

2) UzDRRAP of Chakaria, Cox's Bazar

**Upazila Disaster Risk Reduction
Action Plan**

Chakaria, Cox's Bazar

November 2023

**Upazila Disaster Management Committee
(UzDMC) of Chakaria**

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Preface

Bangladesh is one of the most disaster-prone countries in the world due to its geographical location. The frequency and intensity of disasters have been increased in recent years due to climate change as floods and storm surges are likely to become more severe with increases in intense tropical cyclones. Natural disasters cause not only direct physical damages to the lives and assets, but also indirect and consequent losses to various sectors such as agricultural sectors, food security, water, health and sanitation, significantly impacting economy and livelihood of the local communities. To tackle the situation, the government has achieved breakthroughs in disaster risk management by mentioning this as one of the top priorities, as described in the 8th Five Year Plan (July 2020- June 2025) “a sustainable development pathway resilient to disaster and climate change” as a core theme.

In order to accelerate the disaster resilience of the country, it is vital to develop and implement local disaster risk reduction strategies and plans as also indicated in the Sendai Framework for Disaster Risk Reduction 2025-2030. Expectedly, by adopting a local disaster risk reduction plan in every Upazila, it is possible to effectively reduce the damage and loss caused by disaster, and enhance continuous and sustainable development of the country's economy and therefore achieving Vision 2041 of the government.

In light of this, "The Project for Capacity Enhancement on Formulation and Implementation of Local Disaster Risk Reduction Plan" has been implemented since December 2020 led by MoDMR and DDM, supported by the Japan International Cooperation Agency (JICA). In this Project, Upazila disaster risk reduction plans have been formulated in six pilot Upazilas of three districts, which are Cox's Bazar (Cox's Bazar Sadar and Chakria), Sunamganj (Chhatak and Jagannathpur) and Kurigram (Chilmari and Ulipur). These plans have been developed by unique approaches that are 1) Scientific analysis for local hazards; 2) Setting DRR targets based on risk quantification; 3) Involvement of project implementing agencies including BWDB, LGED, SoB, GSB, BMD, PWD, FSCD, and so on. These approaches have successfully established this effective plan and promote to execute projects to reduce disaster risk.

This plan is expected to save lives, livelihoods, and resources of the Upazila, as well as pave the way for the enhancing future development through disaster risk reduction in the country.

Implemented by the Department of Disaster Management (DDM)
Technical Assistance from the JICA Expert Team (JET) of "The Project for Capacity Enhancement on Formulation and Implementation of Local Disaster Risk Reduction Plan", and the Bangla-German
Sampreeti (BGS)



Director General
Department Of
Disaster Management

Message

While Bangladesh is advancing rapidly on the path of development, natural disasters are hindering the ongoing dynamic development of Bangladesh. Although Bangladesh is disaster-prone due to geographical reasons, climate change adds insult to injury as one or the other disaster strikes the nation almost every year. As a result, the country's resources and lives are being lost on a large scale, which impedes the pace of development consequently. Natural disasters hampering sustainable development, therefore, make it impossible to achieve the desired progress.

In this context, the Bangladesh government has placed more importance on disaster risk reduction and pre-disaster investment, as well as in light of the Sendai Framework for Disaster Risk Reduction (SFDRR), the Ministry of Disaster Management and Relief (MoDMR) and the Department of Disaster Management (DDM) has taken a project named "The Project for Capacity Enhancement on Formulation and Implementation of Local Disaster Risk Reduction Plan" with the support of JICA. This project is piloting the formulation of the local disaster risk reduction plans in six Upazilas of three districts which had been selected in consideration of the different types of hazards, namely Cox's Bazar, Sunamganj, and Kurigram. This pilot activity is finally aimed at the establishment of the mechanism to spread this initiative nationwide in the country, by the leadership of the MoDMR and the DDM.

The local Upazila Disaster Risk Reduction Action Plan (UzDRRAP) formulation is significantly vital for Upazilas with a view to eliminating the actual damage and loss in their areas. The planning in cooperation among related agencies can promote sufficient proactive disaster risk management that the Bangladesh government has also emphasized, instead of post-disaster response.

It is my great pleasure to implement this pilot project activity with the strong leadership of the Upazila DMC and other stakeholders. This plan will contribute a lot to achieving the vision of 2021 of the Bangladesh government. We are hopeful that the success of this pilot project will add a positive dimension to the development process and this process will later be expanded across the country.

Md. Mijanur Rahman
(Additional Secretary)



Project Director
LDRRP Project
and

Director
Planning & Development
Department Of Disaster Management

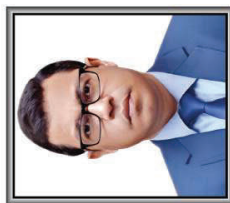
Message

Natural disaster is the main obstacle to the development of this beautiful land of natural beauty. Almost every year this country is affected by cyclones, storm surges, landslides, flash floods, seasonal floods, thunderstorms, lightning, and so on, due to its geographical location. The amount of damage to property, crops, houses and infrastructure caused by the disasters is retarding the development of the country, which results in a decrease in GDP as well as a great barrier to sustainable development.

In aspect to this and in light of the Sendai Framework for Disaster Risk Reduction (SFDRR), the Ministry of Disaster Management and Relief (MoDMR) and the Department of Disaster Management (DDM) initiated a project named "The Project for Capacity Enhancement on Formulation and Implementation of Local Disaster Risk Reduction Plan" with the support of JICA. Under this project, six Upazilas of three districts, which are 1) Cox's Bazar Sadar and Chakaria Upazilas in Cox's Bazar District, 2) Chhatak and Jagannathpur Upazilas in Sunamganj District, and 3) Chilmari and Ulipur Upazilas in Kurigram District were selected as pilot sites in consideration of their different types of hazards due to their diverse geographical features, to formulate and implement the Upazila disaster risk reduction plans (UzDRRAPs). Since the project started in 2021, we have completed formulating the UzDRRAPs of Cox's Bazar and Sunamganj districts through the active participation of all stakeholders as this plan shows, and will start the project activities in Kurigram district soon in 2024. I firmly believe that the development and implementation of the UzDRRAP is significant for all Upazilas to reduce the rate of damage and loss of human and resources by disasters, which will support achieving the vision of 2021 of the Bangladesh government.

As a Project Director, it is my immense pleasure to accomplish this intended project activity through the strong leadership and guidance of the Upazila DMC and Union DMC, as well as the active participation and contributions of other DRR-related agencies. This plan will take us on the path of prosperity by reducing the disaster risks and will play a significant role in the development of the country.

Md. Firoz Uddin
(Additional Secretary)



Deputy Commissioner
Cox's Bazar District

Message

Cox's Bazar District is characterized by natural beauty, diverse special features surrounded by mountains, rivers and the sea. It is a district that has the longest beach in the world and is a source of the unique beauty of nature. Many institutions in the tourism industry have been established here. This area is bustling with domestic and foreign tourists throughout the year to enjoy the natural beauty as Cox's Bazar is famous as the healthiest place in Bangladesh. The present Government has taken a good number of development initiatives here such as Matarbari Deep Sea Port, Matarbari Ultra Super Critical Coal Fired Power Plant, Economic Zones, Unique Railway Station and Runway Extension Projects of Cox's Bazar International Airport etc.

This District consists of nine Upazilas (71 Unions) and four municipalities. Cox's Bazar is home to various tribes or ethnic groups which make the city more diverse and it is a beautiful place where people are living together with communal harmony. Due to the geographical situation, this District is a disaster-prone area because it is situated along the Bay of Bengal. Almost every year this District is affected by cyclones, storm surges, landslides and flash floods. Every year infrastructure, crops and homesteads are damaged and a significant number of resources are lost which is a great barrier to sustainable development. Therefore, I believe that the local Upazila Disaster Risk Reduction Plan formulation is very important for this area in order to reduce the rate of damage and loss. The Bangladesh Government has also emphasized proactive Disaster Risk Management (DRM) instead of Post Disaster Response.

It has come to my attention that the Ministry of Disaster Management and Relief (MoDMR) has taken a pilot project named "The Project for Capacity Enhancement on Formulation and Implementation of Local Disaster Risk Reduction Plan" with the support of JICA and this project is piloting two Upazilas (Cox's Bazar Sadar and Chakaria Upazila) of Cox's Bazar district. The project activity was started in June 2022, and by this time already formulated the Upazila DRR Plan (UzDRRAP) of both Upazilas through the active participation of all stakeholders.

As a District Administrator, it is my pleasure to accomplish this intended project activity through the strong leadership and guidance of the Upazila administration and thanks to Upazila DMC, Union DMC and other stakeholders for their active participation and great effort in this innovative initiative which will reduce the rate of damage and loss of human and national resources by the disaster. I would like to express thanks to all the stakeholders for their relentless effort to formulate this UzDRRAP.

Muhammad Shaheen Imran



Chairman
Chakaria Upazila Parishad
Cox's Bazar District

Message

Chakaria Upazila is a remarkable place of immense natural beauty in Cox's Bazar District surrounded by the mountains and rivers. The area of this Upazila is 503.78 km² where 4,78,465 people (as per Census of 2011) are residing under 18 unions (221 Villages) and one municipality. In this habitat, surrounded by forests and humming with the chirping of birds and the sound of flowing river water, the tribals and the common people have been living together century after century with communal harmony. Chakaria is famous for prawns and salt, and the salt of this area is supplied to all over the country. Shrimps from this area are supplied to all over the world. Due to its geographical location, this Upazila is a disaster-prone area and is affected by cyclones, floods and flash floods every year. This results in massive damage to infrastructure, crops, salt production, shrimp culture, human lives and habitats which are major obstacles to sustainable development. In this situation, it is necessary to take steps towards disaster risk reduction for saving resources through a Upazila Disaster Risk Reduction Plan.

It is my immense pleasure that the pilot activities under "The Project for Capacity Enhancement on Formulation and Implementation of Local Disaster Risk Reduction Plan" has been taken in my Upazila funded by the GOB and JICA. This is a timely step, as a result of which the people of Chakaria Upazila will be benefited from the works done and as a public representative I applaud this great initiative. If the loss of assets can be reduced through proper planning, the Upazila will move forward in the path of development, which can contribute to the achievement of the vision 2041 undertaken by the Bangladesh government.

I express my gratitude to the Upazila Disaster Management Committee, Union representatives, and all concerned for their immense efforts to prepare this plan.

Fazlul Karim Saidy



Upazila Nirbahi Officer
Chakaria, Cox's Bazar District

Message

Chakaria Upazila is the gateway to the tourist town of Cox's Bazar District. This Upazila is surrounded by an unprecedented combination of mountains, forests, rivers and seas and is full of natural beauty. This Upazila consists of 18 unions and one municipality, and it is a beautiful place where indigenous people and common people live together in communal harmony. On the other hand, due to the geographical situation, this Upazila is a disaster-prone area because it is close to the Bay of Bengal, as well as the hill on the northwest side of the Upazila. Almost every year this Upazila is affected by cyclones and flash floods, and increasing salinity is another big issue of this Upazila. Every year, infrastructures (e.g., roads, embankments, bridges, culverts, drainage, retaining walls), crops and homesteads are damaged, and a significant number of resources are lost which is a great barrier to sustainable development. Therefore, Upazila Disaster Risk Reduction Action Plan (UzDRRAP) formulation is very important for this area in order to reduce the rate of damage and loss.

"The Project for Capacity Enhancement on Formulation and Implementation of Local Disaster Risk Reduction Plan" has been taken with the support of JICA and in compliance with the "Sendai Framework for Disaster Risk Reduction (SFDRR)". The Project is being piloted in the six Upazilas, including this Upazila, of three districts (1. Cox's Bazar 2. Sunamganj, 3. Kurigram), considering the variety of hazards. I would like to express my gratitude to the Ministry of Disaster Management and Relief (MoDMR) for selecting this Upazila and am delighted that this initiative will be disseminated countrywide based on the result of our pilot activities. In order to develop this Plan, we established Upazila Sub-Committee (UzSC) and had a series of workshops for precisely understanding disaster risks and collecting necessary DRR countermeasures with great involvement of communities and representatives, government officers of various sectors and other stakeholders. I firmly believe that this Plan will provide us and all the stakeholders including project implementing agencies with the direction for the future which can save lives, livelihoods and national resources.

As a Chief Executive Officer of this Upazila Parishad, I feel honor and privileged to accomplish the development of this plan, and appreciate all the active participation and efforts of UzDMC members, UzSC members, union representatives, and all stakeholders.


Jepy Dewan

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Attachment 1: Proposed countermeasure list

Attachment 2: Member lists of UzDMC and UzSC

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Acronyms

ADP	Annual Development Programme
BCC	Building Construction Committee
BDRCS	Bangladesh Red Crescent Society
BGS	Bangla-German Sampreeti
BIWTA	Bangladesh Inland Water Transport Authority
BMD	Bangladesh Meteorological Department
BNBC	Bangladesh National Building Code
BWDB	Bangladesh Water Development Board
CBS	Columbia Broadcasting System
CFSO	Central Food Safety Officer
CPP	Cyclone Preparedness Program
CRA	Community Risk Assessment
DAE	Department of Agricultural Extension
DDM	Department of Disaster Management
DDMC	District Disaster Management Committee
DEM	Digital Elevation Model
DGM	Deputy General Manager
DMC	Disaster Management Committee
DPHE	Department of Public Health Engineering
DPP	Development Project Proposal
DRMP	Disaster Risk Management Plan
DRR	Disaster Risk Reduction
ECHO	Directorate-General for European Civil Protection and Humanitarian Aid Operations
ERCC	Emergency Response Coordination Centre
EU	European Union
FSCD	Fire Service and Civil Defence
GIS	Geographic Information System
GOB	Government of Bangladesh
GSD	Ground Sampling Distance
ID	Identity Document
JET	JICA Expert Team
JICA	Japan International Cooperation Agency
LDRRP	Local Disaster Risk Reduction Plan
LGED	Local Government Engineering Department
MoDMR	Ministry of Disaster Management and Relief

MoE	Ministry of Education
MoF	Ministry of Finance
MoH&FW	Ministry of Health and Family Welfare
MoL	Ministry of Land
MoL&F	Ministry of Livestock and Fisheries
MoLGRD&C	Ministry of Local Government Rural Development & Cooperatives
MoP&ME	Ministry of Primary and Mass Education
MoPA	Ministry of Public Administration
MoSW	Ministry of social welfare
MoY&S	Ministry of Youth and Sports
NGO	Non-governmental Organization
PGA	Peak Ground Acceleration
PIO	Project Implementation Officer
PWD	Public Works Department
RRAP	Risk Reduction Action Plan
SDGs	Sustainable Development Goals
SFDRR	Sendai Framework for Disaster Risk Reduction
SOB	Survey of Bangladesh
SOD	Standing Orders on Disaster 2019
TSC	Technical Sub-Committee
UDD	Urban Development Directorate
UN OCHA	United Nations Office for the Coordination of Humanitarian Affairs
UNO	Upazila Nirbahi Officer
Ups	Union Parishads
UzCC	Upazila Construction Committee
UzDMC	Upazila Disaster Management Committee
UzDMP	Upazila Disaster Management Plan
UzDRRAPs	Upazila Disaster Risk Reduction Action Plans
UzSC	Upazila Sub-Committee

Chapter-1. Introduction

1.1 Purpose and aim of the Plan

The purpose of the Chakaria Upazila Disaster Risk Reduction Action Plan (UzDRRAP) is to identify necessary countermeasures against natural disasters and implement them in cooperation with relevant stakeholders to reduce disaster risks in the Upazila. This Plan contributes to increasing investment in disaster risk reduction by ensuring a mechanism for project implementation of the line ministries' countermeasures and by promoting further funding from agencies.

1.2 Rationale for the formulation of the Plan

This Plan corresponds to the Risk Reduction Action Plan (RRAP) that is required to be developed as a part of the Disaster Risk Management Plan (DRMP) by Disaster Management Committees (DMC) at District, Upazila and Union DMCs, according to the Standing Orders on Disaster 2019 (SOD). In the SOD, it is recommended to prepare RRAP by local DMCs, as well as the Contingency Plan. While the disaster response which is covered by the Contingency Plan has been relatively conducted as required in emergencies, risk reduction measures based on the objective hazard and risk assessment had not been sufficiently implemented at the Upazila level. In consideration of this situation and the importance of the DRR investment for the further development of the country, this plan, therefore, emphasises disaster risk reduction and proposes the necessary actions as a master plan corresponding to the RRAP of the Upazila Disaster Management Plan (UzDMP), which directly leads to the preparation of Development Project Proposals (DPPs) and Annual Development Programmes (ADPs).

