFID, 2004). "With the change of precipitation patterns that are likely to compromise the supply of freshwater through floods and waterlogging, the risk of waterborne diseases such as diarrhea, cholera, skin and eye diseases increases" (BIRDEM, 2012). "For the 20 million coastal people who are already facing increased exposure to diseases such as hypertension because of the increased of water salinity, the situation is alarming" (UNDP, 2007). "Approximately 15 million people are now forced to drink salty water and 30 million people are unable to collect potable drinking water in coastal Bangladesh due to a shortage of sufficient fresh water sources" (Hoque, 2009). Bangladesh has ward level Community Clinic facilities. They also provide assistance during time of crisis. They provide neighborhood individuals with a seasonal disease information service. For instance,

Radio Nalta in Kalignj of Shatkhira forecasts the coastal population's early warning system and climate adaptation measures for public health. The International Centre for Diarrhoeal Disease, Bangladesh (ICDDR, B) is a highly cholera – ased, climate-based cholera prediction model for Matlab, Chandpur (*Vibrio Choleae*) epidemic area (CCC, 2009). Adaptation decreases vulnerability and increases resilience, and a successful adaptation plan, allowing their knowledge and information gives the highest major concern to the needs of local communities, During a pre-disaster period, coastal people assumed that four types of strategies have been reduced the severity and magnitude of climate induced waterborne disease in the coast of Bangladesh (Table 7.12). Among them, take necessary advice from near health care office or register doctor, awareness buildup on water born disease and take pure water and nutrient food are the main strategies. Also, during the disaster period, coastal people are followed three types of coping mechanism to safe themselves from this disaster (Table 7.12). Among them, take pure water and nutrient food is the key coping mechanism during disaster period in the coastal belt of Bangladesh. Additionally, in a post or after a disaster period, coastal people are proposing four type ways to prevent this disaster (Table 7.12). Among them, take nutrient food and medicine and take necessary advice from near govt. / non govt. health care office are the major attempts to manage water bear disasters in the coastal regions of Bangladesh.

Table 7.12: Measures/Initiatives for Adaptation with Waterborne Disease (Pre, During and Post disaster) in the Study Area.

Period /*Types of initiatives*		**Western Zone**		**Central Zone**		**Eastern Zone**	
		f	***%***	*f*	***%***	*f*	***%***
Pre	Awareness buildup on water Born disease	45	25.86	41	29.93	37	34.58
	Take pure water and nutrient food	41	23.56	36	26.28	31	28.97
	Use skin protection *molom* / ointment	39	22.41	25	18.25	16	14.95
	Take necessary advice from near health care office or register doctor	49	28.16	35	25.55	23	21.50
	Total	174	100%	137	100%	107	100%
During	Take necessary medicine	51	29.31	41	29.93	32	29.91
	Take pure water and nutrient food	69	39.66	57	41.61	45	42.06
	Take advice from near Govt./ non Govt. health care office	54	31.03	39	28.47	30	28.04
	Total	174	100%	137	100%	107	100%
Post	Take Nutrient food and medicine	74	42.53	57	41.61	42	39.25
	Take necessary advice from near govt./ Non Govt. health care office	53	30.46	41	29.93	37	34.58
	Awareness buildup	47	27.01	39	28.47	28	26.17
	Total	174	100%	137	100%	107	100%

Source: Field Survey 2018-19 N.B: Multiple answer considered

7.3 Adaptation to Social Vulnerability with CCIDs in the study area

Climate change is one of Bangladesh's single most critical challenges (Elahi, 2016). Most of the social sectors are highly susceptible by the climate change because of poor economic capacity and lack of proper management. The National Adaptation Program of Action (NAPA, 2005) and other scholars have recognized the coastal areas of Bangladesh as one of the most vulnerable areas as one of the country's and the world's most vulnerable area because of the recurring coastal hazards and the impacts caused by climate change. The physical isolation of the coastal communities makes them highly resource-dependent accessible to the coast and primarily to natural resources and decreases access to alternative livelihoods making coastal communities particularly vulnerable to disruption. The household vulnerability in the coastal zone varies with the seasons and now the climate changes take the lead to change the livelihood and increase the vulnerability. The Government of Bangladesh has documented coastal zone as areas of massive potentials. In contrast, these areas are cover behind in socio-economic development and susceptible to different disasters, environmental degradation and global climate changing procedure (GoB, 2005). For developing countries such as Bangladesh, where the process of climate change takes the form of a natural disaster that not only impacts the socio-economic situation of coastal communities and increases poverty, but also changes the coastal territory of the country. Nineteen coastal districts having three geo-physical characteristics that distinguish the coastal zone from rest of the country and the distinguish characteristics are: interplay of tidal regime, salinity in soil and water, and cyclone and storm surge; with economic and social implications on the population (PDO-ICZMP, 2003a).

7.3.1 Health Sector Adaption with CCIDs in the Study Area

Climate change and variability, particularly impacts from drought, flooding, and tropical cyclones, pose a substantial threat to water security and are projected to increase the potential of waterborne infectious diseases in Bangladesh, including cholera and other diarrheal diseases (Alam, 2015). Besides, to better understand the health risks of an adaptation to climate change a vulnerability and adaptation assessment Climate Change and Health: Bangladesh was conducted in 2011 with the goal to assess existing patterns of climate-sensitive diseases, documenting climate

change and health impacts on vulnerable populations, reviewing existing climate change and health-related policies and programmes, and recommend actions to further protect human health from climate change (IEDCR, 2011). Moreover, an assessment supported by the World Bank using monthly surveillance data in regions of high-incidence of vector-borne disease found strong seasonality and statistically correlation between short-term climate variability and vector-borne disease (CCHP, 2014). The following table 7.13 explores that the strategies to protect of coastal people from different waterborne disease. To explore the health sector in response to climate change, the study has been emphasized four types of subsectors for instance, general health, child health, mother health, pregnancy health (Table 7.13).

Table 7.13: Existing Strategy for Keeping/ Protect the Health from CCIDs

	Pre-Disaster				During Disaster				Post Disaster			
	Types of initiatives	***W***	***C***	***E***	***Types of initiatives***	***W***	***C***	***E***	***Types of initiatives***	***W***	***C***	***E***
General Health	Awareness buildup	27.47	32.24	31.43	Use water purifying tablet	18.99	19.10	20.00	Make clean around the house	16.23	16.85	18.18
	Having primary health content	13.73	13.11	15.00	Try to keep up the toilet clean	16.46	17.42	16.92	Clean the sewerage system around the house	20.18	19.02	22.38
	Regular treatment	10.73	10.38	10.00	Take necessary food and medicine	27.43	29.21	31.54	Take necessary advice from the local health care office /Doctor	9.65	9.24	6.29
	Take the advice of the doctor	11.59	9.29	7.86	Food supplied by Govt./ Non Govt. Org/ Person	13.92	12.92	10.77	Pitch up the expire livestock's	9.21	8.15	7.69
	Follow hygiene	8.15	7.65	8.57	Take necessary advice from the Doctor/ MO/*kobarij*	13.08	12.36	11.54	Drink pure water and take food	23.68	23.91	23.78
	Essential medicines collection	9.44	7.65	5.00	Try to keep clean and fresh.	10.13	8.99	9.23	Maintain the health advice	21.05	22.83	21.68
	Total	**N=201 100%**	**N=141 100%**	**N=118 100%**	**Total**	**N=201 100%**	**N=141 100%**	**N=118 100%**	**Total**	**N=201 100%**	**N=141 100%**	**N=118 100%**
Child Health	Awareness buildup	16.67	16.55	18.42	Breast-feeding and balanced food	32.98	37.32	37.50	Breast-feeding and balanced food	32.98	35.14	38.79
	Vaccination	37.88	38.85	38.60	Go to the shelter center	17.02	9.86	10.00	Use mental development	19.90	22.30	26.72
	Keep and collection of medicines	21.72	19.42	21.05	Keep the children in the same and clean place	22.87	23.24	25.83	Take doctor's /medical officer's advice	21.47	20.95	18.97
	Regular consultation with doctor/ medical officer	23.74	25.18	21.93	Take doctor's /medical officer's advice	27.13	29.58	26.67	Keep the children in the same and Healthy place	25.65	21.62	15.52

Table 7.13: Existing Strategy for Keeping/ Protect the Health from CCIDs (Continued)

	Total	**N=198 100%**	**N=139 100%**	**N=114 100%**	**Total**	**N=188 100%**	**N=142 100%**	**N=120 100%**	**Total**	**N=191 100%**	**N=148 100%**	**N=116 100%**
Mother Health	Awareness build up	17.19	19.72	19.83	Take necessary medicine	35.96	42.36	43.80	Take necessary medicine	39.83	40.46	39.68
	Take necessary balanced food	38.54	38.73	41.38	Take necessary nutrient and balanced food	22.17	22.92	25.62	Take necessary nutrient and balanced food	21.68	21.39	21.43
	Contact the health worker	22.40	22.54	20.69	Drink safe water	16.75	14.58	13.22	Stay in the clean and safe house	18.14	18.50	19.84
	Take the advice of the doctor	21.88	19.01	18.10	Take the advice of the doctor/ health care officer's	25.12	20.14	17.36	Take the advice of the doctor/ health care officer's	20.35	19.65	19.05
	Total	**N=192 100%**	**N=142 100%**	**N=116 100%**	**Total**	**N=203 100%**	**N=144 100%**	**N=121 100%**	**Total**	**N=226 100%**	**N=173 100%**	**N=126 100%**
Pregnancy Health	Consultancy with registered physician	26.73	29.80	33.62	Take the advice of the doctor/ health care officer's	32.67	33.77	46.55	Return to house as soon as possible	34.16	35.10	46.55
	Kabriaj and Jhar-fuk	10.89	11.92	10.34	Take necessary nutrient and balanced food	27.23	29.14	18.10	Take the advice of the doctor/ health care officer's	25.25	27.81	23.28
	Awareness buildup	19.80	19.21	21.55	Stay with experience women and necessary goods	21.29	17.88	23.28	Try to keep in clean and fresh environment	24.26	19.21	18.10
	Contact the health worker	20.79	17.22	18.10	Try to keep clean and fresh	18.81	19.21	12.07	Take necessary medicine	16.34	17.88	12.07
	Collect the necessary medicine	21.78	21.85	16.38								
	Total	**N=202 100%**	**N=151 100%**	**N=116 100%**	**Total**	**N=202 100%**	**N=151 100%**	**N=116 100%**	**Total**	**N=202 100%**	**N=151 100%**	**N=116 100%**

Source: Field Survey 2018-19 N.B: Multiple answer considered

N.B: W=Western coastal zone, C= Central Coastal Zone , E= Eastern coastal zone.

To explore the health sector in response to climate change, the study has been emphasized four types of subsectors for instance, general health, child health, mother health, pregnancy health (table 7.13).

7.3.1.1 General Health

During pre-disaster or before disaster period coastal people followed six types of strategies to safe themselves from potential effects of climate change (Table 7.13). Among them, awareness building, having primary health content, regular treatment are the key strategies during pre-disaster period. Besides, during disaster, people are practices six types of coping strategies to protect themselves from health related disasters (Table 7.13). Among them, take necessary food and medicine, try to keep up the toilet clean, use water purification tablet are the main coping mechanisms during disaster period in the coastal areas of Bangladesh. Furthermore, in post disaster or after disaster period, coastal people take six types of actions in coastal region of Bangladesh (Table 7.13). Among them, drink pure water and take food, clean the sewerage system around the house and maintain the health advice are the leading initiatives to manage the general health sector from climate induced disasters in the coastal areas of Bangladesh.

7.3.1.2 Child Health

Before disaster period coastal people monitored that they are practices four types of strategies to safe their children from potential effects of climate change (Table 7.13). Among them, vaccination and take regular consultation with doctor/ medical officer are the main strategies to protect the children health during pre-disaster period. Besides, during disaster, people are practices four types of coping strategies to protect their children health from health related disasters (Table 7.13). Among them, breast-feeding and balanced food, take doctor's /medical officer's advice and keep the children in the same and clean place are the main coping mechanisms during disaster period in the coastal areas of Bangladesh. Additionally, in post disaster or after disaster period, coastal people take four types of actions to safe their children health from climate induced disasters in coastal areas of Bangladesh (Table 7.13). Among them, breast-feeding and balanced food, keep the children in the same and Healthy place and take doctor's

/medical officer's advice are the principal initiatives to manage the children health sector from climate induced disasters in the coastal areas of Bangladesh.

7.3.1.3 Mother Health

During pre-disaster period coastal people checked that they are applies four types of strategies to safe mother health from potential effects of climate change (Table 7.13). Among them, take necessary balanced food, contact the health worker and take the advice of the doctor are the highest opined strategies to protect the mother health from climate induced disasters during pre-disaster period. Also, during disaster, people are practices four types of coping strategies to protect mother health from health related disasters in the coastal areas of Bangladesh (Table 7.13). Among them, take necessary medicine, take the advice of the doctor/ health care officer's and take necessary nutrient and balanced food are the leading coping mechanisms during disaster period in the coastal region of Bangladesh. Besides, in post disaster or after disaster period, coastal people take four types of actions to safe mother health from climate induced disasters in coastal region of Bangladesh (Table 7.13). Among them, take necessary medicine, take necessary nutrient and balanced food and take the advice of the doctor/ health care officers are the primary initiatives to manage the mother health sector from climate induced disasters in the coastal areas of Bangladesh.

7.3.1.4 Pregnancy Health

Before disaster period, coastal people express that they are monitored five types of approaches to safe pregnancy health from possible effects of climate change in the coastal areas of Bangladesh (Table 7.13). Among them, consultancy with registered physician, collect the necessary medicine and contact the health worker are the utmost strategies to protect the pregnancy health from climate induced disasters during pre-disaster period. Similarly, during disaster, people are practices four types of coping strategies to protect pregnancy health from health related disasters in the coastal areas of Bangladesh (Table 7.13). Among them, take the advice of the doctor/ health care officer's, take necessary nutrient and balanced food and stay with an experience women and necessary goods are the prominent coping mechanisms during disaster period in the

coastal areas of Bangladesh. As well, in post disaster or after disaster period, coastal people take four types of actions to safe pregnancy health from climate induced disasters in coastal areas of Bangladesh (Table 7.13). Among them, return to house as soon as possible, take the advice of the doctor/ health care officer's and try to keep in clean and fresh environment are the crucial initiatives to protect the pregnancy health from climate induced disasters in the coastal areas of Bangladesh.

7.3.2 Education Sector Adaptation with CCID in the study area

Owing to climate change vulnerability, the social sector, particularly education program or children education mostly hampered. Table 7.14 explores that perception about the strategies to protect the different social sectors, especially education in the coastal areas of Bangladesh. The education sector has been divided into two subcategories such as school going students and infrastructure (road).

7.3.2.1 School Going Students

Before disaster period, coastal people express that they apply four types of approaches to continue their school going children from possible effects of climate change in the coastal areas of Bangladesh (Table 7.14). Among them, Education and awareness build up, Keep education materials in dry and high place and Earning knowledge on disaster resilience are the utmost strategies to continue their school going children from climate induced disasters during pre-disaster period. Similarly, during disaster, people are practices four types of coping strategies to continue their school going children from disasters in the coastal areas of Bangladesh (Table 7.14). Among them, stay in the shelter center or in a safe place, help to each and others, and function as volunteer are the prominent coping mechanisms during disaster period in the coastal areas of Bangladesh. As well, in post disaster or after disaster period, coastal people take six types of actions to continue their school going children from climate induced disasters in coastal areas of Bangladesh (Table7.14). Among them, make clean around the house, help to pitch up the expire livestock's and help to repair the damaged toilet/sanitation system are the crucial initiatives to continue their school going children from climate induced disasters in the coastal areas of Bangladesh.

7.3.2.2 Infrastructure (road)

Pre, during and post disaster period, coastal people express that they apply two types of approaches at each zone to protect infrastructure (road) from possible effects of climate change in the coastal areas of Bangladesh (Table 7.14).

Table 7.14: Existing Strategies to Protect the Education Sector from CCIDs

	Pre-Disaster				During Disaster				Post Disaster			
	Types of initiatives	***W***	***C***	***E***	***Types of initiatives***	***W***	***C***	***E***	***Types of initiatives***	***W***	***C***	***E***
Schools going students	Education and awareness build up	31.61	36.96	38.26	Stay in the shelter center or in a safe place	31.61	35.51	41.74	Make clean around the school	23.56	28.26	27.83
	Keep education materials in a dry and high place	23.56	25.36	26.96	Help to each and others	23.56	26.81	23.48	Help to Pitch up the expire livestock's	20.11	22.46	23.48
	Earning knowledge on disaster resilience	22.41	22.46	21.74	Function as volunteer	22.41	23.91	23.48	Help to repair the damaged toilet/ sanitation system	18.39	20.29	20.87
	Learn about signal	22.41	15.22	13.04	Take safe and clean water and medicine	22.41	13.77	11.30	Help to repair the damaged school	16.09	15.22	19.13
									Start read and write	9.77	7.25	5.22
									Function as volunteer	12.07	6.52	3.48
	Total	**N=174 100%**	**N=138 100%**	**N=115 100%**	**Total**	**N=174 100%**	**N=138 100%**	**N=115 100%**	**Total**	**N=174 100%**	**N=138 100%**	**N=115 100%**
Infrastructure (Road)	Tree plantation beside the road	57.03	59	57.61	Take care of the road	55.47	57	55.43	Buildup the damaged road Network	60.16	61	61.96
	Repair the damaged road	42.97	41	42.39	Try to repair the break down road	44.53	43	44.57	Repair the damaged culvert, Bridge etc.	39.84	39	38.04
	Total	**N=128 100%**	**N=100 100%**	**N=92 100%**	**Total**	**N=128 100%**	**N=100 100%**	**N=92 100%**	**Total**	**N=128 100%**	**N=100 100%**	**N=92 100%**

Source: Field Survey 2018-19 N.B: Multiple answer considered

N.B: W=Western coastal zone, C= Central Coastal Zone , E= Eastern coastal zone.

7.3.3 Infrastructure Sector Adaptation with CCIDs in the Study Area

Coastal green belt is one of the best adaptation practices to protect local, coastal and regional areas from storms, cyclone and tidal surges. It is essential to reduce the wind speed by planting appropriate tree species, which can withstand the high speed of wind and break the wind speeds. Naturally grown halophytic plants have the special adaptation for withstanding in the littoral zones with clayey alluvial soil, tides and strong salinity and winds. There are several palm species and swamp grasses having soil binding capacity to control erosion. They also reduce the speed of tidal surges (Alauddin and Rahman, 2013).Table 7.15 shows the perception about the strategies to protect the different social sectors, particularly physical infrastructure. In this context, the study has been mentioned five subcategories under the sector of physical infrastructure.

Table 7.15: Existing Strategies to Protect the Infrastructure Sector from CCIDs

	Pre-Disaster				**During Disaster**				**Post Disaster**			
	Types of initiatives	***W***	***C***	***E***	***Types of initiatives***	***W***	***C***	***E***	***Types of initiatives***	***W***	***C***	***E***
Settlement / Accommodation	Tension barrier around	26.73	29.80	33.62	Observe the pull of the pull	55.47	57	55.43	Clean and repair	16.67	16.55	18.42
	Height up the floor	10.89	11.92	10.34	Keep an eye on the weak places	44.53	43	44.57	Repair	23.74	25.18	21.93
	Constriction of houses high	19.80	19.21	21.55	--	--	--	--	Repair if needed	21.72	19.42	21.05
	Build houses in high place	20.79	17.22	18.10	--	--	--	--	Monitor the shedding	37.88	38.85	38.60
	Weak house change	21.78	21.85	16.38	--	--	--	--				
	Total	**N=202 100%**	**N=151 100%**	**N=116 100%**	**Total**	**N=128 100%**	**N=100 100%**	**N=92 100%**	**Total**	**N=198 100%**	**N=139 100%**	**N=114 100%**

Table 7.15: Existing Strategies to Protect the Infrastructure Sector from CCIDs (Continued)

Educational Institution	Disaster prepared	16.67	16.55	18.42	Work with the committees	57.47	59	58.43	Clean the school	60.16	67	65.96
	Shelter center cum the school	37.88	38.85	38.60	Staying the shelter center	42.53	41	41.57	Study rerun	39.84	33	34.04
	Provide student education	21.72	19.42	21.05	--				--			
	Let the students know about the disaster	23.74	25.18	21.93	--	--	--	--	--	--	--	--
	Total	**N=198 100%**	**N=139 100%**	**N=114 100%**	**Total**	**N=128 100%**	**N=100 100%**	**N=92 100%**	**Total**	**N=128 100%**	**N=100 100%**	**N=92 100%**
Road Construction	Construction of high and eldest roads and planting trees on both sides	16.67	16.55	18.42	Keep an eye on the weak place	32.98	37.32	37.50	Repair the weak spot	32.98	35.14	38.79
	Construction the high quality road	23.74	25.18	21.93	Monitoring the road	22.87	23.24	25.83	Giving sand to breakdown space	21.47	20.95	18.97
	Raise of the road	21.72	19.42	21.05	Watch the breakdown space	17.02	9.86	10.00	Maintenance	19.90	22.30	26.72
	Construction of highway around the river	37.88	38.85	38.60	Construction of the dam on the side of the road	27.13	29.58	26.67	Reconstruction the road	25.65	21.62	15.52
	Total	**N=198 100%**	**N=139 100%**	**N=114 100%**	**Total**	**N=188 100%**	**N=142 100%**	**N=120 100%**	**Total**	**N=191 100%**	**N=148 100%**	**N=116 100%**
Bridge and Culvert	The disaster is created in a tolerable way	26.73	29.80	33.62	Pillar on side	32.67	33.77	46.55	Repair the weak spot	16.67	16.55	18.42
	Don not build at breakage points	10.89	11.92	10.34	Stay in the shelter center	27.23	29.14	18.10	keep clean	23.74	25.18	21.93
	Repairing	19.80	19.21	21.55	Observe the weak spot	21.29	17.88	23.28	Repairing	37.88	38.85	38.60
	Regular observation	20.79	17.22	18.10	Prevention the erosion	18.81	19.21	12.07	Newly created if needed	21.72	19.42	21.05
	Repair the weak spot	21.78	21.85	16.38	--				--			
	Total	**N=202 100%**	**N=151 100%**	**N=116 100%**	**Total**	**N=202 100%**	**N=151 100%**	**N=116 100%**	**Total**	**N=198 100%**	**N=139 100%**	**N=114 100%**

Table 7.15: Existing Strategies to Protect the Infrastructure Sector from CCIDs (Continued)

Shelter centers	Created on the column	16.67	16.55	18.42	Give shelter to everyone	26.73	29.80	33.62	Cleaning	16.67	16.55	18.42
	Keep access door open	37.88	38.85	38.60	Observe the column	10.89	11.92	10.34	Repairing	23.74	25.18	21.93
	Communication development	21.72	19.42	21.05	Everyone it is one place	19.80	19.21	21.55	Arrange dry food	21.72	19.42	21.05
	Raise up	23.74	25.18	21.93	When the committee is formed	20.79	17.22	18.10	Barrack in original purpose	37.88	38.85	38.60
	--				Notify everyone about signals	21.78	21.85	16.38	--			
	Total	**N=198 100%**	**N=139 100%**	**N=114 100%**	**Total**	**N=202 100%**	**N=151 100%**	**N=116 100%**	**Total**	**N=198 100%**	**N=139 100%**	**N=114 100%**
Embankment	Raise height of the dams	26.73	29.80	33.62	Observed the dam	32.67	33.77	46.55	Repair if needed	16.23	16.85	18.18
	The fence on the two sides of the dam is given	10.89	11.92	10.34	See whether the breakdown took place	27.23	29.14	18.10	Repair the breakdown sport	20.18	19.02	22.38
	High and broad	19.80	19.21	21.55	Block the breakdown area	21.29	17.88	23.28	Repair the weak spot	9.65	9.24	6.29
	Raise up	20.79	17.22	18.10	avoid collapse ,keep it focused	18.81	19.21	12.07	Forfending on both sides if necessary	9.21	8.15	7.69
	Grassed around the dam	21.78	21.85	16.38					Repair the dam damage	23.68	23.91	23.78
	--								Repair	21.05	22.83	21.68
	Total	**N=202 100%**	**N=151 100%**	**N=116 100%**	**Total**	**N=202 100%**	**N=151 100%**	**N=116 100%**	**Total**	**N=202 100%**	**N=151 100%**	**N=116 100%**

Source: Field Survey 2018 -19 N.B: Multiple answer considered

N.B: W=Western coastal zone, C= Central Coastal Zone, E= Eastern coastal zone.

Table 7.15 shows the perception about the strategies to protect the different social sectors, particularly physical infrastructure. In this context, the study has been mentioned five subcategories under the sector of physical infrastructure.

*7.3.3.1 Settlement/*Accommodation

During pre-disaster or before disaster period coastal people followed five types of strategies to safe physical infrastructure, particularly settlement from potential effects of climate change (Table 7.15). Among them, tension barrier around, construction of houses high and build house in high place are the key strategies during pre-disaster period in the coastal areas of Bangladesh. Besides, during disaster, people are practices two types of coping strategies to protect their settlement (Table 7.15). For instance, observe the pull of the pull and keep an eye on the weak places are the main coping mechanisms during disaster period in the coastal areas of Bangladesh. Moreover, in post disaster or after disaster period, coastal people safe their settlement through four types of actions in coastal areas of Bangladesh (Table 7.15). Among them, monitor the shedding, repair if needed and repair are the leading initiatives to safe their settlement from climate induced disasters in the coastal areas of Bangladesh.

