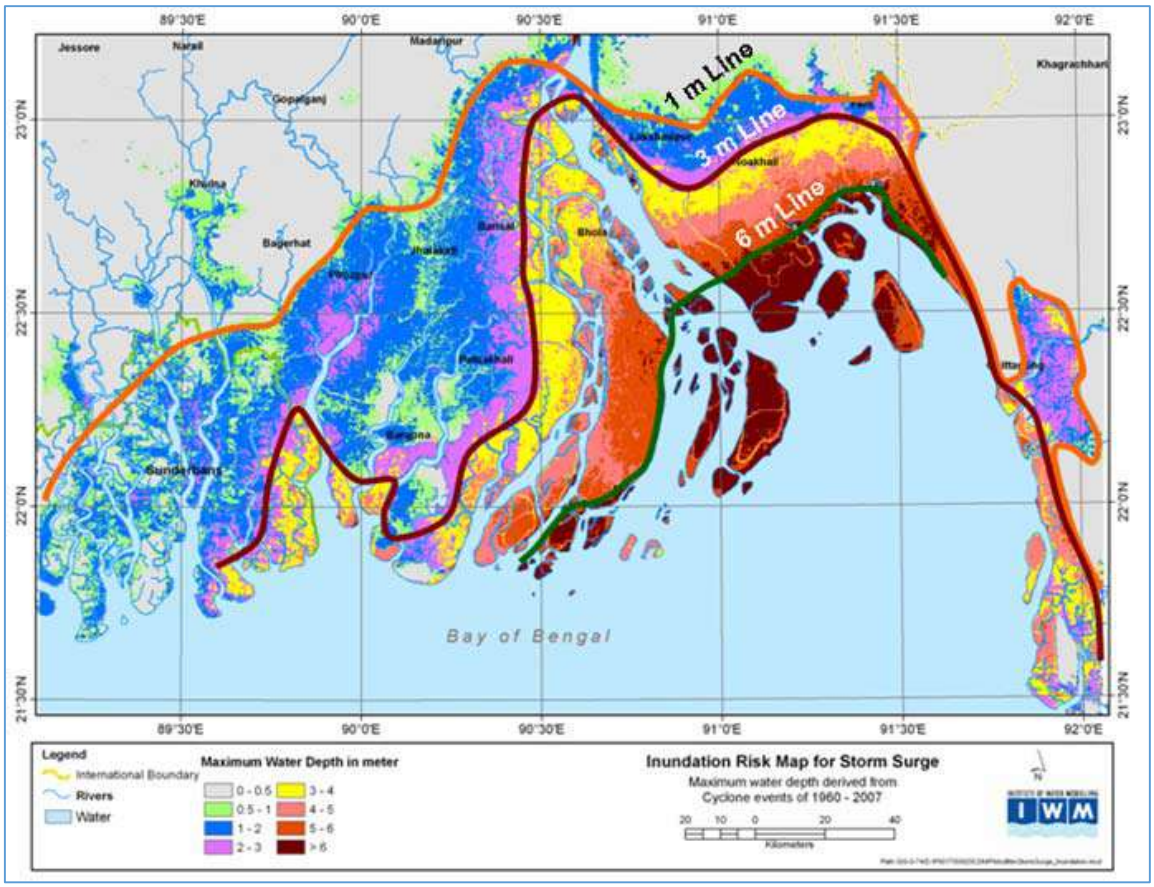
URBAN DEVELOPMENT DIRECTORATE (UDD)

Ministry of Housing and Public Works

Government of the People's Republic of Bangladesh

Report on an Overview of Hazards and Threats in Payra-Kuakata Coastal Project Area and Guidelines for Hazard Mitigation Including Climate Change



Sujit Kumar Bala

IWFM, BUET

1.0 Introduction

The Payra-Kuakata regional planning area includes seven upazilas from Patuakhali and Barguna district. They are Galachipa, Kalapara, Rangabali, Barguna Sadar, Patharghata, Amtali, and Taltali. They are all located very close to the Bay of Bengal having all kinds of severe disasters that befall upon the coast (**Figure 1**).

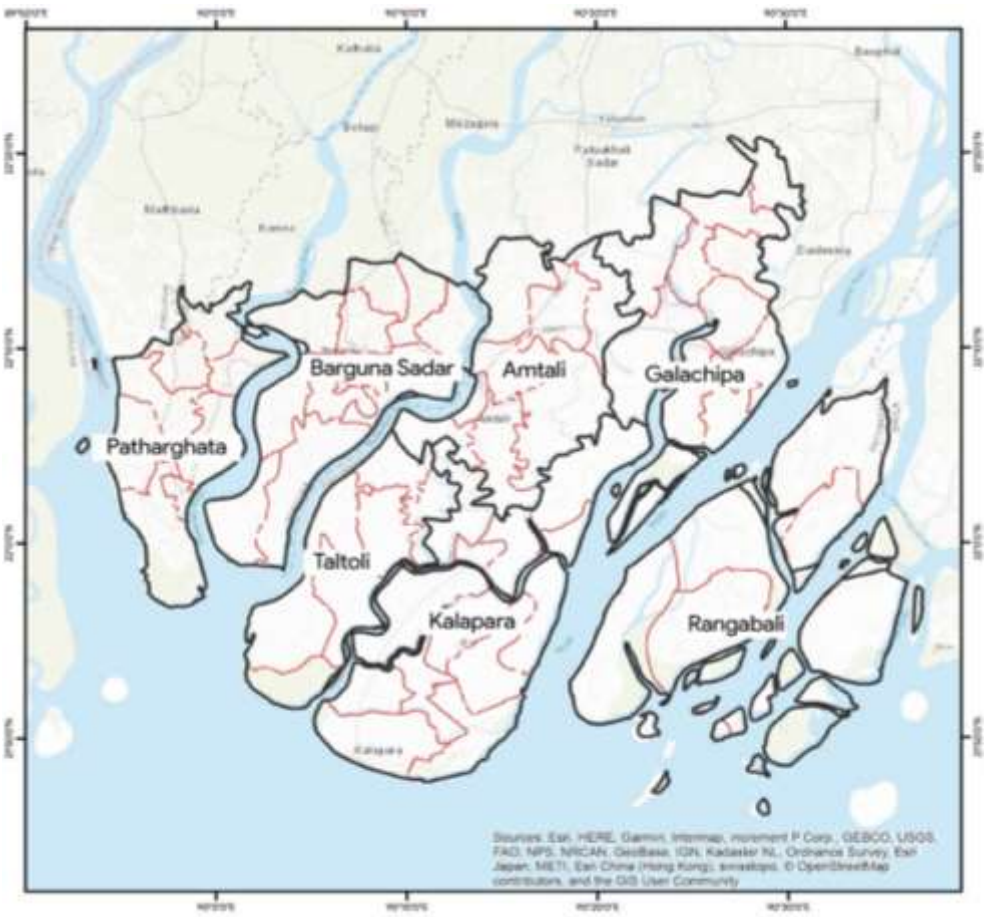


Figure **Error! No text of specified style in document.:** Payra-Kuakata Coastal Region

The Payra-Kuakata region is very dynamic and comes under many kinds of hazards and threats from coastal disasters and vulnerabilities. They are cyclone hazards, storm surge hazards, salinity hazards, erosion hazards, sea level rise hazards, etc.

For geographic location and climatic conditions, Bangladesh is to be severely affected by climate change and the country's agriculture and water sectors would be highly impacted. The country's ability to achieve its Sustainable Development Goal would be under threats.