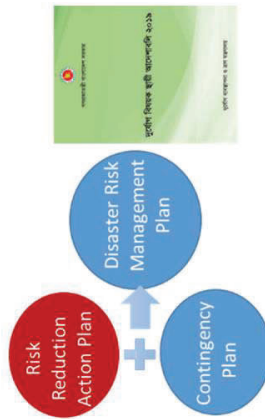


Figure 1-1. Risk Reduction Action Plan in the SOD

The formulation of the UzDRRAP and the implementation of the countermeasure against disasters are in line with government strategies, policies, and plans of the country, as listed below.

- The Bangladesh Delta Plan 2100 mentions the importance of strengthening the disaster risk management and combating the effects of climate change.
- 8th Five Year Plan (July 2020-June 2025) emphasizes appropriate policy and institutional capacity building to address their concerns on climate-resilient development and disaster management at all levels of the government, especially at the local government level where most of the programmes are to be implemented.

- The National Plan for Disaster Management (NPDM 2021-2025) focuses on "Making disaster risk reduction a development practice to achieve resilient public investment and the SDGs" and "Building capacity and leadership to implement NPDM 2021-2025 at the national and local level".

In addition, from an international perspective, this plan directly contributes to the Sendai Framework for Disaster Risk Reduction 2015-2030 (SFDRR), specifically the Target (e) "To substantially increase the number of countries with national and local disaster risk reduction strategy".

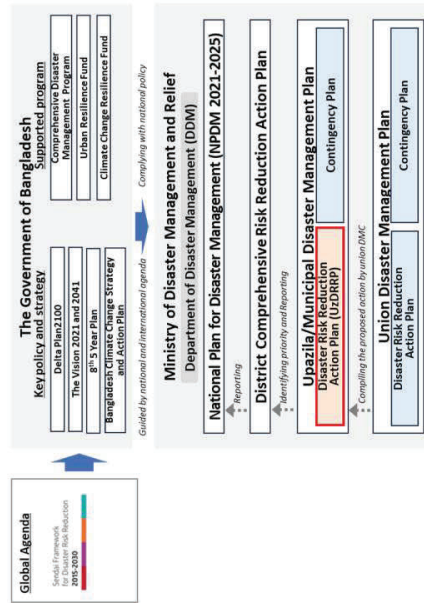


Figure 1-2. Relationship between national key policies and this plan

1.3 Relevance to other Upazila plans

Based on the Local Government (Upazila Parishad and Upazila Administration Reorganization) Act 1998 and the Local Government (Upazila Parishad) Act 2009, each Upazila shall prepare a development plan and land use plan. This plan and the proposed countermeasure against the disasters has been considered to ensure consistency with these plans in this Upazila.

1.4 Features of the Planning

The features of this Planning are 1) Scientific Analysis for Local Hazards, 2) Setting DRR Targets based on Risk Quantification, and 3) Involvement of Project Implementing Agencies, which are expected to contribute to the actual execution of the effective countermeasures.

Feature 1: Scientific Analysis for Local Hazards:

The hazard maps were developed by simplified technical analysis, which processes are not adopted in the Community Risk Assessment (CRA), using observed disaster records of rainfall and tidal level, the Digital Elevation Model (DEM), and current hazard maps. The developed hazard maps represent the vulnerable areas of the Upazila and help promote to objectively understanding of the hazard potential.

Feature 2: Setting DRR Targets based on Risk Quantification:

Risks in this Upazila were quantified based on risk quantification using the hazard maps and various factors such as natural conditions and socio-economic factors and visualized to share with relevant agencies. A DRR target was set in consideration of the result of identifying which areas are highly affected by potential hazards, by these risk quantifications.

Feature 3: Involvement of Project Implementing Agencies:

The Upazila Sub-Committee (UzSC), which is composed of the Upazila chairman, UNO, PIO, engineers from LGED, BWDB, and DPHE in the Upazila, Upazila officials, Union Parishad chairman, was established to identify disaster risks and consider priorities of countermeasures against the disasters at the Upazila level. Since the committee at the Upazila level does not have the authority to determine the countermeasures listed in the plan to be implemented, the members from the line ministries at the central level are involved in the planning processes to promote the schemes/projects listed in the UzDRRAP and secure budgets.

1.5 Methodology for the development of the Plan

1.5.1 Institutional Arrangement

For the development of this Plan, an UzSC, that is stipulated in the SOD, was established in this Upazila. The roles and responsibilities of this committee are to:

- 1) Prepare this UzDRRAP by identifying existing DPPs and pipeline projects related to DRR, Union Parishads (UPs) priority, some development projects that might affect people or increase disaster risk;
- 2) Summarize DRR projects by examining needs of UPs and Risk Reduction Action Plans developed by UPs;
- 3) Identify possible DPP to be able to collaborate among line ministries on structural and non-structural measures to maximize the efficiency and effectiveness of DRR.

In addition to this UzSC at the Upazila level, Technical Sub Committee (TSC) was established to coordinate projects proposed by other Upazilas in addition to Chakaria Upazila at the central level, implementation of the projects proposed in the UzDRRAP are determined by the line ministries at the central level. The roles and responsibilities of this TSC are to:

- 1) Summarize and monitor the progress of the DRR related projects based on the plans that UzSC submitted;
- 2) Request line ministries on the possibility to do further investigation on DRR project needs based on the UzDRRAP;
- 3) Make efforts to integrate DRR ideas into DPP, ADP and SYP in Upazila and line ministries, considering disaster risk reduction target in the UzDRRAP;
- 4) Discuss among line ministries on development projects which might affect people or cause disaster;
- 5) Establish the guidelines and manuals to prepare UzDRRAPs
- 6) Take an initiative to start up UzSCs for preparation of the UzDRRAPs.

1.5.2 Planning Process and Methodology

This plan was established based on a combination of methods, namely JICA 8 steps and the CRA method which has been broadly utilized as a vulnerability assessment in the country, as shown in the figure below. For developing each chapter of this plan, the following methodology was introduced.

Chapter 2: Geographic, Socio-economic, and Meteorological Conditions

This chapter illustrates the characteristics of the Upazila, that is the conditions to develop the Action plan for DRR. The statistics data including the Census 2011 and meteorological data was collected and analyzed.

Chapter 3: Target Hazards and Disaster-prone Areas

This chapter explains the disaster records, target hazards, as well as disaster-prone areas by showing hazard maps. While disaster records of the Upazila were collected by the DRRRO of the district or online media sources, disaster-prone areas were identified through scientific analysis by utilizing data such as elevation data (DEM), probability rainfall data and sea water level data and so on. For flood, the RRI (Rainfall Runoff Inundation) model was introduced. These hazard maps were then confirmed in workshops where the UzDMC members participated.

Chapter 4: Disaster Risk and DRR Targets of the Upazila

This chapter describes the estimations of damages caused by each hazard. The damage estimations of flood and storm surge target paddy fields, settlement areas, as well as the important public facilities and infrastructures, while those for sediment disasters and earthquake shaking target settlement or households. These damages were estimated by overlaying hazard data with statistical data¹, and consequently confirmed by the UzDMC members and the UzSC members in workshops and meetings, along with the priority unions that were set by such disaster risk.

Chapter 5: Action Plan of DRR Countermeasures

This chapter shows the current status and issues of the countermeasures as well as the necessary projects for DRR. The current status of the countermeasures was identified and analyzed by consultation with UzDMC and UzSC members, while the necessary projects were proposed by the UzDMC members. The proposed projects were then validated with line agencies, and prioritized with UzDMC and UzSC members.

¹ The risk assessment was conducted in accordance with the developed guideline – Guideline on Hazard and Risk Assessment.

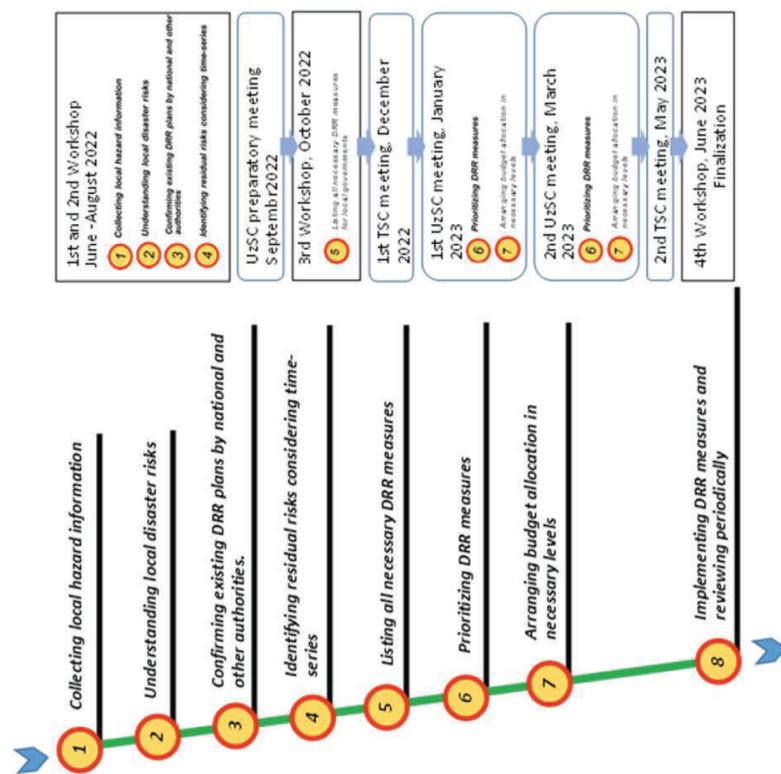


Figure 1-3. "8 Steps" for Upazila DRR Planning in case of this plan

Chapter-2. Geographic, Socio-economic, and Meteorological Conditions

2.1 Location and Geographic Conditions

2.1.1.1 Location of the Upazila

Chakaria Upazila is situated on the coast of the Bay of Bengal in Cox's Bazar District under the Chattogram Division of the south-eastern part of Bangladesh. It is located 98 km south of the divisional headquarter city of Chittagong. It is bounded by Lohagara and Banskhali Upazilas of Chittagong District on the north, Cox's Bazar Sadar and Ramu Upazila on the south, Lama Upazila of Bandarban District on the east, and Mooheshkhali and Pekua Upazilas on the west (Figure 2-1). The area of the Upazila is approximately 530.55 km².



Figure 2-1. Location Map of Chakaria Upazila

2.1.2 Topography of the Upazila

The topography of Chakaria Upazila consists of low-lying plains with an elevation of less than 10 m in the southwest of Road N1, and hilly area with an elevation between 30 and 50 m in the east of Road N1 and the northern area (Figure 2-2). Therefore, the Upazila is vulnerable to flooding due to cyclones and storm surges. The flat area is used for agriculture, salt and shrimp farming, and settlement.

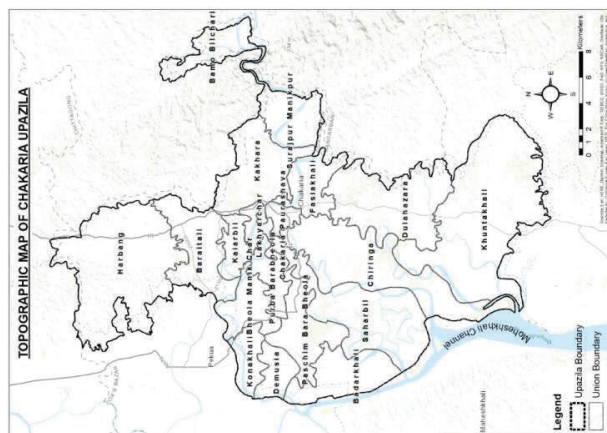


Figure 2-2. Topographic Map

2.1.1.3 River System of the Upazila

Cox's Bazar District has 5 major rivers: Matamuhuri River, Bakkhali River, Nar River, Reju Khal, and Moeshkhali and Kutubdia Channel (Figure 2-3). The Matamuhuri River is especially important among them upon considering the countermeasures against the disasters in the Upazila. The river flows from the Myanmar border to the north, then turns to the west, flows past Lamu Upazila, Chakaria Upazila and Pekua Upazila, and falls into the Kutubdia Channel. At the downstream, the river bifurcates into several branches like Bura Matamuhuri, Manikchhari, Bhola Khal and Rajakhali Khal. The Matamuhuri River with a length of 174 km comprises a basin area of approximately 3,600 km² out of which about 1,400 km² is hilly.

It is an important source of water for irrigation and fishing, and domestic water for the local communities living in its vicinity. Especially, the river contributes agricultural sector having immense role on employment generation, poverty alleviation, food security and nutritional attainment.

It is a tidal river² influenced by tide in the downstream. There are 3 rubber dams; Pekua Rubber Dam, Bhagujira Rubber Dam, and Palakata Rubber Dam, which prevent the tide from entering the upstream of the river during the dry season. The river flows decrease during dry season, causing severe problems for drinking and irrigation water supplies, fisheries, and inland navigation. The average monthly flow of Matamuhuri River at Lama Union varies between $7.67 \text{ cm}^3/\text{s}$ to $95.33 \text{ cm}^3/\text{s}$ ², with high flows between June and August, and low flows between November and April. The water level varies between 6.74 m PWD to 14.65 m PWD. Regular flooding is observed in the river and there are flood embankments along both banks.

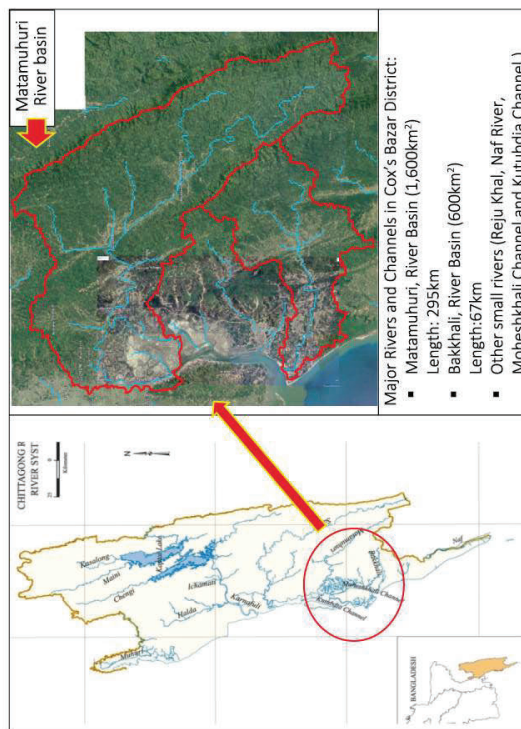


Figure 2-3. Major River and Channels of the Upazila

² IWM (2021), Feasibility Study for Restoration of Sangu and Matamuhuri River Basin

2.2 Socio-economic Conditions

2.2.1 Demography

Chakaria Upazila is divided into 18 unions: Badarkhali, Bamo Bilchari, Baraitali, Bheola Manik Char, Chiringa, Demusia, Dulahazara, Fasiakhali, Harbang, Kaiarbil, Kakhara, Khuntakhali, Konakhali, Lakhyarchar, Paschim Bara Bheola, Purba Barabheola, Saharbil and Surajpur Manikpur. Chakaria Paurashava is divided into 9 Wards and 54 Mahallas. The demography in Chakaria Upazila is shown below. According to the census, 2022, the total population of the Upazila is 571,241 people.