7.3.3.2 Educational Institution

Before disaster period coastal people followed four types of strategies to safe physical infrastructure, particularly educational institution from potential effects of climate change (Table 7.15). Among them, shelter center cum the school, provide student education and let the students know about the disaster are the significant strategies during pre-disaster period in the coastal areas of Bangladesh. Further, during disaster, people are practices two types of coping strategies to protect their educational institution (Table 7.15). As, work with the committees and staying the shelter center are the key coping mechanisms during disaster period in the coastal areas of Bangladesh. Likewise, in post disaster or after disaster period, coastal people safe their educational institution through two types of actions in coastal areas of Bangladesh (Table 7.15).

7.3.3.3 Road Construction

During pre-disaster coastal people followed four types of strategies to safe physical infrastructure, particularly road construction from potential effects of climate change (Table 7.15). Among them, construction of highway around the river, raise of the road and construction the high quality road are the key strategies during pre-disaster period in the coastal areas of Bangladesh. Moreover, during disaster, people are practices four types of coping strategies to protect road construction (Table 7.15). Among them keep an eye on the weak place, construction of the dam on the side of the road and monitoring the road are the main coping mechanisms during disaster period in the coastal areas of Bangladesh. Additionally, in post disaster or after disaster period, coastal people try to protect their road construction through four types of actions in coastal areas of Bangladesh (Table 7.15). Among them, repair the weak spot, maintenance and giving sand to breakdown space are the leading initiatives to safe road construction from climate induced disasters in the coastal areas of Bangladesh.

7.3.3.4 Bridge and Culvert

Before disaster period coastal people followed five types of strategies to protect physical infrastructure, particularly bridge and culvert from potential effects of climate change (Table 7.15). Among them, the disaster is created in a tolerable way, repair the weak spot and repairing are the key strategies during pre-disaster period in the coastal areas of Bangladesh. Also, during disaster, people are practices four types of coping strategies to protect the bridge and culvert (Table 7.15). Among them, pillar on side, stay in the shelter center and observe the weak spot are the main coping mechanisms during disaster period in the coastal areas of Bangladesh. Furthermore, in post disaster or after disaster period, coastal people protect the bridge and culvert through four types of actions in coastal areas of Bangladesh (Table7.15). Among them, repairing, newly created if needed and keep clean are the leading initiatives to protect bridge and culvert from climate induced disasters in the coastal areas of Bangladesh.

7.3.3.5 Shelter Centers

During pre-disaster or before disaster period coastal people followed four types of strategies to protect physical infrastructure, particularly shelter centers from potential effects of climate change (Table 7.15). Among them, keep access door open, raise up and communication development are the key strategies during pre-disaster period in the coastal areas of Bangladesh. Moreover, during disaster, people are practices five types of coping strategies to protect shelter centers (Table 7.15). Among them, give shelter to everyone, everyone it is one place and when the committee is formed are the main coping mechanisms during disaster period in the coastal areas of Bangladesh. Also, in post disaster or after disaster period, coastal people protect shelter centers through four types of actions in coastal areas of Bangladesh (Table 7.15). Among them, barrack in original purpose, repairing and arrange dry food are the leading initiatives to safe their settlement from climate induced disasters in the coastal areas of Bangladesh.

7.3.3.6 Embankment

Before disaster period coastal people followed five types of strategies to protect physical infrastructure, particularly embankment from potential effects of climate change (Table 6.15). Among them, raise height of the dams, grassed around the dam and high and broad are the key strategies during pre-disaster period in the coastal areas of Bangladesh. Besides, during disaster, people are practices four types of coping strategies to protect the embankment (Table 7.15). Among them, observe the dam, see whether the breakdown took place and block the breakdown area are the main coping mechanisms during disaster period in the coastal areas of Bangladesh. Moreover, in post disaster or after disaster period, coastal people protect the embankment through six types of actions in coastal areas of Bangladesh (Table 7.15). Among them, repair the dam damage, repair the breakdown sport and repair the embankment are the leading initiatives to safe the embankment from climate induced disasters in the coastal areas of Bangladesh.

7.3.4 Government Activities Sector Adaptation with CCID in the Study Area

Government is the sole agent to serve the basic needs and rights to citizen across the whole country. In this circumstance, government related agencies, department and representatives of different ministerial and autonomous bodies have been distributed basic necessaries and relief program to disaster affected people at during disaster period in disaster prone areas. Qualitative findings explores that, as a citizen of Bangladesh, disaster affected people are depending on the government assistance first. Besides, disaster related initiatives, like relief and rehabilitation program, relocation, dissemination of signals; rescue and *Khas land* distribution have been implemented by the disaster management committees and local level administrative bodies. However, the study reveals that the government has been involved in different types of activities to protect, safe and rehabilitated of disaster affected people in the coastal areas of Bangladesh, especially asset distribution, relocation, *Khas* land distribution, ensure human rights, basic needs and justice to all (Table 7.16). Besides, the study has been explained and explored the detail strategies among three periods, like pre or before the disaster, during disaster and post or after the disaster period in response to three different coastal zones in the coastal areas of Bangladesh. The following table 6.16 explores the perception about the strategies to protect the different sectors, especially government activities across the whole coastal areas of Bangladesh. As well as expert opinion explores that most of time government activities are interrupted by different local problems, for instance responsible or dutiful persons are involved with corruption and nepotism, maintain rolling political agenda and considered their followers. In these contexts, maximum times right people could not benefited. However, the government is implementing social safety net programmes across the whole country. Unfortunately, this program also interrupted on the above mentioned causes. Besides, owing to the uneven geographical location and recurrent nature of disasters, relevant authority cannot reach everywhere or cannot reach right time. As a result, sometime the government authorities cannot provide emergency assistance to disaster victim in the coastal areas of Bangladesh. Moreover, skilled manpower, lack of budget, limited resources, traditional technology, limited rescue boat, ship as well as lack of volunteer are the common phenomena that increasing the causality of disaster in the coastal areas.

Table 7.16: Existing Strategies to Protect the Government activities Sector from CCIDs

	Pre-Disaster				During Disaster				Post Disaster			
	Types of initiatives	***W***	***C***	***E***	***Types of initiatives***	***W***	***C***	***E***	***Types of initiatives***	***W***	***C***	***E***
Asset distribution	Help climate affected people	26.73	29.80	33.62	Asset distribution properly	27.56	28.45	39.56	Awareness buildup	34.16	35.10	46.55
	Advice to go to the shelter center	10.89	11.92	10.34	Communication with the affected people	24.67	25.33	19.43	Supply inputs to real affected people	25.25	27.81	23.28
	Proper maintenance of shelter center	19.80	19.21	21.55	First aid services to disaster victims	17.43	16.83	21.67	Ensure good governance	24.26	19.21	18.10
	Repair or rebuild shelter center before disaster	20.79	17.22	18.10	Ensure security	15.45	14.65	11.54	Service providers should sympathize to affected people	16.34	17.88	12.07
	Ensure essential needs for rescue people	21.78	21.85	16.38	Provide dry food, safe water and medicine	14.89	14.74	7.8	Proper monitoring of asset distribution by relevant authorities			
	Total	**N=205 100%**	**N=149 100%**	**N=121 100%**	**Total**	**N=205 100%**	**N=149 100%**	**N=121 100%**	**Total**	**N=205 100%**	**N=149 100%**	**N=121 100%**
Relief Program	Storage of more relief materials	25.79	24.32	23.59	Ensure the relief activities	25.25	27.81	23.28	Continue the relief work	24.67	25.33	19.43
	Storage of quality relief materials	15.89	17.33	19.44	Ensure relief for every affected people	24.26	19.21	21.44	Give relief to the right person	17.43	16.83	21.67
	Storage of relief in right place	14.88	15.89	14.42	Relief/Aid Management	16.34	17.88	15.33	Rehabilitation as per their choose	15.45	14.65	11.54
	Assumption loss and - damage	16.89	15.01	9.01	Monitoring relief distribution	12.45	11.56	12.67	Work for food program should enhance	14.89	14.74	7.8
	Relief collection from different stakeholders	13.67	12.78	13.97	Control nepotism through proper Monitoring	13.56	12.77	13.86	Climate victims should include on social safety net program	13.56	12.77	13.86
	Humanitarian initiatives should enhance	12.88	14.67	19.57	Reduce corruption	8.14	10.77	13.42	Linked between service providers and climate victims	14	15.68	25.7
	Total	**N=198 100%**	**N=152 100%**	**N=127 100%**	**Total**	**N=198 100%**	**N=152 100%**	**N=127 100%**	**Total**	**N=198 100%**	**N=152 100%**	**N=127 100%**

Table 7.16: Existing Strategies to Protect the Government activities Sector from CCIDs (Continued)

Relocation	List the affect people from vulnerable zones	19.45	22.55	25.67	Evacuate of affected people first	17.99	21.56	23.66	Monitoring the relocation area regularly	18.69	22.34	24.44
	Categorize the affected people as per their vulnerability	22.56	17.47	16.44	Distribution of house as per the cross-sectional survey	21.87	18.45	15.33	Service providers should inclusion the relocated people at their program at priority basis	21.87	18.45	17.33
	Ensure basic rights and needs	12.56	14.55	13.76	Relocation people as per their choose	11.45	16.33	13.76	Manage alternate livelihood for relocated people	13.54	14.55	13.76
	Building strong house and install tubewell and sanitation system	12.45	11.56	12.67	Properly oriented with local people and relocated people by local administration	12.11	11.78	11.45	Relocation program should share way where both party will contribute	12.45	12.56	11.55
	Manage electricity facilities	13.56	12.77	9.43	Manage alternate livelihood for relocated people	13.55	11.98	9.95	After certain time, building should repair by government authority	13.55	12.44	9.43
	Select safe zone for building shelter center	8.14	10.77	13.42	Ensure security	7.66	9.44	12.97	Ensure children education, prayer center and market system	12.24	10.22	10.52
	Ensure local people inclusion with the development process	11.28	10.33	8.61	Properly oriented with service providers and relocated people by local administration	15.37	10.46	12.88	Ensure social inclusion and neighborhood with local people	87.76	89.78	89.48
	Total	**N=205 100%**	**N=156 100%**	**N=131 100%**	**Total**	**N=205 100%**	**N=156 100%**	**N=131 100%**	**Total**	**N=205 100%**	**N=156 100%**	**N=131 100%**

Table 7.16: Existing Strategies to Protect the Government activities Sector from CCIDs (Continued)

Khas land distribution	Land free from local goons (political, elite, muscleman)	24.67	25.33	19.43	Open the land for victims who selected at earlier time	25.25	27.81	23.28	Monitoring regularly	25.79	24.32	23.59
	Land acquisition and formation	15.45	14.65	11.54	Essential support to victims like food, utensil, house material and so on	24.26	19.21	21.44	Relocated people can't selling or exchange with others	14.88	15.89	14.42
	Application procedure should dissemination by online and electronic medias	17.43	16.83	21.67	Khas land should connect road networks	16.34	17.88	15.33	Khas land providing authority assess the number of family status periodically	15.89	17.33	19.44
	Miking before distribution	14.89	14.74	7.8	Ensure victims gathering during land distribution day by local administration	12.45	11.56	12.67	Need based development activities should install adjacent of Khas land areas	16.89	15.01	9.01
	Simplicity of application procedure	13.56	12.77	13.86	Discourage nepotism and reduce corruption	13.56	12.77	13.86	Ensure nepotism and corruption less initiatives	12.88	14.67	19.57
	Climate victims should priorities among others	14	15.68	25.7	Doing approachable behave with victims	8.14	10.77	13.42		13.67	12.78	13.97
	Total	**N=201 100%**	**N=142 100%**	**N=118 100%**	**Total**	**N=201 100%**	**N=142 100%**	**N=118 100%**	**Total**	**N=201 100%**	**N=142 100%**	**N=118 100%**
Human Right	Awareness buildup on human rights among the people	36.44	37.45	33.54	Need to ensure the Human rights	35.66	36.99	35.55	Continue the human rights	34.22	35.12	34.22
	Ensure basic needs and rights for victims	29.66	34.32	33.59	Consider and respect victims emotions and pain	31.55	33.23	35.98	Introduce legal aid service to victims	33.45	34.66	34.88
	Service providers should easily, accessible and simply for victims	33.9	28.23	32.87	Provide legal aid to victims for free allotment	32.79	29.78	28.47	Service providers should easily, accessible and simply for victims	32.33	30.22	30.9
	Total	N=188 100%	N=135 100%	N=121 100%	Total	N=188 100%	N=135 100%	N=121 100%	Total	N=188 100%	N=135 100%	N=121 100%

Table 7.16: Existing Strategies to Protect the Government activities Sector from CCIDs (Continued)

Basic needs	Collect humanitarian support from local elite person, politician and rich people	37.69	38.44	35.66	Ensure the supply of basic needs	36.77	37.66	35.99	Continue the supply of basic needs	35.44	34,66	36.43
	Create fund for selling and distribution of basic needs	35.66	36.44	37.55	Ensure safe water and medicine	34.77	32.55	33.44	Monitoring the distribution program	34.22	34.55	34.32
	Government relevant body should connect who are provides dry food, medicine and utensil	26.65	25.12	26.79	Provide essential utensils as per demand	28.46	29.79	30.57	Ensure nepotism and corruption less initiatives	30.34	65.45	29.25
	Total	**N=192 100%**	**N=141 100%**	**N=124 100%**	**Total**	**N=192 100%**	**N=141 100%**	**N=124 100%**	**Total**	**N=192 100%**	**N=141 100%**	**N=124 100%**
Justice	Create the social group	52.42	54.66	53.88	Social group will function on ensure the justice	53.55	52.54	54.88	Gov. and CBOs will continue the work for Justice within the community	56.44	57.32	54.33
	Aware to victims about basic justice facility	47.58	45.34	46.12	Free legal aid service	46.45	47.46	45.12	People should seeks basic justice facilities for victims	43.56	42.68	45.67
	Total	**N=197 100%**	**N=139 100%**	**N=125 100%**	**Total**	**N=197 100%**	**N=139 100%**	**N=125 100%**	**Total**	**N=197 100%**	**N=139 100%**	**N=125 100%**

Source: Field Survey 2018 -19 N.B: Multiple answer considered

N.B: W=Western coastal zone, C= Central Coastal Zone, E= Eastern coastal zone

7.3.5 Demographics and Geographic Sector Adaptation with CCID in the Study Area

The coastal zone of Bangladesh covers an area of 47201 sq. km^2, 32% of the country, being the landmass of 19 districts. Around 35 million people, representing 29% of the population, live in the coastal zone (BBS, 2018). Besides, the population or demographic distribution has been depending on the different factors, for instance social, economic, cultural and political as well as disaster intensity and also geographical location. Besides, Bangladesh is a densely-populated, low-lying, mainly riverine country located in South Asia with a coastline of 712 sq. km on the northern littoral of the Bay of Bengal. The delta plain of the Ganges (Padma), Brahmaputra (Jamuna), and Meghna Rivers and their tributaries occupy 79 percent of the country (Brammer, 2012 and Rashid, 1991). On the above circumstances, the population distribution and geographical causes are directly influence the severity and magnitude of disaster in the whole coastal areas of Bangladesh. Qualitative findings have been explored that population distribution, migration, livelihood of coastal people mainly depend on the coastal physiography, distance from rive and sea, and frequency of disasters and so on. In Bangladesh, coastal areas are uneven, people lives bank of river and sea, recurrent disaster are the common phenomena. So, coastal people are easily faces severity and magnitude of disasters in their everyday life. Maximum time the normal setting of environment totally changed due to adverse effect of disasters. So, livelihood of coastal people have been oriented on the nature of disaster. Therefore, relevant experts deliberated that equitable distribution of local resources, proper utilized the local raw materials, established local raw materials based small industry, encourage the alternative livelihood and inclusion of costal people on local development process would be accelerated the 'localization' and reduce unplanned migration from coastal areas to urban slum areas and uneven distribution of country population in Bangladesh. Besides, the following Table 7.17 illustrates the perception of coastal people about the strategies to protect the different social sectors, especially demographics and geographic causes.

Table 7.17: Existing Strategies to Protect the Demographics and Geographic Sector from CCIDs

	Pre-Disaster				During Disaster				Post Disaster			
	Types of initiatives	***W***	***C***	***E***	***Types of initiatives***	***W***	***C***	***E***	***Types of initiatives***	***W***	***C***	***E***
Population	Manage alternative livelihood for climate vulnerable people	27.56	28.45	39.56	Victims should include on ongoing development project	26.73	29.80	33.62	Rehabilitation the affected people	22.05	23.74	21.54
	Giving training as per their needs	24.67	25.33	19.43	Manage incentives for climate victims households	10.89	11.92	10.34	Awareness the victims about their rights	10.89	11.92	10.34
	Training on disaster management	17.43	16.83	21.67	Victims people should inclusion of social safety net program	19.80	19.21	21.55	Proper monitoring the training schedule	16.55	19.21	21.55
	Building awareness about disaster	15.45	14.65	11.54	Potential victims should use payable volunteer for relief program	20.79	17.22	18.10	Utilize their knowledge and wisdom to facing any difficulties	17.33	17.22	18.1
	Establish local raw material based small industry	14.89	14.74	7.8	Utilize their knowledge and wisdom to facing any difficulties	21.78	21.85	16.38	Ensure inclusion them on ongoing development project	14.63	15.63	16.38
	Total	**N=198 100%**	**N=141 100%**	**N=127 100%**	**Total**	**N=198 100%**	**N=141 100%**	**N=127 100%**	**Total**	**N=198 100%**	**N=141 100%**	**N=127 100%**

Table 7.17: Existing Strategies to Protect the Demographics and Geographic Sector from CCIDs (continued)

Migration	Victims collect certificate from local administration as a displaced people from their origin	26.78	26.28	28.65	Stop! migration to supply basic needs	28	29.02	28.65	Awareness the victims about their rights at local level	29.05	28.34	29.12
	Establish local raw material based small industry	23.86	24.33	23.31	Potential victims should use payable volunteer for relief program	24.36	25.35	24.71	Giving training as per their needs	26.75	27.32	25.21
	Training on disaster management	23.67	24.53	23.23	Utilize their knowledge and wisdom to facing any difficulties	24.32	23.81	24.97	Utilize their knowledge and wisdom to facing any difficulties	22.22	22.21	21.32
	Giving training as per their needs	25.69	24.86	24.81	Rehabilitated the displaced people	23.32	21.82	21.67	Training on disaster management	21.98	22.13	24.35
	Total	**N=204 100%**	**N=145 100%**	**N=126 100%**	**Total**	**N=204 100%**	**N=145 100%**	**N=126 100%**	**Total**	**N=204 100%**	**N=145 100%**	**N=126 100%**
Live and livelihood safety	Awareness buildup about the life	27.56	28.45	39.56	Stay in shelter center	34.16	35.10	46.55	Need to return home as soon as possible	26.73	29.80	33.62
	Giving training as per their potentialities	24.67	25.33	19.43	Utilize their knowledge and wisdom to facing any difficulties	25.25	27.81	23.28	Provide govt. help	10.89	11.92	10.34
	Establish local raw material based small industry	17.43	16.83	21.67	Potential victims should use payable volunteer for relief program	24.26	19.21	18.10	Repair and rebuild worn house through local raw materials	19.80	19.21	21.55
	List the victims	15.45	14.65	11.54	Supply of food and medicine	16.34	17.88	12.07	Relevant stakeholders should provide essential house materials	20.79	17.22	18.10
	Build the home out of low-lying area	14.89	14.74	7.8					Build disaster resilient house	21.78	21.85	16.38
	Total	**N=206 100%**	**N=151 100%**	**N=129 100%**	**Total**	**N=206 100%**	**N=151 100%**	**N=129 100%**	**Total**	**N=206 100%**	**N=151 100%**	**N=129 100%**

Table 7.17: Existing Strategies to Protect the Demographics and Geographic Sector from CCIDs (continued)

River erosion	Embankment buildup on both side of the river	36.77	37.66	35.99	Control and monitoring the riverbank erosion	37.69	38.44	35.66	Repair the riverbank (If damage)	22.22	28.34	29.12
	River dredging at every year	34.77	32.55	33.44	Keep mobilization of water current	35.66	36.44	37.55	Dredging the river bed	29.05	27.32	25.21
	Afforestation salt tolerant tree and vegetation on the both side of river	28.46	29.79	30.57	Triangular block build wall should install on the bank areas	26.65	25.12	26.79	Afforestation salt tolerant tree and vegetation on the both side of river	26.75	22.21	21.32
									Increase the height of the river bank	21.98	22.13	24.35
	Total	**N=194 100%**	**N=146 100%**	**N=123 100%**	**Total**	**N=194 100%**	**N=146 100%**	**N=123 100%**	**Total**	**N=194 100%**	**N=146 100%**	**N=123 100%**
Location of Sea	Buildup the strong house	35.66	36.99	35.55	Keep news about the disaster	35.44	34,66	36.43	Return to the house	38.44	37.69	35.66
	Buildup multipurpose use based house/ shelter center	31.55	33.23	35.98	Move to the shelter center	34.22	34.55	34.32	Start as usual work	36.44	35.66	37.55
	Awareness buildup among the coastal people	32.79	29.78	28.47	Follow the weather signal	30.34	65.45	29.25	Repair the damage house / place	25.12	26.65	26.79
	Total	**N=196 100%**	**N=148 100%**	**N=129 100%**	**Total**	**N=196 100%**	**N=148 100%**	**N=129 100%**	**Total**	**N=196 100%**	**N=148 100%**	**N=129 100%**

Source: Field Survey 2018-19 N.B: Multiple answers considered, N.B: W- western zone, C-central zone, E- eastern zone

7.3.6 Agricultural dependency Sector Adaptation with CCID in the Study Area

"The share of agriculture, in the gross domestic product of Bangladesh's in 2018 was 13.07 percent" (Economic review, 2019) and leading agricultural depends country in south Asian region. Bangladesh's economic growth still depends largely on the agriculture sector. In Bangladesh, roughly 1.2 million hectares of land is used for agricultural production. The industry is highly vulnerable to higher temperatures and shifting patterns of rainfall. Increased flooding and drought and increasing salinity affect crop yields and crop production in coastal areas (Asia Foundation, 2012:18). The IPCC (2013) estimates that Bangladesh's rice production will decrease by 8 percent by 2050 and wheat by 32 percent (compared with the base year of 1990), which could lead to sever food insecurity. Bangladesh will face a net increase in poverty of 15% by 2030 in a low crop productivity scenario. (IPCC, 2013). In addition, , the livelihood of the vast majority of the population in Bangladesh is based on the agricultural sector, with 39.71 of the population directly employed percent and about 70 percent of the population relying in one way or another on this sector for their (WB, 2019 and PC, 2015). However, Government of Bangladesh, 2018 has prescribed six types of adaption strategies in response to agriculture in Bangladesh. These adaptation strategies are build roads and embankment with a view to protect crop land; research, develop and promote resilient crop varieties; stop sand collection from rivers (this induces river bank erosion and thus crop land loss); introduce floating seed beds during flood season; promote the flood tolerant traditional rice variety (Joli Aman) and enhance capacity of the private sector/NGOs who work directly with community people. The following Table 7.18 explores that perception of coastal people about the strategies to protect the different social sectors, especially agricultural dependency in the coastal region of Bangladesh. The agricultural dependency has been classified into five sub-sectors such as drought, excess rainfall, livestock, forestry and fishing. Besides, qualitative findings show that due to extreme weather events coastal weather components have been imbalanced. In these consequences, the farmer faces drought and uneven or irregular rainfall across the whole year. In these circumstances, coastal people face tremendous problems with their livestock, forestry and fishing sectors. Due to drought and uneven or irregular rainfall, farmer faces different types of problems such as fodder crisis, shortage of gazing land, insufficient of space for domestication and so on.