The area of coastal zones provides shelter, sustenance and livelihood for approximately 46 million people, with 2.85 million hectares of cultivable land (Bala and Hossain, 2010) supporting 20% of the rice production of Bangladesh (Begum and Fleming, 1997). The economy of most of the upazilas is predominantly agricultural. Much of the coast of Bangladesh experiences a large tidal range, reaching up to 6 m or more at Sandwip Island (Barua, 1997). Each and every upazila are vulnerable to natural systems like storm surge, cyclone, riverine flood, sea level rise, salinity intrusion, erosion and so on.

2.0 Disasters and Hazards

To achieve sustainable solutions and project development, mitigation and adaptation become more and more urgent. The government of Bangladesh is very active to manage and up-to-date in-country disasters through establishment of related Ministries, Department, Organizations, and Institutions by enforcing concerned policies, laws, strategies and action plans.

One of the latest actions of the Bangladesh govt. is the Bangladesh Climate and Disaster Risk Atlas: Hazards—Volume I and Exposures, Vulnerabilities, and Risks—Volume II (2022) and was published with ADB support. The Atlas contains spatial information and thematic maps of different coastal hazards and threats that might face coastal region and Bangladesh as a whole. These maps demonstrate the degree of hazards and threats that the Pyra-Kuakata region might face. To understand hazards and threats that might face seven coastal upazilas, the maps are taken as reviews. This review is to provide information about the status of hazards and threats and to formulate guidelines for various mitigation and adaptation measures for disaster risk reduction and sustainable management of coastal region.

The Figure 2 is a combined map of major hazards like drought, earthquake, flash flood, flood and salinity due to cyclone. These are all natural hazards. The Figure 2 demonstrates that among the mentioned hazards, salinity comes to be the major influential hazard for the Pyra-Kuakata coastal belt.

The coastal belt is always under hazards of salinity from the Bay of Bengal. Sea level rise due to climate change, upstream withdrawal of fresh water and huge infrastructural interventions have made salinity increase a major hazard.

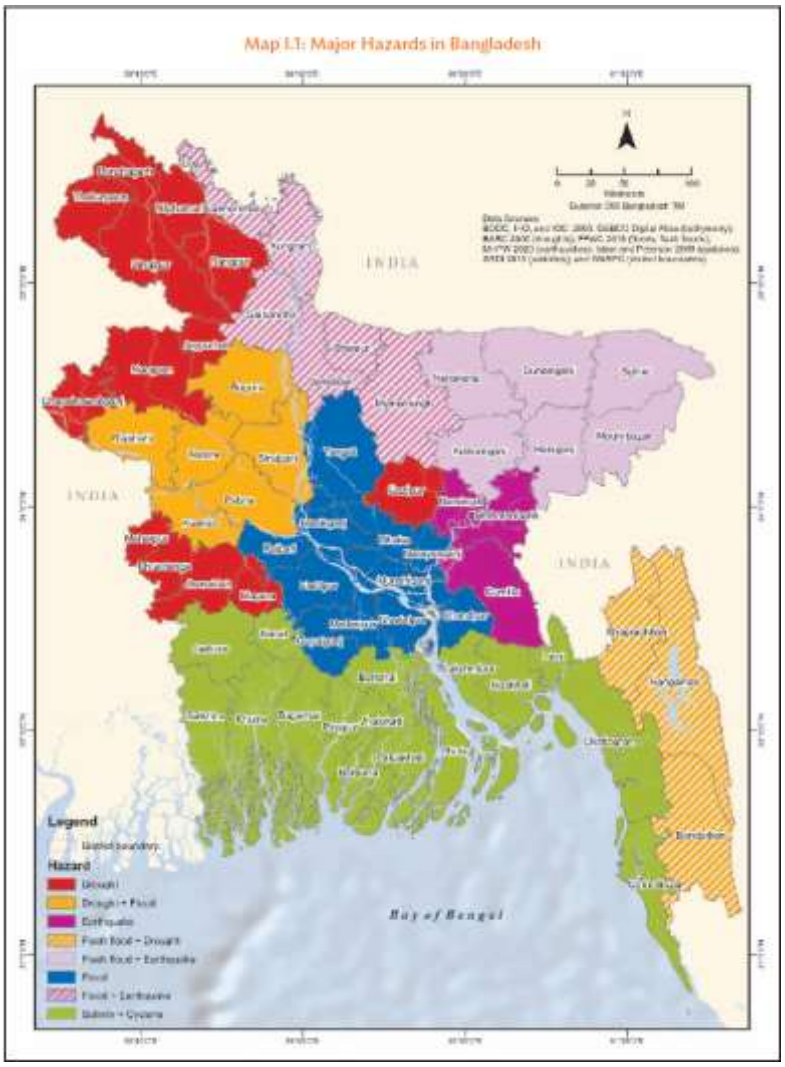


Figure 2: Combined Map of major hazards in Bangladesh

(Source: Bangladesh Climate and Disaster Risk Atlas: Hazards—Volume I)

2.1 Salinity Intrusion due to Sea Level Rise

Salinity intrusion due to sea level rise for the present scenario has been obtained from Center for Environmental and Geographic Information Services (CEGIS) map of salinity intrusion using 1

ppt line. For 0 cm sea level rise, the ppt line is shown in the Figure 3 and used for the reference of salinity intrusion in the upazilas through on-screen digitizing.

The vulnerability ranking has been done in terms of percentage of coverage using the ppt line fall in each upazila. For example, if one upazila is covered by the ppt line up to 25%, then it is considered in the first range of vulnerability.