Table 2-1. Demography of the Upazila

Union Name ^a	Total Area (km ²)	Total Population	Number of Households
Badarkhali	17.70	36,700	8,615
Bamo Bilchari	11.89	10,167	2,387
Baraitali	26.30	38,837	9,117
Bheola Manik Char	25.58	24,800	5,822
Chakaria Paurashava	15.77	94,398	22,160
Chiringa	21.67	19,021	4,465
Demusia	8.070	13,397	3,145
Dulahazara	66.77	53,612	12,585
Fasiakhali	17.81	34,351	8,064
Harbang	69.17	44,820	10,522
Kaiarbil	7.97	21,676	5,089
Kakhara	57.01	29,825	7,002
Khuntakhali	77.90	38,730	9,092
Konakhali	10.10	21,770	5,111
Lakhyarchar	5.98	8,974	2,107
Paschim Bara Bheola	25.96	10,732	2,520
Purba Barabheola	45.23	30,823	7,236
Saharbil	10.43	24,480	5,747
Surajpur Manikpur	9.24	14,164	3,325
Total	530.55	571,241	134,111

Source: Population & Housing Census 2022 and interview with Unions

2.2.2 Economy and Industry

According to the Bangladesh Population Census, 2011, Chakaria Upazila has the second lowest poverty and extreme poverty headcount ratios in the District, at 28.5% and 13.2% respectively. These are also lower than the national averages of 31.5% and 17.6% respectively.

^a Union Names within this plan are in accordance with and consistent with the names of the unions in the GIS data set of UN OCHA.

Traditionally, the main economic activities in the Upazila have been agriculture, forestry, salt production and fishery. According to Agriculture Census 2019 for Cox's Bazar District, 31.44% of all labor households is agriculture labor households. Rice is cultivated mainly in the flat lands, however, salt water from the sea continues to destroy soil quality, resulting in more common shrimp farming (Jacaps, 2019). Vegetable cultivation is carried out along the fertile Matamuhuri River. However, water salinity in the soil prevents farmers from large-scale vegetable farming and households continue to rely on access to markets for their own food consumption.

Moreover, in the Upazila that flourishes with fishery and shrimp farming, government plans to develop a smart city for fisheries to tap the potentials of the blue economy through marine fisheries (daily sun, 2023). Chakaria Upazila has more diversified income opportunities due to urbanization and the concentration of hotels and other tourism-related enterprises, as well as Cox's Bazar Sadar Upazila, in the district.

The Upazila plans to strategically promote economic activities as shown in the land use zoning map below.

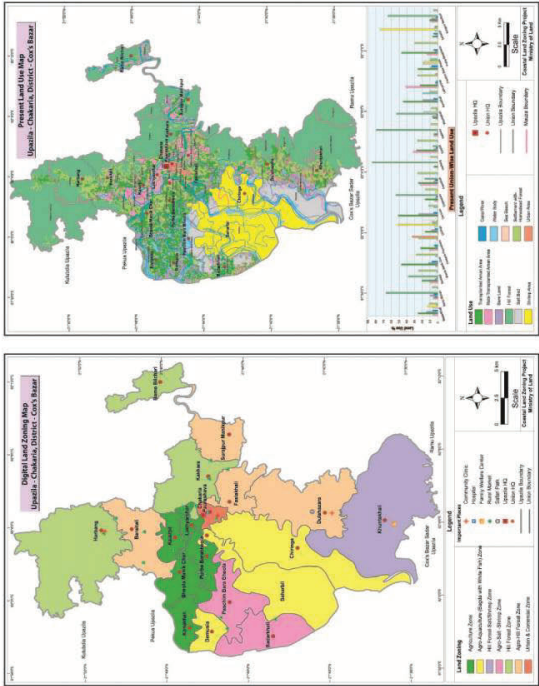


Figure 2-4. Land Use Zoning Map by Ministry of Land, 2023

2.2.3 Urbanization

The rate of Chakaria Upazila is 30.48%, which is high compared to the average rate of Bangladesh of 28.37% (District Development Plan for Cox's Bazar-Phase I, 2019).

The movement of people and goods increases because of development of Chittagong–Cox's Bazar railway and Matarbari Port Access Road between Road N1 and Matarbari Port, may affect urbanization in Chakaria Upazila.

2.3 Meteorological Conditions

The climate of Chakaria Upazila (District) is dominated by the tropical monsoon and is distinguished in 2 seasons: a rainy season and a dry season. The southwest monsoon brings the rainy season from May to October as shown in Figure 2-5. Then, the northeast monsoon flows and dries the area from November to April.

As shown in Figure 2-5, the Upazila has an annual rainfall of more than 3,000 mm. Most rainfall is concentrated during the rainy season, especially the 3 months between June and August, when a half of the annual rainfall occurs. The heavy rainfall often devastates coastal areas and causes flooding. In addition, tropical cyclones generally strike in two seasons, March through July and September through December. They also cause tremendous damage from the thunderstorms, violent winds, heavy rainfall bringing flooding and landslides, and storm surge.

Chakaria Upazila (District) has a high temperature and high humidity climate. The average temperature reaches a maximum of 39.5°C in June, and a minimum of 11.80°C in January (Figure 2-6).

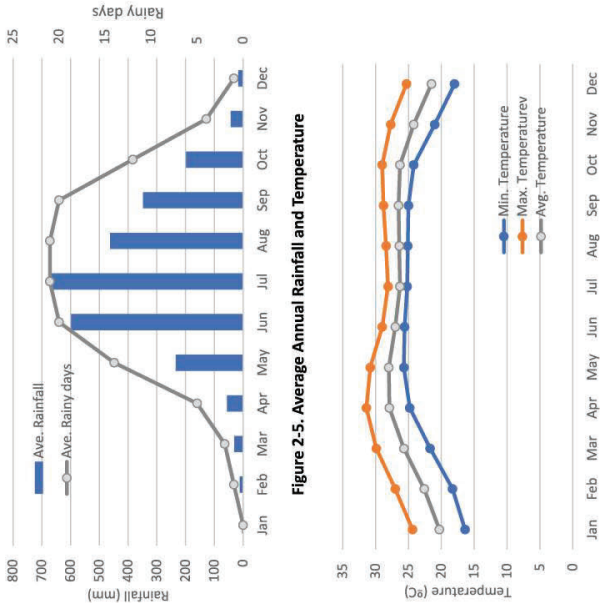


Figure 2-6. Average Temperature

Chapter-3. Target Hazards and Disaster-prone Areas

3.1 Disaster Record of the Upazila

Cox's Bazar District where Chakaria Upazila is located, has experienced several disasters affecting the lives and livelihoods of the local communities, due to its topography and meteorology. The table below shows the disaster records in this Upazila. The most historic and destructive cyclone of 1991 caused the storm surge and fierce winds and severely affected Cox's Bazar District. In addition to the following, damage caused by lightning also occurs in the area.

Table 3-1. Disaster Record in Chakaria, Cox's Bazar since 1970

No.	Year	Upazila	Damage
1. Flood			
(1)	Jun. 2007	Chakaria, Ramu, Sadar and Teknaf Upazilas	Cause: Flash flood by heavy rain Affected families: 25,695 people ⁴ Casualty: 15 dead people and 2 injured people
(2) ⁵	Jun. 2010	Kutubdia, Moheshkhali, Sadar, Pekua, Chakaria and Teknaf Upazilas	Cause: Collapse of embankment along the Bay Affected population: 11,545 people Casualty: 51 dead people Damaged House: More than 800 Damaged Infrastructures: More than 10 km stretch of coastal embankment, school, tube well, and pond Other Damage: livestock, crop, and shrimp/fish culture
(3)	Jul. 2019	7 Upazilas (No detailed information)	Cause: Heavy rain Affected population: 41,280 people ⁶ Casualty: 1 dead people Damaged Infrastructures: river dam and road Other Damage: seed bed
(4)	Jul. 2021	Ukhia and Teknaf Upazilas	Inundation area: 36km ²
(5)	August 2023	Chakaria Upazila ⁷	Cause: Heavy rainfall Affected Area: 187.22 sq. km Affected HHs: 78,100 nos. Affected Population: 3,388 nos., including 13 nos. (including 06 children) of casualties Affected Crops Land: 10788 hectors Affected Fish Cultivation (Pond & Shrimp): 11404.66 hectors. Affected Roads: Pucca – 15.98 km. Bricks – 24.29 km. Earthen Road: 35 km Embankment Damaged: 2,935 km Nos. of Tube-wells and Toilets Damaged: Deep Tube well- 3054, Shallow Tube well-4730, Hand Tube well-3430, Toilet: 26358

⁴ Floods Landslides and Tornadoes Appeal no. MDRBD002, <https://reliefweb.int/report/bangladesh/bangladesh-floods-landslides-and-tornadoes-appeal-no-mdrbd002>

⁵ District Disaster Management Plan for Cox's Bazar, 2014, and Bangladesh: Situation Report No.175 – Flood <https://reliefweb.int/report/bangladesh/bangladesh-situation-report-no175-flood>

⁶ Nirapad, Monsoon Flood Situation, July 16, 2019

⁷ According to the D-form of Chakaria Upazila, EOC, DDM.

No.	Year	Upazila	Damage
2. Cyclone			
(1)	Nov. 1970	-	Cyclone Bhola No detail information in Cox's Bazar District
(2) ⁸	Nov. 1983	Kutubdia, Teknaf, Ukhia Upazila	Cyclone near Cox's bazar Casualty: 300 missing fishermen (incl. other Districts) Damaged House: 2,000 Other Damage: crops
(3)	Apr. 1991	8 Upazilas (No detailed information)	Cyclone Gorky Affected population: 1,121,689 people Casualty: 135,000 to 145,000 dead people ⁹ Damaged Infrastructures: road, bridge, culvert, dam, and school Other Damage: electricity, telecommunication system, industry, livestock, crops/land, salt field, shrimp/fish culture, and natural resources
(4)	Apr. 1994	8 Upazilas (No detailed information)	Cox's Bazar Cyclone Affected population: 390,615 people Casualty: 127 dead people Damaged Infrastructures: road, dam, and school Other Damage: livestock, crops, and shrimp/fish culture
(5)	Nov. 1995	-	Cyclone near Cox's Bazar Casualty: 650 dead people Other Damage: livestock
(6)	May 1997	8 Upazilas (No detailed information)	Cyclone "One Bravo" Affected population: 1,132,174 people Casualty: 34 dead people and 3,516 injured people Damaged Infrastructures: bridge, culvert, dam, and school Other Damage: livestock and shrimp/fish culture
(7)	Nov. 2007	8 Upazilas (No detailed information)	Cyclone "Sidr" Affected population: 855 people. Casualty: 7 dead people. Damaged Infrastructures: road, dam, and school Other Damage: livestock Other Damage: livestock and shrimp/fish culture
(8) ¹⁰	Apr. 2009	Sadar, Ramu, Chakaria, Pekua, Moheshkhali and Kutubdia Upazilas	Cyclone Bilji Affected population: 29,165 people Casualty: 2 dead people Damaged Infrastructures: road and dam Other Damage: crops and salt field
(9)	May 2009	5 Upazilas (No detailed information)	Cyclone Aila Affected population: 77,500 people Casualty: 3 dead people Damaged Infrastructures: embankment Other Damage: crops and salt field
(10)	Jul. 2015	-	Cyclone Komen Affected population: 270,000 people ¹¹ Casualty: 4 dead people

⁸ <https://coloreo.com/bhola-cyclone-the-devasted-natural-disaster-in-bangladesh-in-1970/>

⁹ <https://www.history.com/topics/natural-disasters-and-environment/bangladesh-cyclone-of-1991>

¹⁰ Bangladesh: Disaster Management Information Centre situation report 20 Apr 2009, 11:30 <https://reliefweb.int/report/bangladesh/bangladesh-disaster-management-information-centre-situation-report-20-a-pr-2009>

¹¹ Tropical Cyclone Komen (ECHO Daily Flash of 31 July 2015)

<https://reliefweb.int/report/bangladesh/bangladesh-india-myanmarburma-tropical-cyclone-komen-echo-daily-flash-31-july-2015>

No.	Year	Upazila	Damage
(11)	May 2016	-	Cyclone Roanu Affected population: 8,250 people ¹² Casualty: 3 dead people
(12)	May 2017	Kutubdia, Moleshkhali, Pekua, Ramu, Ukhia, Teknaf Upazilas	Cyclone Mora Affected population: 500,000 people (evacuees from storm surge) Casualty: 5 dead people, 10 injured people and at least 21 missing fishermen Damaged House: 17,000 ¹³
(13)	May 2019	-	Cyclone Fani No detail information for Cox's Bazar District
(14)	May 2020	-	Cyclone Amphan with flooding and landslide No detail information for Cox's Bazar District
(15)	May 2021	Chakaria, Pekua, Cox's Bazar Sadar, Teknaf and St. Martin Upazilas	Cyclone Yaas Damaged Infrastructures: coastal structures, dunes and jetties
(16)	May 2023	-	Cyclone Mocha No detail information for Cox's Bazar District
3. Landslide			
(1)	Jul. 2003	-	Cause: Heavy rain Casualty: at least 6 people ¹⁴
(2)	Jul. 2008	Teknaf Upazila	Cause: Heavy rain Casualty: at least 10 dead and injured people ¹⁵
(3)	Jun. 2010	Ukhia Upazila	Cause: Heavy rain Casualty: at least 20 dead people ¹⁶
(4)	Jun. 2017	-	Cause: Cyclone Mora Casualty: 2 dead people ¹⁷
4. Earthquake			
(1)	Jul. 1999	Moleshkhali Upazila	Magnitude: 5.2 ¹⁸ Casualty: 6 dead people and over 200 injured people Damaged House: More than 700
(2)	Jul. 2003	City of Cox's Bazar and Moleshkhali Union	Magnitude: 5.7 ¹⁹ Buildings developed cracks.

¹² Bangladesh meteorological Department (2017), Report on Cyclone 'Roanu' (Bangladesh meteorological Department)

¹³ Bangladesh | 2017 Severe Cyclonic Storm Mora
<https://reliefweb.int/report/bangladesh/bangladesh-2017-severe-cyclonic-storm-mora-office-un-resident-coordinator-flash-0>

¹⁴ <https://reliefweb.int/report/bangladesh/landslide-kills-six-southeast-bangladesh>

¹⁵ <https://reliefweb.int/report/bangladesh/landslide-kills-10-bangladesh-several-injured>

¹⁶ Bangladesh: Landslides - Situation Report No.176, <https://reliefweb.int/report/bangladesh/bangladesh-landslides-situation-report-no176>

¹⁷ Emergency Response Coordination Centre (ERCC) – DG ECHO Daily Map | 14/06/2017

<https://reliefweb.int/map/bangladesh/bangladesh-landslides-dg-echo-daily-map-14062017>

¹⁸ <https://earthquake.usgs.gov/earthquakes/eventpage/usp0009bys/executive>

¹⁹ <https://earthquake.usgs.gov/earthquakes/eventpage/usp000c3ex/executive>

3.2 Target Hazards of this Plan

Apart from the above, there are several types of other disasters that can also cause damage to this Upazila. This plan targets all the possible hazards in the Upazila including lightning and drought, whereas it was decided that the following hazards were objectively and scientifically analyzed and shown by maps to identify the spatial distribution of hazard potentials in the Upazila in terms of relatively frequency and potential for occurrence.

- Flood
- Storm surge
- Sediment disaster
- Earthquake shaking

3.3 Hazard Map and Disaster-Prone Areas by Each Hazard

3.3.1 Flood

Figure. 3-1 shows a flood hazard map for Chakaria Upazila estimated by using a 2-days rainfall of 20-year return period. According to the map, the area along the Matamuhuri River and its tributaries are most prone to flooding in Chakaria Upazila. In particular, while more than 80 % of total areas in Bheola Manik Char, Demusia, Konakhali, Lakhyarchar, Paschim Bara Bheola Unions and Chakaria Paushava are at risk of inundation with an estimated depth of 0.3m and over, Chiringa Union has the largest flood risk areas with 2,923 ha of said inundation depth including some areas with the estimated inundation depth of more than 1.8m. The Matamuhuri River divides into two major distributaries around the joining point of boundaries of Kaiarbil, Lakhyarchar and Bheola Manik Char unions. These distributaries are situated at low-lying areas where the flat terrain prevents smooth drainage. Along the distributary flowing to the west side of the Chakaria Upazila, Badarkhali, Bheola Manik Char, Demusia and Konakhali Unions are highly affected, while along the other distributary flowing to the southern side of the Upazila, Chiringa, Paschim Bara Bheola and Saharbil Unions are inundated due to flooding in canals as well. On the upstream side of these distributaries, Baraitali, Kaiarbil, Kakhara, Lakhyarchar Unions and Chakaria Paushava are affected by river flooding. Harbang and Khuntakhali Unions which are located at higher elevation areas and have no major rivers, are less prone to flooding. Although Matamuhuri River runs through Bamo Bilchari Union, rainfall in this area flows relatively quickly into the river due to steep topography. Therefore, Bamo Bilchari Union is also less prone to flooding. However, it does not mean these areas are completely safe against flood disaster.