Table 7.18: Existing Strategies to Protect the Agricultural Dependency Sector from CCIDs

	Pre-Disaster				During Disaster				Post-Disaster			
	Types of initiatives	***W***	***C***	***E***	***Types of initiatives***	***W***	***C***	***E***	***Types of initiatives***	***W***	***C***	***E***
Drought	Develop the irrigation system	19.65	22.41	22.60	Homestead agriculture	20.07	24.36	36.22	Early farming	26.07	32.36	32.41
	Rain Water Harvesting	21.40	25.29	24.66	Drip irrigation	30.95	33.89	34.50	Farming of short day crops	25.95	43.26	42.37
	Innovation of drought tolerant crops	21.21	18.39	18.49	Implant the drought tolerant crops	28.45	20.75	18.06	Farming more crops	18.98	12.45	10.06
	Mini ponds digging for alternative irrigation	18.34	16.67	17.12	Control the wastage of irrigate water	7.68	7.04	2.65	Evaluation the past work	8.87	5.40	6.26
	Tree plantation	6.55	6.90	6.85	Monitoring, Repair and heighten the bank of land	5.33	6.73	4.50	Make post plan in community stage	10.02	3.20	3.50
	Construction of shallow and deep tube wells	12.85	10.34	10.27	Moderate irrigation by Frugal method	7.52	7.23	4.7	Communicate with agriculture Officer	10.11	3.43	5.40
	Total	**N=229 100%**	**N=174 100%**	**N=146 100%**	**Total**	**N=229 100%**	**N=174 100%**	**N=146 100%**	**Total**	**N=229 100%**	**N=174 100%**	**N=146 100%**
Excess rainfall	Buildup safe and sustainable embankment	33.22	34.49	39.27	Use rainwater for agriculture	44.43	47.21	37.27	Use saved rainwater for farming	38.36	37.07	41.41
	Buildup reservoir for save the rainwater	46.43	45.21	36.44	Rain water harvesting for future irrigation	34.22	35.49	33.44	Early farming	45.89	41.95	44.53
	Innovation of flood tolerant crops	20.35	20.3	24.29	Implant the flood tolerant crops	21.35	17.3	29.29	Use fertilize in field	15.75	20.98	14.06
	Total	**N=174 100%**	**N=134 100%**	**N=108 100%**	**Total**	**N=174 100%**	**N=134 100%**	**N=108 100%**	**Total**	**N=174 100%**	**N=134 100%**	**N=108 100%**

Table 7.18: Existing Strategies to Protect the Agricultural Dependency Sector from CCIDs (Continued)

Livestock	Make house in high land	56.43	59.22	53.41	Keep livestock on high place	55.32	52.67	51.97	Return to home	59.66	61.53	56.44
	Shift to the high place	43.57	40.78	46.59	Keep livestock house risk free	44.68	47.33	48.03	Keep in safe place	40.34	38.47	43.56
	Total	**N=166 100%**	**N=125 100%**	**N=103 100%**	**Total**	**N=166 100%**	**N=125 100%**	**N=103 100%**	**Total**	**N=166 100%**	**N=125 100%**	**N=103 100%**
Forestry	Save and increase the forest	31.61	36.96	38.26	Prevent the speed of wind	31.61	35.51	41.74	Newly planted the tree	34.16	35.10	46.55
	Control the deforestation	23.56	25.36	26.96	Use pool for supporting of plant	23.56	26.81	23.48	Repair the broken/ eroded forest area	25.25	27.81	23.28
	Awareness buildup on importance of forest	22.41	22.46	21.74	Regular observation	22.41	23.91	23.48	Control the deforestation	24.26	19.21	18.10
	Tree plantation	22.41	15.22	13.04	Prevent soil erosion	22.41	13.77	11.30	Fencing around tree	16.34	17.88	12.07
	Total	**N=174 100%**	**N=138 100%**	**N=115 100%**	**Total**	**N=174 100%**	**N=138 100%**	**N=115 100%**	**Total**	**N=174 100%**	**N=138 100%**	**N=115 100%**
Fishing	Prepare pond / fishing farm	59.43	53.36	52.45	Regular observation	51.48	59.36	55.47	Start fishing	57.46	62.45	54.88
	Strong dyke around water bodies	40.57	46.64	47.55	Use net cum embankment	48.52	40.64	44.53	Small fish farming	42.54	37.55	45.12
	Total	**N=178 100%**	**N=143 100%**	**N=125 100%**	**Total**	**N=178 100%**	**N=143 100%**	**N=125 100%**	**Total**	**N=178 100%**	**N=143 100%**	**N=125 100%**

Source: Field Survey 2018 -19 N.B: Multiple answers considered W- west zone, C-central zone, E- eastern zone

7.4 Barriers to Adaptation/Cope with CCID in the Study Area (opinion of the respondent)

Factors such as climate knowledge accessibility and usefulness the institutional environment and the socio-economic condition of households influence the ability to respond to climate change (Roncoli*et al.* 2002; Eakin 2003; Ziervogel*et al*. 2006; Agarwal 2008). Coastal people proposed barriers to the implementation of different adaptation strategies (Table 7.19). The respondents outlined that the most vital barriers as not have of Collaboration among the Gov., NGOs and CBOs stood in 1st rank in the study area. From FGD, it is found that due to lack of Collaboration among the Gov., NGOs and CBOs the victims are not getting help in proper way at the time of disaster. Followed by Insufficient shelter center, Lack of Institutionalization of IK, Lack of adaptation facilities, Poor communication and Transport system, Lack of knowledge concerning suitable adaptation, Poor infrastructure, Lack of proper education, Lack of awareness of the coastal people, Lack of economic solvency, Shortage of information about possible climate change, Political interfering, Shortage of own land and others which were ranked 2nd , 3rd , 4th , 5th , 6th , 7th , 8th , 9th , 10th , 11th , 12th , 13th and 14th rank respectively in the study area (Table 7.20). On the other hand, according to zone it varies in percentage and rank (Table 7.19).

Table 7.19: Barriers to Adaptation/Cope with CCID in the Study Area

Nature of Barriers	Western Coast n=218		Central Coast n=170		Eastern Coast n=212		Total n=600	
	%	R	%	R	%	R	%	R
Lack of Collaboration among the Gov., NGOs and CBOs	100	1	95.38	2	98.25	1	97.88	1
Insufficient shelter center	100.0	1	96.15	1	97.15	2	97.77	2
Lack of Institutionalization of IK	97.05	2	96.15	1	95.25	3	96.15	3
Lack of adaptation facilities	94.11	3	93.84	3	90.15	5	92.70	4
Poor communication and Transport system	91.17	4	90.79	6	88,00	7	89.99	5
Lack of knowledge concerning suitable adaptation	91.17	4	86.15	8	92.34	4	89.89	6
Poor infrastructure	82.35	8	91.53	4	89.25	6	87.71	7
Lack of proper education	85.29	6	90.76	5	87.00	8	87.68	8
Lack of awareness	88.23	5	90.00	7	76.00	9	84.74	9
Lack of economic solvency	85.29	6	84.61	9	75.55	10	81.82	10
Lack of information about possible climate change	79.41	9	83.84	10	74.00	11	79.08	11
Political interfering	83.52	7	75.38	11	55.35	12	71.42	12
Lack of own land	73.52	10	67.96	12	55.35		65.61	13
Others	32.35	11	34.61	13	33.42	13	33.46	14

Source: Field Survey 2018-19 Multiple Answers Considered R-Rank,

N.B: Rank size was demarcated considering the percentage of questionnaire Survey.

7.5 Respondent's Principal Choice/Advice for Healthier Adaptation with CCID in the Study Area

After adaptation has taken place, people take more adjustment steps (Mertz, 2009). This is because costs are incurred by adaptation. Adaptive strategies can resolve one problem, but they also generate other problems that involve an 'adapt to adaptations' (Paul, 1998; Mertz, 2009). After adaptation, respondents in the field of study take other adaptation steps (Table 7.20).The maximum respondents have advised like Collaboration with Govt., NGOs and CBOs (100%, Rank-1), Sustainable and Sufficient shelter center (For human) (98.11%, Rank-2), Tree plantation/ Afforestation through the coastal area (96.38%, R-3), Education and public awareness increase (95.42%, R-4), Proper medical/ health service (95.11%,R-5), Short duration rice and others crops (94.67%, R-6), Buildup high, wide ,strong & sustainable embankment (94.42 %, R-7), Training on Indigenous knowledge (93.63%, R-8), Good communication and transport system (93.51%, R-9), Buildup the house strong and on highland (93.19%, R-10), Buildup the easy drainage system (91.12%, R-11), Changing planting and harvesting date/time (90.82%, R-12), Salinity tolerant crops (90.78%, R-13), Ensure good governance (90.51%, R-14), Construction of area based Livestock shelter center (90.22%, R-15), Create Voluntary Group in Local Level (90.17%, R-16), Dragging the river and Raising the River Bank (88.55%, R-17) and Others (31.32%, R-18).

As pr peoples' perception Collaboration with Govt., NGOs and CBOs, Sustainable and Sufficient shelter center (For human) ,Short duration rice and others crops ,Salinity tolerant crops, Dragging the river and Raising the River Bank stood in 1st rank in the western coastal belt of the study area. Followed by Education and public awareness increase, Tree plantation/ Afforestation through the coastal area, Buildup the house strong and on highland, Buildup high, wide ,strong & sustainable embankment, Good communication and transport system, Training on Indigenous knowledge, Create Voluntary Group in Local Level, Changing planting and harvesting date/time , Proper medical/ health service, Construction of area based Livestock shelter, Ensure good governance, Buildup the easy drainage system, and which others were ranked 2nd , 3rd , 4th , 5th , 6th , 7th , 8th , 9th , 10th , 11th , 12th , 13th and 14th rank respectively (Table 7.20).

As per respondents' estimation Collaboration with Govt., NGOs and CBOs, Sustainable and Sufficient shelter center (For human) ,Tree plantation/ Afforestation through the coastal area, Education and public awareness increase, Short duration rice and others crops , Dragging the river and Raising the River Bank stood in 1st rank in the study area's central coastal zone of the Followed by Buildup high, wide ,strong & sustainable embankment, Good communication and transport system, Proper medical/ health service, Buildup the house strong and on highland, Buildup the easy drainage system, Changing planting and harvesting date/time, Training on Indigenous knowledge, Ensure good governance, Construction of area based Livestock shelter center, Create Voluntary Group in Local Level, Salinity tolerant crops and others were ranked 2nd , 3rd , 4th , 5th , 6th , 7th , 8th , 9th , 10th , 11th , 12th and 13th rank respectively (Table 7.20).

On the root of respondents opinion Collaboration with Govt., NGOs and CBOs, stood in 1st rank in the study area's eastern coastal zone. Followed by Proper medical/ health service, Sustainable and Sufficient shelter center (For human) , Training on Indigenous knowledge, Tree plantation/ Afforestation through the coastal area, Ensure good governance, Create Voluntary Group in Local Level, Buildup the easy drainage system, Construction of area based Livestock shelter center, Education and public awareness increase, Salinity tolerant crops, Buildup high, wide ,strong & sustainable embankment, Good communication and transport system, Changing planting and harvesting date/time, Buildup the house strong and on highland, Short duration rice and others crops , Dragging the river and Raising the River Bank, and others which were ranked 2nd , 3rd , 4th , 5th , 6th , 7th , 8th , 9th , 10th , 11th , 12th, 13th, 14th ,15th ,16th , 17th and 18th rank respectively (Table 7.20).

Table 7.20: Respondents' Principal Choice/Advice for Sustainable Adaptation with CCIDs in the Study Area

Principle Choice /Advice for Sustainable Adaptation	Western Coast n=251		Central Coast n=176		Eastern Coast n=189		Total n=607	
	%	**R**	**%**	**R**	**%**	**R**	%	R
Collaboration with Govt., NGOs and CBOs	100	1	100	1	100	1	100	1
Sustainable and Sufficient shelter center (For human)	100	1	100	1	94.34	3	98.11	2
Tree plantation / Afforestation through the coastal area	99.15	3	100	1	90.00	5	96.38	3
Education and public awareness increase	99.25	2	100	1	87.00	10	95.42	4
Proper medical/ health service	92.33	10	97.00	4	96.00	2	95.11	5
Short duration rice and others crops	100	1	100	1	84.00	16	94.67	6
Buildup high, wide ,strong & sustainable embankment	98.25	5	98.34	2	86.66	12	94.42	7
Training on Indigenous knowledge	95.34	7	92.54	8	93.00	4	93.63	8
Good communication and transport system	97.25	6	97.75	3	85.54	13	93.51	9
Buildup the house strong and on highland	98.35	4	96.00	5	85.21	15	93.19	10
Buildup the easy drainage system	90.00	13	95.35	6	88.34	8	91.12	11
Changing planting and harvesting date/time	93.26	9	94.00	7	85.33	14	90.82	12
Salinity tolerant crops	100	1	86.22	12	86.12	11	90.78	13
Ensure good governance	91.33	12	90.88	9	89.33	6	90.51	14
Construction of area based Livestock shelter center	92.00	11	90.65	10	88.00	9	90.22	15
Create Voluntary Group in Local Level	93.35	8	89.15	11	89.00	7	90.17	16
Dragging the river and Raising the River Bank	100	1	100	1	65.66	17	88.55	17
Others	35.35	14	30.25	13	28.34	18	31.32	18

Source: Field Survey 2018 Multiple Answers Considered, R-Rank

N.B: Rank size was demarcated considering the percentage of questionnaire Survey

7.6 Conclusion

Human adaptation to CCIDs varies from area to area and community to community in the study area. For instance, Bangladesh's southern coastal practices vary from the western coastal region, which shows that adaptation practices can apply to a region but not to all. A new strategy that is implemented by the respective area and be introduced from the learnings of a strategy. After study findings, the study tried to explain that proper and appropriate strategies at pre disaster period can be able to

decrease the negative impact of disasters at a during disaster period. It is therefore understood that the damages incurred by the disaster recovery in the coastal region of Bangladesh will be minimized properly and adequately during the pre-disaster period. Besides, the mitigation strategies differ from area to area and society to society; for instance, the practices of southern coastal area of Bangladesh are different from the western coastal area. Moreover, mitigation strategies are applicable to one region may be or may not be applicable in another area or society, but the leanings from each strategy can introduce a new strategy that is adopted in the respective region. After analysis the qualitative and quantitative findings, the study tried to explain that proper and appropriate strategies at pre disaster period can be able to decrease the negative effects of disasters at a during disaster period. Also this study prescribed the major barriers to adaptation as well as principal choice or advice for healthier adaptation with CCID in the coastal region of Bangladesh. Hence, it is understood that proper and appropriate strategies at pre disaster is the opposite condition or by reducing the losses at the during disaster period in the coastal areas of Bangladesh.

Chapter 8

COMMUNITY BASED SUSTAINABLE DISASTER MANAGEMENT OBTAINING SCIENTIFIC AND INDIGENOUS KNOWLEDGE ALONG WITH ADAPTATION STRATEGY

8.1 Introduction

Given its ambition to achieve upper middle-income status by 2030, the government of Bangladesh takes a pro-active approach in addressing main challenges related to climate change and development (Ministry of Finance, 2014). In support of this process, an integrated approach is needed to assess Bangladesh‘s climate vulnerability in detail, with special regard to different regions and sectors (The World Bank Group 2011). Indeed, vulnerability assessments can help estimate the nature and degree of future threats to a given human or ecological system (Intergovernmental Panel on Climate Change, 2007). Bangladesh, however, is considered to be an adaptation capital (Irfanullah, 2013), and numerous adaptation activities have been developed and implemented by relevant stakeholders. In this chapter has been explored the community based sustainable disaster management obtaining scientific and indigenous knowledge and adoption approaches in the coastal areas of Bangladesh. To finalize this chapter, researcher logically arranged and organized the opinions, perceptions and thoughts of expertise, planners, researchers, community leaders, economists, lawyers, political scientists, sociologists, industry leaders, regulators and high official or key persons of Govt. and NGOs for reducing the vulnerability of climate induced disaster in the Bangladesh’s coastal areas. Few strategies and approach have been prepared on the basis of adaption measurements (before, during and after disaster) of the coastal flocks of Bangladesh.

8.2 Common/ Recommended Adaptation Strategies and Approaches in the Whole Coastal Areas of Bangladesh

Bangladesh’s government has acknowledged that climate change poses a major threat to Bangladesh’s goal to accelerating economic development, eradicating poverty significantly and becoming a middle-income nation by 2021 (Planning Commission GoB 2010). Bangladesh was the first developing country to develop a National Programme of Action for Adaptation (NAPA) (MoEF, 2005). The Bangladesh Climate Change Strategy and Action Plan (BCCSAP) was established by the country in 2009 as a national strategy to address climate change (Irfanullah, 2016). The following strategy has been prescribed in this study to reduce the vulnerability of climate induced disasters and increase adaptation approaches in the study area.

8.2.1 Strategy 1: *Strengthening the Disaster Management Committees and Promoting Existing Adaptation Practices*

The mention strategy recommends three types of approaches as follows:

8.2.1.1 Approach 1: *Implementing 'top-down' Approach to Effective the Committees*

This approach has been emphasized and properly implementing on the Standing Orders on Disaster (SOD) 2010 from national to local level across the whole Bangladesh. In order to finalize the revised version of the Standing Orders on Disasters, the Ministry of Disaster Management and Relief (MoDMR) has initiated a comprehensive consultation (SOD, 2010). In respect of their responsibilities under the Standing Orders, all Ministries, Divisions/ Branches, Departments and Agencies prepare their own Action Plans. Coordination of disaster related operations at the national level is ensured by the National Disaster Management Committee and Inter-Ministerial Disaster Management Coordination Committee. On the other hand, Coordination at District, Upazila and Union levels is ensured by respective District Disaster Management Committee (DDMC), Upazila Disaster Management Committee (UZDMC), Union Disaster Management Committee (UDMC) and Union Parishad Ward Disaster Management Committee (UPWDMC). This mechanism is supported by the Department of Disaster Management facilitates and offers required assistance. This technique has been illustrated in the on 'top-down' approach (Figure 8.1). Because of every disaster emergency or management related order, attempt and initiative have been implementing or maintain from top order hierarchy. Here honorable prime minister is the chair of the NDMC and Union chairman is the chair of the UPWDMC. These committees have been takes every type of decision, before, during and post disaster periods across the whole county. Therefore, committee strengthening would effectively aligned to emergency attempt as well as reduce the vulnerability of potential disasters and accelerating proper relief and rehabilitation program in the disaster prone areas of Bangladesh. As per respondents opinion "officially this approach highly recognize but in the field it is not properly used, local people are not very familiar with this approach". So, the study has been proposed to properly apply this approach to reduce the CCIDs vulnerability in the study area.

Fig 8.1: Top-down approach to Strengthening of the Disaster Management Committees

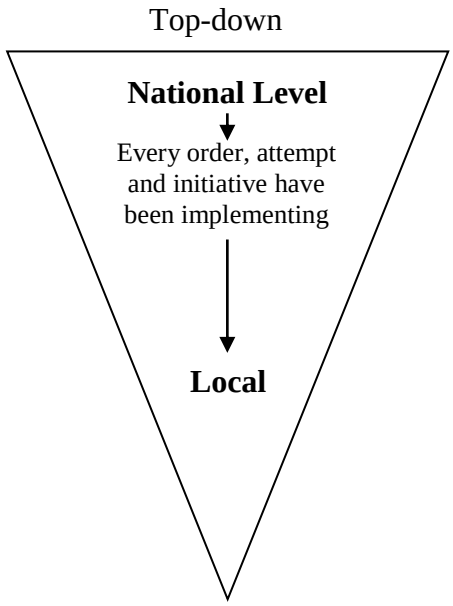
Top-down Approach

National Level

NDMC-National Disaster Management Council
IMDMCC- Inter-ministerial Disaster Management Coordination Committee
NDMAC- National Disaster Management Advisory Committee
NPDRR- National Platform Disaster Risk Reduction
NDRCG- National Disaster Response Coordination Group

Local Level

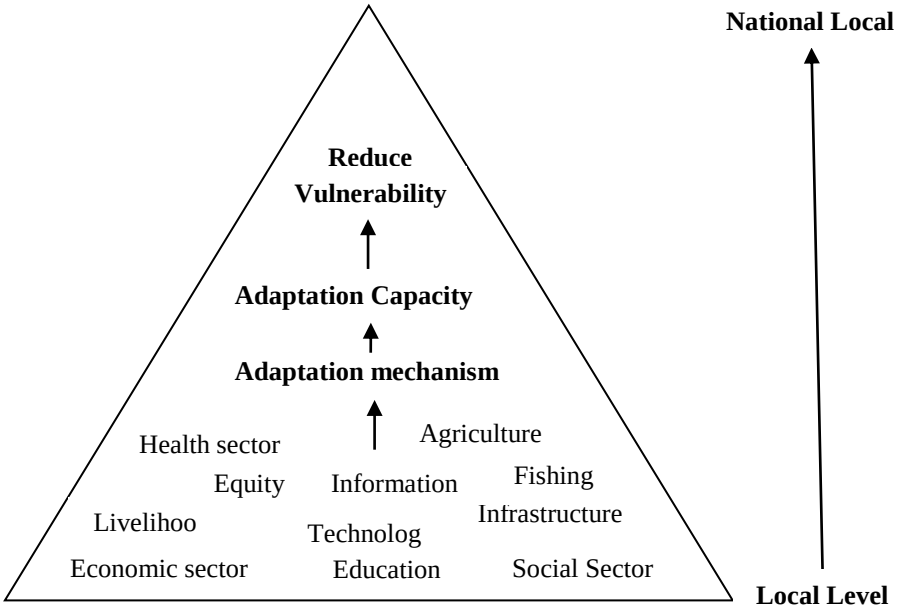
CCDMC- City Corporation Disaster Management Committee
DDMC- Divisional Disaster Management Committee
DDMC- District Disaster Management Committee
UDMC- Upazila Disaster Management Committee
PDMC-Paurashava Disaster Management Committee
PWDMC- Paurashava Ward Disaster Management Committee
UDMC- Union Disaster Management Committee
UPWDMC- Union Parishad Ward Disaster Management Committee



8.2.1.2 Approach 2: *Applying 'bottom-up' Approach to Performs Existing Adaptation*

This approach i.e. 'Bottom-up' has been emphasized to reduce the susceptibility and risk management of disaster by practices of existing adaptation measures (Figure 8.2). However, last few decades, the climate induced disasters are recurrent nature in the Bangladesh's coastal region of especially in the coastal zone. In this context, coastal people are very much familiar with these disasters. In this consequences, they have taken some attempts to protect themselves from these disasters as well as to manage their social and economic sectors, like agriculture, fishing, infrastructure, livelihood, children education and health sector. As well as, they are able to create an adaptation mechanism; these are enhancing their capacity building in response to disasters. Ultimately, they are capable to decrease the susceptibility of disaster in the coastal region of Bangladesh. That's why relevant or key stakeholders should be promoting existing adaptation practices in local areas. So, the study prescribed that 'bottom-up' approach would reduce the vulnerability of potential disasters in the Bangladesh's coastal zone. It will also train disadvantaged people on the coast and reduce their loss of life and property.

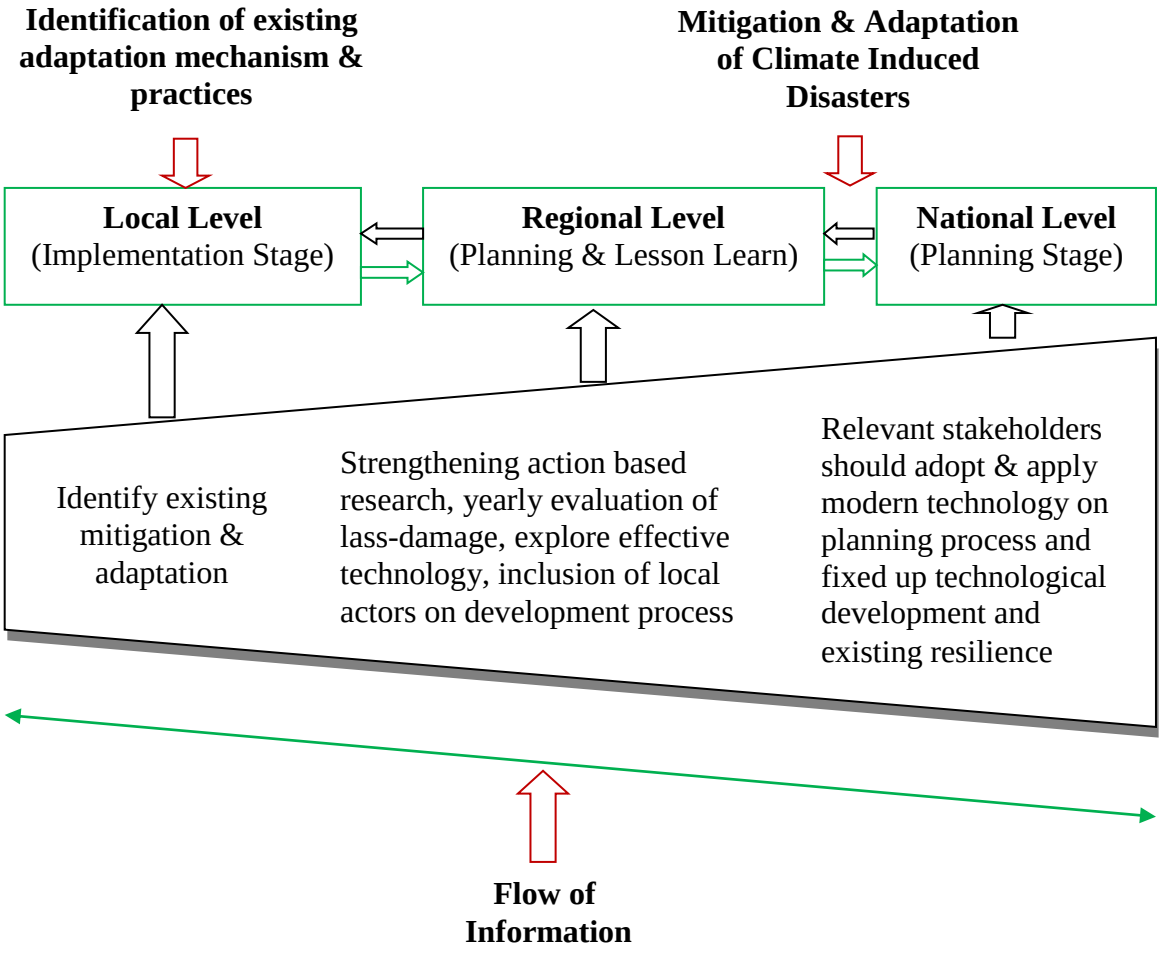
Figure 8.2: Bottom-up Approach to Effectively to Performs Existing Adaptation



8.2.1.3 Approach 3: *Narrowing the Focusing, i.e. Think Nationally and Implement Locally*

The following approach has highlighted the facts or problems through 'narrowing the focusing' and build 'flow of information from local areas to central and central area to local (Figure 8.3). Besides, three levels, like national, regional and local levels. In local level or implementation stage, which helps to identify existing mitigation and adaptation practices of coastal people to save and protect their life and properties from disasters. Moreover, in regional level or planning and lesson learn stage, this stage helps to explore the real facts through action based research, calculate lass-damage in response to fiscal year, explore effective technology and inclusion of local actors in the development process. Furthermore, in national level or planning stage, this stage refer that the relevant stakeholders should adopt & apply modern technology in planning process and fixed up technological development and existing resilience for sustainable disaster management in the Bangladesh's. Coastal region. Here every key persons and actors of state, especially relevant ministry, secretary, departmental head as well as non-state key persons who involve planning processes have should consider the existing adaptation mechanism and mitigation processes incorporate of laws, policies, rules and regulations. This process would accelerate and promoting the resilience of disaster and reduce the vulnerability of disasters in the coastal areas of Bangladesh.