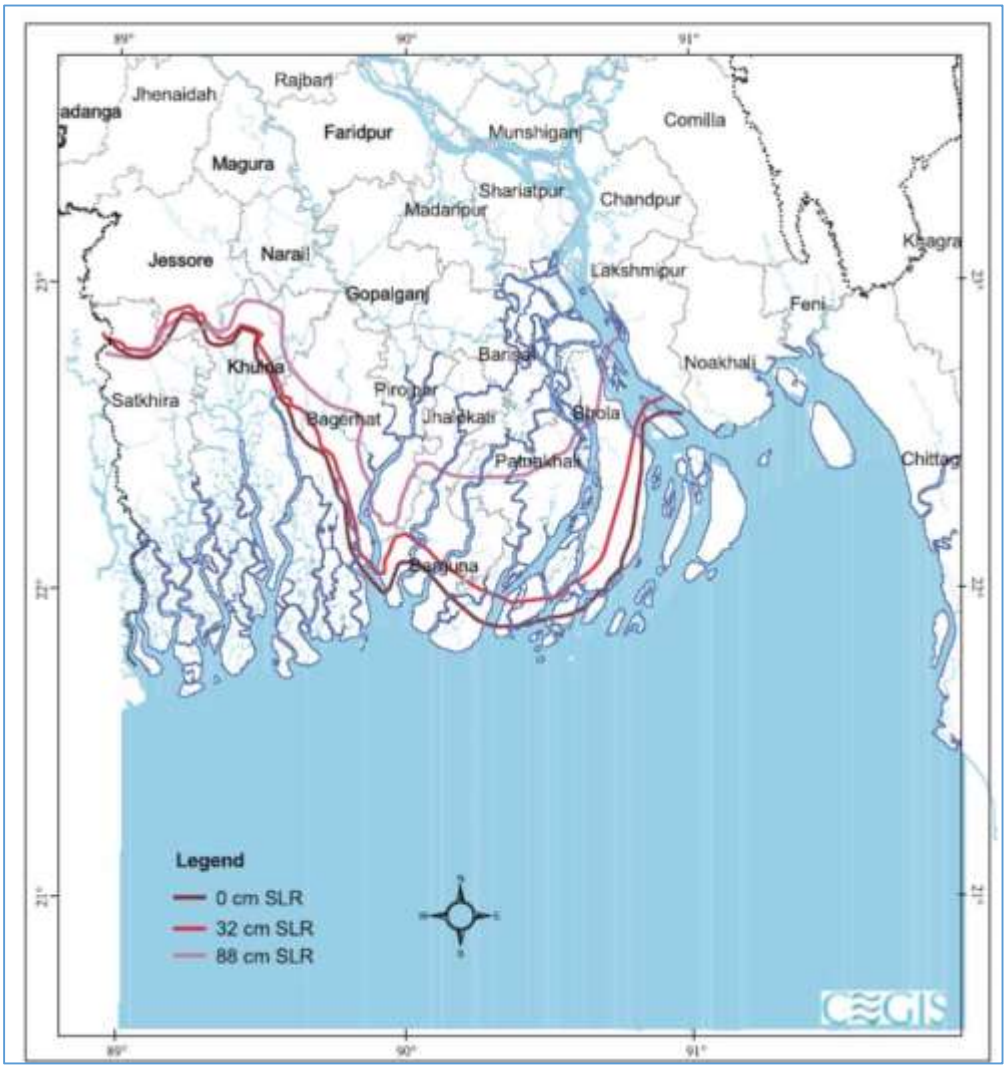


Figure 3: Base Line Salinity Intrusion Map due to sea level rise (Source CEGIS)

2.2 Soil Salinity Hazard Index

As per the Soil Salinity Index Map of Bangladesh, the Pyra-Kuakata coastal region falls under very high risk area (Figure 4). The entire western coastal belt suffer from the very high salinity which impacts severely upon soil of the region. So, implications of soil salinity in the region would have multiple impacts on different sectors like agriculture, infrastructure, transport system, rural and urban development, etc.

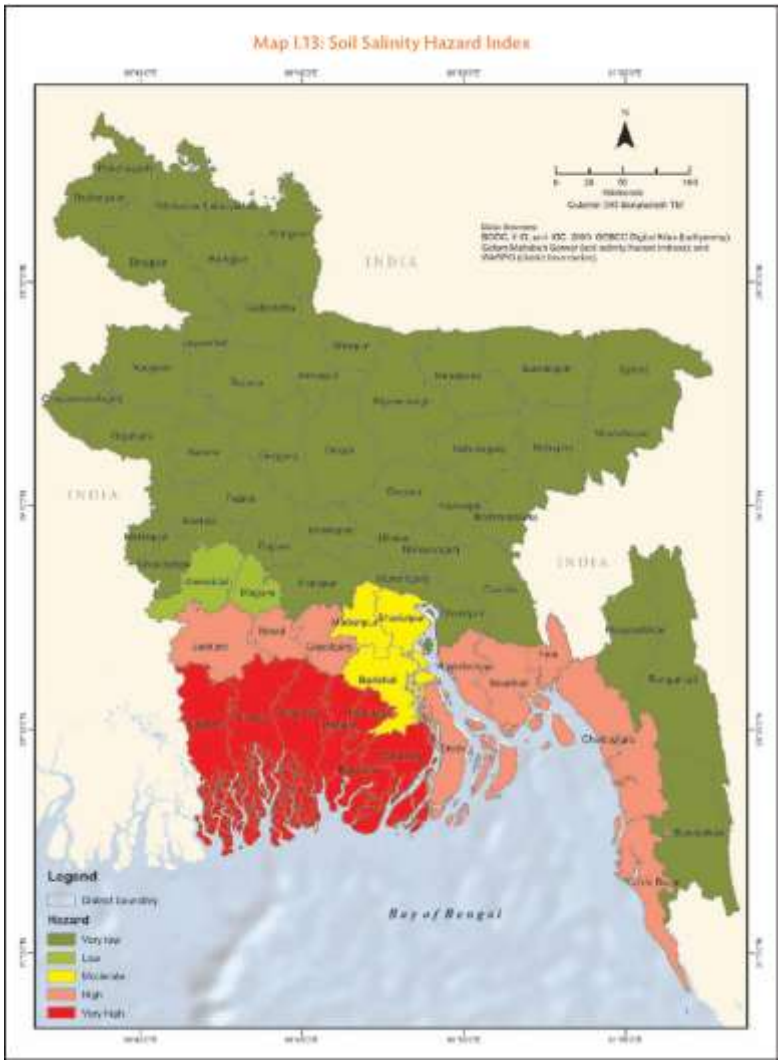


Figure 4: The Soil Salinity Index Map of Bangladesh.

2.3 Cyclone and Storm Surge Hazards

The Figures 4 and 6 demonstrate the hazard index map due to cyclone and storm surge. Hazards due to cyclone is very high in the Pyra-Kuakata region for the 7 upazilas indicating the befall of cyclone very often in the area.

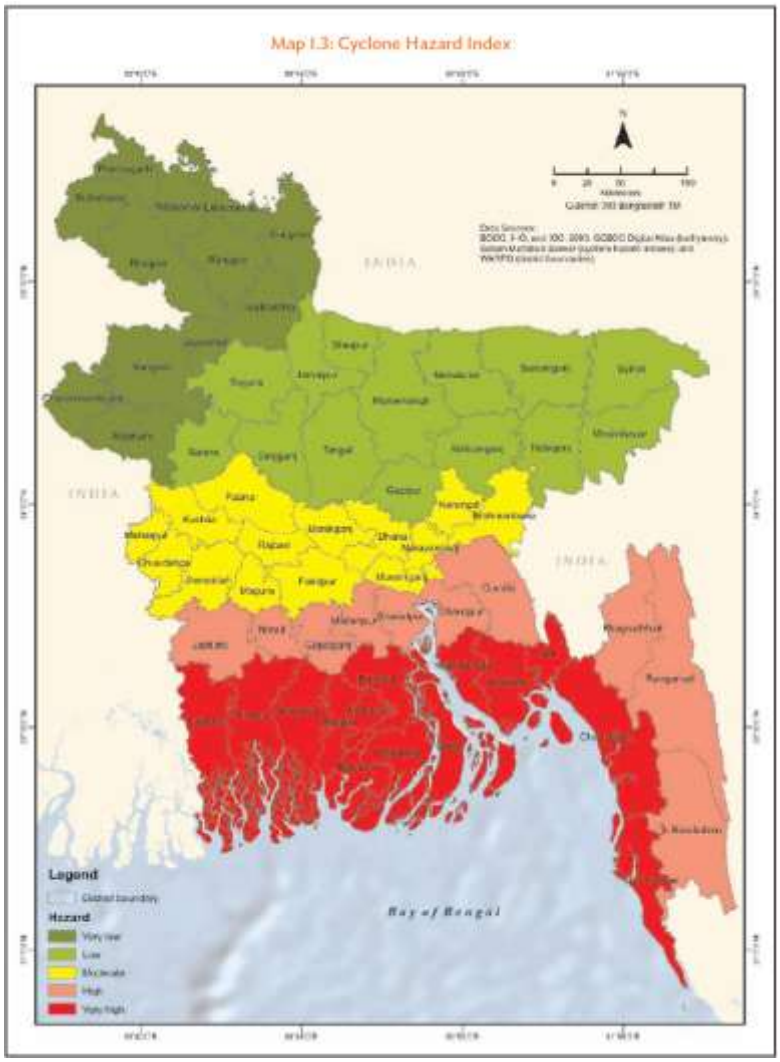


Figure 5: Cyclone Hazard Index Map of Bangladesh
(Source: Bangladesh Climate and Disaster Risk Atlas: Hazards—Volume I)

The Storm Surge Hazard Index Map of Bangladesh (Figure 5) shows a clear distinction between cyclone hazard index and storm surge hazard index. Though cyclone index hazard is **very high** for the Pyra-Kuakata region, but storm surge hazard index indicates a lower status with a **high** ranking. It shows that storm surge related hazards in the region are to be less than cyclonic hazards. The

disasters in the region from storm surges would occur in a lower intensity than other coastal areas like Bhola, Lakshmipur, Feni and Chittagong (Figure 5).