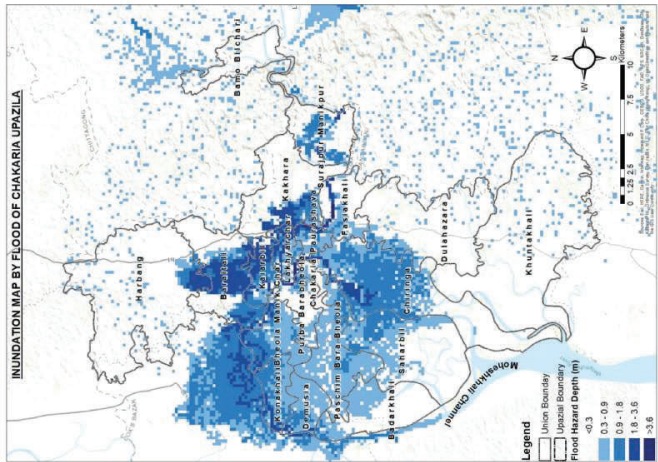


Figure 3-1. River Floods Hazard map in Chakaria

Analysis:
Probability year: 2-days Rainfall for 20-year Return Period (427mm: Ref. JICA Study for Matarbari Sea Port in 2018)
Landform: Satellite-based DEM (AW3D)
Land Cover (Soil Condition): Bangladesh Soil Map available on-line

Notes:

1. In consideration of the complex flooding condition along the two major distributaries at downstream of the Matamuhuri River, the flood hazard map was developed by integrating two results of flood simulation assuming different diversion patterns toward the west side and the southern side of the Chakaria Upazila.
2. Hazard was estimated under no existing embankments of polders.
3. The hazard analysis and risk assessment (Chapter 4.1.1) introduced in this plan does not consider the possible effects of the climate change.
4. When viewing the flood hazard map, users are recommended to consider the elevation of their houses or unions and compare them with the flood depths indicated in the map.
5. Overlaying evacuation routes and shelter locations with the map, is helpful to identify where and how to evacuate before and during flood events.

Figure 3-2 shows a 50-year probability and 100-year probability flood hazard map for this Upazila. As these maps show, the flood affected areas along the Matamuhuri River are likely to expand with deeper depth of inundation, especially at the lower sections of the river such as Chiringa, Demusia, Konakhali, Bheola Manik Char, Paschim Bara Bheola and Saharbilthe Unions. For other Unions, especially in Baraitali, Kaiarbil, Fasiakhali, Chakaria Paushava and Lakhvarchar, the extent of flooding is not much different compared to the situation with a 20-year probability flood, but the risk to human life is considered to be higher due to the increase in the area with flood depth of 0.9 m or greater.

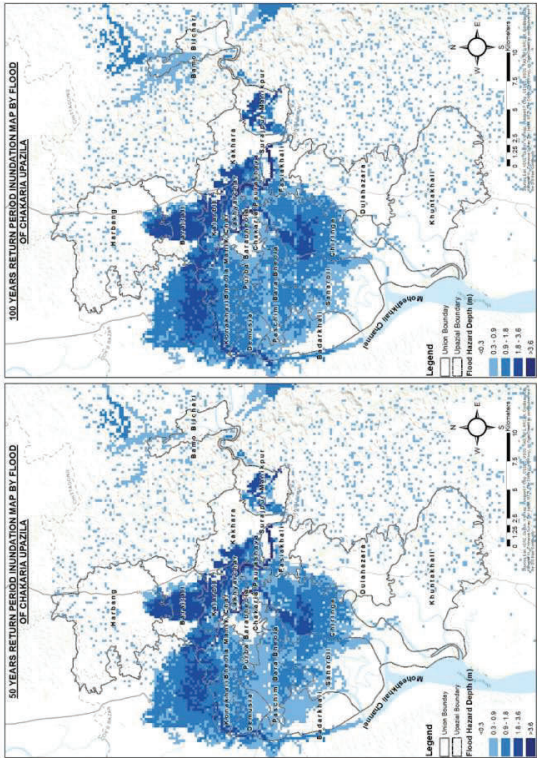


Figure 3-2. River floods hazard maps of large-scale disasters
(Left: 50-year return period, Right: 100-year return period)

Analysis:
Probability year: 2-days Rainfall for 50-year Return Period and 100-year Return Period (50-year - 469mm, 100-year - 511mm: Ref. JICA Study for Matarbari Sea Port in 2018)
Landform: Satellite-based DEM (AW3D)
Land Cover (Soil Condition): Bangladesh Soil Map available on-line
Notes: See the Notes of Figure 3-1

3.3.2 Storm Surge

Figure 3-3 shows a 20-year probability storm surge hazard map for Chakaria Upazila. According to the map, the areas along canals connected to Moheshkhali Channel is vulnerable to inundation by the storm surge. The inundation in these areas caused by the storm surge running up the Channel. The depth of flooding is generally more than 0.9m, and locally it reaches more than 1.8m in some areas.

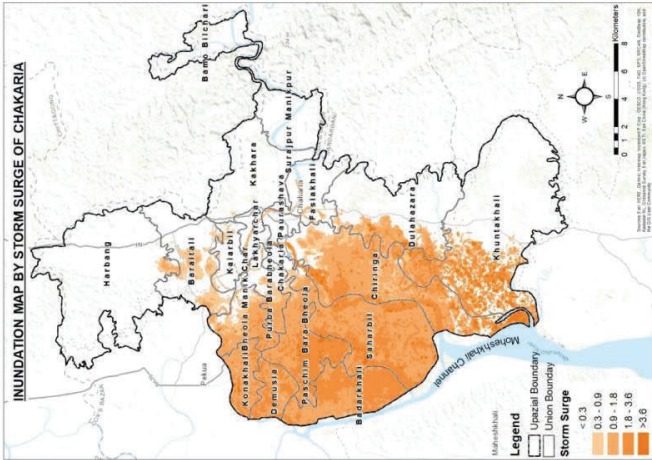


Figure 3-3. Storm Surge Hazard map in Chakaria

Analysis:
Probability year: 20-year probability storm surge estimated based on probabilistic analysis by using the historical tide observation data.
Landform: Satellite-based DEM (AW3D)

Notes:

1. The results of the probabilistic analysis might be changed if a severe disaster occurs. The inundation area might be larger if much larger disasters are considered.
2. Hazard was estimated under no existing embankments of polders.
3. The water level is assumed completely flat from coastline to inland.
4. The hazard analysis and risk assessment (Chapter 4.1.2) introduced in this plan does not consider the possible effects of the climate change.

Figure 3-4 shows a 50-year probability and 100-year probability of storm surge hazard map for this Upazila. As these maps shows, the storm surge affected areas are almost the same as those of 20-year probability storm surge, although the inundation depth and area are gradually increased. The reason is because the slope of the probability function of storm surge is relatively gentle based on the results of tide observation.

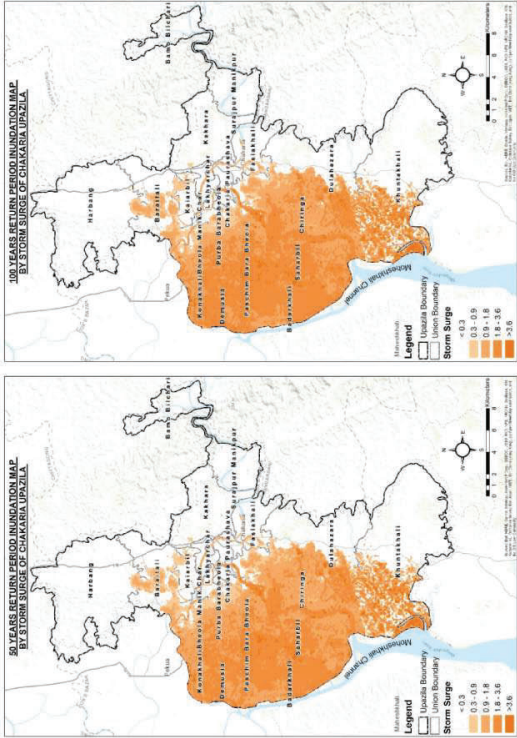


Figure 3-4. Storm surge hazard maps of large-scale disasters
(Left: 50 year return period, Right:100 year return period)

Analysis:
Probability year: 50-year and 100-year probability storm surge estimated based on probabilistic analysis by using the historical tide observation data.
Landform: Satellite-based DEM (AW3D)
Note: See the Notes of Figure 3-3

3.3.3 Sediment Disasters

3.3.3.1 Slope Failure

According to the slope failure hazard map as shown in Figure 3-5, in Chakaria Upazila, slope failure can occur mainly in Harbang, Baraitali, Kakhara, Surajpur manikpur, and Bamo Blichari Unions with steep slopes. In these areas, it is observed that many steep slopes have been formed by slope cutting for road and house and building construction without any countermeasure. The mechanisms of disasters are mainly slope failures behind roads and settlements and falling rocks and fallen trees from the upper slopes, triggered by above-normal rainfall and earthquakes.

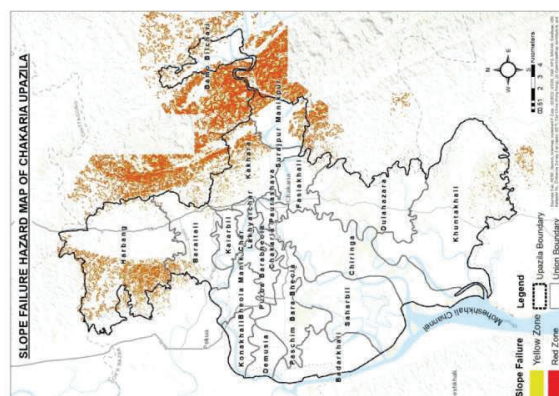


Figure 3-5. Slope Failure Hazard Map in Chakaria

<Red Zone:>

Area where there is a high risk of damage to buildings and threat to people. The force acting on buildings due to moving debris and earth of landslides in the Red Zone is expected to be larger than the resistance capacity of normal buildings. Therefore, normal buildings in Red Zone would be completely destroyed by the moving debris and earth of landslide.

<Yellow zone:>

Area that is susceptible to landslide. The resistance capacity of normal buildings in Yellow Zone is expected to be larger than the force acting on buildings due to the moving debris and earth of landslide.

Analysis:

Hazard zone: Calculated by using GIS software and an application elaborated by the Project Team

topographic map of SOB. (Resolution: 5m)

Notes:

1. It is a simplified method to calculate Hazard Zones (Red and Yellow zones) based only on topographic information.
2. The map shows areas where disaster can occur triggered by heavy rain fall and earthquake.
3. It is recommended to monitor precursor phenomenon such as small rocks falling from the slope, occurrence of cracks in the cliff, water gushing out from the cliff, springs water drying up, river water turbidity (muddy water flow), etc.

3.3.3.2 Debris Flow

The debris flow can occur in the hilly area of Harbang, Baraitali, Kakhara, Surajpur Manikpur, and Bamo Bilchari Unions, and at the border between Dulahazara and Khuntakhali Unions.

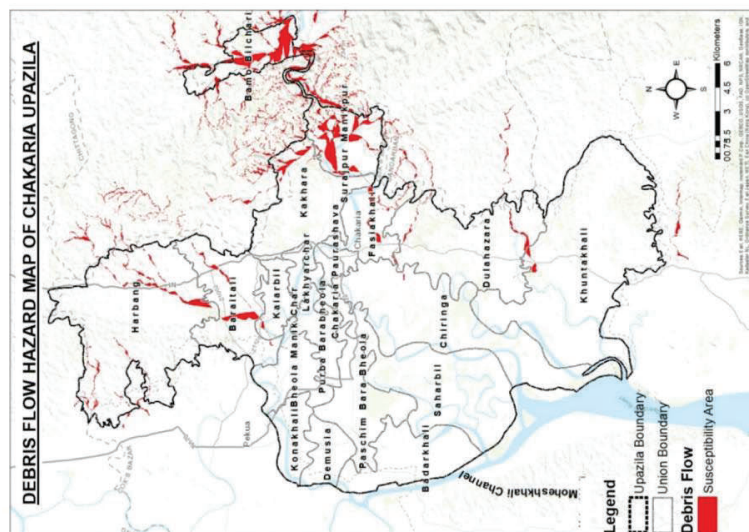


Figure 3-6. Debris Flow Hazard Map in Chakaria

Analysis:

The algorithm to calculate debris flow hazard levels is based on Flow-R algorithm.

3.3.4 Earthquake Shaking

Figure 3-7 shows an earthquake shaking hazard map for Chakaria Upazila. The earthquakes in the Cox's Bazar District can be mainly caused by the collision of the Indian and Eurasian tectonic plates, which creates a complex fault system in the region. The southwestern regions, where low-lying area extend, are estimated with relatively weak shaking rather than other unions.

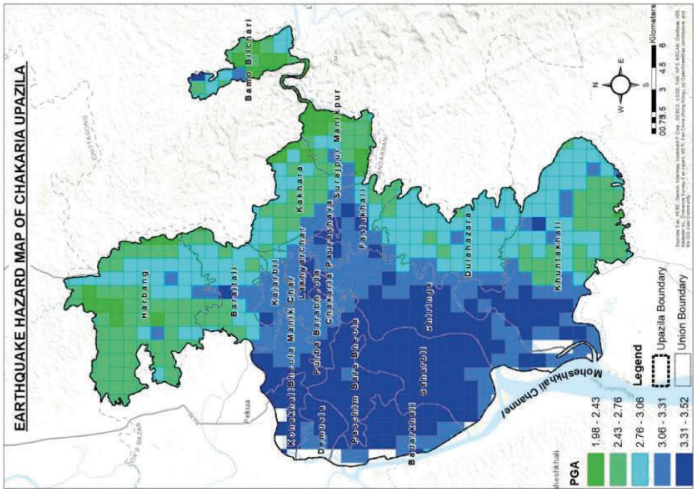


Figure 3-7. Earthquake Hazard map in Chakaria

- Analysis:
- 1. The PGA was estimated considering the ground conditions in Cox's Bazar Sadar Upazila based on the seismic zoning described in the Bangladesh National Building Code (BNBC) 2020.
 - 2. V30 model: the time-averaged shear-wave velocity to 30 m depth <<https://earthquake.usgs.gov/data/vs30/>>
 - 3. Formula for estimation of the surface soil amplification factor: Midorikawa et al. (1994) <https://isee.kenken.go.jp/eqflow/reference/4_1.htm>
- Notes:
- 1. Hazard maps are not perfect. Actual situations may not follow the hazard maps exactly.
 - 2. Each union shows also various PGA values based on its characteristic local topography and on-site sediment conditions.
 - 3. The estimated results should be re-calculated if the reference data or assumptions are updated.

Chapter-4. Disaster risk and DRR Targets of the Upazila

4.1 Disaster risk

4.1.1 Flood

The flood risk in the Upazila was estimated focusing on three major assets to be protected: paddy fields, settlement areas, as well as important infrastructures and public facilities. By overlaying the flood hazard map on these areas, the affected areas can be identified.

In general, the countermeasures against flood include 1) river and canal improvement such as construction of embankments, dredging and widening to increase flow capacity, 2) construction of retarding basins/reservoirs to temporarily store a portion of flood water, and 3) drainage improvement such as installation of sluice gates and pumping stations to drain the flood water to nearby rivers.

(1) Damage estimation of paddy field affected by flood

As shown in Figure 4-1 and Figure 4-2, the most vulnerable union to flooding is Chiringa Union with low-lying area along tributaries from Matamuhuri River. The inundation area is approximately 1,040 m2. In particular, 70 % of the inundated area in Chiringa Union has a flooding depth of more than 0.9m.