Figure 8.3: Narrowing the Focusing, *i.e. Think Nationally and Implement Locally*



8.2.2 Strategy 2: Protection and Conservation of Coastal Afforestation

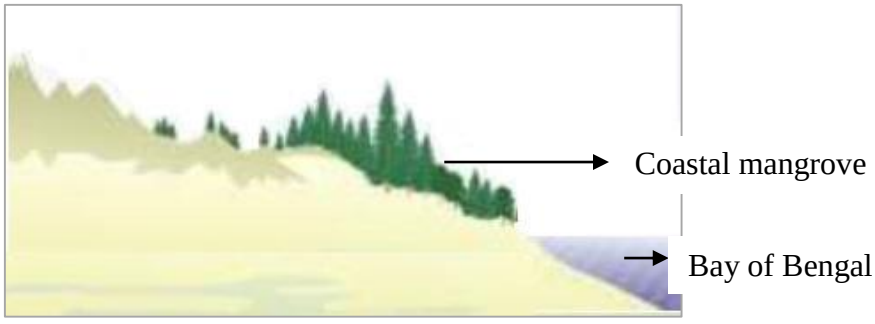
This strategy as the protection and conservation of coastal afforestation has been recommended from the field survey observation. Also, this strategy has been referred three types of approaches, *firstly*, undisturbed existing mangrove forest or promote regeneration, *secondly*, build natural protection through afforestation of mangrove forest and *thirdly*, coastal 'Green Belt Plantation' through salt and non-salt tolerant plants. Mainly, this strategy has referred the undisturbed coastal afforestation, because of 'plant community' gives the natural protection of coastal inhabitants in everywhere. This protection not only protects the life and livelihood from the vulnerability of cyclone, flood, storm surge, bank erosion, sea level rise, and thunderstorm but also gives food, shelter, fuel and raw materials for local communities. Besides, it is well-proven that coastal afforestation has largely contributed to reducing the loss of life and property damage from repeated disasters,

as well as reducing the effect of waves, storm surges, devastating high winds during disaster times. For instance, the coastal islands and chars near Patuakhali, Barisal, Noakhali and Chittagong were struck in 1991 a cyclone. The highest wind speed reached 110 km/h and the surge of storm was 1.9 m and the dead are almost 2 lac coastal dweller. Besides, in 2007 a Cyclone Sidr hit the same coastal areas with wind speeds up to 260 km/h and causing over 3,500 deaths in the Bangladesh's coastal region. It had possible only for coastal afforestation, particularly 'Sundarbans'.

8.2.2.1 Approach 1: *Undisturbed Existing Mangrove Forest or Promote Regeneration of Mangrove Forest*

This approach suggests that undisturbed existing mangrove forest or promote regeneration of mangrove forest in the Bangladesh's coastal region (Figure 8.4). After the disaster, the forest covered area is facing tremendous affects, trees or plant community is broken at every year, for example, Sundarbans in Khulna and Barisal division. Sometimes coastal people make a crab or shrimp farming plots in brackish water areas and salt cultivation purpose that they are cutting the trees or mangrove plants, for instance Chakaria mangrove forest, Sitakund coast, Mirsharai cost, Feni and Noakhali coast areas. Besides, fortunately, the mangrove plant community generates or regenerate in undisturbed coastal areas of Bangladesh. This situation is observed in every coastal area where the deposition activities are active and easily create marsh land areas. So, this approach could be protected coastal inhabitants and reduce the vulnerability of upcoming disasters in the coastal belt of Bangladesh.

Figure 8.4: Undisturbed Existing Mangrove Forest or Promote Regeneration



8.2.2.2 Approach 2: *Building Natural Protection through Artificial Plantation of Mangrove Forest*

This approach recommends that building natural protection through artificial plantation of mangrove forest in the Bangladesh's coastal region. The forest

department has planted mangrove trees or plants across the whole coastal areas under the supervision of the MoEFC (Ministry of Environment, Forest and Climate Change). As well as existing mangrove forest areas are declared as a protect area or reserve forest and public activity are limited here. Due to irresponsibility of high officials, local people are cutting the forest for wood and fire wood collection and housing material purposes. In addition, mangrove forest protects the soil bondage and reduce the bank erosion, create brackish water ecology and fishing ground (Figure 8.5). So, relevant stokeholds should take proper action to protect the existing mangrove forest and plantation of mangrove forest in the Bangladesh's coastal belt.

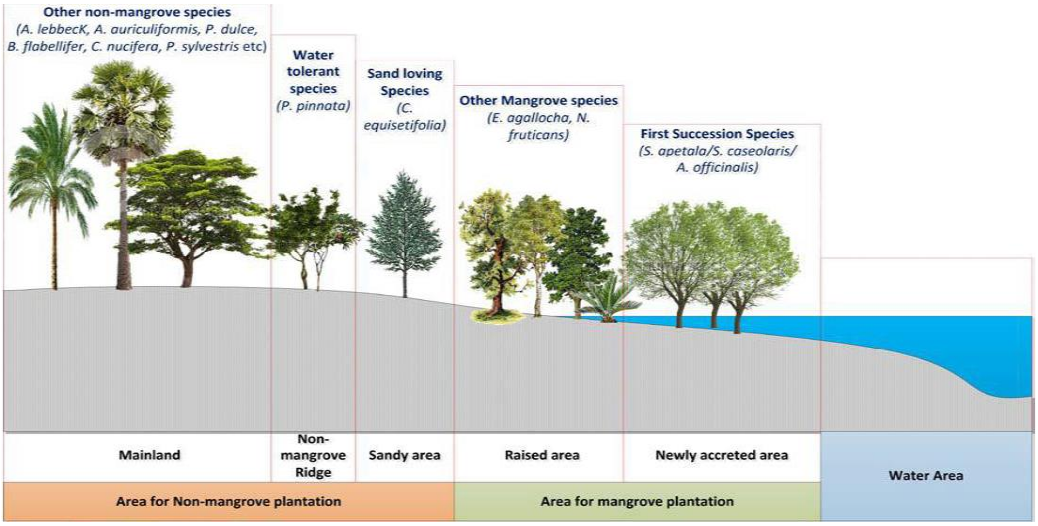
Figure 8.5: Build Natural Protection through Artificial Plantation of Mangrove Forest

8.2.2.3 Approach 3: *Coastal Green Belt Plantation through Saline and Non-saline Tolerant Plants*

This approach mentions that coastal green belt plantation through saline and non-saline tolerant plants in the Bangladesh's coastal region. Whatever, coast is the meeting zone of land and water. This meeting zone is divided different types on the basis of location, soil structure and texture, salinity and landforms such as saline

water area, newly accreted or first succession species area, raised or mangrove species area, sandy or sand loving species area, non-mangrove ridge or water tolerant species area and mainland or other non-mangrove species areas (Figure 8.6) (World Bank, 2017). So, the study highly recommended this approach should be implemented. Because of it would ensure and accelerate the coastal green belt and reduce the vulnerability of CCIDs in the Bangladesh's coastal belt.

Figure 8.6: Coastal Green Belt Plantation through Saline and Non-saline Tolerant Plants (After World Bank, 2017)

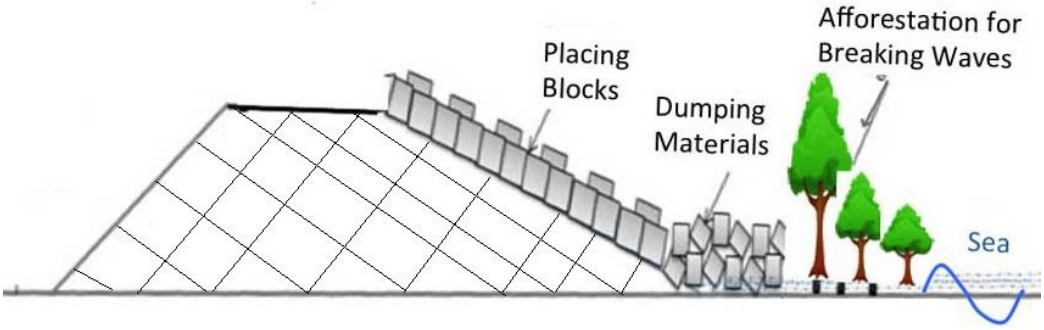


8.2.3 Strategy 3: Develop Sustainable Coastal Embankment

Coastal embankment is the first and foremost structural measure to reduce the severity of vulnerability of disaster. It is the familiar and an earlier strategy at every country which is situated in the coastal area of the world. This strategy recommended that mangrove or saline tolerant trees are planted adjacent areas of bay, this plantation would reduce the strength of waves, tides, wind and surge. Then dumping triangular concrete block from plantation area to edge of slope of the embankment. Then placing blocks on the gentle slope of embankment. After that peak of the embankment would be plateau or plain. This plain land would be used for light transport communication purposes, for example the connecting highway from Fojderhat at Sitakund to Chittagong port. This connecting highway is used in multipurpose way. It is not only used to connect port to Sitakund upazila but also protect the Chittagong city from recurrent disasters. So, this strategy should implement in the whole coastal areas and also it would reduce the vulnerability of disasters and accelerate the national

communication and eco-tourism across the whole coastal areas of Bangladesh (Figure 8.7). It would help the localization of coastal people, because they could easily connect divisional headquarters and creating huge employment opportunity for local people.

Figure 8.7: Develop Sustainable Coastal Embankment



8.2.3.1 Approach 1: *Build Multipurpose Embankment*

The approach has emphasized that coastal embankment should be aligned with multipurpose way. However, the existing embankment did not develop at the multipurpose way in the Bangladesh's coastal region. As per 'Delta Plan' the proposed and ongoing embankment project is building on multipurpose way which would be used for different purposes. Like, to reduce the vulnerabilities of disasters, land transport purposes, eco-tourism purpose, to protect of coastal land and huge volume of land would be used for agricultural purpose. So, the Bangladesh Water Development Board should follow the 'Delta Plan' and develop the coastal embankment in multipurpose and sustainable ways.

8.2.3.2 Approach 2: *Rebuild and Repair of Existing Embankment*

This approach has highlighted the rebuild and repair existing embankment. Sometimes existing embankments are broken due to the irresponsibility of related departments, lack of monitoring, violence of earth worms and negative attempts of dishonest local people. As a result, flooded new areas suddenly. Also, saline water destroyed the fresh water ecology adjacent areas of the embankment. So, rebuild and repair of existing embankments would protect the agricultural crops, fresh water ecology, life and livelihood of coastal people in the coastal areas. In this context, BWDB (Bangladesh Water Development Board) should ensure the proper monitoring of existing embankment, repair and check the embankment regularly, inclusion of

local people in the embankment related development processes and create awareness of local people about the importance of embankment to safe of life and livelihood in the coastal areas. As well as, BWDB should organize the monthly coordination meeting among state and non-state actors, elite group, political persons, journalists and local people during the disaster period where they discuss about how to protect existing embankment? How to increase durability of embankment? And how to inclusion of local people on embankment related development process?

8.2.3.3 Approach 3: *Established Sluice Gate and Control Saline water Intrusion Toward Land*

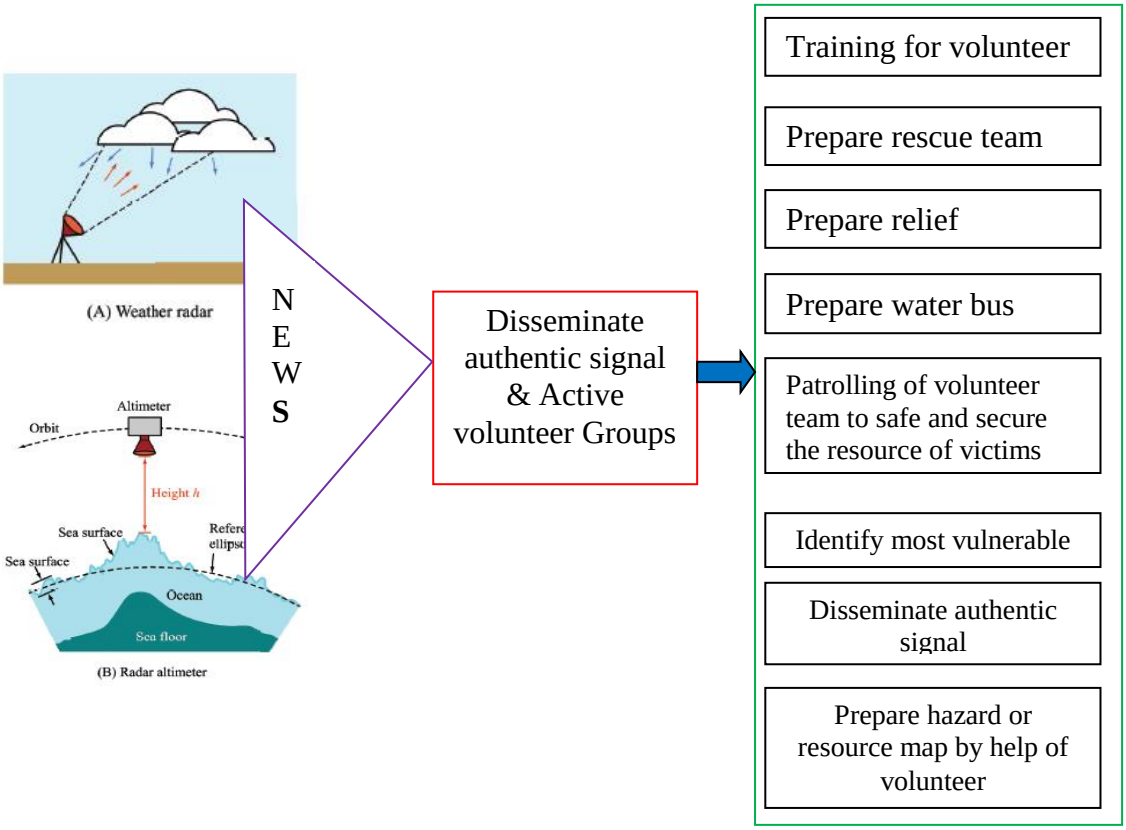
This approach recommended the established sluice gate and control saline water intrusion toward land in the coastal areas of Bangladesh. Sluice gate has played double role in coastal areas either positive or negative. Sluice gate helps to passing out upper steam flow to downward. Sometimes local people willing entrance the saline water to farming crab and shrimp. However, due to inadequate of sluice gate on the embankment, upper catchment stream water cannot pass out to downward. Also, huge volume of deposited materials are deposited on the final stage of cannel, tidal creek and stream and water are logged. As a result, coastal low-lying topography is flooded, inundated crops land and fish farming plots. Besides, sluice gate is the contingency way of engineer to pass water one side to another side. Sometimes it creates big disaster in coastal areas, because maximum time it is abandoned, nobody cannot manage this. As a result it losses functionality and useless. One day it is broken due to pressure of water and saline water enters the main land and abruptly damages fresh water ecology, suddenly floods adjacent area. Although, BWDB is the sole agent to install, manage and monitor the sluice in coastal areas. So, government should promote and activate BWDB authority to monitor the embankment regularly and maintain the functionality of sluice gate during disaster period.

8.2.4 Strategy 4: Ensure Digital or Modern Technology

This strategy has emphasized of the advance and modern techonology to prediction and forecosting of weather, wider dissemination of disaster related information, introduced modern techonology signals of disaster to volunteers and developed hazard & resource mapping using aerial photograph, remote sensing and geographical information system

(Figure 8.8). Besides, the strategy has prescrived four approaches to implementing this strategy across the whole coastal areas of Bangladesh.

Figure 8.8: Ensure Digital Information Afflux through Modern Technology



8.2.4.1 Approach 1: *Disseminate Actual Weather Condition and Promote Weather Forecasting*

This approach has endorsed that proper dissemination of weather condition and promote weather forecasting. Because of, weather forecasting is the preconditions of pre disaster preparation of coastal people and during disaster evacuation of vulnerable people. As well as agricultural production, crops harvesting and growing, industrial development, commercial activities and development activities and so on. However, sometimes people are misguided and lose properties due to wrong weather forecasting. After disseminate the disaster signal, coastal people going to safe areas like, cyclone shelter center, embankment, high land and school cum shelter center keep behind their valuable resources. At that time, some dishonest people steal their resources. As a result, sometimes they do not respond to the disaster signal. This situation has accelerated the severity of disasters in coastal areas. So, relevant ministry and department should disseminate the actual weather conditions and giving disaster signal by their local actors as soon as possible.

8.2.4.2 Approach 2: Keep Active Volunteer Groups

This approach has emphasized on the activation of volunteer groups in the coastal areas of Bangladesh. Yet, development activities cannot touch everywhere equally. Also, due to uneven topography, absence of network frequency, absence of modern communication system and limited road network, coastal people cannot reach the disaster signal. In this situation, volunteer group member is the only one way to disseminate the disaster signal, Miking the disaster signal and update, show the signal representing red flag. The volunteer group cannot take rest, they work every day and night during the disaster, although either paid volunteer or unpaid volunteer. So, to keep volunteer groups active, government should arrange the incentive or honorium for them and volunteer group members should inclusion on social safety net program, development project, and development activities as priority basis.

8.2.4.3 Approach 3: *Ensure Training Facility for Rescue Team Including Local Level Volunteers*

This approach has suggested to ensure training facility for rescue team and local volunteers in the coastal areas. Training is the way to increase the capacity and skilled of manpower. Mainly, coastal areas people are facing a different sort of poverty. Sometime people cannot meet their basic needs due to uneven resource allocation, limited scope of resources, politicalization of local people, people become an unemployed after disaster, corruption, ignorance, unawareness and mismanagement. Nowadays, the government has run different types of initiatives to empower the coastal people, like 'Youth Development Training Center', 'Social Safety Net Program', Rural Development Program' 'Rural Electrification Program' and so on. Yet, disaster risk reduction related training is not familiar and provides limited training opportunity to volunteer. The time has come, the government should start the inclusive and comprehensive training for a disaster rescue team and volunteer group members as per variability of disasters. Also, the training schedule should circulate and orient around whole year.

8.2.4.4 Approach 4: *Develop Hazard and Vulnerability Mapping and Resource Mapping*

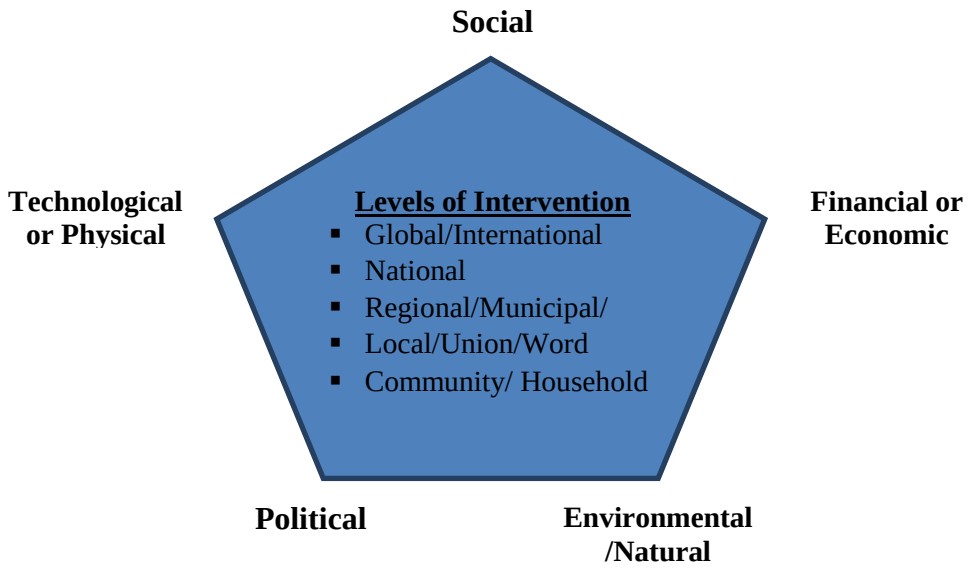
This approach has proposed to develop hazard, vulnerability and resource mapping at every coastal administrative units like ward, union, upazila, district and division. It reflects and clarifies the good, moderate and bad condition of facts. So, government related ministry, division and department should prepare the hazard, vulnerability and

resource map by using Arial Photograph, Remote Sensing, GIS (Geographical Information System) and GPS (Global Positioning System). In this circumstance, government should provide extra subsidies or increase budget to these ministries, divisions and departments. They would hire technical experts, like state and non-state actors, including academicians, geographers, and planners and must inclusion of local people in this process.

8.2.5 Strategy 5: Promoting Disaster Resilience Coastal belt and Localization

This strategy has emphasized the promoting disaster resilience coastal belt in Bangladesh. Mainly, the strategy focused on resilience of social, economic, environmental, technological and political. Bangladesh is internationally known in literature reviews for its cutting-edge achievement in tacking climate change as the world 'adaptation' capital. So, relevant actors either state or non-state actors should promote the existing ways of resilience from national level to local or community level, for instance social, economic, environmental, technological and political expression in the Bangladesh's coastal areas, besides localization of above mentioned sectors (Figure 8.9).

Figure 8.9: Promoting Disaster Resilience Coastal belt and Localization (modified by DFID Approach)



Social or Human

Although nowadays we have a higher rate of natural calamities, coastal people are applying different ways of adaptive resilience. That's why Bangladesh is the capital

of adaptation in response to climate change disasters. Therefore, government relevant department should promote existence resilience on coastal housing pattern, educational and religious center, cyclone shelter center and so on. Also, government and related organizational officials should consider the geographical location, nature of disaster and wind flows before build and rebuild of disaster resilience housing pattern, educational and religious and cyclone shelter center in coastal region. It would protect the prime essential need, like shelter for coastal people in Bangladesh.

Financial or Economic

The coastal region of Bangladesh is the pool of resources, for instance commercial fishing (fish hatchery, fry collection, shrimp cultivation), salt cultivation, source of mollusk and oyster to make ornaments, source of sea weed and sea grass, Crab cultivation, sources of housing materials, honey, crude wax, source of furniture wood and fossil fuels, dry fish and location for eco-tourism spot. Above mentioned each sector could be promoted as a small industry in the Bangladesh's coastal region. In the coastal areas from Satkhira to Teknaf districts, every district has an opportunity to build a small industry, like Satkhira, Khulna and Bagherhat districts have an opportunity to build shrimp farming industry, fishing related industry, salt industry, and hub of crude wax, honey, furniture wood and housing material and create eco-tourism center. Besides, Island areas, namely Sandwip, Hatia, Kutubdia, Maheskhali, St. Martin, and Bhola as well would be considered for salt and fishing business ground and tourism center. Therefore, government and non-government organizations should emphasis the location based resource production, conservation and manufacturing. As well as to provide financial support and training them who are interested to establish or set up local resources or materials based small industry.

Environmental / Natural

In the earlier stage, environment or nature is to control the life and livelihood of humankind. However, people are able to use instruments and technologies since the first industrial revolution to either change or fix environmental issues, scientifically it is called environmental possibilism. Nowadays, people try to change their environment as per their relaxation, but sometime they are fatalistic. Like that, cost of Bangladesh is not uniform, somewhere active fluvial process, somewhere sandy or clay and somewhere mature, moribund and active deltaic regions. So, the nature

considerably or slightly controls the life and livelihood of coastal people. In these contexts, the world biggest mangrove or tidal forest is the Sundarbans. As well as it is the natural protector of the western part of Bangladesh from nearly twelve cyclones in the last two decades. Besides, the eastern coastal part of Bangladesh is strip from Feni district to Cox's Bazar district including St. Martin Island. As a result, disasters easily affect the long strip coastal belt and damage huge volume of resources then other belt. After the above condition, coastal people adopt this environment through use of traditional resilience mechanism. Hence, government and non-government authorities or related organizations should explore these resilience mechanisms and promote these mechanisms across the whole coastal areas of Bangladesh.

Political

From international to the national arena, political as an indicator of resilience is a more powerful indicator like others. An international aspect, as per Conference of Parties (COP), carbon treads and loss and damage issues, every developed country who is producing or emission of CO_2 or GHGs gases has paid to developing countries who are affected due to those gases. In this context, few victim countries cannot receive currency as per their demand. Fortunately, few countries received their allotted currency those countries are appointed a foreign lobbyist to talk for appointing countries, good foreign affairs ministry, good bi-literal relationships with developed countries. Besides, in national or country level, ruling party followers are easily included in the ongoing development processes, easily inclusion on relief and rehabilitation program, getting social safety net benefits and so on. Therefore, developed countries or local government actor's behavior should be regardless, bias less and optimum behavior for all. It will accelerate to get actual consideration (currency/ benefits) from develop country to developing country, ruling party followers to opposite party followers.