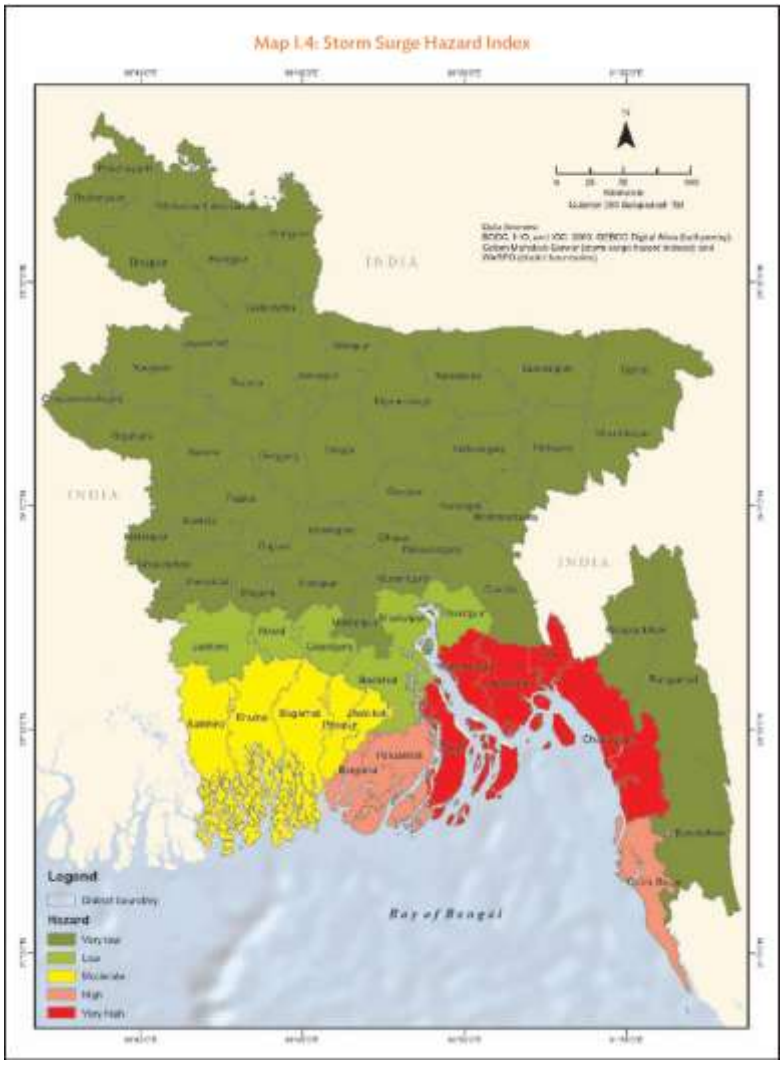


Figure 6: Storm Surge Hazard Index Map of Bangladesh
(Source: Bangladesh Climate and Disaster Risk Atlas: Hazards—Volume I)

2.4 Inundation due to storm surge

Inundation due to storm surge in the coastal upazilas is obtained from an inundation risk map from the report 'Tsunami and Strom Surge Inundation of the Coastal Area of Bangladesh', Volume-I, April 2009, Institute of Water Modeling, Bangladesh and Bangladesh Institute of Social Research and is shown in Figure 7. A High Risk Area (HRA) has been delineated by a one meter inundation depth line according to the criteria adopted by the MCSP (July 1993). It shows that the Sundarbans

area, Bagerhat, Pirozpur, Barguna, Jhalakati, Barisal, a part of Patuakhali, Bhola, Lakshmipur, Noakhali, Chittagong and Cox's Bazar districts fall under High Risk Area. Another two lines having depth of 3 m and 6 m have been drawn in order to delineate the affected zone with maximum inundation.

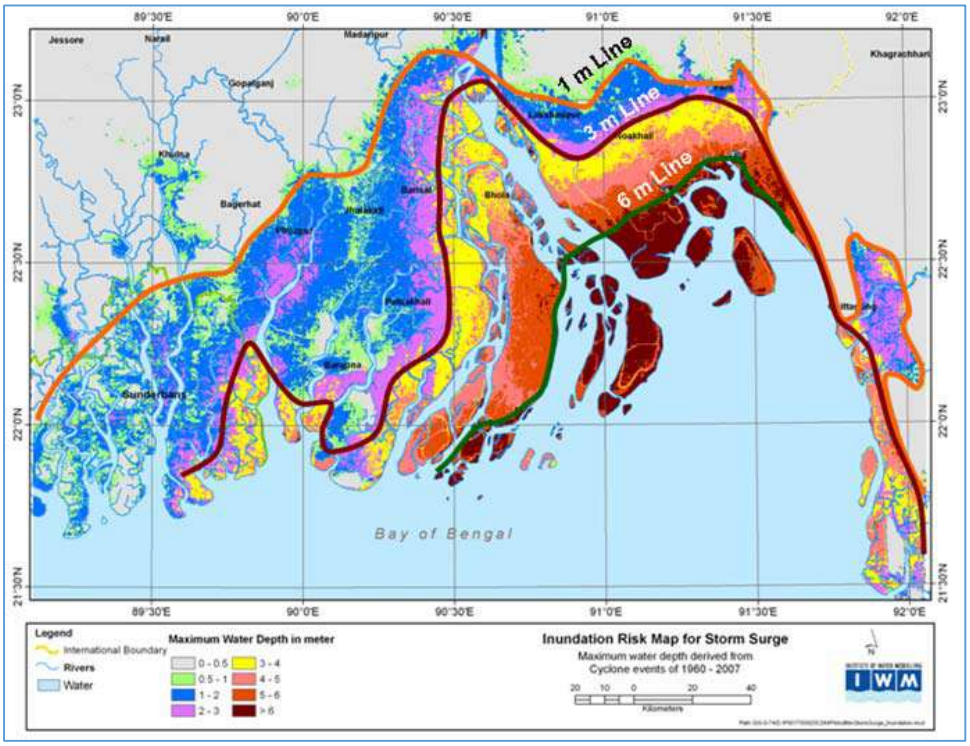


Figure 7: A Base or a Reference Map for inundation due to storm surge (Source IWM)

2.5 Erosion Hazard Index

As per Erosion Hazard Index Map of Bangladesh (Figure 8), the Pyra-Kuakata coastal region comes under very high risk zone (red zone), where shore line erosion poses serious threats. It implies that the Pyra Port and Kuakata Tourist area need high attention for regional planning and development.

IWFM carried out a vulnerability study on coastal belt "Vulnerability Analysis for Selection of Area of Intervention for Climate Resilient Rural Infrastructure Project" in 2015 for LGED. Erosion/accretion was estimated in the study for 140 costal upazila, where a shoreline change comparison for the coastal zone of Bangladesh, six scenes of Landsat imagery (referred to as LS-

1, LS-2, LS-3, LS-4, LS-5, and LS-6 respectively) were acquired for two different years: 1989 and 2009 from the Earth Explorer database of the USGS in the research article that has been used as source of the map of shoreline erosion and accretion (Sarwar and Woodroffe, 2013). The 1989 Landsat-5 Thematic Mapper (TM) imagery has an image resolution of 30 m pixel size for six of the seven spectral bands, whereas 2009 Landsat-7 with the improved Enhanced Thematic Mapper (ETM) scanner acquired all seven bands at 30 m resolution with an additional panchromatic band at 15 m resolution. Reference map for shoreline erosion and accretion is shown in Figure 9.