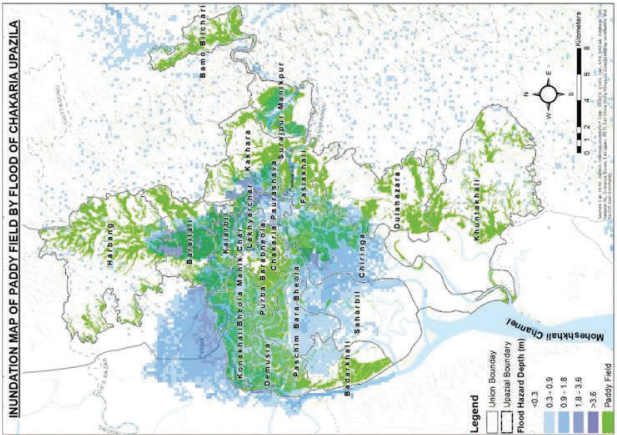


Figure 4-1 Inundated Paddy Field by 20-year Return Period Flood

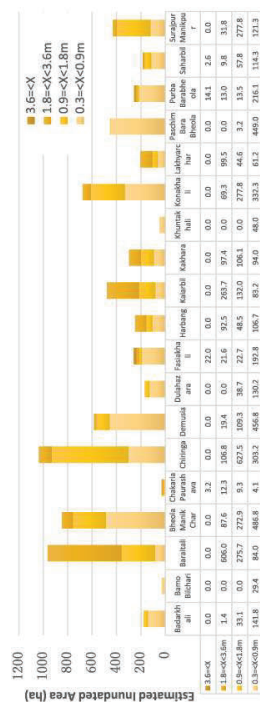


Figure 4-2. Inundated Area of Paddy Field by 20-year return period flood

Total Economic loss estimated based on the areas of the inundated paddy fields, reaches about 1,439 million Taka. Chiringa Union is most affected with about 202 million, followed by Baraitali Union with 188 million Taka, and Rheola Manik Char Union with 165 million Taka.

Table 4-1. Estimated Economic Loss by Flood

Union	Area of Inundated Paddy Field (≥ 0.3m) [ha]	Ratio (Inundated Area / All Paddy Field)	Estimated Economic Loss [Thousand Taka]
Badarkhali	176.35	25.2%	34,379
Bamo Bilchhari	29.38	5.1%	5,727
Baraitali	965.74	68.4%	188,272
Bheola Manik Char	847.24	91.9%	165,169
Chakaria Paurashava	28.96	83.5%	5,646
Chiringa	1037.57	88.5%	202,274
Demusia	585.49	91.6%	114,141
Dulahazara	168.85	15.9%	32,917
Fasiakhali	259.19	36.1%	50,530
Harbang	247.73	15.5%	48,295
Kalarbil	478.87	90.3%	93,357
Kakhara	297.53	33.1%	58,004
Khuntakhali	47.96	4.0%	9,350
Konakhali	679.42	97.8%	132,454
Lakhyachar	205.34	86.1%	40,030
Paschim Bara Bheola	452.21	70.5%	88,158
Purba Barabheola	256.65	46.0%	50,035
Saharbil	184.49	59.3%	35,967
Surajpur Manikpur	430.86	61.3%	83,995
Total	7379.84	50.6%	1,438,699

Notes: 1. 5.57 ton/ha of rice yield was used to estimate amount of affected rice production, which is based on data in "Yearly Production and Damage Report on Agriculture of Cox's Bazar Sadar Upazilla, DAE" (2019, 2020 and 2021). <https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0261128>

2. The Unit price of rice was calculated with the data above (Note 1), to be 35 Taka/kg.

(2) Damage estimation of settlement area by flood

Figure 4-3 shows that the low-lying areas of the tributary's basin from Matamuhuri River, are most severely affected by the flooding. Comparing the affected settlement areas by the union, Chiringa Union is the most affected with approximately 450 m². The flooding depth in the Upazila ranges from 0.3 m to 3.6m in most areas.

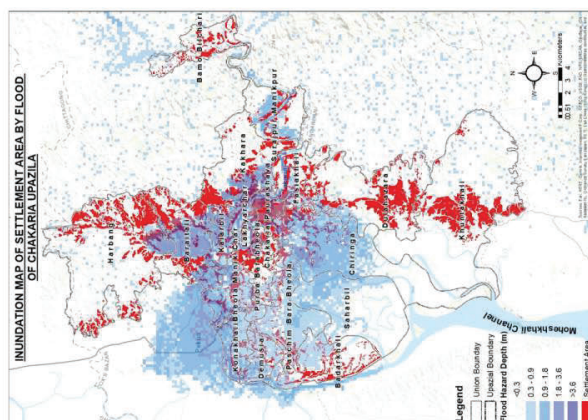


Figure 4-3 Inundated Settlement by 20-Year Return Period Flood

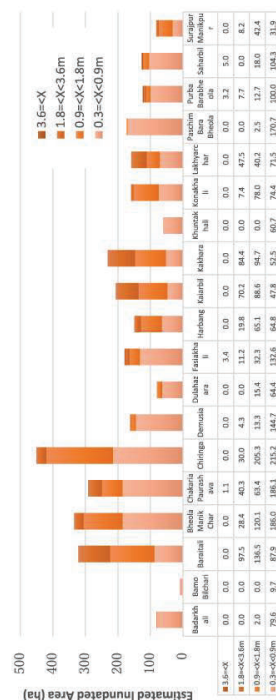


Figure 4-4. Inundated Area of Settlement by 20-Year Return Period Flood

In terms of the population numbers, Chakaria Paurashava is the most vulnerable to flooding, while the Union with the highest percentage of affected population is Konakhali Union, followed by Bheola Manik Char, Demusia, and Lakhyarchar Unions (Figure 4-5 and Table 4-2).

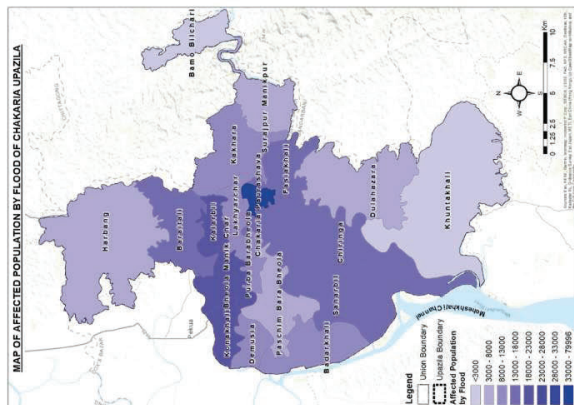


Figure 4-5. Affected Population by 20-Year Return Period Flood

Table 4-2. Flood Affected Population by Union

Union	Population (Census, 2022)	Affected Population	Percentage
Badarkhali	36,715	8,158	22.2%
Bamo Bilchari	10,176	341	3.4%
Baraitali	38,837	14,486	37.3%
Bheola Manik Char	24,800	22,741	91.7%
Chakaria Paurashava	94,398	79,996	84.7%
Chiringa	19,921	17,119	85.9%
Demusia	13,397	12,176	90.9%
Dulahazara	53,612	3,994	7.4%
Fasiakhali	34,391	13,638	39.7%
Harbang	40,820	4,787	11.7%
Kaibail	22,676	19,630	86.6%
Kakhara	29,825	9,960	33.4%
Khuntakhali	38,730	2,186	5.6%

Union	Population (Census, 2022)	Affected Population	Percentage
Konakhali	22,770	22,687	99.6%
Lakhyarchar	8,974	8,114	90.4%
Paschim Bara Bheola	10,732	7,622	71.0%
Purba Barabheola	31,823	11,491	36.1%
Saharbil	24,480	15,146	61.9%
Surajpur Manikpur	14,164	5,358	37.8%
Total	571,241	279,630	49.0%

(3) Damage estimation of important facilities and infrastructures by flood

Figure 4-6 and Table 4-3 illustrate the damage estimation of the DRR-related important facilities and infrastructures in this Upazila, namely roads and bridges, government offices, schools and shelters, and hospitals, in consideration of the disaster management and emergency operation. As the Figure and the Table show, roads and public facilities in Konakhali, Demusia, Bheola Manik Char, and Lakhyarchar Unions are relatively severely affected by the flood.

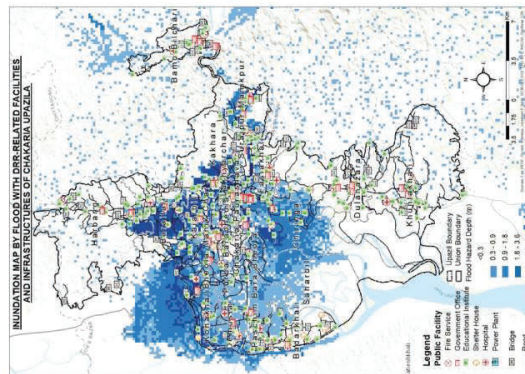


Figure 4-6. Inundation map by flood with DRR-related facilities and infrastructures²⁰

²⁰ In this analysis, the facilities means government facilities (government office, government miscellaneous buildings, Paurashava office, Upazila office, Union Parishad office, fire service, police station, telephone office), education institutions (college/institute, educational miscellaneous buildings, high school, Madrasa, NGO school, Primary school), Shelter House, and health building (Community clinic, Government hospitals, NGO hospital), and Power plant that are in the dataset of SOB. The data may not show all the current facilities and infrastructures and does not always show the exact locations due to its research/published year and its data scale.

Data source: SOB: "This map sheet has been compiled by digital photogrammetric method using colored aerial photographs of 50cm GSD taken during 2010-12 and also SPOT imagery of 2.5 m resolution acquired in 2011 and verified on the ground during 2014-2015.
Flood hazard map of 20-year return period (see Chapter 3.3.1)

Table 4-2. Flood Affected Population by Union

Union Name	Road length (m)			DRR-related important facilities (no.)			(Reference) Bridges		
	Total	Inundated (≥0.3m)	%	Total	Inundated (≥0.3m)	%	Total	Inundated (≥0.3m)	%
Badarkhali	68,457.5	26,109.5	38.1%	58	14	24.1%	15	2	13.3%
Bamo	27,009.0	857.3	3.2%	17	0	0.0%	15	0	0.0%
Bilchari	92,351.7	55,803.5	60.4%	27	20	74.1%	4	2	50.0%
Bheola	56,739.2	50,695.2	89.4%	20	19	95.0%	3	3	100.0%
Manik Char	58,628.4	37,294.4	63.6%	20	14	70.0%	4	3	75.0%
Chakaria	62,828.6	43,092.9	68.6%	31	27	87.1%	3	3	100.0%
Paurashava	25,044.6	22,832.6	91.2%	13	13	100.0%	5	5	100.0%
Chiringa	65,146.4	2,575.9	4.0%	41	0	0.0%	8	1	12.5%
Demulia	37,759.1	14,987.6	39.7%	25	5	20.0%	8	1	12.5%
Fasakhali	68,045.8	13,828.0	20.3%	29	12	41.4%	9	1	11.1%
Harbang	18,347.2	15,946.6	86.9%	17	15	88.3%	2	2	100.0%
Kaarpil	36,206.5	20,186.9	55.8%	28	17	60.7%	6	1	16.7%
Kakhara	71,315.7	4,045.9	5.7%	27	1	3.7%	11	0	0.0%
Khuntakhali	9,417.4	9,304.6	98.8%	8	8	100.0%	3	2	66.7%
Konakhali	8,688.4	7,897.2	90.9%	11	10	90.9%	1	1	100.0%
Lakhyarchar	40,497.1	28,954.1	71.5%	20	14	70.0%	4	1	25.0%
Paschim	24,102.2	10,519.4	43.7%	19	7	36.8%	4	1	25.0%
Purba	4,988.5	2,362.2	47.4%	7	6	85.7%	1	0	0.0%
Barabheola	21,617.2	10,960.7	50.7%	21	10	47.6%	7	4	57.1%
Saharbil									
Surajpur									
Manikpur									

4.1.2 Storm Surge

The storm surge risk in the Upazila was estimated focusing on three major assets to be protected: paddy fields, settlement areas, as well as important infrastructures and public facilities. By overlaying the storm surge map on these areas, the affected areas can be identified.

Generally, the countermeasures against storm surge include 1) construction of dyke, seawall/guide wall and revetments along the coastline to protect inland areas, and 2) construction of river embankments to prevent rivers from overtopping when seawater running up through rivers.

(1) Damage estimation of paddy field affected by storm surge

As shown in Figure 4-7 and Figure 4-8, the most vulnerable unions to storm surge is Chiringa Union along canals connected to Moheshkhali Channel. The inundation areas are approximately 980 m2. Especially, 70% of the affected area in Chiringa Union has a flooding depth of more than 0.9m.

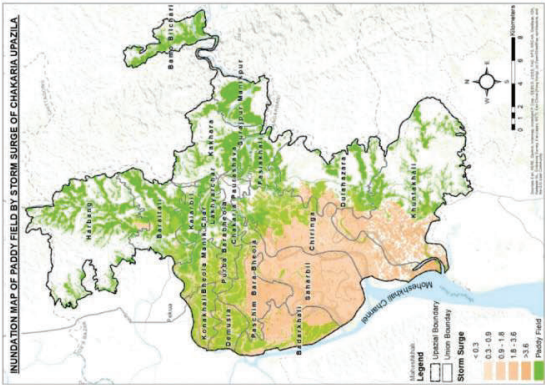


Figure 4-7. Inundated Paddy Field by 20-Year Return Period Storm Surge

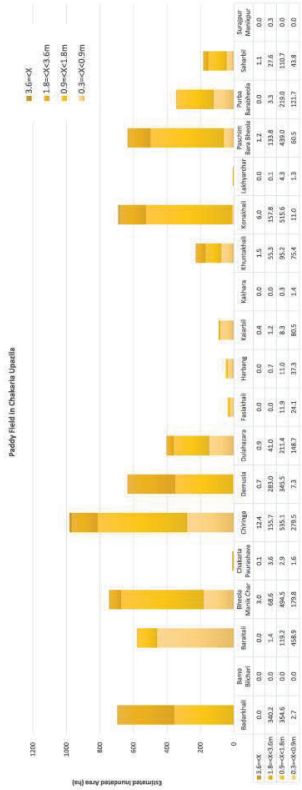


Figure 4-8. Inundated Area of Paddy Field by 20-year Return Period Storm Surge

Total Economic loss estimated based on the areas of the inundated paddy fields, reaches about 1,231 million Taka. Chiringa Union is most affected with about 191 million, followed by Bheola Manik Char Union with 145 million Taka.

Table 4-4. Estimated Economic Loss by Storm Surge

Union	Area of Inundated Paddy Field (≥ 0.3m) [ha]	Ratio (Inundated Area / All Paddy Field)	Estimated Economic Loss [Thousand Taka]
Badarkhali	697.57	99.7%	135,992
Bamo Bilchhari	0.00	0.0%	0
Baraitali	579.47	41.0%	112,968
Bheola Manik Char	745.99	81.0%	145,430
Chakaria Paurashava	8.12	23.4%	1,582
Chiringa	982.72	83.8%	191,582
Demusia	636.42	99.6%	124,070
Dulahazara	401.98	37.7%	78,365
Fasiakhali	36.03	5.0%	7,025
Harbang	48.92	3.1%	9,537
Kaiarbil	90.38	17.1%	17,620
Kakhara	1.63	0.2%	318
Khuntakhali	227.47	19.1%	44,346
Konakhali	690.47	99.4%	134,608
Lakhyachar	5.67	2.4%	1,106
Paschim Bara Bheola	634.47	98.9%	123,689
Purba Barabheola	343.89	61.7%	67,042
Saharbil	183.30	58.9%	35,735
Surajpur Manikpur	0.27	0.0%	53
Total	6314.79	43.3%	1,231,068

Notes: 1. 5.57 ton/ha of rice yield was used to estimate amount of affected rice production, which is based on data in "Yearly Production and Damage Report on Agriculture of Cox's Bazar Sadar Upazila, DAE" (2019, 2020 and 2021). <https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0261128>

2. The Unit price of rice was calculated with the data above (Note 1), to be 35 Taka/Kg.

(2) Damage estimation of settlement area by storm surge

Figure 4-9 shows that the areas on the left side of the Moheshkhali Channel and Matamuhuri River are most severely affected by the flooding of the channel, river and canals in the polder connected to the channel and river. Comparing the affected settlement areas by the union, Badarkhali, Bheola Manik Char and Chiringa Unions are the most affected with approximately 360 m², 300 m² and 300 m², respectively. The flooding depth in these unions ranges from 0.9 m to 3.6 m in more than half of the areas.