Technology or Physical

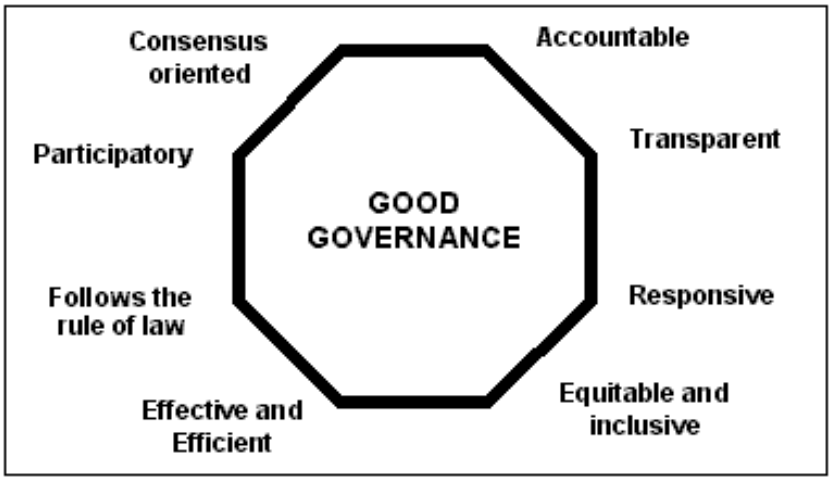
Without any formal recognition, coastal people adopt with disasters to use some indigenous resilience mechanism from their forefathers. These resilience is informally established at local or community level. However, the current decade is the time of advance technology. So, relevant authority should explore the resilience those are informal but established and try to fix the modern technology with traditional

technology. Both technologies created a strong resilience mechanism in the coastal areas of Bangladesh.

8.2.6 Strategy 6: Ensure Good Governance

The strategy has emphasized to ensure good governance across the entire coastal areas of Bangladesh relevant to 'Disaster Risk Mitigation' and 'Climate Adaptation' issues. Along with good governance should have ensured on relief distribution, rehabilitation program, Khas land distribution and inclusion of community people in local development processes. After modification of the good governance model of UNDP, this model has tried to replicate on disaster management and climate adaptation issues in Bangladesh (Figure 8.10). Furthermore, this strategy has suggested following four approaches to accelerate the good governance during relief distribution, rehabilitation program, Khas land distribution and inclusion of community people in local development processes.

Figure 8.10 Ensure good governance on disaster risk reduction and climate adaptation



8.2.6.1 Approach 1: *Equitable Distribution of Relief Program*

This approach gives emphasis to equitable distribution of relief program during and post disaster periods in the Bangladesh's coastal areas of. During and post disaster periods, people are helpless, shelter less, foodless and effortless. In this context, relief program is the first and foremost aid or humanitarian aid for climate victims. So, it should be optimal to all. Therefore, to make sure equitable distribution of relief program, relevant stakeholders either government or non-government organizations or department should ensure disclosed relief distribution related information through

Miking, relief distribution without nepotism, relief should be received by all disaster victims equally, responsible role play by the local administration and people representatives, i.e. ward member & union chairman , effectively solve the undesired complains, well-hearted behavior of volunteer group who involve relief distribution program, ensure security of victims during and post disaster period, provide unpaid legal aid to victims at everywhere in Bangladesh.

8.2.6.2 Approach 2: *Planned Rehabilitation Program*

This approach focuses on planned rehabilitation program for disaster induced displaced people across the whole coastal areas of Bangladesh. Yet, no specific rehabilitation program for climate forced displaced people in Bangladesh. While, Government has established a number of rehabilitation or resettlement programs, like *Ghore Phera, Ashrayan*, *Adarsha Gram, Ashrayan-2*, *Guccha Grams (clustered villages)* and *Adarsha Gram (ideal villages)* programs for landless people across the Bangladesh. Although, very few proportion of the climate displaced people receiving the opportunity under these programs. So, to make sure planned rehabilitation program, relevant stakeholders either government or non-government organizations or department should enumerate of displaced people in the whole coastal areas, selection of displaced people without biasness or nepotism, relocate area selection with concern of displaced people, inclusion of earlier displaced peopled with land acquisition, land formation and land development process, legal processing of documents, linkage with host community through community meeting, link among service providers, like educational, health services, community leaders at relocate areas and option to choose about rehabilitation system either barracks/camp system housing or one house one family in community level.

8.2.6.3 Approach 3: *Impartial Distribution of Khas Land*

This approach has ensured the impartial or regardless distribution of *Khas land* to climate induced displaced people across the whole coastal areas of Bangladesh. Yet, relevant officials do not consider the climate induced displaced people to get the *Khas land* for rehabilitation purposes. Although very few proportion of the victims of river bank erosion get access this opportunity. So, to make sure planned rehabilitation program, relevant stakeholders either government or non-government organizations or department should prioritize the displaced people during *Khas land*

distribution, the application procedure should be accessible to literate or illiterate displaced people, distribution procedure should be reduced and effective, Miking of the schedule of the distribution of *Khas land*, location of *Khas land* should well connect and safe from disasters and appropriate candidates should be selected after cross-check or double check by the help of local administration, elected persons, elite groups and so on.

8.2.6.4 Approach 4: *Implementing Development Projects*

This approach has emphasized on the implementing the development project including to emphasis eights things such as participation of local people, consensus orient about development programme, accountable of state actors, working transparent, responsive of state or non-state actors, effective and efficient of ongoing programme, equitable and inclusive and follows the rule of law. To ensure seven five year plan, the Delta plan-2100 and Sustainable Development Goals, relevant state and non-state actors should follow the pillars and preconditions of good governance at everywhere in Bangladesh inkling coastal areas.

8.2.7 Strategy 7: Innovation High Yielding and Disasters Tolerant Crop Species and Changing Growing and Harvesting Period of Crops

This strategy has emphasized to innovate high yielding variety and disaster tolerant crop species. The government of Bangladesh has established different autonomous research institutes, department, and organizations, like SAC (SAARC Agricultural Center), BRRI, BARD, BINA (Bangladesh Institute of Nuclear Agriculture), BARC, Bangabandhu Agricultural Research Institute (BARI), SRDI (Social Resource Development Institute), Upazila Livestock Department and Agricultural University across the whole country. Besides, different shorts of non-state organizations who are working at relevant issue to innovation of disaster tolerant crops species in Bangladesh. However, this strategy has prescribed following three strategies, such as –

8.2.7.1 Approach 1: Innovate *HYV (High Yield Varity)* and Disaster Tolerant Crops

This approach has highlighted to innovate HYV and disaster tolerant crops, especially salt and flood tolerant species in Bangladesh. Owing to overpopulation, recurrent

disasters, like saline and flood, violence of pest and shortage of agricultural land, agricultural research centers should innovate high yield variety and disaster tolerant seed in Bangladesh. In these context, government should provide sufficient subsidy in agricultural sectors. Because, introducing modern or advance technology, create skill manpower and hire expert on relevant field, purchase instrument for laboratory to innovate HYV and saline or flood tolerant species or seeds.

8.2.7.2 Approach 2: *Early Growing and Harvesting of Crops*

Due to unpredicted weather conditions and seasonal variation, farmers cannot articulate the actual time for growing and harvesting of crops on the field. So, farmer should use indigenous knowledge to growing and harvesting crops from field. As well as, research related organizations should trend analysis of weather conditions minimum three decades. Also, researchers should give guidelines to farmer after analysis the disaster variability and seasonal variation in a particular region.

8.2.7.3 Approach 3: *Encouraging Farmer with Floating Agriculture Practice*

This approach has encouraging farmer to grow floating agricultural crops in the Bangladesh's coastal region. Nearly 80% land of Bangladesh are flood plain topography. Also, 30% land is covered by coastal areas. Therefore, these areas are inundated maximum times due to fluvial process and coastal flooding. So, government relevant departments should introduce the floating agricultural practised in the coastal areas of Bangladesh. However, floating agricultural techniques are practices in the western and central coastal belt of Bangladesh, particularly Satkhira, Bagherhat, Khulna, Pautakhali and Bola and Haor areas in Sylhet district. Farmers are growing different shorts of seasonal vegetables, like arum, bean, beet, brinjal, cucumber, celery, gourd, pumpkin and so on. So, government should increase the wider use of floating agricultural practices across the whole coastal areas of Bangladesh.

8.2.8 Strategy 8: Ensure Modern Infrastructural Development in Coastal Areas

This strategy gives emphasis to ensure modern infrastructural development in the Bangladesh's coastal areas. Nowadays, we are in a time of globalization, framed by new technologies. Besides, the modern infrastructural development is the first clue of possibilism, where people are the moderator of his/her living environment. Modern technology would not only ensure safe and secure our life and livelihood but also

reduce the loss-damages of potential disasters in the coastal areas. In these contexts, the research has prescribed four approaches to ensue or implementing this strategy in the coastal areas of Bangladesh.

8.2.8.1 Approach 1: *Introducing Disaster Resilience Housing*

This approach has recommended to introduce disaster resilience housing in the Bangladesh's coastal areas. During the disaster, coastal dwellers lost their settlement first as a result people become shelter less. Sometimes broken settlement due to cyclone, sometimes inundated due to flood, storm surge and catastrophic web and tide, and sometimes disappearing due to bank erosion. So, government and relevant stakeholders should introduce disaster resilience housing in the Bangladesh's coastal region. In this circumstance, coastal people as well as every citizen should follow the 'Bangladesh National Building Code, 2015 (BNBC, 2015)'. This Act has prescribed the detailed guidelines how to build your settlement either in urban or rural areas of Bangladesh where tidal web are active and prone of different disaster.

8.2.8.2 Approach 2: *Accessible Cyclone Shelter Center for Persons with Disabilities, Children, Pregnant Mother and Senior or Older Citizens*

This approach emphasizes the accessible cyclone shelter center for all, especially physically disabled, children, pregnant mother, senior or older citizens in the coastal areas of Bangladesh. Sometimes, the center shelter cyclone has been two or more floor. In that cases, physically disabled, children, pregnant mother, senior or older citizens cannot access during disaster period. So, relevant authority should follow guidelines on the relevant laws and policies, particularly SOD (Standing Orders on Disaster) 2010, Disaster Management Act, 2012, Cyclone Shelter Construction, Maintenance and Management Policy, 2011 and Disaster Management Rules (committee formulation and functions), 2015. These laws and policies clearly prescribed the different guidelines and recommendation to service providers and receiver before, during and post disaster period.

8.2.8.3 Approach 3: *Multipurpose Uses of Cyclone Shelter Center*

This approach recommended that cyclone shelter center become multipurpose ways in the coastal region of Bangladesh. The types of cyclone shelter center are earthen fort, earthen fort cum cyclone shelter, cyclone shelter center, school cum shelter center,

union health and family welfare center and UP building. Due to limited budget allocation, huge vulnerable people and uneven topography or geographical location, relevant government department should install the multipurpose building at coastal areas, which accelerate to shelter of disaster victims, educational center, coastal people gathering to distribute relief program, Khas land distribution center and use of UP chairman and member for official purposes. The multipurpose types of cyclone shelter would budget effective, functional, contemporary and cost effective concept in the coastal areas of Bangladesh.

8.2.8.4 Approach 4: *Regime of River Course and Bay Bank through Use of Modern Technology*

This approach has emphasized on the regime of rive course and bay bank through the use of modern technology. However, the decade has been over the period of modern technology and advance development methods. Bangladesh is situated in the deltaic region in south Asia. Huge rivers, tidal creek, streams are cress-crossed in everywhere. Along with large volume of river course over the central part of this country. So, every personal, economic, social, and cultural like are framed by these action of river. In this situation, coastal and river erosion is the common phenomena here. Every moment, river course and bay bank shape and reshape the land across the whole country including coastal areas. So, relevant ministry, division and department should use modern technology to regime the river course and bay bank across the whole county including coastal areas of Bangladesh. For instance, the Sirajgong City was vulnerable due to excessive erosional activity of Jamuna River. In this context, government relevant stakeholders successfully changed or shifting the river course through utilized the modern technology at the course of Jamuna River and protected the Sirajgong city.

8.2.9 Strategy 9: Institutionalization of Indigenous Knowledge

This strategy has recommended to institutionalization of Indigenous Knowledge (IK) in Bangladesh.. The coastal people are applying different sorts of adaptation mechanisms to cope themselves with recurrent disasters. Technically, these types of adaptation mechanisms are called IK or existing resilience. This knowledge is practiced from generations to generations. However, this knowledge is unwritten, undocumented and unauthorized, but very much familiar to coastal folks. IK has been

changed as per geographical location, situation and its diffusion through oral sharing from one people to other. This knowledge framed the life and livelihood of local people in the coastal region of Bangladesh. Besides, IK not only safe and secure the life and livelihood of costal inhabitants but also reduce the causalities, loss and damages and accelerate the evacuation or rescue of disaster victims during disaster period. What is more, the local citizens are not as formal expert or researcher but their prediction, practice, coping measure, thoughts and thinking as like as a formal expert or researcher. Because they easily evaluate the situation or easily understand what is going on? That's why Bangladesh is the adaptation capital of the world. Therefore, government should collect the Indigenous Knowledge from everywhere across the whole Bangladesh through relevant ministry, division, department and agencies under the supervision of Prime Minister Office (PMO). After collection these knowledge, PMO should isolate these collected knowledge as per sectors. Then PMO share these knowledge with every relevant ministry, division, department and agencies for cross-check the authenticity. This process has been continued. Aftermath, these knowledge should be included on ongoing strategies, plan, guidelines and recommend to people for applying in their daily life. Additionally, these tested knowledge should display at every office at Upazila and Union level through relevant state and non-state service delivers. Finally, these knowledge included in the national academic curriculum text book and mandatory at primary and secondary education level as well as studied at the relevant institutions or departments.

8.2.9.1 Approach 1: *Execution of IKs on Socio-economic Sectors*

The introduction of IKs on socio-economic sectors in the coastal areas of Bangladesh has been acclaimed by this approach. Through social safety net program, relevant departments of the government have been implementing more than fifty types of programmes to ensure civilian rights and meet limited livelihood of the countryside people across the whole country. Besides, according to social safety net programme, ensure 'Delta Plan-2100' and achieve Sustainable Development Goals, government has tried to implementing huge types of development projects in the coastal areas. Subsequently, government should inclusion of local people on this development process and receive the opinions and thoughts before implementing the development projects in their area. Because local people is the informal expert and planner in their

area. Also, they understand well about causes and effects, problems and possible solutions and also development changes in their known areas.

8.2.9.2 Approach 2: Promoting of IKs on National Academic Curriculum

This approach has highlighted to promote IKs on national academic curriculum in Bangladesh. Indigenous Knowledge, however, is the special knowledge of a specific community or society. It is often referred to as local knowledge, folk knowledge, and knowledge of individuals, traditional wisdom or traditional science. In these contexts, a local people become an expert and protect themselves from recurrent disasters. Hence, relevant government authority should include these IKs in the national academic curriculum text book and mandatory at primary and secondary education level as well as studied at the relevant institutions or departments. This process will accelerate to promote IKs at everywhere in Bangladesh.

8.2.10 Strategy 10: Promoting Fact Finding Based Research and Bring Technological Development

This strategy has been featured to promote fact finding based research and bring technological development in Bangladesh. Nowadays, we are living over the period of fourth industrial revolution means digital world, where people introduce artificial intelligence, cloud competency, internet sensation-social media for communication, block chain technology, 3D printing, and divergent thinking. As well as knowledge is shifted, increased place oriented education, like boost student and teacher engagement, enhance academic outcomes and impacts communication and distance learning have accelerated this revolution smoothly. Therefore, to achieve the strategy, the study has recommended two following approaches.

8.2.10.1 Approach 1: *Increase Research Grant*

This approach has emphasized to increase research grant, because it uses innovative, multidimensional, original and realistic research to extend the horizons of knowledge. As well as it paves way to innovation new facts, explores new knowledge and idea and justification of existing knowledge. An authentic research is the preconditions of durable and planned strategy and effective planning process on every development activity in everywhere. However, MoST (Ministry of Science and technology), Ministry of planning, Prime Minister Office and research cell of public and few private universities are giving academic and professional grants to expert citizens in

Bangladesh. Nowadays, few national non-state organizations are giving research grant for development practitioners, academicians and graduate researcher. Although, the number of fellowship or scholarship and stipend are limited and the amount of budget is also minimum level. Hence, government and relevant stakeholders who are conducting innovative research in Bangladesh have been allocated sufficient grant for research and increase the number of fellowship or scholarship and stipend. Also, government should keep the certain grant for research purposes of every ministry to smoothly evaluate their need based assessment before implementing their projects or programmes.

8.2.10.2 Approach 2: *Encouraging on Climate Change based Research*

This approach has underlined to encourage climate change based research in Bangladesh. According to World Bank, climate induced disasters are only one drawback to achieve the 'Seven Five Year Plan', 'Delta Plan-2100', 'Sustainable Development Goals' and overall economic growth in Bangladesh. Time has come, government of Bangladesh has emphasized this issue very sincerely. Yet, no specific organization cannot announce any sorts of grant to conduct climate change based research, we have specific ministry, more division and departments. Therefore, ministry of forest, environment and climate change and ministry of disaster management and relief should open 'Climate Research Cell' and offer the research grant to relevant stakeholders, like university department, expert, academicians, development practitioners, graduate students who are potential to work in this field. After that relevant ministry gathered and aligned these research findings on the existing laws, rules, policies, strategies and planning. This process will accelerate to achieve 'Seven Five Year Plan', 'Delta Plan-2100', 'Sustainable Development Goals' in Bangladesh.

8.2.11 Strategy 11: Exploring the level of vulnerability with international arena

This strategy has recommended to exploring the level of vulnerability including loss and damages due to climate change with international arena through, COP-Conference of Parties, bi-literal and multi-literal meeting, international conference, UNEP–United Nation Environmental Programme, CCF-Climate Change Fund, UN general or secretary meeting, UN Climate Action Summit, diplomatic meeting with

the ambassador of developed countries, meeting with key officials of developed countries, SAARC summit, BIMSTEC(Bay of Bengal Initiative for Multi-sectorial Economic Corporation) meeting, CIRDAP (Center on Integrated Rural Development Asia and the Pacific) summit, WTF-World Tiger Forum and so on. These are the ways in which actual scenarios about the effects of climate change in Bangladesh can be discussed. So, relevant officials of ministry, key persons of related division and department, key experts and academician should joining relevant conference, seminar, symposium, meeting, summit will share the relevant research findings and vulnerability of climate change with international delegators and actors. This process will easily explore the current scenario of climate change susceptibility across the whole coastal region of Bangladesh.

8.2.12 Strategy 12: Reduce the Uses of Technology those Produce Green House Gases (GHGs)

This strategy is designed to reduce the uses of technology emitting Green House Gases (GHGs) to earth. GHGs are the undesirable effects of the industrial revolution. As well as developed countries are the producer of GHGs while developing countries like Bangladesh are victims. According to Greenhouse Gas Emission Factsheet, 2016 Bangladesh has produced only 2% GHGs while USA produced 6.5 billion metric tons. Even so, Bangladesh is one of the world's least vulnerable nations. Therefore, the time has come to take proper attempt to innovate climate friendly technology and citizen should use renewable energy sources, especially solar and wind harvesting technologies, biodegradable plastic, turning food waste into fertilizers, reuse and recycle of daily using goods as well as eco-friendly lifestyle across the whole world like Bangladesh. To achieve this strategy, following four approaches will be recommended.

8.2.12.1 Approach 1: *Promote and Use of Renewable Energy Resources*

The promotion and use of renewable energy resources in Bangladesh has been emphasized by this approach. Bangladesh is capable with an enormous amount of renewable energy sources. Among the sources solar energy, wind energy, ocean current, gravitational forces (tides), hydro, biogas to electricity and biomass to electricity energy are considered the most favorable and effective resources. However,

coastal people have started to use solar panel for electricity purposes. Nowadays, different departments of government and non-governmental organizations giving solar panel to coastal people for humanitarian purpose where electricity is unreachable. Thus, relevant governmental bodies should encourage the citizen to use solar panel for electricity purpose. This practice will discourage the commercial production of electricity through the use of non-renewable energy sources, like gas and coal.

8.2.12.2 Approach 2: *Utilize the Era of 'Blue Economy 'and Sea Resources*

This approach highlighted to utilize the 'Blue Economy' and sea resources in Bangladesh. The approach of the Blue Economy is based on calculating and incorporating the real value of the natural (blue) resources into all areas of economic activity (planning, conceptualization, infrastructure development, trade, travel, renewable resource exploitation, energy production and consumption). This approach helps to achieve the entire set of SDGs, and many SDGs are right way relevant to fisheries and aquaculture, in particular SDG 14 (Conserve of the coasts, seas and aquatic resources and their sustainable use for sustainable growth). Twenty six maritime economic functions have been established by the government of Bangladesh in the areas of fishery, maritime trade and transportation, energy, tourism, coastal defense, maritime safety and surveillance for the growth of Bangladesh blue economy. The three key drivers of change will be a part of long-term growth as well: 1) sea level rise and related climate change conditions 2) population pattern and 3) economy. Government should therefore prioritize this issue and it is necessary for the growth of the Blue Economy and coastal areas of Bangladesh to apply science-based technology.

8.2.12.3 Approach 3: *Reduce Pollution*

This approach emphasizes to reduce pollution i.e. every undesired condition of air, water, soil and noise across the whole Bangladesh. However, Bangladesh is an overpopulated country where unplanned or centralized industrialization, augmentation of automobiles, unplanned urbanization, citizen violate 'National Building Code, 2015, while have standard laws, rules, policies, strategies, plans and guidelines to manage above mentioned problems. As well as to prevent pollution, Bangladesh has specific standard acts, laws, rules and policies, for instance 'Bangladesh act of Environment Court, 2000', 'Conservation Rules Environment,1997', 'National Environmental Management Plan, 1995', 'Bangladesh Environment Conservation Act, 1995 (Amendment Act, 2010)', '1977, ordinance of Environmental Pollution

Control,', 'Water Pollution Control Ordinance, 1970', 'Policy of National Environment, 1992', 'National Environmental Management Plan, 1995', 'The Brick Manufacturing and Brick Kilns Establishment (Control) Act 2013', 'The Bangladesh Biodiversity Act 2017' and so on. These laws, acts, policies and rules have enough slope to protect and conserve our environment from every underside conditions like pollution. Unfortunately, state actors are uninterested about their responsibilities and duty, they involve with corruption and illegal linkage with dishonest people, folks are unconscious and indifferent about their responsibilities. As a result mismanagement is everywhere and corrupted person hamper every way of development path. Therefore, relevant department or division of government should ensure the responsibilities of key officials and non-state actors and citizen should be aware of the negative impacts of pollution and their responsibilities to themselves, family, community, society and country as well as future generation. Along with citizen should use eco-friendly technology, avoid the initiatives those produce GHGs and different undesired components to the environment.

8.2.12.4 Approach 4: *Ensure Planned Urbanization*

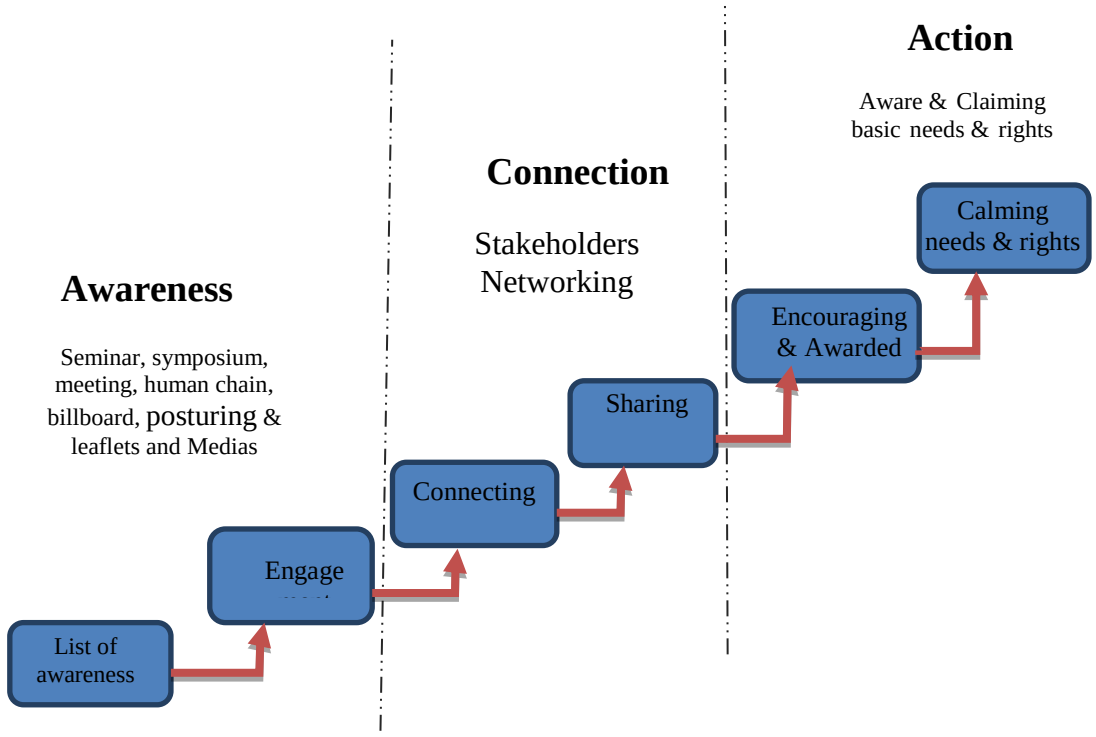
This approach has recommended ensuring planned urbanization in Bangladesh. Urbanization is one the very important indicators of growth an also plays a vast role in the country's socio-cultural and political progress. After independence, the average urbanization rate in Bangladesh is 5% (WB, 2012) and the urban population has doubled from 15% in 1974 to 28.4% in 2011 (Population Census-2011). However, our urban areas cannot develop planned way and urban actors cannot follow the any sorts of urban development theories. As well as huge volumes of coastal people influx in urban areas due to adverse effects of climate change and effects of different push and pull factors. In this situation, urbanization rate is gradually increased while urban management bodies cannot ensure civilian rights and basic amenities for city dwellers at every urban center of Bangladesh. So, time has come to reform our urban area, because urban area is the functional region of any countries, here urban folks are engaging secondary, tertiary and quaternary economic activities. Therefore, relevant state and non-state actors should ensure urban management way forward to good governance, law enforcement authorities should ensure safe living condition and force to urban developer and owners to ensure the national building code, urban autonomous bodies should ensure friendly living environment for city dwellers, as well as urban citizen should respect existing urban management related laws, acts, rules and policies and wiliness to obey these at everyday

life. Besides, industrial owners should develop ETP-Effluent Treatment Plant at every industry to control emission of pollutants from industries.