Net erosion and accretion rates were calculated for six sections of the mainland coast, and for four of the larger islands, the same boundaries between the zones for both 1989 and 2009 were used and net erosion and accretion rates were calculated. Particularly rapid accretion, more than 600 m/yr, was observed in the active mouth of the Meghna estuary, while erosion of up to 285 m/yr on an adjacent island was observed. The main findings are shown in Table 1. The Table 1 shows that shoreline erosion in Barguna Patuakhali coastal zone is 98.26 m/year, where shoreline accretion is 77.87 m/year. It means shoreline erosion in the area for each year is 21.39 m. It is quite alarming for the region, as the area is to be a regional hub of development for the country.

Table 1: Shoreline erosion and accretion rate as reference of vulnerability ranking

Coastal Zone	**Shoreline Erosion (m/year)**	**Shoreline Accretion (m/year)**
Sundarbans coastal zone (SBCZ)	42.47	107.68
Barguna Patuakhali coastal zone (BPCZ)	**98.26**	**77.87**
Bhola coastal zone (BCZ)	124.39	53.3
Noakhali Feni Coastal Zone (NFZ)	116.71	633.14
Chittagong coastal zone (CBCZ)	36.53	63.35
Cox's Bazar coastal zone (CBCZ)	51.83	198.07
Manpura Is.	119.35	14.27
Hatia Is.	285.86	221.93
Sandwip Is.	160	201.55
Kutubdia Is.	98.04	11.6

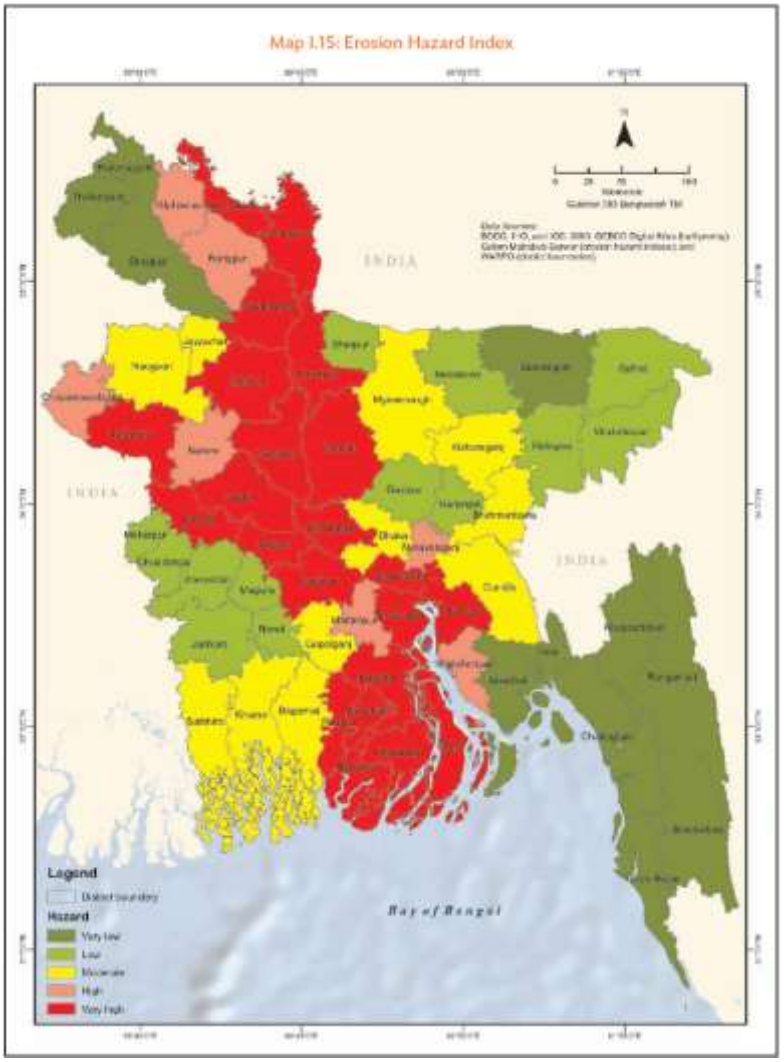


Figure 8: Erosion Hazard Index Map of Bangladesh.

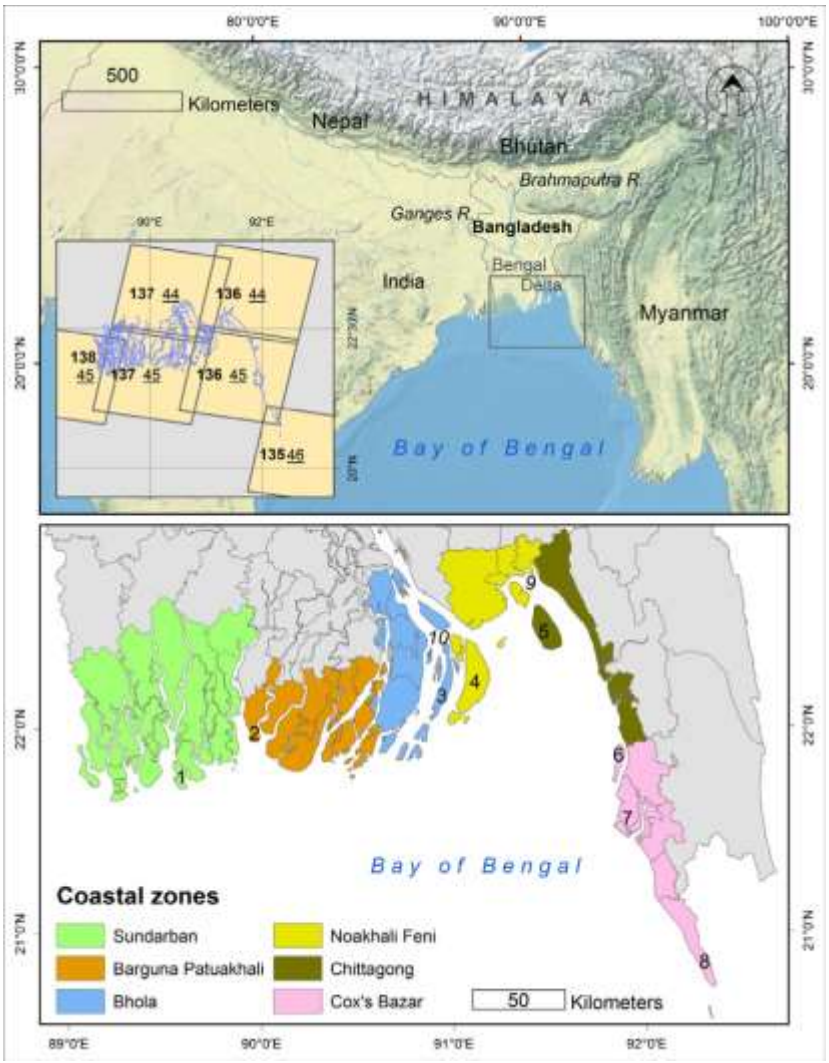


Figure 9: Reference map for shoreline erosion and accretion.

2.6 Sea Level Rise Hazard Index

The Sea Level Rise Hazard Index Map of Bangladesh (Figure 10) shows a high risk for the Pyra-Kuakata region and the Barguna Patuakhali coastal zone is to suffer highly due to sea level rise as a result of climate change impact. But the region does not come under very high risk zone due to sea level rise.