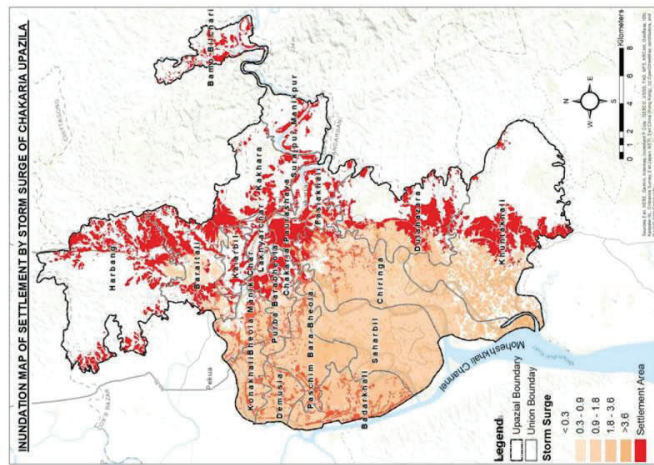


Figure 4-9. Inundated Settlement by 20-year Return Period Storm Surge

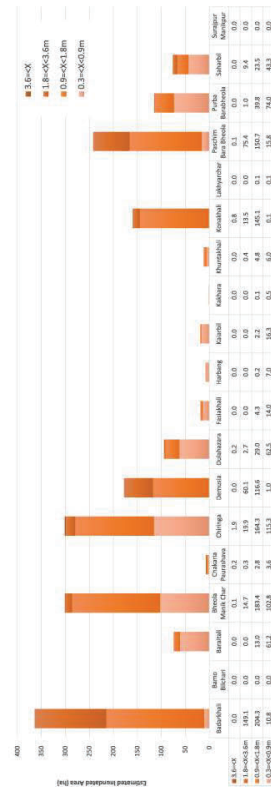


Figure 4-10. Inundated Area of Settlement by 20-year Return Period Storm Surge

In terms of the population numbers, Badarkhali Union is the most vulnerable to flooding, while the unions with the highest percentage of affected population are Demusia, Konakhali, Badarkhali, and Paschim Bara Bheola Unions (Figure 4-11 and Table 4-4).

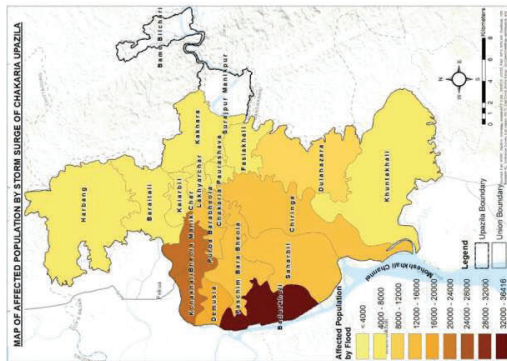


Figure 4-11. Affected Population by 20-Year Return Period Storm Surge

Table 4-5. Storm Surge Affected Population by Union

Union	Population (Census, 2022)	Affected Population	Percentage
Badarkhali	36,715	36,416	99.2%
Bamo Blichari	10,176	0	0.0%
Baraitali	38,837	3,343	8.6%
Bheola Manik Char	24,800	20,471	82.5%
Chakaria Paurashava	94,398	1,914	2.0%
Chiringa	19,921	11,457	57.5%
Demusia	13,397	13,335	99.5%
Dulahazara	53,612	4,719	8.8%
Fasakhali	34,391	1,395	4.1%
Harbang	40,820	234	0.6%
Kalarbi	22,676	1,758	7.8%
Kakhara	29,825	24	0.1%
Khuntakhali	38,730	402	1.0%
Konakhali	22,770	22,644	99.4%
Lakhyarchar	8,974	10	0.1%
Paschim Bara Bheola	10,732	10,646	99.2%

Union	Population (Census, 2022)	Affected Population	Percentage
Purba Barabheola	31,823	10,670	33.5%
Saharbi	24,480	9,064	37.0%
Surajpur Manikpur	14,164	0	0.0%
Total	571,241	148,502	26.0%

(3) Damage estimation of important facilities and infrastructures by Storm Surge

Figure 4-12 and Table 4-6 illustrates the damage estimation of the DRR-related important facilities and infrastructures in this Upazila, namely roads and bridges, government offices, schools and shelters, and hospitals, in consideration of the disaster management and emergency operation. As the Figure and the Table show, roads and public facilities in Badarkhali, Demusia, Konakhali and Paschim Bara Bheola Unions are relatively severely affected by storm surge.

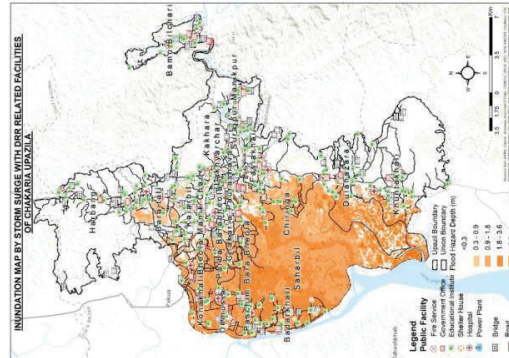


Figure 4-12. Inundation map by storm surge with DRR-related facilities and infrastructures²¹

Data source: SOB: "This map sheet has been compiled by digital photogrammetric method using colored aerial photographs of 50cm GSD taken during 2010-12 and also SPOT imagery of 2.5 m resolution acquired in 2011 and verified on the ground during 2014-2015.

Storm Surge hazard map of 20-year return period (see Chapter 3.3.2)

²¹ In this analysis, the facilities means government facilities (government office, government miscellaneous buildings, Paurashava office, Upazila office, Union Parishad office, fire service, police station, telephone office), education institutions (college/institute, educational miscellaneous buildings, high school, Madrasa, NGO school, Primary school), Shelter House, and health building (Community clinic, Government hospitals, NGO hospital), and Power plant that are in the dataset of SOB. The data may not show all the current facilities and infrastructures and does not always show the exact locations due to its research/published year and its data scale.

Table 4-6. Storm Surge affected facilities and infrastructure by Union

Union Name	Road length (m)		DRR-related important facilities (no.)		(Reference) Bridges	
	Total	Inundated (≥0.3m)	%	Total	Inundated (≥0.3m)	%
Badarkhali	68,457.5	68,457.5	100.0%	58	15	100.0%
Bamo Blichari	27,009.0	0.0	0.0%	17	0	0.0%
Baraitali	92,351.7	58,043.7	62.9%	27	5	18.5%
Bheola Manik Char	56,739.2	54,875.5	96.7%	20	19	95.0%
Chakaria	58,628.4	29,085.3	49.6%	20	0	0.0%
Paurashava	62,828.6	56,459.2	89.9%	31	14	45.2%
Chiringa	25,044.6	25,044.6	100.0%	13	13	100.0%
Demusia	65,146.4	11,913.4	18.3%	41	0	0.0%
Dulahazara	37,759.1	4,896.2	13.0%	25	0	0.0%
Fasiakhali	68,045.8	3,707.0	5.4%	29	0	0.0%
Harbang	18,347.2	2,509.9	13.7%	17	2	11.8%
Kaiarbil	36,206.5	2,237.3	6.2%	28	0	0.0%
Kakhara	71,315.7	23,386.0	32.8%	27	0	0.0%
Khuntakhali	9,417.4	9,417.4	100.0%	8	8	100.0%
Konakhali	8,688.4	2,406.7	27.7%	11	0	0.0%
Lakhyarchar	40,497.1	40,497.1	100.0%	20	20	100.0%
Paschim Bara Bheola	24,102.2	18,165.4	75.4%	19	5	26.3%
Purba Barabheola	4,988.5	2,787.6	55.9%	7	1	14.3%
Saharbil	21,617.2	0.0	0.0%	21	0	0.0%
Surajpur Manikpur						

4.1.3 Sediment Disaster

Figure 4-13 shows that, in Chakaria Upazila, sediment disaster risk is concentrated around north and north-east area of the Upazila, namely Harbang, Bamo Blichari, Baraitali and Kakhara Unions. In Harbang Union, 4.8 % of settlement area, which is 61.18 ha, was evaluated as the red and yellow areas and it was estimated that about 2,000 people lives in these areas (Figure 4-15 and Table 4-7). Especially, 70 % of affected people are included in the red zone.

Generally, the countermeasures against sediment disasters include 1) slope stabilization /Retaining walls and rock-fall prevention to protect settlement areas from slope failures and rock falling, and 2) restrictions of development activities.

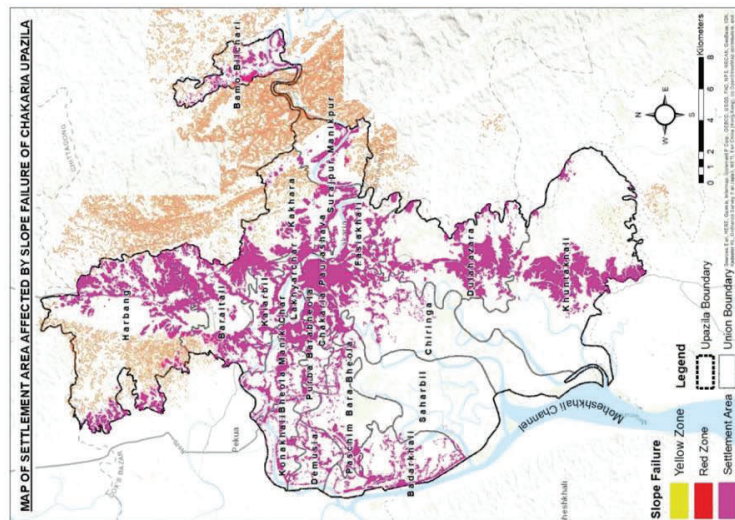


Figure 4-13. Affected Settlement by Slope Failure

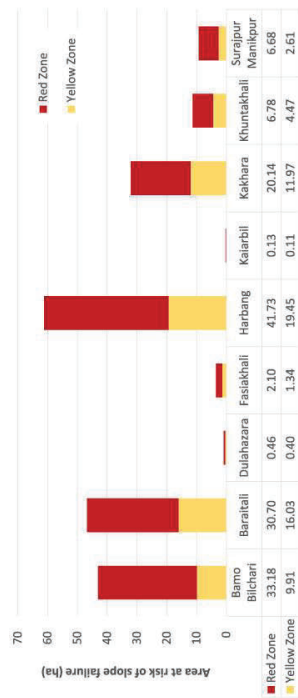


Figure 4-14. Settlement Area Affected by Slope Failure

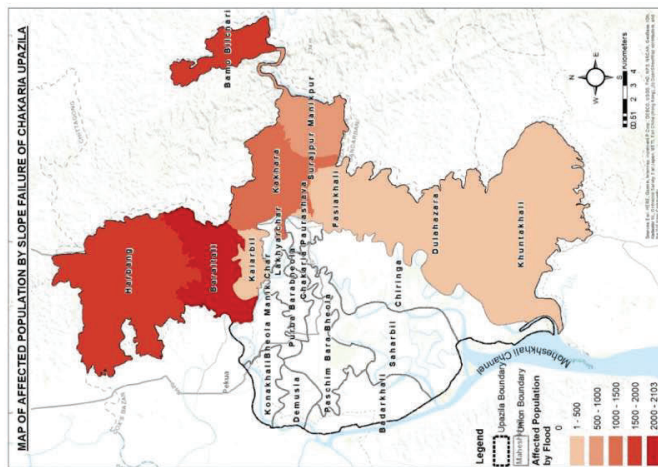


Figure 4-15. Affected Population by Slope Failure

Table 4-7. Damage by Slope Failure

Union	Potential Area (Red+Yellow) [ha]	Ratio (Potential Area / Settlement Area)	Estimated Affected Population
Badarkhali	0.00	0.0%	0
Bamo Bilchari	43.09	14.9%	1,508
Baraitali	46.73	5.5%	2,103
Bheola Manik Char	0.00	0.0%	0
Chakaria Paurashava	0.00	0.0%	0
Chiringa	0.00	0.0%	0
Demusia	0.00	0.0%	0
Dulahazara	0.86	0.1%	43
Fasiakhali	3.44	0.8%	262
Harbang	61.18	4.8%	1,958
Kalarbili	0.24	0.1%	23
Kakhara	32.11	4.6%	1,381
Khuntakhali	11.25	1.0%	405
Konakhali	0.00	0.0%	0
Lakhyarchar	0.00	0.0%	0
Paschim Bara Bheola	0.00	0.0%	0
Purba Barabheola	0.00	0.0%	0
Saharbil	0.00	0.0%	0
Surajpur Manikpur	9.29	4.2%	604
Total	208.2	2.3%	8,287

4.1.4 Earthquake Shaking

The risk of earthquake shaking is high due to inadequate seismic resistant buildings in Chakaria Upazila. Figure 4-16 and Table 4-8 shows that Chakaria Paurashava having the largest population in Chakaria Upazila, is most affected by earthquake shaking, followed by Dulahazara, Badarkhali, and Khuntakhali Unions. The ratio of the affected households is highest in Konakhali Union.

In general, earthquake resistance measure is to strengthen the buildings, which depends on economic conditions of each government and household.

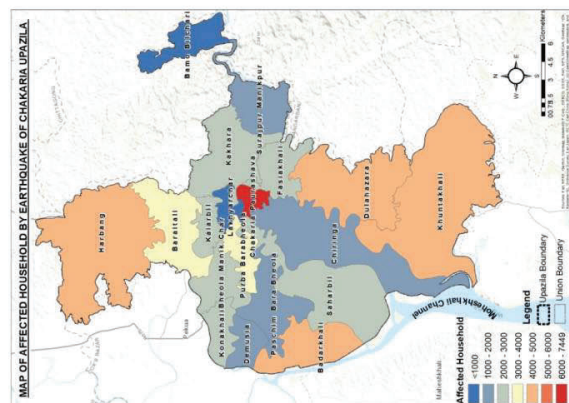


Figure 4-16. Number of Affected Households

Notes: Notes:

1. The concrete values of the average PGA on unions are estimated with variation between 2.43 m/s² and 3.39 m/s².
2. Grade 4 and 5 of the building damage degree in Figure 4-17, was used for estimation of the earthquake risk.
3. The number of affected households was estimated by assuming that one household uses one building based on the number of households and ratio of house types in the Population & Housing Census 2011 below.

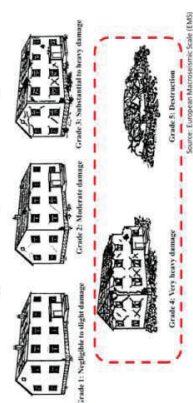


Table 4-8. Percentage of Type of Structure and Number of Households

Administrative Unit Residence Community	Number of Households	Percentage of Type of Structure			
		Pucca	Semi_pucca	Kutcha	Jhupri
Badarkhali	5,920	5.3	10.9	64.9	18.9
Bamo Bilchali	1,623	3.0	4.9	86.3	5.9
Baraitali	6,375	4.9	9.2	73.9	12.0
Bheola Manik Char	3,842	3.9	7.9	79.7	8.6
Chakaria Paurashava	13,065	16.4	21.7	52.7	9.2
Chiringa	2,752	4.6	13.5	72.1	9.8
Demusia	2,405	3.0	4.2	85.9	6.8
Dulahazara	7,773	4.5	10.6	79.6	5.3
Fasiakhali	4,522	2.9	13.4	63.4	20.3
Harbang	8,441	6.3	8.9	81.5	3.3
Kaiarbil	3,362	5.2	8.7	74.6	11.5
Kakhara	4,169	4.1	14.1	76.1	5.7
Khuntakhali	6,385	4.4	10.5	74.2	10.9
Konakhali	3,526	2.8	6.7	47.4	43.2
Lakhyarchar	1,478	12.0	23.5	58.5	6.0
Paschim Bara Bheola	1,653	5.2	6.2	72.1	16.6
Purba Barabheola	5,205	4.6	9.4	72.0	13.9
Saharbil	3,417	6.3	13.6	66.5	13.6
Surajpur Manikpur	2,134	2.9	6.4	82.0	8.8
Total	88,047	5.3	10.9	64.9	18.9

Table 4-9. Affected Household by Earthquake Shaking

Union	Households (Census, 2011)	Affected Households	Percentage
Badarkhali	5,920	4,131	69.8
Bamo Bilchali	1,623	953	58.7
Baraitali	6,375	3,996	62.7
Bheola Manik Char	3,842	2,694	70.1
Chakaria Paurashava	13,065	7,449	57.0
Chiringa	2,752	1,856	67.4
Demusia	2,405	1,745	72.5
Dulahazara	7,773	4,838	62.2
Fasiakhali	4,522	2,962	65.5
Harbang	8,441	4,695	55.6
Kaiarbil	3,362	2,226	66.2
Kakhara	4,169	2,423	58.1
Khuntakhali	6,385	4,076	63.8
Konakhali	3,526	2,721	77.2
Lakhyarchar	1,478	838	56.7
Paschim Bara Bheola	1,653	1,195	72.3
Purba Barabheola	5,205	3,621	69.6
Saharbil	3,417	2,316	67.8
Surajpur Manikpur	2,134	1,149	53.8
Total	88,047	55,882	63.5%

4.2 Priority Unions for Disaster Risk Reduction

Based on Chapter 4.1, this plan identified high disaster risk unions as the priority unions by disaster. According to the relation between the affected area or population and its ratio in Figure 4-18, the identified priority unions by disaster are shown in Table 4-10.