8.2.13 Strategy 13: Awareness Buildup among the Coastal Dwellers

This approach has emphasized that relevant stakeholders, either state actors, non-state actors, academicians, experts, researchers, planners and development practitioners are providing differ sorts of awareness building for local or coastal people across the whole Bangladesh. By birth people are illiterate, they learn knowledge from their whole life through facing different situations. The familiar media, for instance, newspapers (electronic and print media), radio, television (where available), exhibition, outdoor hoarding (billboards), printed material in the form of booklets, posters and stickers are ways to spread or disseminate information from urban areas to countryside areas. From earlier discussion, we know that Bangladesh is a capital of adaptation to disaster and climate change in the world. So, we have different sorts of adaptation measurements, native technology means indigenous knowledge, 7th Five Year Plan and Delta Plan-2100. Therefore, relevant government and non-government bodies should disseminate sector based adaptation practices or mechanisms or awareness practices with grassroots level or countryside people then they would be aware about the potential disasters, loss and damages of disasters across the whole coastal areas of Bangladesh. To achieve this strategy, the study recommended three approaches to beware coastal people in response to potential disaster in the coastal areas of Bangladesh. The approach has mentioned three stages such as awareness, connection and action to award of coastal people about building awareness and calming their needs and rights from relevant authorities (Figure 8.11).

Figure 8.11: Awareness Buildup Process among the Coastal People



8.2.13.1 Approach 1: Approach 1*: Basic Needs, Citizen Rights and Security*

This approach has highlighted the basic needs, citizen rights and security of coastal people to disaster and climate victims in the coastal areas of Bangladesh. The coastal people of Bangladesh are facing different sorts of problems, like inadequate access to information and education, poverty, religious superstition, life is uncertain due to recurrent disasters and so. Besides, people do not know how to meet their basic needs, claiming their citizen rights and security. The Constitution of the People's Republic of Bangladesh (1972) states that however, **Article 15** "It is the fundamental duy of the State to achieve, by means of planned economic development, a constant increase of productive forces and a steady improvement of the material and cultural standard of living of the people, with a view to ensuring that citizens are safe guard- (a) the provision of the basic necessities of life, including food, clothing, housing, medical care and education; (b) the right to work, is the right to guaranteed job at a fair salary, taking into account the quantity and nature of the work. **Article 19(2)** "The State shall adopt effective measures to remove social and economic inequality…and to ensure the equitable distribution of wealth among citizens, and of opportunities in order to attain a uniform level of economic development throughout the Republic". **Article 25**

"The State shall base its international relations on the principles of respect for national sovereignty and equality…and respect for international law and the principles enunciated in the United Nations Charter. **Article 27** "All citizens are equal before law and are entitled to equal protection of law". So, the Constitution of the People's Republic of Bangladesh (1972) has clearly explain the basic needs, rights and security of every citizen of Bangladesh, but citizen cannot know how to meet or claim their basic needs, rights and security from relevant departments of the government. Therefore, relevant key officials of the government and non-state actors should working to beware the coastal people how to meet their essential needs and claiming their rights and security.

8.2.13.2 Approach 2*: Nature-based Development Project and Their Inclusion*

This approach has emphasized nature and science-based development project and inclusion of local people in this development process in the coastal areas of Bangladesh. Mainly, this approach refers that development activity cannot change the natural setting of the environment. Sometimes development activity has changed the natural settings of the environment, it may create huge natural imbalance. Besides, coastal area's soil is new and comparatively younger than mainland and fluvial activities are very much active there. So, relevant governmental authorities should doing in-depth research and feasibility study before establishing any development project in coastal areas. Moreover, relevant authorities should ensure the inclusion of local people on the every phase of development activity. It will accelerate the sustainability of this project and creation of employment opportunity to coastal people.

8.2.13.3 Approach 3: *Wider Social Safety Net Program*

This approach has highlighted the wider social safety net program in the coastal areas of Bangladesh. For Vulnerable Group Feeding: In the wake of the famine in 1974, the Government of Bangladesh, in partnership with the WFP (World Food Program), launched the VGF (Vulnerable Group Feeding) program in Bangladesh. Almost 130 types of programmes have been introduced under various heading such as social welfare, social empowerment, cash transfer (special) programme, food security programmes: social protection, micro-credit programmes: social empowerment programmes and miscellaneous funds: social protection programmes. This approach

has recommended that government related department has emphasized this program in the Bangladesh's coastal areas. Because coastal people are poverty stagnant as well as their life has been circulated on poverty cycle. Due to recurrent disasters, absence of adequate employment opportunity, mismanagement, politicalization of local society, nepotism and absence of good governance of every development process. Therefore, relevant government should wider the operation of a social safety net programme in coastal areas. As well as they should ensure the good governance among service providers and also reduce corruption and nepotism. Besides, non-state actors should beware the coastal people about the social safety net program including every development process through their projects activity. They would work for humanitarian aspects.

8.2.14 Strategy 14: Make Collaboration among the Community Base Organizations, NGOs and Local Government

Bangladesh is an over populated and also climatic disaster prone country in the world. For her poor economic capacity and poor management capacity, Bangladesh mostly fail to manage the climate change induced disaster especially in the coastal region. Most of the coastal dwellers live with middle income level. Transport and communication facilities are not in good position. In this circumstance we need to make collaboration among the Community Base Organizations, NGOs and Local Government to ensure the sustainable disaster management within the coastal region of Bangladesh (Figure 8.12).

Figure 8.12: Sustainable Disaster Management Framework Ensuring Collaboration between CBOs, NGOs and Local Government

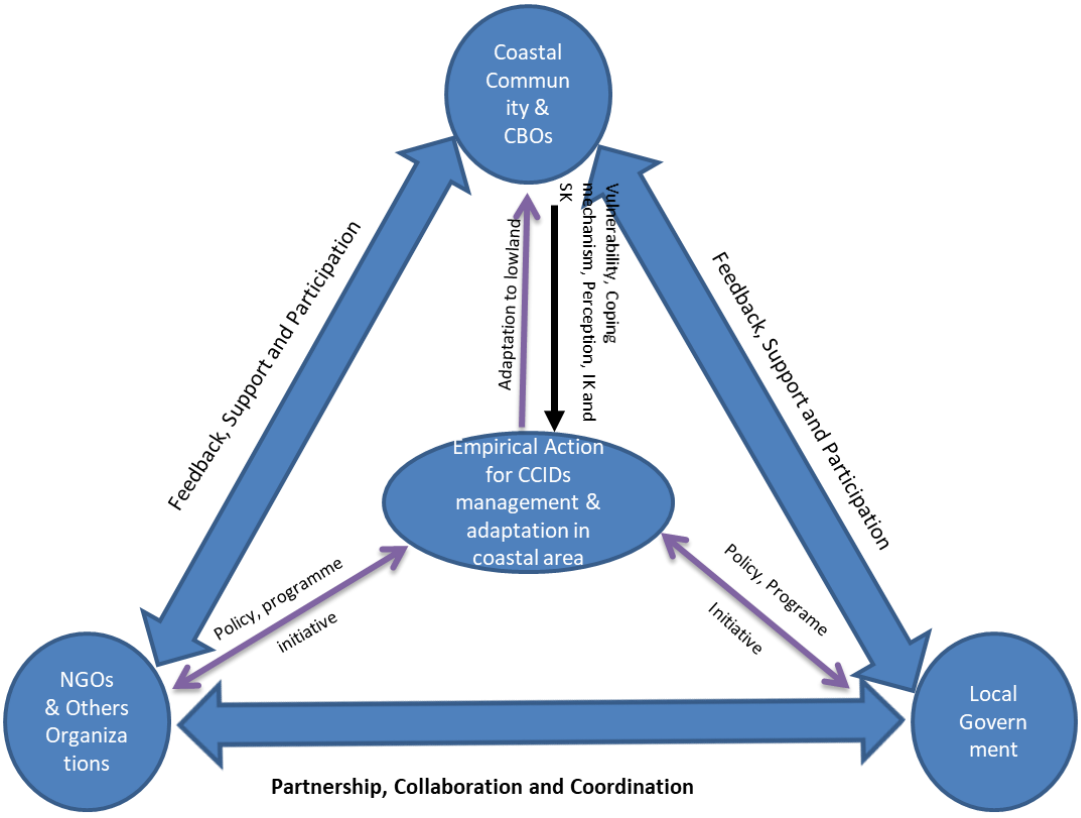


Figure: Empirical action for CCIDs Management and Adaptation in Costal Region of Bangladesh

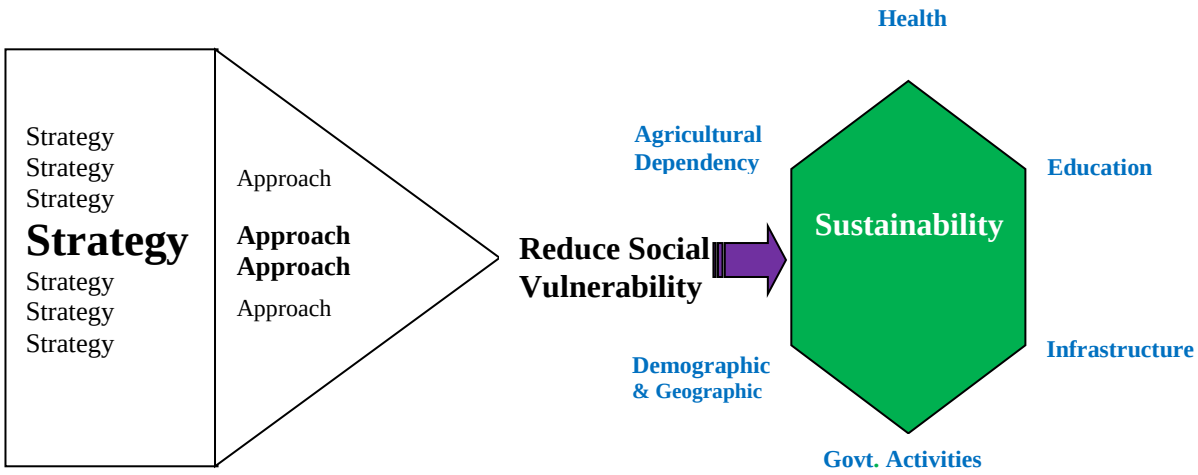
Prepared by the author

8.3 Conclusion

Bangladesh aims to be classified as a developed country in the next 20 years. Despite Bangladesh's huge economic potential, it still has many challenges to overcome and climate change is top of the list with one-third of the population at risk of displacement because of rising sea levels (World Economic Forum, 2019). The remarkable development gained over the last few decades is being gradually outweighed due to harmful impacts of climate change (Delta Plan, 2017). The research has recommended fourteen types of strategies and also given particular adoption approaches under each strategy on the above section. It appears that if state actors or key official as well as non-state actors effectively follows or applying above mentioned strategies, including adaptation approaches then the level of vulnerability would be reduced (Figure 8.13). If the vulnerabilities of the disasters reduce then social sectors, for instance health, education, infrastructure, Govt. activities, demography and agricultural dependency would become sustainable. These changes

would ensure the nature-science based development as well as a climate resilient coastal livelihood in the coastal areas of Bangladesh.

Figure 8.13: Theory of Changes i.e. Research for Possible Changes, Prepared and Proposed by the Author



SDGs are the blueprint to achieve a better and more sustainable future for all while climate change induced disasters are the main drawbacks of overall economic growth and development in Bangladesh. So, if state and non-state actors spontaneously act their actual responsibilities, particularly follow the 'Delta Plan-2100' it would easy to achieve SDGs.

Chapter 9

CONCLUSION AND RECOMMENDATIONS

9.1 Introduction

Bangladesh has been ranked as one of the world's most disaster-prone nations, with 97.1% of its land area and 97.7% of its population at risk from various hazards (UNICEF, 2011). Economic growth is predicted to hit 8% this year and Bangladesh aims to be classified as a developed country in the next 20 years. Despite Bangladesh's huge economic potential. It still has many challenges to overcome and climate change is top of the list with one-third of the population at risk of displacement because of rising sea levels (WEF, 2019). It reduces the poverty line and interrupts the achievement of the least developed countries' Sustainable Development Goals (SDGs) which are highly vulnerable to the climate-induced disasters (IPCC, 2014). The CCIDs, Social vulnerability and adaptation strategies in the coastal region of Bangladesh were explored in this chapter. Based on aggregate primary and secondary data. Primary (quantitative data) data were collected through surveying 400 questionnaires from the coastal dwellers of the three coastal zones of Bangladesh and qualitative data were collected through In Depth Interview, KII, and FGD and from various institutions, the methodical part of this thesis has covered the three major areas:

- An overview of climate change induced disasters in the coastal region of Bangladesh;
- Climate change impact on social vulnerability using coastal dwellers level survey data; and
- An analysis of coastal dwellers' adaptation strategies to CCIDs using coastal dwellers level survey data.

9.2 Conclusion and Summery Findings

In coastal region people have adapted with low-cost available indigenous technologies/knowledge with their limited resources. They are facing lot of problems during past disaster like SIDR, Aila, Foni, and Bulbul etc. In order to improvement their socio- economic capabilities, future developments would require more adaptable infrastructure. However, they need supports from the government or other organizations like NGOs and CBOs. But these supports are very limited and inadequate. Therefore, reducing the vulnerabilities of the disasters social sectors, like,

health, education, and infrastructure, govt. activities, demographic and geographic, and agricultural dependency would become sustainable. These changes will ensure the nature-science based development as well as a climate resilient coastal livelihood in the study area in particular and Bangladesh in general.

In pursuance of the perceptual opinion of different types of respondents, for instance, coastal people, relevant experts, academia's, researchers as well as relevant state and non-state actors, this section has been arranged. Also, this section has been organized as per research objectives as well as research questions. The study concentrate on the demographic and socio-economic characteristics of the respondents before analysis the results. Because these indicators show the accuracy, authenticity and reliability of this research. However, respondents were young and adult aged structure and maximum were male gender group. Besides, educational qualification was moderately good and they engaged with day labor and small business activities. Moreover, middle class income generating group were dominated their family. Also, most respondents were local. Furthermore, main sources of drinking water is tube-well, pond and rain water. Likewise, sanitation system is good most proportion of the respondents use healthy sanitation system. Additionally, housing structure found pucca, semi-pucca and Katcha as well. Because of Bangladesh's geographical location and low socio-economic status it is especially vulnerable to climate change. Most of the coastal people of Bangladesh live with poor socio-economic status and due to that they are vulnerable to climate change induced disasters. Research questions related to objectives, and findings of the study are as follows.

Research Objective 1: Investigate the climate change induced disasters and their spatial variation

Research Question 1: What types of climate change induced disasters occurred in the coastal region of Bangladesh?

Findings:

- Nearly 71% of the respondents in the coastal area of Bangladesh keep idea about climate change.

- Respondents of the Western Coastal Zone are more aware about climate change than Eastern and Central zone of the study area which is about 93%.
- Awareness about climate change in the Central and Eastern Coastal Zone are nearly 65% and 43% respectively.
- Eighty seven percent of the respondents in the study area keep idea about climate change induced disasters (CCIDs).
- Respondents of the Western Coastal Zone are more aware about CCIDs than Eastern and Central zone of the study area which is nearly 98%.
- The perception of awareness about CCIDs in the Central and Eastern Coastal Zone are nearly 86% and 70% respectively.
- Cyclone, Flood, SLR and Salinity intrusion, River Bank Erosion, Storm Surge, Temperature rise (extreme heat), Thunderstorm, Salinity Intrusion, Various Diseases, Tornado, Irregular Rainfall & Drought, and Land Slide are found as CCIDs in the study area.
- Most of the CCIDs in the study area occurred within the month of April to October *i.e.* mid of pre monsoon to early of post monsoon but Salinity intrusion occurred whole the year except September and October *i.e.* late of rainy monsoon to early of post monsoon.

Research Question 2: What are the spatial variations of Climate Change Induced Disasters in the study area?

Findings:

- Highest percentage (17.14%) of the respondents opined cyclone as the main CCIDs in the study area followed by Flood (15.07%), SLR & Salinity Int. (13.71%), RBE (10.05%), Storm Surge (8.87%), TR (7.56%), Thunderstorm (6.85%) etc.
- While concerning spatial variation of CCIDs in the study area it is observed that highest percentage (19.45%) of the respondent's opined cyclone as the main CCID in the Western Coastal Zone, whereas SLR & Salinity Int. (14.42%) in Central Coastal Zone and Flood (20.91%) in Eastern Coastal Zone.

Research objective 2: Assess the social vulnerability and their locational differences in the study area

Research Question 3: What are the present conditions of social vulnerability and their locational differences?

Findings:

- The unique characteristics i.e. uneven physiography, cress crossed of tidal creeks and stream, broken and the poor communication system are common are accelerate the severity of disasters in these areas. Service providers get interrupted to provide their services even basic daily amenities to the coastal inhabitants of Bangladesh.
- Nearly 75% coastal people are aware about social safety net programs and 51% received the benefits from this program. Almost 10 types of benefits people can easily access. Among ten benefits the VGD and VGF card, health facilities, adult allowance, awareness building and free medicine are prominent.
- More than half of the respondents of coastal dwellers are getting benefit from the Social Safety Net Program (SSNP). On the other hand, nearly 68% of the coastal dwellers in Central Coastal Zone are getting benefit from SSNP followed by 50% in Eastern Coastal Zone and 38.2% in Western Coastal Zone of the study area.
- Nearly 68% of the coastal dwellers do not getting benefit from the SSNP due to local influential people interrupted the program.
- Coastal folks argued that local influential people as well as corruption and nepotism of local authority interrupted this program. Besides, almost one third of the coastal people said that non-government organizations are working with governmental bodies and departments.
- Twenty five percent of the respondents of the study area opined that infrastructure sector is in more risk due to CC followed by agricultural dependency sector (21%), education sector (17%), health sector (16%), govt. activities sector(16%). demographic and geographic sector (12%) .

- **Health Sector:** General health more vulnerable in Central zone (1.00) and Eastern zone (1.00), but Mother Health is in less vulnerable position (0.00) in the whole coastal zone. However pregnancy health is in better position in the Western coastal zone (0.00) than that of others zone.
- **Education Sector:** School going students are in more vulnerable position in Western zone (1.00) and Central coastal zone (1.00), Infrastructure (road) is in vulnerable position in Eastern zone (1.00). School infrastructure is less vulnerable position in Central and Eastern zone (0.00). However transportation system is in better position in Western zone (0.00) than that of others zone.
- **Infrastructure Sector:** Education institute is in vulnerable position in Western and Eastern zone (1.00). Shelter center is in vulnerable position in Central zone (1.00). Besides, embankment is in less vulnerable position in Eastern coastal zone (0.00).
- **Government activities Sector:** Re-location system is in more vulnerable position in Western and Central zone (1.00). Basic needs are more vulnerable position in Western zone (1.00) Eastern zone (1.00). However, Asset distribution is in less vulnerable position in Western zone (1.00) and Central zone (1.00). On the other hand Khas land distribution is in less vulnerable position in Western zone (0.00) than that of other zones. Relief program is in better position in Western zone (0.00) and Eastern zone (0.00). Human rights are in better position in Western zone (0.00) and also Justice is in better position in Western coastal zone (0.00).
- **Demographic and Geographic Sector:** Population sub sector is in more vulnerable position in Eastern zone (1.00) than that of other zones. Migration is in more vulnerable position in Western zone (1.00). On the other hand Altitude is in more susceptible position in Western zone (1.00) and Central zone (1.00). However, according to location of Sea Eastern coastal zone (0.00) in less vulnerable position than that of others zone.
- **Agricultural Dependency Sector:** Due to Drought, Eastern coastal zone is in more vulnerable position (0.00) than that of others zone. Occupation sub sector is in more vulnerable position in Western coastal zone (1.00) but Fishing is more vulnerable position (1.00) in Central coastal zone than

of other zones. On the other hand, due to excess Rainfall Central zone (0.00) is in less vulnerable position. Livestock is in less vulnerable position in Eastern zone (0.00) and Forest sector is in less vulnerable in Western zone (0.00) comparatively than that of others zone.

Research Objective 3: Existing adaptation practices and their regional variation in the study area

Research Question 4: What are the existing scenarios of adaptation practices in the coastal region of Bangladesh?

Findings:

- The adaptation system varies from region to region and society to society; for instance, the system of southern coastal area of Bangladesh are different from the western coastal area.
- More than 65% of the respondents in the study area have already taken the necessary measures to protect themselves from CCIDs.
- Nearly 84% of the respondents in Western Coastal Zone have already taken the necessary measures to protect themselves from CCIDs followed by 64% in Eastern Coastal Zone and 48.4% in Central Coastal Zone.
- Adaptation practices are applicable to one region may be or may not be applicable in another region or community, but the learning from each strategy can introduce a new strategy that is adopted to the respective region.
- Proper and appropriate strategies at pre disaster period can be able to reduce the negative impact of disasters at during disaster period.
- Coastal people emphasized the indigenous knowledge or local knowledge to adopt the climate induced disasters. Also, people appealed that the indigenous knowledge or local knowledge should be institutionalization immediately.

Research Question 5: What is considered successful adaptation in the line with CCID in the study area?

Findings:

- The coastal people has taken different type of attempts to protect themselves from climate induced disaster in the coastal areas of Bangladesh. Among three zones, maximum coastal people has taken attempts to protect themselves and their family from disaster.
- Nearly 64% coastal flowed in the western coastal zone while half of the people are uninterested and do not take any kind of attempts to protect themselves in the central coastal zone. However, key institutional actors (civil society organizations, academic and research institutes, media and private sector) said that adaptations or strategies or coping methods depend on the nature of disaster, level or indigenous knowledge of coastal people as well as geographical location of the coastal areas.
- The central coastal zone in response to fluvial activity and it is more devastating than others zone. In this situation, coastal people sometime become fatalist with disasters here.
- The mitigation strategies differ from area to area and community to community; for instance, the practices of southern coastal area of Bangladesh are different from the western coastal area.
- Mitigation techniques are applicable to one region may be or may not be appropriate in another region or community/society, but the learning from each strategy can introduce a new strategy that is adopted in the respective region.
- Analysis the qualitative and quantitative data, the study has found that proper and appropriate strategies at pre disaster period can be able to reduce the negative impact of disasters at a during disaster period.
- The study has prescribed the major barriers to adaptation as well as principal choice or advice for healthier adaptation with CCIDs in the Bangladesh' coastal areas.
- The study understood that proper and appropriate strategies at pre disaster is the opposite condition or by reducing the losses at the during disaster period in the coastal areas of Bangladesh.

Research Objective 4: Formulate community based sustainable disaster management obtaining scientific and indigenous knowledge along with adaption strategy.

Research question 6: How the existing techniques and strategies / approaches fit with proposed techniques for comprehensive climate change induced disaster management plan.

Findings:

- Bangladesh is one of the worst vulnerable countries to climate change while Bangladesh is the adaptation capital of the world. However, applying strategies are informal yet, but the effectiveness is unique and contemporary.
- The research recommended fourteen types of strategies and also given particular adoption approaches under each strategy on the above section. It appears that if state actors or key official as well as non-state actors effectively follow or apply the mentioned strategies, including adaptation approaches, then the level of vulnerability would be reduced.
- If the vulnerabilities of the disasters can be reduce then social sectors, for instance health, education, infrastructure, Govt. activities, demography and agricultural dependency would become sustainable.
- Above changes would ensure the natural-science based development as well as a climate resilient coastal livelihood in the Bangladesh's coastal region.
- SDGs are the blueprint to achieve a better and more sustainable future for all while CCIDs are the main drawbacks of overall economic growth and development in Bangladesh. So, if state and non-state actors spontaneously act their actual responsibilities, particularly follow the 'Delta Plan-2100' it would easy to achieve SDGs.

9.3 Recommendations

Broadly, the research prescribes the following zone wise recommendations which will helps to formulate community based sustainable disaster management obtaining scientific and indigenous knowledge along with adaption strategy in the study area.