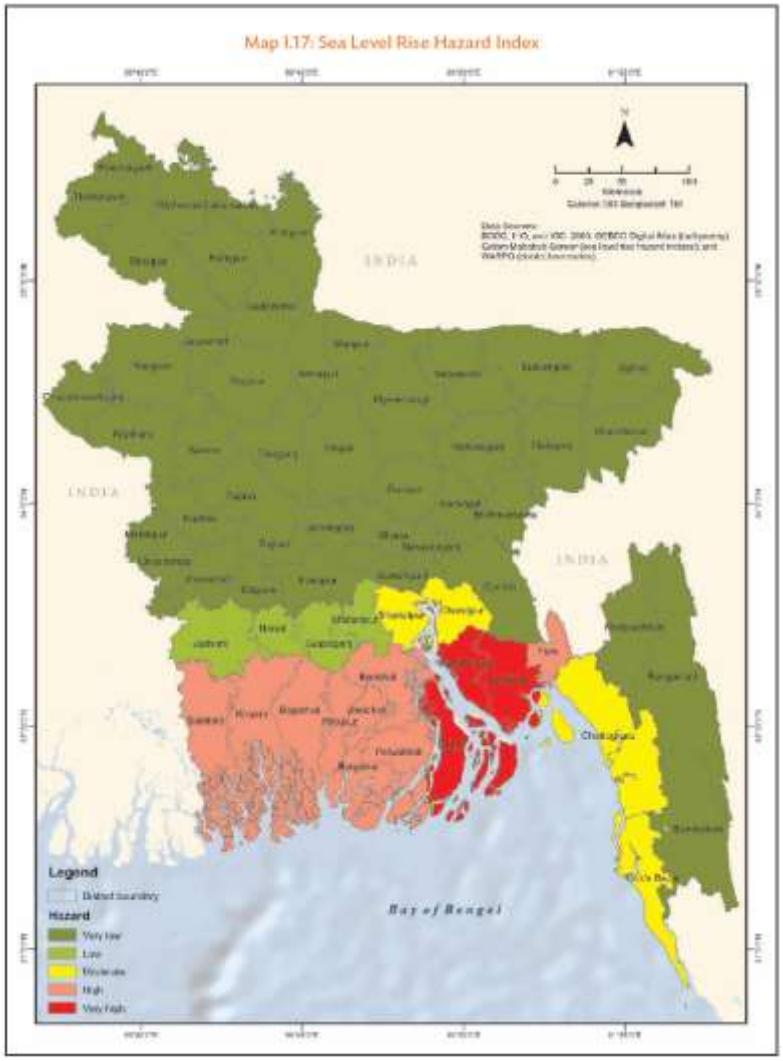


Figure 10: Sea Level Rise Hazard Index Map of Bangladesh.

2.7 Composite Hazard Map of Coastal Belt

It has been mentioned in the 2.5 section that IWFM carried out a vulnerability study on coastal belt "Vulnerability Analysis for Selection of Area of Intervention for Climate Resilient Rural Infrastructure Project" in 2015 for LGED.

Analysis of coastal vulnerabilities for 140 upazilas was completed following specific methods and methodologies for present and future (2050) Bangladesh in changed climate scenario in Figure 11 and 12 respectively. 7 natural and 24 socio-economic indicators were considered for the composite vulnerability analysis. The vulnerability analysis shows that Bangladesh coastal upazilas are not highly vulnerable at present but have to face severe risks of vulnerability in future changed climate.

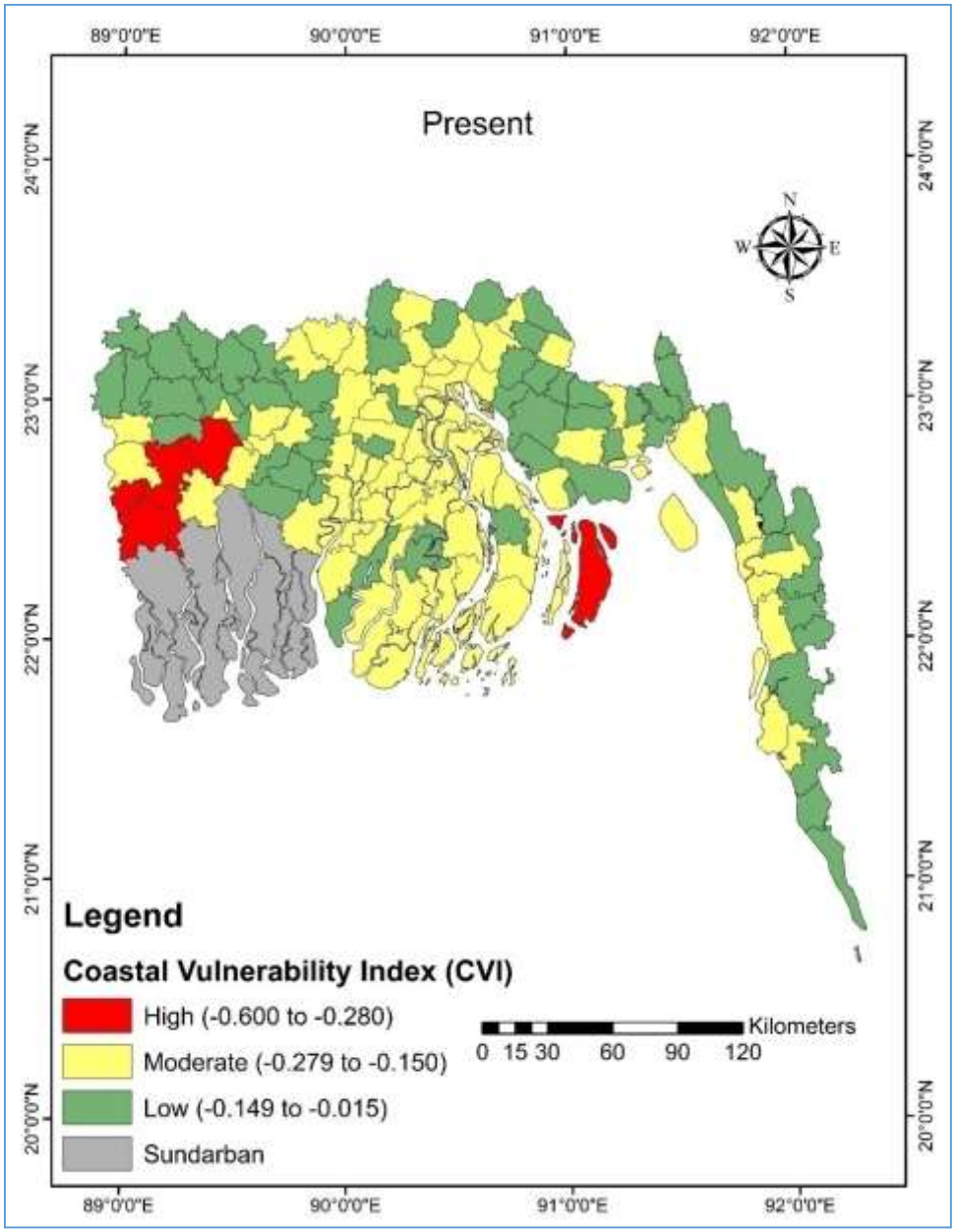


Figure 11: Composite Map of Coastal Vulnerability Index for Present Scenario.

The number of high vulnerable coastal upazilas has been increased hugely from present to future Bangladesh from 9 (nine) to 93 (ninety three) upazilas – more than 10 (ten) folds. Similarly, the number of moderate and low vulnerable coastal upazilas has been reduced hugely from 69 (sixty nine) and 62 (sixty two) upazilas to 26 (twenty six) and 21 (twenty one) upazilas from present to future Bangladesh respectively. It indicates that the whole coastal Bangladesh would be under risk

for future (2050) scenario and our developmental planning and actions are to be taken up accordingly.