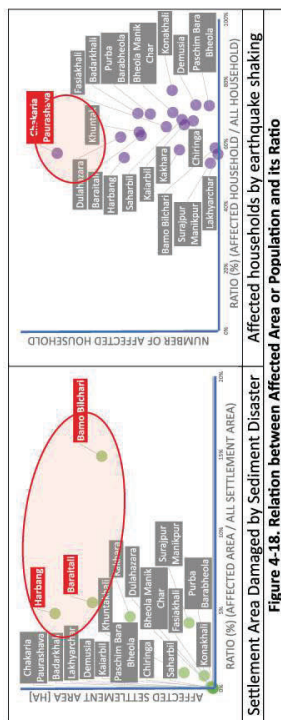
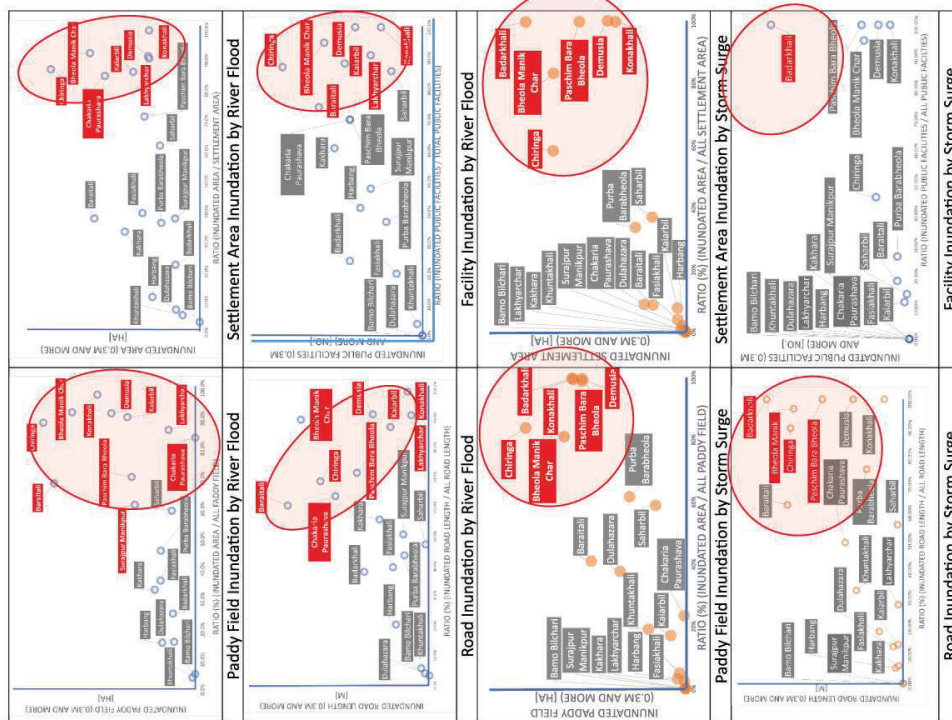


Table 4-10. Priority Unions for Disaster

Disaster	Priority Union
Flood	Chakaria Paurashava, Chiringa, Lakhyarchar, Surajpur Manikpur, Baraitali, Bheola Manik Char, Konakhali, Paschim Bara Bheola, Demusia, Kalarbil
Storm Surge	Badarkhali, Bheola Manik Char, Chiringa, Demusia, Konakhali, Paschim Bara Bheola
Sediment Disaster	Bamo Bichari, Baraitali and Harbang
Earthquake Shaking	Chakaria Paurashava

4.3 Disaster Risk Reduction Target

In the risk analysis in Chapter 4.1, the damages by disaster have been calculated. In consideration of this objective estimated results, the target to reduce damages is set as follows.

[Disaster Risk Reduction Target - Mission]

The estimated human and economic damages by each disaster are reduced by 50% within 10 years (from 2023 to 2033).

In order to accomplish the above mission effectively with the limited budget and human resources, the following concrete countermeasures and areas were identified as prioritized areas, based on the risk assessment result identified in Chapter 4.1 and 4.2, as well as consultation results with the UJSC members.

[Disaster Risk Reduction Target- Concrete measures]

(1) Intensive implementation of countermeasures against disasters in high-risk areas

1) Promotion of countermeasures to **reduce inundated area by floods**

- Chakaria Paurashava
- Chiringa
- Lakhyarchar
- Surajpur Manikpur
- Konakhali

- Kalarbil
- Demusia
- Bheola Manik Char
- Purba Barabheola
- Baraitali

2) Promotion of countermeasures to **reduce inundated area by storm surge**

- Badarkhali
- Bheola Manik Char
- Chiringa
- Demusia
- Konakhali
- Paschim Bara Bheola

3) Promotion of countermeasures to **reduce affected area by slope failure**

- Bamo Bilchhari
- Baraitali
- Harbang

4) Promotion of countermeasures to **prevent building collapse by earthquake shaking**

- Chakaria Paurashava

5) Promotion of improvement of the infrastructure **for emergency operation**

- Badarkhali
- Bamo Bilchhari
- Baraitali
- Bheola Manik Char
- Chakaria Paurashava
- Chiringa
- Demusia
- Harbang
- Konakhali
- Lakhyarchar
- Paschim Bara Bheola
- Surajpur Manikpur
- Kalarbil
- Purba Barabheola

(2) Comprehensive improvement of the capacity for disaster risk reduction to respond to residual risks and large-scale disasters.

1) Review of land use plan and restriction of development activities

- Badarkhali
- Bamo Bilchhari
- Baraitali

- Bheola Manik Char
- Chakaria Paurashava
- Chiringa
- Demusia
- Harbang
- Konakhali
- Lakhyarchar
- Paschim Bara Bheola
- Surajpur Manikpur
- Kalarbil
- Purba Barabheola

2) Improvement of early warning information and communication system

- All unions

3) Implementation of disaster management training and materials

- All unions

4) Implementation of education and awareness raising for DRR

- All unions

Chapter-5. Action Plan of DRR Countermeasures

5.1 Current Status and Issues of the Structural and Non-Structural Countermeasure

The implementation status of each type of the DRR countermeasures in this Upazila was summarized in the table below. As the table shows, most part of the flood prevention has been addressed by BWDB and LGED while some countermeasures for sediment disaster and earthquake shaking have not been covered enough by governmental agencies. These infrastructure projects for protection and control against flood have contributed to reduce inundation in a long term in this Upazila. Meanwhile, infrastructure project such as road construction, water supply and sanitation, and shelter have contributed to reducing the secondary effect of flood disaster, helping to enhance the capacity of disaster response. It is further required to accelerate the structural and non-structural countermeasures that have been currently implemented in the Upazila, as well as to initiate promoting the coordination and discussion among related agencies to introduce countermeasures that have not been undertaken or unknown in the Table below.

Table 5-1 Structural Measures Which are Undertaken / not Undertaken

Category	Current status of the countermeasures by type		
	Type	Undertaken	Agency
Infrastructures for Protection and Control against Flood	As efforts of flood prevention, BWDB is making inspection to identify vulnerable embankments, and has been implemented the embankment development plan (65) in this region. This embankment development process includes sluice gates construction and rehabilitation.		
	Meanwhile, retarding basin and reservoir are not commonly applied, and there is no reservoir in Chakaria Upazila.		
	Pumping stations are not installed in Chakaria Upazila while some are installed along the Reju Khal Canal. It depends on basin wise strategy by BWDB whether those countermeasures are better applied or not.		
	Embankments/Dike	✓	BWDB
	Canal Excavation and other river Improvement (Widening and Deepening)	✓	BWDB
	Sluice gates	✓	BWDB
	Retarding Basin/Reservoir	Not undertaken	BWDB
Infrastructures for Protection & Control against Coastal Disasters	Drainage Facilities (Pumping Station etc)	Not undertaken	BWDB
	Dam	Not undertaken	BWDB/LGED
	BWDB plays a key role to construct and maintain the polders while guide walls have been constructed by the efforts of LGED, DDM, and Chakaria Paurashava.		
	Some of the coastal forest with pine trees have been developed by the BWDB efforts, however due to the lack of awareness and poor coordination, those forest are not properly maintained, and some are deforested.		
	Dike (Polder)/Coastal Revetment	✓	BWDB
	Seawall/Guide walls	✓	BWDB

Category	Current status of the countermeasures by type		
	Type	Undertaken	Agency
Infrastructures for Protection & Control against Sediment Disasters	LGED and Chakaria Paurashava are the responsible agencies to cope with sediment disaster such as rock failure. At this moment, LGED implemented some retaining wall construction along the beach side area to protect road infrastructure from rock falls. However, those infrastructures are left to be undertaken in Chakaria Upazila.		
	Slope stabilization/Retaining walls	Not undertaken	LGED
	Rock-Fall Prevention	Not undertaken	DDM/LGED/Chakaria Paurashava
Structural Measures against Earthquake Shaking	Retrofitting to cope with earthquake shaking is the process of modifying existing structures to make them more resistant to seismic activity, ground motion, or soil failure due to earthquakes. No activity has been done in Chakaria Upazila where no refugee camps.		
	Type	Undertaken	agency
	Compliance with the building code (BNBC-2020)	✓	Cox's Bazar Development Authority/BCC/UzCC/Chakari Paurashava
	Building Assessment (Seismic Diagnosis)	Unknown	PWD
	Retrofitting of important facilities and Infrastructures	Partly by International Donor	LGED/ PWD/ Chakaria Paurashava/DDM
Infrastructure for Emergency Operation	Shelter: 171 shelters are listed for cyclones and flood purpose in Chakaria Upazila by UzDMC. 10 of the total shelter have been constructed by LGED and 108 by DDM, and rest of the facilities were constructed by various organization of domestic and international foundations such as BDRCS, CARITAS, EU, World Vision, and Red Crescent.		
	Transportation: LGED is the main responsible agency to develop and maintain the road and transportation infrastructure.		
	Drainage system: Improvement of drainage system is important to prevent prolonged inland flooding. Chakaria Paurashava copes with the challenges of installing and rehabilitating drainage systems.		
	Water and sanitation: Water and sanitation infrastructures are critical to provide safe water and keep living environment hygiene. DPHE is main agency to cope with water related issues to prevent secondary effect of the disaster.		
	Type	Undertaken	Agency
	Shelters/Mujib Kilah	✓	DDM/LGED/Chakaria Paurashava/NGOs
	Roads	✓	DDM/LGED/Chakaria Paurashava
	Bridges	✓	Chakaria Paurashava
	Culverts	✓	Chakaria Paurashava
	Drains	✓	Chakaria Paurashava

Category	Current status of the countermeasures by type		
Infrastructures for Prevention of Other Disasters (Lightning, etc)	Facilities for Water [Tube well, Pipeline, and sanitation (Latrine)]	✓	DPHE/NGOs
	There have been some cases of lightning disasters. However, no measures are taken in the area.		
	Type	Undertaken	Agency
	Lightning Arrester	Unknown	DDM /Chakaria Paurashava

Figure 5-2 Non-Structural Measures Which are Undertaken / not Undertaken

Category	Current status of countermeasures by type		
Land Use Planning	Promoting land use planning in local administrations in Bangladesh are now under the process by the effort of the central ministry (UDD) and Cox's Bazar Development Authority. However, at this moment, no Upazila Governments in Bangladesh have specific regulation or tools for DRR purpose. Land use strategy such as resettlement of inhabitants and industries around vulnerable area is an important tool to mitigate the socio-economic impact. To apply this, more vertical coordination and connection between governmental policy, District plan and strategy, and stakeholders in Union Parishads and Upazila administration is needed. Therefore, it must be a consideration in a long term though, it is worth to discuss in the UzSC continuously.		
	Type	Undertaken	Agency
	Urbanization Control	Unknown	Cox's Bazar Development Authority/UDD
	Resettlement	Unknown	
	Designating Special Warning Area	Unknown	
Early Warning Information and Communication	Early warning system in coastal area in Bangladesh has been developed with CPP since 1972's.		
	Type	Undertaken	Agency
	Installation of Monitoring System of Rainfall & Water Level	✓	BWDB/BWTA
	Flood Forecasting and Warning System, including community radio	✓	BWDB/FFWC
	Cyclone Warning System	✓	SWC-MDB
Disaster Management Training and Materials	Strategy making and basic study for cropping, harvesting and choice of the variety adopted to global warning		
	Telecommunication system for search and rescue	✓	DAE
	Emergency Operations SOPs are in place for disasters at the District level. Disaster preparedness and response drills are conducted prior to the flood season. Regional evacuation drills are conducted once a year at the Union level. Disaster management training for members of DMC is conducted once at least a year.	✓	BTRC/DDM
	Type	Undertaken	Agency
	Preparation of SOP for emergency operation	✓	DDM
	Simulation and Exercise	✓	DDM/FSCD

Category	Current status of countermeasures by type		
Raising Public Awareness & Disaster Education	Evacuation drill / Shelter and evacuation route	✓	DDM/UzDMC/NGOs
	Training on DRR	✓	DDM Field Level: UDMC/UzDMC/DDMC
	Preparation for emergency operation	✓	DDM/FSCD/ DGHS
	Disaster education is provided irregularly in both primary and secondary school classes. Awareness raising for disaster risk reduction is mainly conducted through TV and RADIO, however, in some areas NGOs conduct the courtyard meeting, simulation, drill etc. when support by donors is available. The first Hazard Map was prepared in 1998 to identify disaster risk at upazila level. Several unions have emergency disaster preparedness equipment and emergency warehouses for stockpiled materials in the event of a disaster, and they are not functioning well due to a lack of coordination. Critical infrastructure facilities in the District are listed. Few classifications of hazards and priorities by disaster type has been made.		
	Type	Undertaken	Agency
	Publication of DRR Maps	Unknown	DDM
	Material and emergency goods in the Warehouse	✓	DDM
	Inventory preparation on vulnerable infrastructure such as hospitals, water wells, and schools based on the risk map in this plan	Unknown	UDD/PWD/FSCD/ DMC
	Disaster preparedness education in school	Unknown	DoPE/DoEE
	DRR Awareness Related Billboard	Unknown	DDM/BDRCs

5.2 Prioritized projects for DRR Target

In consideration of the hazard and risk assessment results in Chapter 3 and 4 as well as the current status and issues of the DRR countermeasures in Chapter 5.1, this Chapter describes the policies of DRR countermeasures by category. Furthermore, along with the strategy, concrete proposals of the DRR countermeasures are collected from the communities and implementing agencies, analyzed and prioritized by category, which are shown in the Attachment 1 including the prioritization (priority unions) with red highlights. The processes to propose these projects were as follows.

- The needs of Union Parishad were organized at the LDRRP development workshop held from June to October 2022.
- Existing projects, pipeline projects, and new projects of the implementing agencies were identified at the workshop and by collecting information from the implementing agencies.
- Information on Union Parishad's needs from the line ministries was reviewed and the correspondence between their projects and Union Parishad's needs was validated.

With the aim to achieve the DRR target (Mission), the UzSC will encourage the project implementing agencies to include the proposed projects in their own plans and to implement them.

The legend of the proposed project list (See Attachment 1) is shown below.