Table 9.1: Priority base Recommendation for Adaptation Measures with CCIDs in three Coastal Region of Bangladesh

	Adaptation measures	Vulnerability Types	Timeframe
Western Coastal Zone	Buildup high, wide, strong and sustainable embankment	Cyclone, Storm surge, Flood, Riverbank erosion	Long-term
	Institutionalization of Indigenous Knowledge (IK) or Local Knowledge (LK)	Cyclone, Flood, Riverbank Erosion	Long-term
	Coastal Afforestation	Cyclone, Flood, Riverbank Erosion	Long-term
	Construction of community based shelter center	Cyclone, Flood	Long-term
	Dressing the river & repairing the bank of the river	River Bank Erosion ,Flood and storm surge	Long-term
	Changing land use pattern (Shrimp cultivation to agriculture)	SLR, Flood & Salinity	Long-term
	Salinity tolerant crop cultivation	Salinity	Long-term
	Education and public awareness increase	About CCIDs	Long-term
	Proper medical / health service	cyclone, Flood	Long -term
	Boost of Social safety net program	cyclone, Storm surge, Flood, Riverbank erosion	Long -term
	Buildup the house on highland	Flood, Storm surge	Long-term
	Rain water harvesting	Salinity	Short-term
	Pre-disaster management	Flood, Tidal Surge ,Cyclone, Salinity	Short-term
	Control the political interrupt	Cyclone & Flood	short-term
	Strengthening and Raising the houses/roads	Cyclone, Flood & Storm surge	Short-term
	Construction of area based cattle shelter center	Flood, Cyclone & Tidal Surge	Short-term
	Community based team building for disaster preparedness and combat	Flood & Cyclone	Short-term
	Flood and Storm surge endured tube well establishment	Storm surge, Flood	Short-term
	Construction of water reservoir	Salinity, storm surge	Short-term
	Create Voluntary Group in Local Level	About CCIDs	Short-term
	Changing planting and harvesting date/time/season	About CCIDs	Short-term
	Proper medical/ health service	About CCIDs	Long –term
	Create local based pressure groups	About CCIDs	Long –term

Table 9.1: Priority base Recommendation for Adaptation Measures with CCIDs in three Coastal Region of Bangladesh (Continued)

Central Coastal Zone	Buildup high, wide, strong and sustainable embankment	Storm surge, Flood, Riverbank erosion	Long-term
	Tree plantation/ afforestation through the coastal area	Cyclone, Flood, Riverbank Erosion	Long-term
	Institutionalization of IK and Training on IK	Cyclone, Flood, Riverbank Erosion	Short-term
	Short duration rice and others crops	Seasonal and temperature change	Short-term
	Education and public awareness increase	About CCIDs	Long-term
	Collaboration with Gov., NGOs and CBOs	About CCIDs	Long-term
	Dragging the river and Raising canal bank	Flood, Storm surge, Riverbank Erosion	Long-term
	Proper medical/ health service	About CCIDs	Long-term
	Boost of social safety net program	About CCIDs	Long-term
	Construction of community based shelter center	Cyclone, Flood	Long-term
	Create Voluntary Group in Local Level	Cyclone, Flood & Landslide	Short-time
	Dressing the river & Repairing the bank of the river	River Bank Erosion ,Flood and storm surge	Long-term
	Salinity tolerant crop cultivation	Salinity	Long-term
	Rain water harvesting	Salinity	Short-term
	Pre-disaster management	Flood, Tidal Surge ,Cyclone, Salinity	Short-term
	Control the political interruption	Cyclone, Flood	short-term
	Strengthening and Raising the houses/roads	Cyclone, Flood, Storm surge	Short-term
	Construction of area based livestock shelter center	Flood, Cyclone, Tidal Surge	Short-term
	Community based team building for disaster preparedness and combat	Flood, Cyclone	Short-term
	Flood and Storm surge endured tube well establishment	Storm surge, Flood	Short-term
	Construction of water reservoir	Salinity	Short-term
	Create local based pressure groups	About CCIDs	Long –term

Table 9.1: Priority base Recommendation for Adaptation Measures with CCIDs in three Coastal Region of Bangladesh (Continued)

Eastern Coastal Zone	Tree plantation	Cyclone, Flood, Riverbank erosion	Long-term
	Buildup high, wide, strong and sustainable embankment	Cyclone, Storm surge, Flood, Riverbank Erosion	Long-term
	Institutionalization of IK and Training on IK	Cyclone, Storm surge, Flood, Riverbank Erosion	Long-term
	Short duration rice and others crops	Cyclone, Storm surge, Flood,	Long-term
	Construction of community based Sufficient shelter center	Cyclone, Storm surge, Flood, Riverbank Erosion	Short-term
	Proper medical/ health service	About CCIDs	Long-term
	Collaboration with Gov., NGOs and CBOs	About CCIDs	Long-term
	Boost of social safety net program	About CCIDs	Long-term
	Buildup the easy drainage system	River Bank erosion, flood	Long-term
	Construction of area based Livestock shelter center	Cyclone, Flood	Long-term
	Education and public awareness increase	About CCIDs	Long-term
	Salinity tolerant crops	Salinity Intrusion	Long-term
	Changing planting and harvesting date/time/season	Seasonal and Temperature Change	Long-term
	Create Voluntary Group in Local Level	Cyclone, Flood	Short-term
	Increasing awareness	About CCIDs	Long-term
	Construction, Repair and Raising of Embankment	Storm surge, Flood, Riverbank erosion	Long-term
	Salinity tolerant crop cultivation	Salinity	Long-term
	Rain water harvesting	Salinity	Long-term
	Dressing the river & Repairing the bank of the river	River Bank Erosion ,Flood and storm surge	Short-term
	Pre-disaster management	Flood, Tidal Surge ,Cyclone, Salinity	Short-term
	Control the political interruption	Cyclone, Flood	short-term
	Construction of area based cattle shelter center	Cyclone, Flood, Storm surge	Short-term
	Community based team building for disaster preparedness and combat	Flood, Cyclone, Tidal Surge	Short-term
	Flood and Storm surge endured tube well establishment	Flood, Cyclone	Short-term
	Strengthening the houses/roads	Storm surge, Flood	Long-term
	Construction of water reservoir	Salinity	Short-term
	Create local based pressure groups	About CCIDs	Long –term

Source: Prepared by the Author

9.4 Scope of Further Study

Climate Change is the well talked and burning issues in Bangladesh. Researchers, planners, research organizations, development activists, representative of government and NGOs are doing a lot of research on different aspects across the whole Bangladesh.

Owing to gap analysis, author has carefully reviewed the existing 'Climate Change' related findings, papers, journals, books, magazines, newspaper, and other recent publications and surfing internet, including different organizations such as SPARRSO, SMRC (SAARC Meteorological Research Center), Dhaka Meteorological Organization (DMO), Abhoea Odidoptor, Dhaka & Regional Abhoea Odidoptor Office (Branch Office) were reviewed. After the review, author carefully segregated the findings those are related to this research topic. But it is very disappointing that there is no literature matched with present research topic, although little research has been partially similar and addressed this research objectives. Besides, very little research has been done on the basis of geographical unite and they did not explore the variation of the severity and magnitude of Climate Induced Disaster among the coastal areas.

However, the study is the assessment of CCIDs vulnerability and adaptation strategy in the Bangladesh's coastal region. Also focused on the climate change induced vulnerability and their spatial variation, assessed the social vulnerability index applying on particular social issues and their locational differences and comparison, found the existing facilitating adaptation practices and their regional variation, finally formulated the community based sustainable disaster management obtaining scientific and indigenous knowledge and adoption approaches. In addition, for critical and issue based literature review author has pointed the Keys of the basis of research topic such as '*Coastal Region', 'Climate Change', 'Climate Induced Disaster or Vulnerability', 'Adaptation Strategy', 'Vulnerability Index'* and *'Community Based Sustainable Disaster Management'.* These keys have been demarcation and narrow down of my study from vast and heterogeneous issue. So, author hoping that this research will give valuable clues and future reference to planners, engineers, managers, community leaders, geographers, environmentalists, economists, lawyers, political scientists, sociologists, leaders, regulators and agents of technology transfer and also related division, department and agencies those who are working in this field.

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APPENDIX-I

In-depth Interview

On

Assessment of Climate Change Induced Disaster Vulnerability and Adaptation Strategy in Coastal Region of Bangladesh

Department of Geography and Environment, University of Dhaka

(Only for research purpose)

(With Key persons of institutions, freelance researchers, sector experts, development practitioners and so on)

Interview date (সাক্ষাৎকার গ্রহণের তারিখ) ঃ ...
Name of respondent (সাক্ষাৎকার দাতার নাম) ঃ ..
Education of the respondents (সাক্ষাৎকার দাতার শিক্ষা)ঃ-----
Education of the respondents (সাক্ষাৎকার দাতার বয়স)ঃ---
Name of interviewer (সাক্ষাৎকার গ্রহণকারীর নাম) ঃ .....

QUESTIONS

১। জলবায়ু পরিবর্তন সম্পর্কে আপনি কি বুঝেন? বাংলাদেশে জলবায়ু পরিবর্তনজনিত দুর্যোগ গুলো কী কী? আপনার এলাকায় জলবায়ু পরিবর্তন জনিত কী কী দুর্যোগ হয়ে থাকে? ডযধঃ ফড়ুড়ঁ শহড়ধিনড়ঁঃ পষরসধঃব পযধহমব?

২। জলবায়ু পরিবর্তন জনিত দুর্যোগ গুলো সাধারনত বছরের কোন সময় হয়ে থাকে?

৩। আপনার এলাকায় সরকার কর্তৃক সামাজিক নিরাপত্তা বিষয়ক প্রোগ্রাম/কর্মকান্ড গুলো থেকে দুর্যোগ প্রবন মানুষগুলো কোন সাহায্য পান কিনা? যদি পেয়ে থাকেন, তবে কোন ধরনের সাহায্য প্রদান করা হয় এবং সবাই তা সমভাবে পান কিনা?

৪। আপনার এলাকার রাস্তাঘাটের বর্তমান অবস্থান কেমন? রাস্তাঘাট সংস্কার করার জন্য সরকারী বরাদ্ধ সঠিক ভাবে প্রয়োগ করা হয় কিনা? এক্ষেত্রে কোন প্রতিবন্ধকতা দেখা যায় কিনা??

৫। আপনার এলাকায় জলবায়ু পরিবর্তন জনিত দুর্যোগের কারণে কোন সেক্টর / বিভাগ অধিক ঝুঁকিপূর্ণ? এই ঝুঁকি থেকে উত্তরণ হওয়ার জন্য কী কী করা যায়?

৬। আপনার এলাকায় দুর্যোগ ব্যবস্থাপনা করার জন্য সরকারী প্রতিষ্ঠান কোন কাজ করে কিনা? যদি করে থাকে তবে কাজ গুলো কী কী? উক্ত কর্মকান্ড বাস্তবায়নের ক্ষেত্রে কোন প্রতিবন্ধকতা দেখা যায় কিনা?

৭। আপনার এলাকায় দুর্যোগ ব্যবস্থাপনা করার জন্য বেসরকার প্রতিষ্ঠান কোন কাজ করে কিনা? করলে তা কী কী? উক্ত কাজ বাস্তবায়নের ক্ষেত্রে কোন প্রতিবন্ধকতা দেখা যায় কিনা?

৮। আপনার এলাকার জলবায়ু পরিবর্তনের জনিত দুর্যোগ থেকে রক্ষা পাওয়ার জন্য কোন ধরনের প্রদক্ষেপ/কৌশল গ্রহন করেছেন কিনা? প্রদক্ষেপ গ্রহন করে থাকলে প্রদক্ষেপ গুলো কী কী এবং কখন নেয়া হয় (দুর্যোগ হওয়ার পূর্বে, দুর্যোগকালীন সময়ে, দুযোর্গের পর)?

৯। দয়াকরে আপনার মতামত দিন, কিভাবে আপনার এলাকা কে জলবায়ু জনিত দুর্যোগগুলো থেকে রক্ষা করা যায়?

(আপনার সহযোগিতার জন্য ধন্যবাদ)

APPENDIX-II

Key Informant Interviews

On

Assessment of Climate Change Induced Disaster Vulnerability and Adaptation Strategy in Coastal Region of Bangladesh
Department of Geography and Environment, University of Dhaka
(Only for research purpose)

(Interviews with state actors, like Key persons of administration, policymakers and sector expert and so on)

Interview date (সাক্ষাৎকার গ্রহণের তারিখ) ঃ ...
Name of respondent (সাক্ষাৎকার দাতার নাম) ঃ ..
Education of the respondents (সাক্ষাৎকার দাতার শিক্ষা)ঃ-----
Education of the respondents (সাক্ষাৎকার দাতার বয়স)ঃ---
Name of interviewer (সাক্ষাৎকার গ্রহণকারীর নাম) ঃ .....

QUESTIONS

১। জলবায়ু পরিবর্তন সম্পর্কে আপনি কি বুঝেন? বাংলাদেশে জলবায়ু পরিবর্তনজনিত দুর্যোগ গুলো কী কী? আপনার এলাকায় জলবায়ু পরিবর্তন জনিত কী কী দুর্যোগ হয়ে থাকে? ডযধঃ ফড়ুড়ঁ শহড়ি ধনড়ঁঃ পষরসধঃব পযধহমব?

২। জলবায়ু পরিবর্তন জনিত দুর্যোগ গুলো সাধারনত বছরের কোন সময় হয়ে থাকে?

৩। আপনার এলাকায় সরকার কর্তৃক সামাজিক নিরাপত্তা বিষয়ক প্রোগ্রাম/কর্মকান্ড গুলো থেকে দুর্যোগ প্রবন মানুষগুলো কোন সাহায্য পান কিনা? যদি পেয়ে থাকেন, তবে কোন ধরনের সাহায্য প্রদান করা হয় এবং সবাই তা সমভাবে পান কিনা

৪। আপনার এলাকার রাস্তাঘাটের বর্তমান অবস্থান কেমন? রাস্তাঘাট সংস্কার করার জন্য সরকারী বরাদ্ধ সঠিক ভাবে প্রয়োগ করা হয় কিনা? এক্ষেত্রে কোন প্রতিবন্ধকতা দেখা যায় কিনা?

৫। আপনার এলাকায় জলবায়ু পরিবর্তন জনিত দুর্যোগের কারণে কোন সেক্টর / বিভাগ অধিক ঝুঁকিপূর্ণ? এই ঝুঁকি থেকে উত্তরণ হওয়ার জন্য কী কী করা যায়?

৬। আপনার এলাকায় দুর্যোগ ব্যবস্থাপনা করার জন্য সরকারী প্রতিষ্ঠান কোন কাজ করে কিনা? যদি করে থাকে তবে কাজ গুলোর কী কী? উক্ত কর্মকান্ড বাস্তবায়নের ক্ষেত্রে কোন প্রতিবন্ধকতা দেখা যায় কিনা?

৭। আপনার এলাকায় দুর্যোগ ব্যবস্থাপনা করার জন্য বেসরকার প্রতিষ্ঠান কোন কাজ করে কিনা? করলে তা কী কী? উক্ত কাজ বাস্তবায়নের ক্ষেত্রে কোন প্রতিবন্ধকতা দেখা যায় কিনা?

৮। আপনার এলাকার জলবায়ু পরিবর্তনের জনিত দুর্যোগ থেকে রক্ষা পাওয়ার জন্য কোন ধরনের প্রদক্ষেপ/কৌশল গ্রহন করেছেন কিনা? প্রদক্ষেপ গ্রহন করে থাকলে প্রদক্ষেপ গুলো কী কী এবং কখন নেয়া হয় (দুর্যোগ হওয়ার পূর্বে, দুর্যোগকালীন সময়ে, দুযোর্গের পর)?)

৯। দয়াকরে আপনার মতামত দিন, কিভাবে আপনার এলাকা কে জলবায়ু জনিত দুর্যোগগুলো থেকে রক্ষা করা যায়?

(আপনার সহযোগিতার জন্য ধন্যবাদ)

APPENDIX-III

Focus Group Discussion (FGD)
On
Assessment of Climate Change Induced Disaster Vulnerability and Adaptation Strategy in Coastal Region of Bangladesh
Department of Geography and Environment, University of Dhaka
(Only for research purpose)

জেলার নাম---------- উপজেলার নাম----------

ইউনিয়ন/ওয়ার্ড---------- গ্রাম/মহল্লা----------

গ্রুপের ধরণ---------- অংশগ্রহনকারীর সংখ্যা----------

তারিখ---------- সময়----------

QUESTIONS

১. আপনাদের এলাকায় জলবায়ু পরিবর্তন জনিত কী কী দুর্যোগ হয়ে থাকে? বছরের কোন সময় ঐ দুর্যোগগুলো সংগটিত হয়ে থাকে?

২. আপনাদের এলাকায় সরকার কর্তৃক সামাজিক নিরাপত্তা বিষয়ক কর্মকান্ড গুলো থেকে আপনারা কোন সাহায্য পান কিনা? যদি পেয়ে থাকেন, তবে কোন ধরনের সাহায্য প্রদান করা হয় এবং সবাই তা সমভাবে পান কিনা?

৩. আপনার পরিবারের কেউ জ্বর (কালজ্বর) বা পানি বাহিত রোগ আক্রান্ত হয়েছে কিনা? আপনার এলাকায় কোন প্রতিষ্ঠান (সরকারী/বেসরকারী) থেকে কোন প্রকার স্বাস্থ্যসেবা প্রদান করা হয় কিনা?

৪. আপনাদের এলাকার রাস্তাঘাটের বর্তমান অবস্থান কেমন? রাস্তাঘাট সংস্কার করার জন্য সরকারী কতৃক বরাদ্ধ সঠিক ভাবে প্রয়োগ করা হয় কিনা? এক্ষেত্রে কোন প্রতিবন্ধকতা দেখা যায় কিনা?

৫. আপনাদের এলাকায় জলবায়ু পরিবর্তন জনিত দুর্যোগের কারণে কোন সেক্টর অধিক ঝুঁকিপূর্ণ? এই ঝুঁকি থেকে উত্তরণ জন্য কোন প্রদক্ষেপ গ্রহন করেছেন কিনা? এই ঝুঁকি থেকে উত্তণের জন্য কী কী করা যায়?

৬. আপনারা জলবায়ু পরিবর্তনের জনিত দুর্যোগ থেকে রক্ষা পাওয়ার জন্য কোন ধরনের প্রদক্ষেপ/কৌশল গ্রহন করেছেন কিনা? প্রদক্ষেপ গ্রহন করে থাকলে প্রদক্ষেপ গুলো কী কী এবং উক্ত প্রদক্ষেপ গুলো কখন নেয়া হয় (দুর্যোগ হওয়ার পূর্বে, দুর্যোগকালীন সময়ে, দুযোর্গের পর)?

৭. আপনার এলাকায় দুর্যোগ ব্যবস্থাপনা করার জন্য কোন প্রতিষ্ঠান কাজ করে কিনা? যদি করে থাকে তবে কাজ গুলো কী কী? উক্ত কর্মকান্ড বাস্তবায়নের ক্ষেত্রে কোন প্রতিবন্ধকতা দেখা যায় কিনা?

৮. আপনাদের এলাকায় দুর্যোগকালীন সময়ে ত্রাণ বিতরন করা হয় কিনা? ত্রাণ বিতরনের সময় সবাইকে সমভাবে মূল্যায়ন করে কিনা? ত্রাণ বিতরনের সময় কোন প্রতিবন্ধকতা দেখা যায় কিনা?

৯. দয়াকরে আপনাদের মতামত দিন, কিভাবে আপনার এলাকাকে জলবায়ু জনিত দুর্যোগ থেকে রক্ষা করা যায়?

(আপনার সহযোগিতার জন্য ধন্যবাদ)

APPENDIX- IV

Questionnaire Survey

On

Assessment of Climate Change Induced Disaster Vulnerability and Adaptation Strategy in Coastal Region of Bangladesh

Department of Geography and Environment, University of Dhaka

(Collected information will be used only for research purpose)

নমুনা নং

এলাকাঃ জেলাঃ---------- **উপজেলা/থানাঃ ----------**

ইউনিয়ন/ওয়ার্ডঃ---------- **গ্রামঃ ----------**

উত্তরদাতার জনমিতিক ও আর্থ-সামাজিক অবস্থা সম্পর্কিত

১. **উত্তরদাতার নামঃ** ----------

২. **বর্তমান বয়সঃ** ----------

৩. **শিক্ষাগত যোগ্যতাঃ ১.** নিরক্ষর, **২.** স্বাক্ষর করতে জানেন, **৩.** ক্লাস ১ম থেকে ৫ম, **৪.** ৬ষ্ঠ থেকে নবম, **৫.** এস এস সি, **৬.** এইচ এইচ সি, **৭.** সম্মান/ডিগ্রী, **৮.** স্নাতকোত্তর, **৯.** অন্যান্য (নির্দিষ্ট করুন .....)।

৪. **লিঙ্গঃ ১.** পুরুষ, **২.** মহিলা, **৩.** হিজড়া

৫. **পেশাঃ ১.** কৃষক, **২.** মৎস্যজীবী, **৩.** দিনমজুর, **৪.** রিকশা / ভ্যান/ অটো চালক, **৫.** সিএনজি চালক, **৬.** যানবাহন চালক/ হেলপার, **৭.** গার্মেন্টস/ শিল্প শ্রমিক, **৮.** নির্মাণ শ্রমিক, **৯.** ক্ষুদ্র ব্যবসায়ী, **১০.** নৌকা চালক, **১১.** গৃহিনী, **১২.** অবসরপ্রাপ্ত ব্যক্তি, **১৩.** চাকুরীজীবী, **১৪.** বেকার, **১৫.** কোন কাজ করেন না, **১৬.** অন্যান্য (নির্দিষ্ট করুন .....)।

৬. **উত্তরদাতার পরিবারের সদস্য সংখ্যাঃ** ১. পুরুষ--------- জন ২. মহিলা---------- জন

পুরুষ			**মহিলা**		
ক্রম	**নাম**	**বয়স (বছর)**	**ক্রম**	**নাম**	**বয়স (বছর)**

৭. **বাড়ী/ঘরের অবস্থাঃ ১.** কুঁড়ে ঘর, **২.** মাটির ঘর (মাটির বেড়া, খড়ের ছাদ), **৩.** মাটির ঘর (মাটির বেড়া, টিনের ছাদ), **৪.** আধা পাকা, **৫.** পাকা, **৬.** অন্যান্য (নির্দিষ্ট করুন .....)।

৮. **বাড়ির মালিকানার ধরনঃ ১.** নিজের বাড়ী, **২.** ভাড়া বাড়ী, **৩.** পুত্রের বাড়ী, **৪.** কন্যা/মেয়ের বাড়ী, **৫.** গুচ্ছ গ্রাম, **৬.** খাস জমি,**৭.** অন্যান্য (নির্দিষ্ট করুন.....)।

৯. **আপনার মাসিক আয় কত?**

ক. ৫০০০ টাকার কম খ. ৫০০০-১০০০০ টাকা গ. ১০০০১-১৫০০০ টাকা ঘ. ১৫০০১-২০০০০ টাকা ঙ. ২০০০১-২৫০০০ টাকা চ. ২৫০০০ টাকার বেশী।

১০. অত্র এলাকায় বসবাসের সময়কালঃ ---------- বছর

১১. খাওয়ার পানির উৎসঃ ১. নলকূপ, **২.** কূপ, **৩.** পুকুর/হ্রদ, **৪.** নদী/খাল, **৫.** বৃষ্টির পানি, **৬.** পাইপলাইন, **৭.** অন্যান্য (নির্দিষ্ট করুন.....)।

১২. নিজস্ব শৌচাগার আছে কি না? ১. হ্যাঁ ২. না

উত্তর হ্যাঁ হলে তার ধরনঃ ১. খোলা জায়গা, **২.** প্রতিবেশির টয়লেট, **৩.** খোলা টয়লেট (ময়লা সরাসরি পাশ্ববর্তী এলাকায় ছড়িয়ে পড়ে), **৪.** স্বাস্থ্যকর, **৫.** ড্রেইন, **৬.** অন্যান্য (নির্দিষ্ট করুন.....)।

জলবায়ুগত দুর্যোগ সম্পর্কিত

১৩. জলবায়ু পরিবর্তন সম্পর্কে আপনার কোন ধারনা আছে কি না? ক. হ্যাঁ, **খ.** না।

যদি হ্যাঁ হয়, তাহলে জলবায়ু পরিবর্তন হয়েছে তা কিভাবে বুঝতে পারেন? উল্লেখ করুন .....

১৪. জলবায়ু পরিবর্তন জনিত দুর্যোগগুলো সম্পর্কে আপনি জানেন কি? ১. হ্যাঁ, **২.** না।

যদি হ্যাঁ হয়, তবে বাংলাদেশে জলবায়ু পরিবর্তনজনিত দুর্যোগগুলো কী কী? ১. বন্যা, **২.** ঘূর্ণিঝড় / ঝড়বৃষ্টি, **৩.** টর্নেডো, **৪.** নদী ভাঙ্গন, **৫.** লবণাক্ততা / লবণাক্তকীকরন, **৬.** তাপমাত্রা বৃদ্ধি (চরম তাপ), **৭.** জোয়ারের পানির অনুপ্রবেশ, **৮.** বৃষ্টিপাতের কারনে মৌসুমি ঋতুর পরিবর্তন, **৯.** সাগরের পানির উচ্চতা বৃদ্ধি, **১০.** বজ্রপাত, **১১.** জ্বর (কালজ্বর), **১২.** পানি বাহিত রোগ,**১৩.** বর্জ্রপাত **১৪.** অন্যান্য (নির্দিষ্ট করুন.....)।

১৫. আপনার এলাকায় জলবায়ু পরিবর্তন জনিত কী কী দুর্যোগ হয়ে থাকে?

১. বন্যা, **২.** ঘূর্ণিঝড় /ঝড়বৃষ্টি, **৩.** টর্নেডো, **৪.** নদী ভাঙ্গন, **৫.** লবণাক্ততা / লবণাক্তকীকরন, **৬.** তাপমাত্রা বৃদ্ধি (চরম তাপ), **৭.** জোয়ারের পানির অনুপ্রবেশ, **৮.** বৃষ্টিপাতের কারনে মৌসুমি ঋতুর পরিবর্তন, **৯.** সাগরের পানির উচ্ছতা বৃদ্ধি, **১০.** বজ্রপাত, **১১.** জ্বর (কালজ্বর), **১২.** পানি বাহিত রোগ, **১৩.** অন্যান্য (নির্দিষ্ট করুন.....)।

১৬. সচারচর আপনার এলাকায় সংঘটিত দুর্যোগ সমূহের বর্ণনা --

জলবায়ু পরিবর্তন জনিত দুর্যোগ সমূহ	**সারা বছর (১ বছরের ক্যালেন্ডার)**	
	মাসের নাম (.....টু .....)	**গড়ে এক বছরে কত বার সংঘটিত হয়**
বন্যা		
ঘূর্ণিঝড় /ঝড়বৃষ্টি		
টর্নেডো		
নদী ভাঙ্গন		
লবণাক্ততা / লবণাক্তকীকরন		
তাপমাত্রা বৃদ্ধি (চরম তাপ)		
জোয়ারের পানির অনুপ্রবেশ		
বৃষ্টিপাতের কারনে মৌসুমি ঋতুর পরিবর্তন		
সাগরের পানির উচ্চতা বৃদ্ধি		
বজ্রপাত		
জ্বর (কালাজ্বর) (পরিবারের সদস্য)		
পানি বাহিত রোগ (পরিবারের সদস্য)		
অন্যান্য(নির্দিষ্ট করুন.....)		