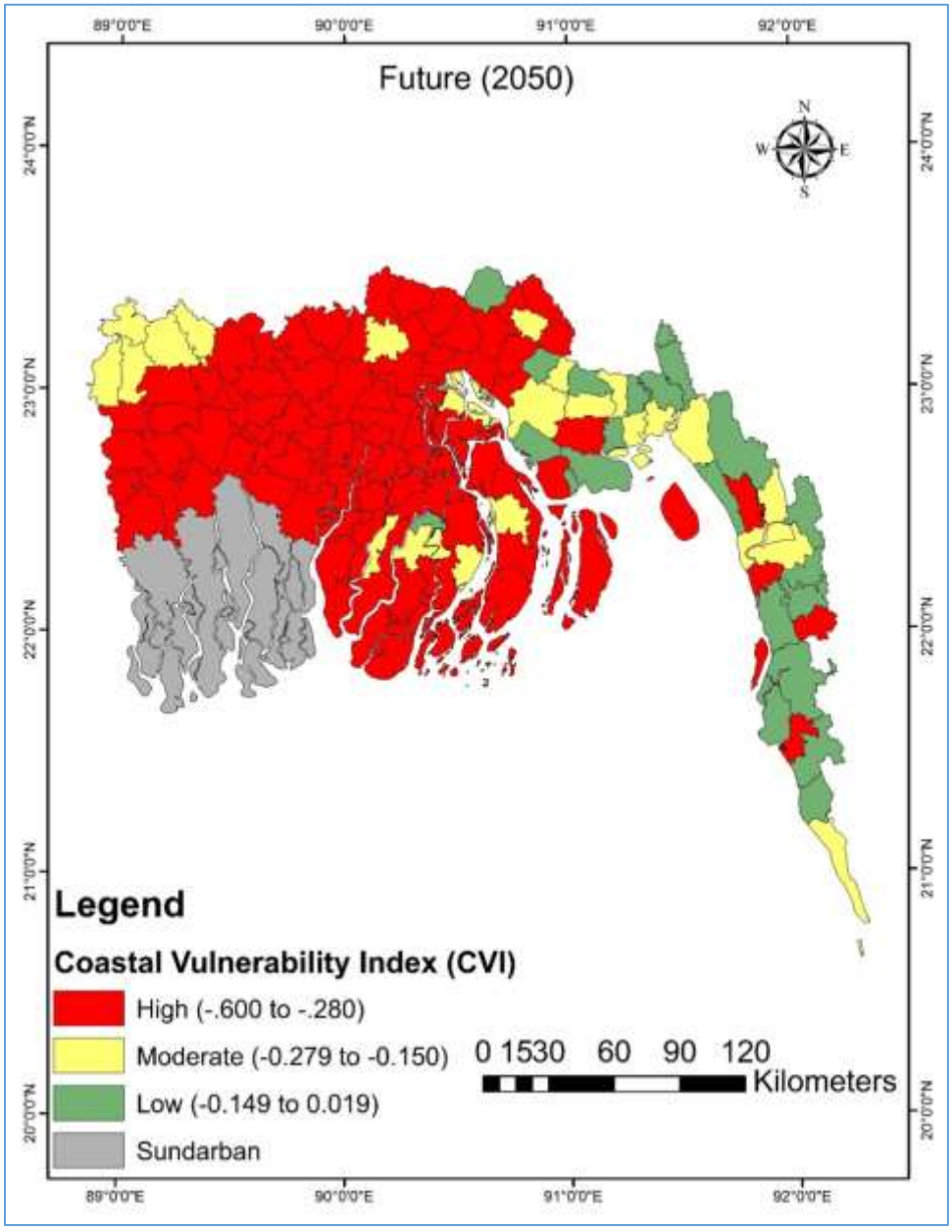


Figure 12: Composite Map of Coastal Vulnerability Index for Future Scenario (2050).

3.0 Guidelines for Hazard Mitigation Considering Climate Change

3.1 Introduction

Historically with geographical setting Bangladesh has become a disaster prone country. The people of the country take birth, grow and live with disasters. Accordingly they are adapted with this system naturally and built up their own management system.

3.2 Disaster Management Mechanism

Disaster Management Mechanism (DMM) usually captures a wide range of means, instruments, processes, systems, rules, manner of acting and the likes of achieving disaster management. The prevailing DMM in Bangladesh is limited to three broad issues - concepts and theories, legal framework and institutional structure.

3.2.1 Concepts and Theories

Since the early-1990s DMM has started to witness a paradigm shift in disaster management approach from conventional response of relief and rehabilitation to a more holistic approach of comprehensive risk reduction culture and ensuring the resilience of the communities to known hazards. The concept of acting after the occurrence of disaster has been replaced by the concept of total disaster management. It came to include all aspects of planning of and responding to disaster. It refers to the management of both risks and consequences of disaster, and includes both—prevention and preparedness measures taken in disaster-prone areas in anticipation of the known hazards—often referred to as 'pre-disaster' measures—and long-term rehabilitation. The second one also included recovery and development. Disaster management is the process of forming common objectives and common values in order to encourage stakeholders to plan for and deal with potential and actual disasters.

The emergency DMM is a cycle of four phases for each event shown in Figure 13.

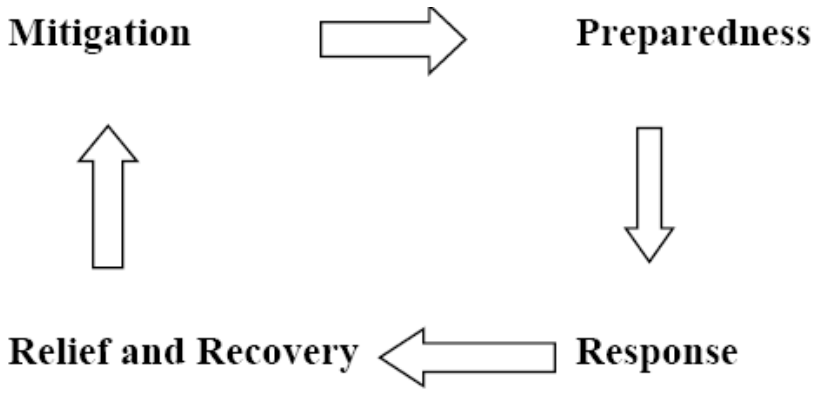


Figure 13: The process of emergency disaster management cycle.

3.2.2 Legal Framework

A legal framework is to regulate the gigantic activities that involve disaster management in Bangladesh and it is a very difficult task. The creation of the Disaster Management Bureau (DMB) in April 1993 by the GoB and now under the Ministry of Food and Disaster Management (MoFDM), is the main organ to coordinate and channel disaster management activities.

The DMB with the guideline of the MoFDM and the entire disaster management community prepared the Standing Orders on Disaster (SOD), upgraded and revised several times with the approval of the Government of Bangladesh in 2019. The SOD is the most detailed and the main legal instrument of disaster management in Bangladesh. The SOD is not a static else a very dynamic document.

3.2.3 Institutional Structure

The GoB is the primary actor in DM and plays pivotal role. The existing institutional structure was initiated with the creation of DMB in 1993. After the floods of 1988 and the cyclone of 1991, the

DMB strengthened and institutionalized. In the existing institutional framework, the MoFDM is the focal point of the GoB for disaster-related issues. The DMB assists the MoFDM with all necessary information. The DMB overviews and coordinates all activities related to disaster management from national to the sub-national level. It is also maintains an effective liaison with government agencies, donors and NGOs to ensure maximum cooperation and coordination in all aspects of disaster management.