Table 5-3. Legend of the prioritized project list

Plan Status	Description			
	Status of the Project	F/S	DPP approved	ADP
	Continuing Project	+	+	+
	Pipeline Project	+/-	-	-
	New Project	-	-	-
	Unknown	-	-	-
	"Unknown" indicates "Union's needs" which has not yet been identified by line ministries			
ID	Identification number in this Plan			
Type of Need	Required work such as repair, rehabilitation or new construction proposed			
Length	The length of the individual infrastructures such as embankment and road in case that the scale of the infrastructure is important information.			
Official ID Number	ID by line agency in case of projects that are already identified by line agency			
Official Name of Countermeasures	Official project name used by the implementing agency, such as DDM, BWDB, or LGED			
Proponents	The length of the countermeasure that was proposed by local people, line ministries or other stakeholders etc.,			
Direct Beneficiaries/Interests to be protected	The beneficiary Union Parishads and wards along the installed countermeasures			
Estimated cost for Countermeasures	The rate and unit price provided by every line department such as LGD, DDM, BWDB. It is shown in Lakh Tk.			
Implementation Time Frame	Short-Term Project: Mid-Term Project; or Long-Term Project Those categories are based on the information by line agencies			
Priority in Terms of Hazard Analysis	High Priority: Project in highly vulnerable Union Parishads. Medium Priority: Project in vulnerable Union Parishads. Low Priority: Project in less vulnerable Union Parishads.			
Remarks	"What to do or what has been done" such as DPP approval or next step of this proposal such as feasibility study			

5.2.1 Prioritized Structural Countermeasures

(1) Infrastructures for Protection and Control against flood

As shown in the flood hazard map in Chapter 3.1.1, and the flood risk assessment results in Chapter 4.1.1, the areas along the Matamuhuri River are most flood prone, especially Chiringa Union due to its location and low-lying condition. In order to reduce flood disaster risk in this Upazila, strengthening the flow carrying capacity of Matamuhuri River with embankment and other improvement works should be prioritized. Apart from them, drainage management works including sluice gate and canal excavation in flood prone areas such as Bheola Manik Char, Lakhvachar and Paschim Baro Bheola are also highly required. The category of the project for flood prevention and mitigation are shown below. Although there are some types of countermeasures that have not been proposed by communities and line agencies currently, it is necessary to clarify the responsible agencies and implementing policies and to subsequently take actions to implement them.

- Embankment/dyke
- Other river improvement (e.g., Widening and Deepening)
- Sluice gates
- Retarding basin/reservoir
- Drainage Facilities (e.g., Pumping Station)

The map below shows infrastructures for flood prevention and mitigation. The areas where the higher priority are put as DRR targets are the high-risk area highlighted in red (shown in Chapter 4). The proposed project list of each countermeasure by category are shown in Attachment 1.

In addition, as shown in the hazard maps for the 50-year and 100-year probability floods in 3.1.1, there is a possibility that there will be a flood of a magnitude greater than the target level in the Plan. In such an event, it will be important to protect human life by expanding non-structural measures (see Chapter 5.2.2 for more detail).

Also, in the future, flood management infrastructure projects should be developed at a higher safety level than that is adopted in the Plan from a long-term perspective. It might be necessary to establish a safety level such as a 50-year or 100-year probability flood scale, which should be determined according to the development status of the region. Possible measures to achieve such a higher safety level include further widening of main channels, diversion of flood waters through construction of diversion channel and reduction of flood flows through construction of retarding basin in the upper reaches of the river, in addition to the development of said non-structural measures. The possibility of these measures should be examined taking into account the hydrological, topographic and geological characteristics of target areas as well as social and environmental conditions.

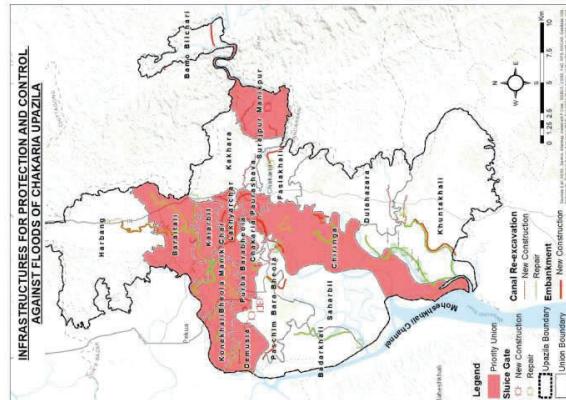


Figure 5-1. Priority Union for Countermeasure to Reduce Risk by Flood

(2) Infrastructures for Protection and Control against Coastal Disaster

The vulnerable areas to inundation by the storm surge are the areas in low-lying land along the polders, Chiringa, Badarkhali, Paschim bara Bheola, Demusia, Paurashava, Konakhali Bheola, and Manik Char. These areas are protected by the polders which may include several weak points to be maintained. To reduce the disaster risks in this Upazila, the mitigation of inundation in these areas should be prioritized, through the construction of seawalls/guide walls in low-lying lands such as Badarkhali, Bheola Manik Char, Chiringa, Konakhali, Paschim Baro Bheola, Paurashava.

Storm surge countermeasure in low-lying area needs to ensure enough elevation of coastal structure such as dyke, revetment, and seawall. At the moment, 20-year probability storm surge level should be applied for development of coastal structure in Bangladesh. The category of the project for protection and control against coastal disasters are shown below;

- Dyke(polder)/coastal revetment
- Seawall/guide wall

The map below shows Infrastructures for protection and control against coastal disaster. Highlighted in red are the high-risk areas where this plan puts priority as DRR targets (shown in Chapter 4). The proposed project list of each countermeasure by category are shown in Attachment 1.

In addition to this, as shown in the hazard maps for the 50-year and 100-year probability storm surge (see Chapter 3.3.2.), a storm surge greater than the target level in the plan can be considered for the future. In such an event, both structural and non-structural measures should be examined. If structural measures are considered, the elevation of coastal revetments should be heightened and their lengths should be extended, compared with that of the 20-year probability level. It is also important to protect human life by expanding non-structural measures introduced in Chapter 5.2.2.

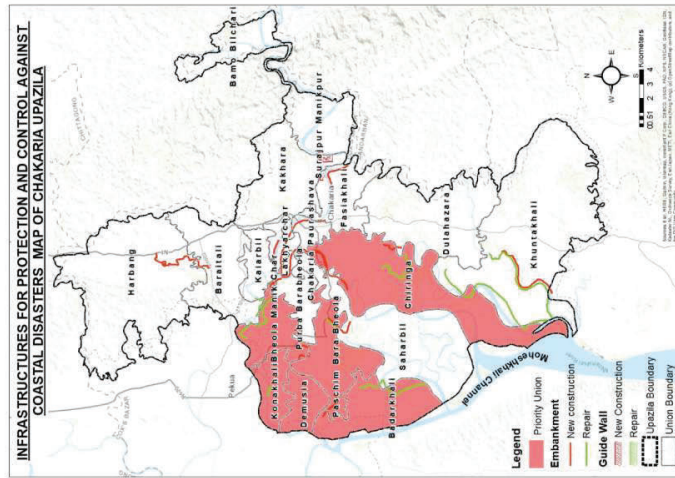


Figure 5-2 Priority Union for Countermeasure to Reduce Risk by Storm Surge

(3) Infrastructures for Protection and Control against Sediment Disasters

The result of risk assessment shows that sediment disaster risk (slope failure) is mainly concentrated around Harbang, Baraitali and Bamo Bilchari Unions. The main reason causing the risk are the steep slopes left unprotected due to construction of roads and buildings. The category of the infrastructure for protection and control against sediment disasters are as follows.

- Slope stabilization/Retaining walls
- Rock-fall prevention

Currently, there is no proposed project by line ministries and communities to protect these areas against sediment disasters. However, the new construction of retaining walls along vital roads in the area should be promoted to ensure the safety of Union people passing through these roads. A retaining wall is a relatively rigid wall that retains (holds back) any material (usually earth) and prevents it from sliding or eroding away. It is designed so that to resist the lateral pressure of the material that is holding back.

(4) Structural Measures against Earthquake Shaking

- a) Compliance with the building code (BNBC-2020)
- b) Building Assessment (Seismic Diagnosis)
- c) Retrofitting of important facilities and infrastructure

There is no proposed project for structural measures against earthquake shaking by line ministries and communities so far. However, seismic diagnosis as well as retrofitting of existing important facilities (e.g., schools, hospitals, shelters) and infrastructure (e.g., bridges, roads, embankments/dykes) are required in advance, for saving lives and evacuation during and after the earthquakes. At the same time, it is significant to promote complying with BNBC2020 with official instructions and monitoring when constructing new buildings.

(5) Infrastructures for Emergency Operations

According to the risk assessment results, Badarkhali, Bamo Bilchari, Baraitali, Bheola Manik Char, Chakaria Paurashava, Chiringa, Demusia, Harbang, Konakhali, Lakhyarchar, Paschim Bara Bheola, and Surajpur Manikpur Unions are relatively high-disaster-prone areas in this Upazila. Although emergency operations are significant in all Upazilas and should be functional in the whole of the administrative area, this plan prioritizes to propose the improvement of the infrastructures for emergency operations in such highly disaster-prone areas first. Specifically, shelters need to be sited in safer sites and have the capacities of all expected evacuees in each above union. It is also significant to consider introducing multi-purpose shelters that can be utilized as schools and community centers in normal times, when newly constructing or maintaining shelters. Regarding public infrastructures, while main roads and bridges connecting important facilities between unions, such as Bamobil Chari UP -Fadukhola -Nandirbil Road (LGED ID-422163017) and the road of Darbesh Khata Timmatha Godarpara Sluice Gate Drist Nanda (LGED ID-422164078), and the bridge at Purbo Bara Bheola UP - Shamsunia Bazar Road to Toroshghata Matamuhuri Canal (LGED ID-422163020), should be constructed or appropriately maintained with the sufficient widths for emergency operation during the disasters. Specifically, the road of Darbesh Khata Timmatha GodarparaSluice Gate Drist Nanda is significant since it works as an embankment in the area as per technical study. The improvement of culverts, drains, and other facilities for water is also necessary in inundation-prone-areas to drain the water to mitigate the stagnant water, which lead to smooth recovery and consequently mitigate infectious diseases. The category of the project for infrastructures for emergency operations are shown below;

- a) Shelters
- b) Roads
- c) Bridges
- d) Culverts
- e) Drains
- f) Facilities for water (e.g., Tube well, Pipeline and sanitation (Latrine))

The map below shows infrastructures for emergency operation, highlighted in red are the high-risk areas where this plan puts priority as DRR targets (shown in Chapter 4). The proposed project list of each countermeasure by category are shown in Attachment.

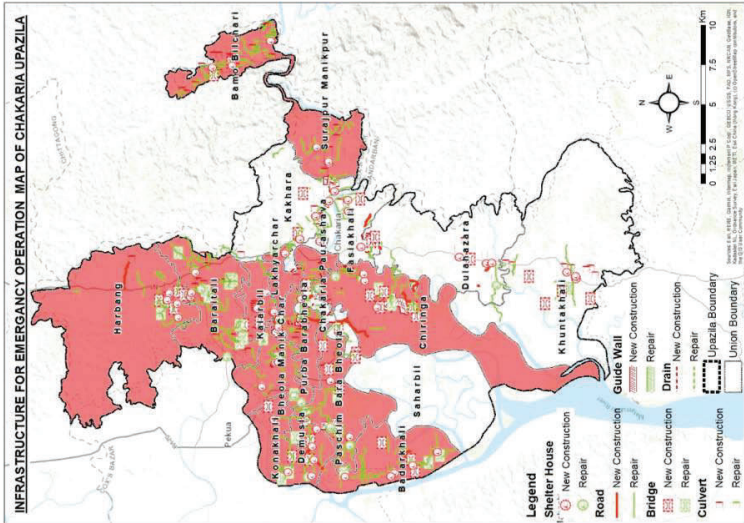


Figure 5-3 Location of Infrastructures for emergency operation

(6) Infrastructures for Prevention of Other disasters

- a) Lightning Arrester

Currently, there are no projects for installing lightning conductors that have been planned or were proposed by line ministries and communities. However, it will be considered to introduce these countermeasures.

5.2.2 Needed Non-Structural Countermeasures

Non-structural countermeasures have been relatively promoted in the Upazila, specifically early warning information and communication, disaster management training and materials, and raising public awareness and disaster education as shown in the Chapter 5.1. However, in consideration of the possibility of large-scale disasters such as 50-year or 100-year return period floods and storm surge (see Chapter 3.1) as well as the residual (remaining) risks of proposed structural countermeasures, it is required to promote improving non-structural countermeasures, specifically evacuation plans (e.g., consideration of the location of the shelter and its capacity, evacuation roads) and early warning systems, at the same time with structural countermeasures. In addition, although land use regulations and controls have not been often seen in this Upazila, such drastic approach should be considered especially in severe high-disaster risk areas. The category of needed non-structural countermeasures is shown below. The proposed project list of each countermeasure by category is shown in Attachment.

- (1) Land use planning (Cox's Bazar Development Authority/UDD)
 - a) Urbanization Control
 - b) Resettlement
 - c) Designating Special Warning Area
- (2) Early Warning Information and Communication
 - a) Installation of Monitoring System of Rainfall and Water level (BWDB/BMD/BWTA)
 - b) Flood Forecasting and Warning System, including community radio (FFWC/BWDB)
 - c) Cyclone Warning System (SWC-BMD)
 - d) Strategy making and basic study for cropping, harvesting and choice of the variety adopted to global warning (DAE)
 - e) Telecommunication system for search and rescue (BTRC/DDM)
- (3) Disaster Management Training and materials
 - a) Preparation of SOP for emergency operation (DDM)
 - b) Simulation and exercise (DDM)
 - c) Evacuation drill/shelter and evacuation route (DDM)
 - d) Training on DRR (DDM/BDRC)
 - e) Preparation for the emergency operation (DDM/FSCD/DGHS/MOHFW/Donors)
- (4) Raising Public Awareness and Disaster Education
 - a) Publication of DRR Maps (DDM)
 - b) Materials and emergency goods in the warehouse (DDM/DPHE)
 - c) Inventory preparation on vulnerable infrastructure (DMC)
 - d) Disaster preparedness education in schools
 - e) DRR awareness related billboard (DDM)

Although currently there has been no such projects proposed by line ministries and communities so far, in order to promote disaster risk reduction, it is necessary to clarify the responsible agencies and implementing policies of the above countermeasures, and subsequently to take actions to execute them.

5.3 Monitoring and Updating of the Plan

For the appropriate implementation of the projects by project implementing agencies, this plan is to be monitored and updated by UzSC supported by TSC in the following steps.

Step 1: The UzSC in coordination with TSC will check the status (rate of progress) of the prioritized project annually, one year and two or three years after their development.

Table 5-3. Legend of the prioritized project list

Status	F/S	DPP approved	ADP	Annual Budget
Continuing Project	+	+	+/-	+/-
Pipeline Project	+/-	-	-	-
New Project	-	-	-	-
Unknown	-	-	-	-

Step 2: The TSC will confirm the effectiveness of existing projects and the need for new proposed projects including the proposal mentioned in 5.2.

Step 3: For those areas where the need for feasibility studies has been identified, the implementing agencies will hold preparatory discussions for the preparation of a DPP, including obtaining the budget for feasibility studies, and report back to the TSC.

Step 4: Based on the findings after the TSC meeting, the UzSC will re-examine the need for new proposals once a year.

Step 5: If any changes are identified, the UzSC will update the plan.

The conceptual model of the monitoring and updating the plan is proposed as shown below.

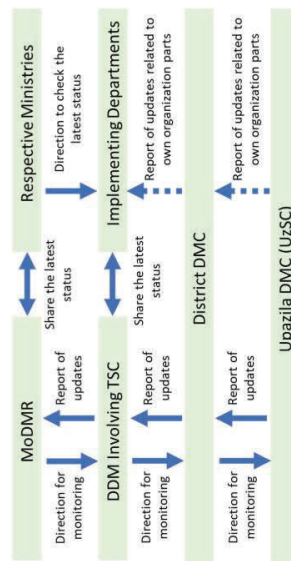


Figure 5-4. Conceptual diagram for monitoring and updating the plan

Attachment 1: Proposed countermeasure list

Attachment 2: Member lists of UzDMC and UzSC

Attachment 3: Activity photos