১৭. জলবায়ু পরিবর্তনের কারণে আপনার এলাকা কোন ঝুকিতে আছে কি? ১. হ্যাঁ ২. না

উত্তর হ্যাঁ হলে কোন সেক্টও গুলো বেশি ঝুকিপূর্ণ। উল্লেখ করুন ----------

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১৮. ঝুকির মাত্রা গুলো কেমন? নির্দিষ্ট করুন ক. খুব বেশী ঝুকিপূর্ণ খ. খুব ঝুকিপূর্ণ গ. মাঝারি ঝুকিপূর্ণ ঘ. মোটামুটি ঝুকিপূর্ণ ং. কম ঝুকিপূর্ণ

সামাজিক বিষয়াদি ও বিপন্নতা সম্পর্কিত প্রশ্নঃ

১৯. আপনি সরকার কর্তৃক সামাজিক নিরাপত্তা বিষয়ক প্রোগ্রাম/কর্মকান্ড সম্পর্কে জানেন কি না? ১. হ্যাঁ, **২.** না।

২০. আপনার এলাকায় কোন সামাজিক নিরাপত্তা বিষয়ক প্রোগ্রাম চলমান আছে কিনা? ১. হ্যাঁ, **২.** না।

যদি চলমান থাকে, তবে আপনি ঐ সকল প্রোগ্রাম/কর্মকন্ডের সুবিধা গ্রহন করতে পারেন কি না? ১. হ্যাঁ, **২.** না।
যদি হ্যাঁ হয় তবে সুবিধা গুলো কী কী ? ১. বৃদ্ধ ভাতা, **২.** চিকিৎসা ভাতা, **৩.** মুক্তিযোদ্ধাদের সম্মাননা ভাতা, **৪.** অক্ষম ব্যক্তিদের জন্য ভাতা, **৫.** ভিজিডির / ভিজিএফ, **৬.** বিধবা ভাতা, **৭.** ফ্রি ঔষধ, **৮.** স্বাস্থ্য সেবা বিষয়ক, **৯.** শিক্ষা বিষয়ক, **১০.** সতেনতা মূলক কর্মকান্ড, **১১.** পরামর্শ দেওয়া, **১২.** অন্যান্য (নির্দিষ্ট করুন .....)।
যদি না হয় তবে কেন পান না? উল্লেখ করুন .....

২১. আপনার **এলাকায় সরকার কর্তৃক সামাজিক নিরাপত্তা বিষয়ক প্রোগ্রাম/কর্মকান্ডের বর্তমান অবস্থান কেমন?**

ক. খুবই ভাল, **খ.** মোটামুটি ভাল, **গ.** ভাল, **ঘ.** খারাপ, **ঙ.** খুবই খারাপ।

২২. আপনার এলাকায় কোন প্রতিষ্ঠানের পক্ষ থেকে কোন প্রকার স্বাস্থ্যসেবা প্রদান করে কিনা? ক. হ্যাঁ, **খ.** না।

যদি হ্যাঁ হয় তবে কে প্রদান করেন? ক. সরকারী প্রতিষ্ঠান, **খ.** বেসরকারী প্রতিষ্ঠান।
স্বাস্থ্যসেবা প্রদানকারী প্রতিষ্ঠানের নাম বলুন? ----------

২৩. আপনার এলাকায় সরকার কর্তৃক স্বাস্থ্যসেবা বিষয়ক কর্মকান্ডের বর্তমান অবস্থান কেমন? **১.** খুবই ভাল, **২.** মোটামুটি ভাল, **৩.** ভাল, **৪.** খারাপ, **৫.** খুবই খারাপ।

২৪. আপনার এলাকায় রাস্তাঘাটের বর্তমান অবস্থান কেমন? ১. খুবই ভাল, **২.** মোটামুটি ভাল, **৩.** ভাল, **৪.** খারাপ, **৫.** খুবই খারাপ।

২৫. আপনার এলাকায় জলবায়ু পরিবর্তন জনিত দুর্যোগের কারণে সামাজিক কোন সেক্টর / বিভাগ অধিক বিপর্ন্ন? নির্দিষ্ট করুন ক. স্বাস্থ্য খাত খ. শিক্ষা খাত গ. অবকাঠামো খাত ঘ. সরকারি খাত ঙ. জনমিতিক ও ভৌগোলিক খাত চ. কৃষি খাত

২৬. জলবায়ু পরিবর্তনশীলতার কারণে সমাজ জীবনের উপর কোন ধরনের প্রভাব পড়ছে বলে আপনি মনে করেন কি? ১. হ্যাঁ, **২.না** ।

উত্তর হ্যাঁ হলে কোন ধরনের প্রভাব পড়ছে উল্লেখ **করুন** ----------
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২৭. জলবায়ু পরিবর্তনশীলতার কারণে আপনার এলাকার অর্থনৈতিক কর্মকান্ডের উপর কোন ধরনের প্রভাব পড়ছে বলে আপনি মনে করেন কি? ১. হ্যাঁ, **২.না** ।

উত্তর হ্যাঁ হলে কোন ধরনের প্রভাব পড়ছে? উল্লেখ **করুন** ----------
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২৮. জলবায়ু পরিবর্তনশীলতার কারণে আপনার এলাকা থেকে মানুষ অন্যত্র **স্থানান্ত্রিত হচ্ছে কি না? .** হ্যাঁ, **২.না** ।

উত্তর হ্যাঁ হলে কেন হচ্ছে? নির্দিষ্ট করুন **১.** লবনাক্ততার অনুপ্রবেশ ২. কার্যকর কর্মসংস্থানের অভাব ৩. পরিস্থিতি মোকাবেলা করতে না পারা ৪. অন্যান্য

২৯. সামাজিক বিষয়াদিগুলো কতটুকু ঝুঁকিপূর্ণ? (টিক দিন √)

সামাজিক সূচক		বিপন্নতা/ ঝুঁকির মাত্রা				
		খুব কম	কম	মাঝারী	বেশি	খুব বেশী
স্বাস্থ্য	২৮,এইচ.১: স্বাস্থ্য (সাধারণ)					
	২৮.এইচ.২: শিশু					
	২৮.এইচ.৩: মাতৃস্বাস্থ্য					
	২৮.এইচ ৪: গর্ভকালীন স্বাস্থ্য					
শিক্ষা	২৪.ই.১: স্কুলগামী ছাত্রছাত্রী					
	২৪.ই.২: অবকাঠামো (রাস্তা)					
	২৪.ই.৩: অবকাঠামো (স্কুলের গঠন)					
	২৪.ই.৪: পরিবহন যোগাযোগ					
অবকাঠাম	২৪. এস.১: বাসস্থান					
	২৪.এস.২: শিক্ষা প্রতিষ্ঠান					
	২৪.এস.৩: কমিউনিটি/সম্প্রদায়ের প্রতিষ্ঠান					
	২৪.এস.৪: রাস্তাঘাট					
	২৪.এস.৫: কালভার্ট এবং সেতু					
	২৪.এস.৬: আশ্রয়কেন্দ্র					
	২৪.এস.৭: বেড়ি বাঁধ					
সরকারি কার্যক্রম	২৪.জি এ.১: সম্পদ বিতরণ					
	২৪.জি এ.২: রিলিফ প্রোগ্রাম					
	২৪.জি এ.৩: পুনর্বাসন					
	২৪.জি এ.৪: খাস ভূমি বিতরণ					
	২৪.জি এ.৫: মানবাধিকার					
	২৪.জি এ.৬: মৌলিক চাহিদা					
	২৪.জি এ.৭: সমদর্শিতা বা ন্যায়বিচার					
জনমিতিক ও ভৌগোলিক কারন	২৪.ডি জি.১: জনসংখ্যা					
	২৪.ডি জি.২: অভিগমন					
	২৪.ডি জি.৩: জীবন ও জীবিকার নিরাপত্তা					
	২৪.ডি জি.৪: ভূ-প্রকৃতিগত বৈশিষ্ট্য					
	২৪.ডি জি.৫: নদী					

সামাজিক সূচক		বিপন্নতা/ ঝুঁকির মাত্রা				
		খুব কম	কম	মাঝারী	বেশি	খুব বেশী
	২৪.ডি জি.৬: সমুদ্রের অবস্থান					
	২৪.ডি জি.৭: উচ্চতা					
কৃষি নির্ভরতা	২৪.এ ডি.৪: খরা					
	২৪.এ ডি.৪: অতিবৃষ্টি					
	২৪.এ ডি.৪: চাকুরি					
	২৪.এ ডি.৪: পশুসম্পত্তি					
	২৪.এ ডি.৪: বনায়ন/বনপালনবিদ্যা					
	২৪.এ ডি.৪: মাছ ধরা					

বি.দ্রঃ খুববেশি = ৫, বেশী =৪, মাঝারী = ৩, কম=২ এবং খুবকম = ১

৩০. আপনার এলাকার জলবায়ু পরিবর্তনের জনিত র্দুযোগ গুলোর কারণে কখন সামাজিক সূচকগুলি অত্যন্ত ঝুঁকিপূর্ণ হয়ে পড়ে?

সামাজিক সূচকগুলি		ঝুঁকিপূর্ণ হওয়ার সময়											
		জানু	ফ্রে	মার্চ	এপ্রি	মে	জুন	জুল	আগ	সে	অ	নভে	ডিসে
স্বাস্থ্য	শিশু												
	মাতৃস্বাস্থ্য												
	গর্ভকালীন স্বাস্থ্য												
	গর্ভপাত												
শিক্ষা	স্কুলেগামী ছাত্রছাত্রী												
	অবকাঠামো (রাস্তা)												
	অবকাঠামো (স্কুলগঠন)												
	পরিবহন												
ভৌত অবকাঠামো	বসতবাড়ী												
	শিক্ষা প্রতিষ্ঠান												
	কমিউনিটি/ সম্প্রদায়ের স্থান												
	রাস্তা নির্মাণ												
	কালভার্ট এবং সেতু												
	আশ্রয় কেন্দ্র												
	বাঁধ												
সরকা [illegible]	সম্পদের বিতরণ												

সামাজিক সূচকগুলি		ঝুঁকিপূর্ণ হওয়ার সময়											
		জানু	ফ্রে	মার্চ	এপ্রি	মে	জুন	জুল	আগ	সে	অ	নভে	ডিসে
	রিলিফ প্রোগাম												
	পুনর্বাসন												
	খাস জমি বিতরণ												
	মানবাধিকার												
	মৌলিক চাহিদা												
	ন্যায়বিচার												
জলবায়ুতিক ও ভৌগলিক কারন	জনসংখ্যা												
	অভিবাসন												
	জীবন ও জীবিকার নিরাপত্তা												
	ভূমির বৈশিষ্ট্য												
	নদী												
	সমুদ্রের অবস্থান												
	উচ্চতা												
কৃষি নির্ভরতা	খরা												
	অতিরিক্ত বৃষ্টিপাত												
	চাকরি												
	পশুসম্পত্তি												
	বনায়ন/বন পালনবিদ্যা												
	মাছ ধরা												

অভিযোজন সম্পর্কিত

৩১. আপনার এলাকার জলবায়ু পরিবর্তনের জনিত দুর্যোগ থেকে রক্ষা পাওয়ার জন্য কোন ধরনের প্রদক্ষেপ গ্রহন করেছেন কিনা? ১. হ্যাঁ, **২.** না, **৩.** ভাগ্যনির্ভর, **৪.** কিছুই করেন না, **৫.** অন্যান্য (নির্দিষ্ট করুন .....)।

যদি হ্যাঁ হয়, তবে দুর্যোগ অনুযায়ী নিম্নের টেবিলে আপনার মতামত দিন?

জলবায়ু পরিবর্তনের জনিত দুর্যোগ	খাপ খাওয়ানোর কৌশল		
	প্রাক দুর্যোগ (দুর্যোগ হওয়ার পূর্বে)	দুর্যোগকালীন সময়ে	দুযোগের পর
২৬.সি বি.১: বন্যা			

২৬.সি বি.২: ঘূর্ণিঝড় /ঝড়বৃষ্টি			
২৬.সি বি.৩: টর্নেডো			
২৬.সি বি.৪: নদী ভাঙ্গন			
২৬.সি বি.৫: লবণাক্ততা / লবণাক্তকীকরন			
২৬.সি বি.৬: তাপমাত্রা বৃদ্ধি (চরম তাপ)			
২৬.সি বি.৭: জোয়ারের পানির অনুপ্রবেশ			
২৬.সি বি.৮: বৃষ্টিপাতের কারনে মৌসুমি ঋতুর পরিবর্তন			
২৬.সি বি.৯: সাগরের পানির উচ্চতা বৃদ্ধি			
২৬.সি বি.১০: বজ্রপাত			
২৬.সি বি.১১: জ্বর (কালজ্বর/ম্যালেরিয়া)			
২৬.সি বি.১২: পানি বাহিত রোগ			
২৬.সিবি.১৩:অন্যান্য(নির্দিষ্ট করুন.....)।			

৩২. আপনার এলাকার জলবায়ু পরিবর্তনের জনিত দুর্যোগ থেকে সামাজিক সুচক গুলোকে রক্ষা পাওয়ার জন্য কোন ধরনের প্রদক্ষেপ/কৌশল গ্রহন করেছেন?

সামাজিক খাত		খাপ খাওয়ার কৌশল		
		প্রাক দুর্যোগ (দুর্যোগ হওয়ার পূর্বে)	প্রাক দুর্যোগ (দুর্যোগ হওয়ার পূর্বে)	প্রাক দুর্যোগ (দুর্যোগ হওয়ার পূর্বে)
স্বাস্থ্য	এইচ এ আই -১: সাধারন স্বাস্থ্য			
	এইচ এ আই -২: শিশু স্বাস্থ্য			
	এইচ এ আই -৩: মাতৃস্বাস্থ্য			
	এইচ এ আই -৪: গর্ভকালীন স্বাস্থ্য			
শিক্ষা	ই এ আই-১: স্কুলেরগামী ছাত্রছাত্রী			
	ই এ আই-২: অবকাঠামো (রাস্তা)			
	ই এ আই-৩: অবকাঠামো (স্কুলগঠন)			
	ই এ আই-৪: পরিবহন/যোগাযোগ ব্যবস্থা			
ভৌত অবকাঠামো	এস এ আই-১: বাসস্থান			
	এস এ আই-২: শিক্ষা প্রতিষ্ঠান			
	এস এ আই-৩: কমিউনিটি প্রতিষ্ঠান			
	এস এ আই-৪: রাস্তা নির্মাণ			
	এস এ আই-৫: কালভার্ট এবং সেতু			
	এস এ আই-৬: আশ্রয়কেন্দ্র			
	এস এ আই-৭: বাঁধ			
সরকারী কর্মকান্ড	জি এ এ আই-১: সম্পদের বিতরণ			
	জি এ এ আই-২: রিলিফ প্রোগাম			
	জি এ এ আই-৩: পুনর্বাসন			
	জি এ এ আই-৪: খাস জমি বিতরণ			
	জি এ এ আই-৫: মানবাধিকার			
	জি এ এ আই-৬: মৌলিক চাহিদা			
	জি এ এ আই-৭: ন্যায়বিচার			

সামাজিক খাত		খাপ খাওয়ার কৌশল		
		প্রাক দুর্যোগ (দুর্যোগ হওয়ার পূর্বে)	প্রাক দুর্যোগ (দুর্যোগ হওয়ার পূর্বে)	প্রাক দুর্যোগ (দুর্যোগ হওয়ার পূর্বে)
জনমিতিক ও ভৌগলিক কারন	ডি জি এ আই-১: জনসংখ্যার ঘনত্ব			
	ডি জি এ আই-২: অভিবাসন			
	ডি জি এ আই-৩: জীবন ও জীবিকার নিরাপত্তা			
	ডি জি এ আই-৪: ভূমির বৈশিষ্ট্য			
	ডি জি এ আই-৫: নদী			
	ডি জি এ আই-৬: সমুদ্রের অবস্থান			
	ডি জি এ আই-৭: উচ্চতা			
কৃষি নির্ভরতা	এ এ আই-১: খরা			
	এ এ আই-২: অতিরিক্ত বৃষ্টিপাত			
	এ এ আই-৩: চাকরি			
	এ এ আই-৪: পশুসম্পত্তি			
	এ এ আই-৫: বনায়ন/বনপালনবিদ্যা			
	এ এ আই-৬: মাছ ধরা			

৩৩. আপনার এলাকায় জলবায় পরিবর্তনজনিত দুর্য়োগ মোকাবেলায় প্রধান বাঁধাগুলো কি কি বলে মনে হয়? উল্লেখ করুন ----------

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৩৪. আপনার এলাকায় জলবায় পরিবর্তন জনিত দুর্য়োগ মোকাবেলা ও অভিযোজন এর জন্য কোন কিষয় গুলিকে আপনি প্রধান পছন্দের তালিকায় রাখবেন? উল্লেখ করুন ----------

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৩৫. দয়াকরে আপনার এলাকায় পুনরাবৃত্ত জলবায়ু পরিবর্তন জনিত দুর্যোগগুলো মোকাবেলা ও অভিযোজনে আপনার মতামত দিন, ----------

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(সাক্ষাৎকার প্রদানের জন্য আপানাকে ধন্যবাদ)

APPENDIX- V

Relationship between idea about climate change and CCIDs of the coastal dwellers

Idea about climate change induce Disaster * Flood (.... times)
Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	55.437[a]	8	.000
Likelihood Ratio	59.585	8	.000
Linear-by-Linear Association	2.533	1	.112
N of Valid Cases	400		

a. 9 cells (50.0%) have expected count less than 5. The minimum expected count is .13.

Idea about climate change induce Disaster * Cyclone (.... times)
Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	63.286[a]	10	.000
Likelihood Ratio	68.776	10	.000
Linear-by-Linear Association	4.637	1	.031
N of Valid Cases	400		

a. 9 cells (40.9%) have expected count less than 5. The minimum expected count is .13.

Idea about climate change induce Disaster * Tornado (.... times)
Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	13.170[a]	6	.040
Likelihood Ratio	10.666	6	.099
Linear-by-Linear Association	.096	1	.757
N of Valid Cases	400		

a. 7 cells (50.0%) have expected count less than 5. The minimum expected count is .39.

Idea about climate change induce Disaster * River Bank erosion (.... times)

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	84.419[a]	11	.000
Likelihood Ratio	80.406	11	.000
Linear-by-Linear Association	19.114	1	.000
N of Valid Cases	400		

a. 11 cells (45.8%) have expected count less than 5. The minimum expected count is .13.

Idea about climate change induce Disaster * Salinity (.... times)

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	36.705[a]	9	.000
Likelihood Ratio	36.230	9	.000
Linear-by-Linear Association	5.372	1	.020
N of Valid Cases	400		

a. 10 cells (50.0%) have expected count less than 5. The minimum expected count is .26.

Idea about climate change induce Disaster * Increase of Temperature (....times)

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	41.277[a]	9	.000
Likelihood Ratio	47.541	9	.000
Linear-by-Linear Association	.330	1	.565
N of Valid Cases	400		

a. 10 cells (50.0%) have expected count less than 5. The minimum expected count is .13.

Idea about climate change induce Disaster * Entrance of tidal water (.... times)

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	74.435[a]	9	.000
Likelihood Ratio	65.947	9	.000
Linear-by-Linear Association	20.968	1	.000
N of Valid Cases	400		

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	74.435[a]	9	.000
Likelihood Ratio	65.947	9	.000
Linear-by-Linear Association	20.968	1	.000

a. 13 cells (65.0%) have expected count less than 5. The minimum expected count is .13.

Idea about climate change induce Disaster * Changing precipitation (.... times)

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	25.108[a]	7	.001
Likelihood Ratio	19.943	7	.006
Linear-by-Linear Association	20.653	1	.000
N of Valid Cases	400		

a. 13 cells (81.3%) have expected count less than 5. The minimum expected count is .13.

Idea about climate change induce Disaster * Sea level rise (.... times)

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	27.575[a]	9	.001
Likelihood Ratio	22.761	9	.007
Linear-by-Linear Association	12.312	1	.000
N of Valid Cases	400		

a. 15 cells (75.0%) have expected count less than 5. The minimum expected count is .13.

Idea about climate change induce Disaster * Thunderstorm (.... times)

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	23.703[a]	11	.014
Likelihood Ratio	33.173	11	.000
Linear-by-Linear Association	6.536	1	.011
N of Valid Cases	400		

a. 15 cells (62.5%) have expected count less than 5. The minimum expected count is .52.

Idea about climate change induce Disaster * Kala Fever (.... times)

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	28.647[a]	8	.000
Likelihood Ratio	20.455	8	.009
Linear-by-Linear Association	4.691	1	.030
N of Valid Cases	400		

a. 14 cells (77.8%) have expected count less than 5. The minimum expected count is .13.

Idea about climate change induce Disaster * Water borne disease (.....times)

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	22.793[a]	9	.007
Likelihood Ratio	17.158	9	.046
Linear-by-Linear Association	16.587	1	.000
N of Valid Cases	400		

a. 15 cells (75.0%) have expected count less than 5. The minimum expected count is .13.

APPENDIX- VI

Relationship between CCIDs and Livelihood in the Study area

Whole Coastal Area

Idea about climate change induce Disaster * Situations of SSNP programmes in your area

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	47.479[a]	4	.000
Likelihood Ratio	39.023	4	.000
Linear-by-Linear Association	21.467	1	.000
N of Valid Cases	400		
a. 2 cells (20.0%) have expected count less than 5. The minimum expected count is 1.69.			

Idea about climate change induce Disaster * Situations of Health service provide in your area

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	21.534[a]	4	.000
Likelihood Ratio	18.874	4	.001
Linear-by-Linear Association	19.411	1	.000
N of Valid Cases	400		
a. 2 cells (20.0%) have expected count less than 5. The minimum expected count is 1.04.			

Idea about climate change induce Disaster * Situations of roads in your area

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	25.289[a]	4	.000
Likelihood Ratio	23.382	4	.000
Linear-by-Linear Association	12.359	1	.000
N of Valid Cases	400		
a. 2 cells (20.0%) have expected count less than 5. The minimum expected count is .65.			

APPENDIX- VII

Zonal Variation in Relationship between CCIDS and Livelihood in the Study Area

Western Area

Idea about climate change induce Disaster * Situations of SSNP programs in your area

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	3.688[a]	3	.297
Likelihood Ratio	4.817	3	.186
Linear-by-Linear Association	1.492	1	.222
N of Valid Cases	170		
a. 4 cells (50.0%) have expected count less than 5. The minimum expected count is .18.			

Idea about climate change induce Disaster * Situations of Healt service provide in your area

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.540[a]	4	.819
Likelihood Ratio	2.478	4	.649
Linear-by-Linear Association	1.068	1	.301
N of Valid Cases	170		
a. 7 cells (70.0%) have expected count less than 5. The minimum expected count is .02.			

Idea about climate change induce Disaster * Situations of roads in your area

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	12.190[a]	3	.534
Likelihood Ratio	3.283	3	.350
Linear-by-Linear Association	1.870	1	.171
N of Valid Cases	170		
a. 4 cells (50.0%) have expected count less than 5. The minimum expected count is .14.			

Central Area

Idea about climate change induce Disaster * Situations of SSNP programs in your area

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	5.791[a]	4	.215
Likelihood Ratio	6.772	4	.148
Linear-by-Linear Association	.261	1	.610
N of Valid Cases	110		
a. 5 cells (50.0%) have expected count less than 5. The minimum expected count is .29.			

Idea about climate change induce Disaster * Situations of Health service provide in your area

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	18.233[a]	4	.083
Likelihood Ratio	8.066	4	.089
Linear-by-Linear Association	1.382	1	.240
N of Valid Cases	110		
a. 5 cells (50.0%) have expected count less than 5. The minimum expected count is .15.			

Idea about climate change induce Disaster * Situations of roads in your area

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	4.986[a]	4	.289
Likelihood Ratio	4.662	4	.324
Linear-by-Linear Association	2.381	1	.123
N of Valid Cases	110		
a. 5 cells (50.0%) have expected count less than 5. The minimum expected count is .73.			

Eastern Area

Idea about climate change induce Disaster * Situations of SSNP programs in your area

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	15.366[a]	4	.004
Likelihood Ratio	15.665	4	.004
Linear-by-Linear Association	13.405	1	.000
N of Valid Cases	120		
a. 2 cells (20.0%) have expected count less than 5. The minimum expected count is .30.			

Idea about climate change induce Disaster * Situations of Health service provide in your area

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	22.045[a]	4	.000
Likelihood Ratio	21.157	4	.000
Linear-by-Linear Association	9.779	1	.002
N of Valid Cases	120		
a. 3 cells (30.0%) have expected count less than 5. The minimum expected count is 1.20.			

Idea about climate change induce Disaster * Situations of roads in your area

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	24.066[a]	3	.000
Likelihood Ratio	30.508	3	.000
Linear-by-Linear Association	18.623	1	.000
N of Valid Cases	120		
a. 1 cells (12.5%) have expected count less than 5. The minimum expected count is 3.90.			