The DMB also has the responsibility to create public awareness on the severity and risks associated with natural and human-induced hazards. All Ministries, Divisions/Departments and Agencies prepare their own Action Plans in respect of their responsibilities for efficient implementation. The National Disaster Management Council (NDMC) and Inter-Ministerial Disaster Management Coordination Committee (IMDMCC) created in 1993 ensure.

3.2.4 National Level Institutions

The following three institutions are responsible for policy formulation and coordination of Disaster Management at the national level:

i. National Disaster Management Council (NDMC);
ii. Inter-Ministerial Disaster Management Coordination Committee (IMDMCC); and
iii. National Disaster Management Advisory Committee (NDMAC).

Beside these three apex national bodies, there are a large number of institutions active at the national level in a wide variety of areas in the broader field of disaster management.

3.2.5 Sub-national Level Institutions

Each of the administrative units down to the grass-root level has its own disaster management committee with a clearly defined set of tasks.

Following is a brief account of the sub-national level institutions:

i. District Disaster Management Committee (DDMC),
ii. Upazila Disaster Management Committee (UZDMC),
iii. Union Disaster Management Committee (UDMC),
iv. Pourashava Disaster Management Committee (PDMC), and
v. City Corporation Disaster Management Committee (CCDMC),

All are assigned to co-ordinate, review and implement the disaster management activities within its area of jurisdiction.

3.2.6 Development Partners, INGOs and the NGOs

Development Partners, INGOs and the NGOs are very important partners of Bangladesh to manage disasters.

3.2.7 Other Legal Frameworks

There are several very important legal documents have been published or continuously being upgraded by the Government of Bangladesh on the process of disaster management They are Water Management Act 2012, Bangladesh Delta Plan 2100, Perspective Plan of Bangladesh 2021-2041, 8th Five Year Plan (2020 - 2025), National Plan for Disaster Management 2008-15, 2016-20 and 2021-2025, National Disaster Management Policy 2015, Coastal Developemnt Policy 2005, Coastal Development Strategy 2006, National Adaptation Plan of Action 2005, Bangladesh Climate Strategy and action Plan 2008, etc.

4.0 Mitigation

Mitigation is the use of strategies to reduce risks prior to, during, and post disaster. It is related to short-term and long-term measures; for example, preventing or reducing risk to property or lives by improving the inherent capacities of people and strengths of habitats, infrastructure, and critical facilities. Mitigation, sometimes called prevention or risk reduction, is often considered the "cornerstone of disaster management". The three other components of the disaster management cycle (preparedness, response, and recovery) are performed either in reaction to hazards or in anticipation of their consequences, mitigation measures seek to reduce the likelihood or consequences of hazard risk before a disaster ever occurs.

4.1 Types of Mitigation - Structural and Nonstructural

The mitigation measures are grouped into two primary categories: structural and nonstructural.

4.1.1 Structural Mitigation Measures

Structural mitigation measures are those that involve or dictate the necessity for some form of construction, engineering, or other mechanical changes or improvements aimed at reducing hazard risk likelihood or consequence. They often are considered attempts at "man controlling nature"

when applied to natural disasters. Structural measures are generally expensive and include a full range of regulation, compliance, enforcement, inspection, maintenance, and renewal issues.

The general structural mitigation groups to be described are:

- Resistant construction
- Building codes and regulatory measures
- Relocation
- Structural modification
- Construction of community shelters
- Construction of barrier, deflection, or retention systems
- Detection systems
- Physical modification
- Treatment systems
- Redundancy in life safety infrastructure

4.1.2 Non-structural Mitigation Measures

Nonstructural mitigation, as defined previously, generally involves a reduction in the likelihood or consequence of risk through modifications in human behavior or natural processes, without requiring the use of engineered structures. Nonstructural mitigation techniques are often considered mechanisms where "man adapts to nature." They tend to be less costly and fairly easy for communities with few financial or technological resources to implement.

The various categories of nonstructural mitigation measures may be grouped as below:

- Regulatory measures
- Community awareness and education programs
- Nonstructural physical modifications
- Environmental control
- Behavioral modification

4.2 Disaster Management Practice in Bangladesh

The GoB gives equal importance to both structural as well as non-structural mitigation measures.

4.2.1 Structural Mitigation Measures

As part of structural measures, the GoB with its own and external resources has so far constructed 2,085 cyclone shelters and 200 flood shelters for evacuation of people exposed to impending cyclone as well as flood.

Following colossal floods in the 1988s, Bangladesh developed a flood action plan and established disaster-focused institutions such as the Flood Forecasting Warning Centre (FAP-10) in the country with the help of Danish Hydraulic Institute to reduce vulnerability and developed policy and planning guidelines. In addition, during the last four decades 482 small, medium and large water and flood control projects have been implemented. Of these, more than 400 projects were implemented after liberation war in 1971. Through these projects, about 8,200 km. long flood protection embankment, drainage channels of total length 3,400 km. and 9,000 sluice gates and regulators on different rivers and canals as safety measures against inundation by tidal waves, storm-surges and flooding have been constructed.

About 3,931 km. long coastal embankment to protect coastal land from inundation by tidal waves and storm-surges, and drainage channels of total length 4,774 km. have so far been constructed.

4.2.1 Non- Structural Mitigation Measures

For non-structural mitigation GoB has given emphasis on

- Legislation & Policy
- Training and Public Awareness

As part of training and public awareness nearly 45,000 people related to disaster have been trained through 721 courses/workshops/seminars. As part of public awareness activities, booklets containing information about cyclone, flood, earthquake etc. and calendar, posters depicting disaster points have been regularly printed and distributed up to the grass-root levels. To raise awareness among the students on various hazards/ disaster management, a chapter on disaster management has been included in the educational curricula from classes V to XII. In addition, there exists Cyclone Preparedness Program (CPP) which plays very useful role during cyclone.

4.3 Community-Based Disaster Management in Bangladesh

The Government alone cannot and is not possible to properly manage and handle all types of disasters with its machinery. Need to include policy makers, experts and professionals in active participation by the people in any region of a country.

So, a new approach of managing disasters has been evolved known as Community-Based Approach (CBA) which emphasis to the total participation of all people facing any hazard or disaster and make sure to render all possible services to the community. This approach in Bangladesh is being popularized gradually.

The Government of Bangladesh initiated a community based disaster management project "Support to Comprehensive Disaster Management" in 1993 and includes development of Local Disaster Action Plan (LDAP) to increase the capacities of the households and local communities in the highly disaster prone areas, organize quite good number of training and awareness campaign at local level to sensitize and mobilize community people and to cope with cyclones, floods and other potentially disaster situations and/or in the overall risk management system. Total 900 numbers of LDAPs had been developed as of today.

Under the project "The Rights-based Planning & Monitoring: Disaster Preparedness" 112 training programmes have been completed in 2002 and 119 training programmes have been completed in 2003 covering the disaster-prone districts and sub-districts. Many individual communities have their own/indigenous coping system to face the disasters. In the year 2003, Disaster Management Bureau (DMB) organized 06 (six) workshops for Community Leaders on disaster preparedness & indigenous knowledge on coping mechanism.

Summary

A short review on hazards and threats in Payra-Kuakata Coastal Project Area and Guidelines for Hazard Mitigation Including Climate Change has been accomplished based on existing literatures. Hazards and risks on riverine flood, drought in agriculture, earthquake, etc. are not reviewed as they pose low or very low hazards. Composite map of present and future (2050) considering climate change impacts are presented. A short review has been made upon disaster management mechanism and processes of Bangladesh. Moreover, Mitigation approaches are also reviewed in a short. Activities of community based organizations and government supports are also highlighted.

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